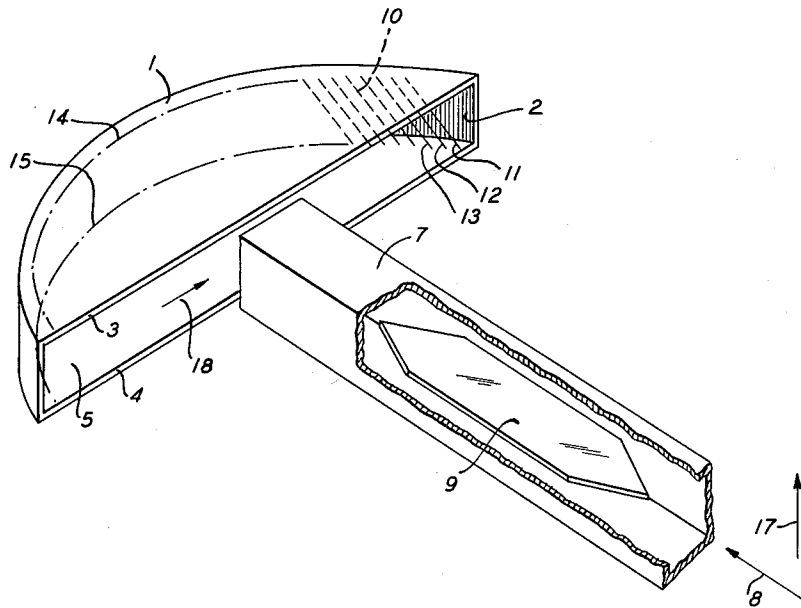


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RE-RADIATION INTO FEED GUIDE  
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ANTENNA WITH MEANS FOR PREVENTING  
RE-RADIATION INTO FEED GUIDE

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This invention relates to directive antenna systems and more particularly to one in which a primary source of electromagnetic radiation illuminates a mirror which serves as a reflector and focusing element.

An object of the invention is to widen the band over which the input impedance is matched in an antenna of this type. Further objects are to minimize feed scattering and improve the radiation pattern.

In a directive antenna system in which a wave guide or other source of radiation illuminates a focusing mirror, reflections from the mirror back to the source reduce the band over which a good impedance match may be obtained. Furthermore, rereflection of these reflected waves by the source causes feed scattering which produces undesired side lobes in the radiation pattern of the antenna.

In accordance with the present invention, these difficulties are greatly reduced by inserting a 90 degree polarization rotator between the mirror and the source and by associating a polarization-selective energy absorber with the source. The source, which may include a wave-guide feed, is adapted to support electromagnetic waves of two orthogonal polarizations but is supplied with waves of only one of these polarizations. The waves reflected from the mirror back to the source are rotated by 90 degrees. An energy absorber in the wave guide absorbs only these rotated, reflected waves. Rereflection and feed scattering are thus largely avoided.

In the embodiment disclosed herein, the wave-guide feed has a square cross section, but it may be round or of other suitable shape. The energy absorber is shown as a longitudinal vane positioned parallel to the polarization of the waves to be absorbed. The mirror is the cylindrical portion of a single-layer pillbox antenna. The shape of the mirror is preferably either elliptical or hyperbolic, depending upon the original polarization of the waves. The polarization rotator comprises a grating of wires which make an angle of approximately 45 degrees with the polarization of the incident waves and are spaced apart not more than a half wavelength at a frequency within the transmission band. The grating is placed approximately an odd integral number of quarter wavelengths in front of the mirror.

The nature of the invention and its various objects, features, and advantages will appear more fully in the following detailed description of a typical embodiment illustrated in the accompanying drawing, the single figure of which is a perspective view, partly broken away, of a microwave antenna system comprising a single-layer pillbox fed by a wave guide.

The pillbox 1 comprises a short, conductive, cylindrical reflector or mirror 2 which is concave in contour. The mirror 2 extends perpendicularly between the conductive, parallel end plates 3 and 4 which close the ends of the cylinder and form a rectangular aperture 5 containing the focal line at its center.

The pillbox 1 is fed by a wave guide 7, the open end

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of which is positioned at the focal line of the mirror 2. The guide 7 has a cross section which will support electromagnetic waves of two orthogonal polarizations. As shown, the guide 7 is square and will support either vertically or horizontally polarized waves. It is supplied with energy from a suitable source, not shown, as indicated by the arrow 8. The energy absorber within the guide 7 is a longitudinally positioned, dissipative vane 9.

The 90 degree polarization rotator, located between the guide 7 and the mirror 2, is constituted by a grating 10 of wires such as 11, 12, and 13, only a few of which are shown. The position of the remainder of the grating 10 is indicated by the dot-and-dash lines 14 and 15. The wires make an angle of approximately 45 degrees with the plates 3 and 4 and are spaced from each other a distance not greater than half of a freespace wavelength at the midband frequency. The grating 10 is spaced from the mirror 2 a distance chosen to provide the widest possible transmission band. This distance is equal approximately to an odd integral number of quarter wavelengths, and is usually somewhat greater than one-quarter wavelength.

