

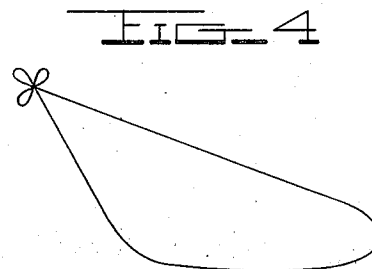