The operation of the antenna system will now be described. It will first be assumed that the wave guide 7 is emitting plane electromagnetic waves with a vertically polarized electric field, as indicated by the arrow 17. These waves radiate from the open end of the guide 7 and illuminate the mirror 2, from which they are reflected toward the aperture 5. The reflected waves are rotated 90 degrees in polarization by passing twice through the 45 degree grating 10, and are now horizontally polarized as indicated by the arrow 18. Since the electric field of these waves is now parallel to the plates 3 and 4 of the pillbox 1, their phase velocity is greater than that of the vertically polarized waves originally radiated from the guide 7. In the absence of the grating 10, the mirror 2 must be parabolic in contour in order to provide a plane wave front at the aperture 5 and thus provide a collimated beam. With the grating, an elliptical mirror 2 is required in order to compensate properly for the change in phase velocity after reflection.

Some of the waves reflected from the mirror 2 reenter the open end of the guide 7. The vane 9 is positioned parallel to the horizontal polarization of these waves. The vane 9 thus absorbs these waves and prevents their reradiation at the end of the guide. The band over which the guide 7 can be made to match the input impedance of the pillbox 1 is thus widened and feed scattering is minimized.

On the other hand, if the waves radiated by the guide 7 are horizontally polarized, they will be vertically polarized after reflection from the mirror 2 and a double passage through the grating 10. In this case, to compensate for the change in phase velocity, the mirror 2 is made hyperbolic in shape to get a collimated beam. Also, the vane 9 is rotated 90 degrees so that it will be parallel to and absorb the perpendicularly polarized reflected waves re-entering the open end.

For either the elliptical or the hyperbolic mirror 2, the eccentricity of the curve used is made equal to the ratio of the phase velocities of the waves before and after reflection to obtain a plane wave at the aperture 5.

It is to be understood that the above-described arrangement is only illustrative of the application of the principles of the invention. Numerous other arrangements may be devised by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. An antenna comprising a primary source radiating electromagnetic waves polarized in a selected plane, a reflector arranged to be illuminated by the waves,

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means associated with the reflector to make the direction of polarization of the reflected waves substantially perpendicular to the selected plane, and polarization-selective means associated with the source for absorbing only the waves returned thereto from the reflector.

2. An antenna comprising a radiator of the pillbox type, means including a wave guide for feeding electromagnetic energy to the radiator, a 90 degree polarization rotator within the radiator, and a polarization-selective energy absorber within the guide for absorbing only the energy returned to the guide from the radiator.

3. A directive microwave antenna comprising a cylindrical reflector, a pair of conductive, parallel end plates coupled to the reflector and forming therewith a radiating aperture, a primary radiator positioned to illuminate the reflector, a grating of wires positioned in front of the reflector, the wires making an angle of 45 degrees with the end plates, and polarization-selective absorbing means associated with the radiator to absorb only the energy returned to the radiator from the reflector.

4. A directional microwave antenna comprising a concave reflector formed with an aperture, means including a wave guide for illuminating the reflector, means between the guide and the reflector for rotating by 90 degrees the polarization of the waves returned by the reflector to the guide, and polarization-selective means within the guide for absorbing only the returned waves.

5. An antenna system comprising a wave-guide feed adapted to support electromagnetic waves of two orthogonally related polarizations, means for supplying waves of only one of the polarizations to the feed, a mirror illuminated by the feed, means between the feed and the mirror for rotating by 90 degrees the polarization of the waves reflected from the mirror back to the feed, and polarization-selective means associated with the feed for absorbing only the reflected waves which return to the feed.

6. A directional antenna system comprising a cylindrical mirror, an open-ended wave guide of rectangular cross section positioned with its open end at the focus of the mirror, a grating of wires located between the guide and the mirror, the wires making an angle of 45 degrees with the plane of a wall of the guide, and a dissipative vane positioned longitudinally within the guide parallel to one of the walls thereof.

7. An antenna comprising a mirror, a feed for il-

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luminating the mirror with linearly polarized electromagnetic waves, a grating of wires positioned between the feed and the mirror, the wires making an angle of 45 degrees with the direction of polarization of the waves, and means associated with the feed for absorbing only the waves reflected back to the feed by the mirror.

8. An antenna in accordance with claim 7 in which the grating is spaced  $\lambda/4$  from the mirror and the wires are spaced apart not more than  $\lambda/2$ , where  $\lambda$  is a free-space wavelength at a frequency within the transmission band.

9. A directional antenna system comprising a single-layer pillbox including a curved, cylindrical, focusing mirror and two parallel end plates connected thereto, an open-ended wave guide of square cross section adapted to feed electromagnetic waves to the pillbox, the guide having a wall parallel to the plates and the waves having an electric field parallel to a wall of the guide, means positioned adjacent to the front of the mirror for rotating by 90 degrees the polarization of the waves reflected from the mirror back to the guide, and means within the guide for absorbing electromagnetic waves having an electric field perpendicular to the first-mentioned field.

10. A system in accordance with claim 9 in which the first-mentioned field is perpendicular to the plates and the mirror is elliptical in shape.

11. A system in accordance with claim 9 in which the first-mentioned field is parallel to the plates and the mirror is hyperbolic in shape.

12. A system in accordance with claim 9 in which the eccentricity of the contour of the mirror in a plane parallel to the plates is equal to the ratio of the phase velocities of the waves before and after reflection from the mirror.

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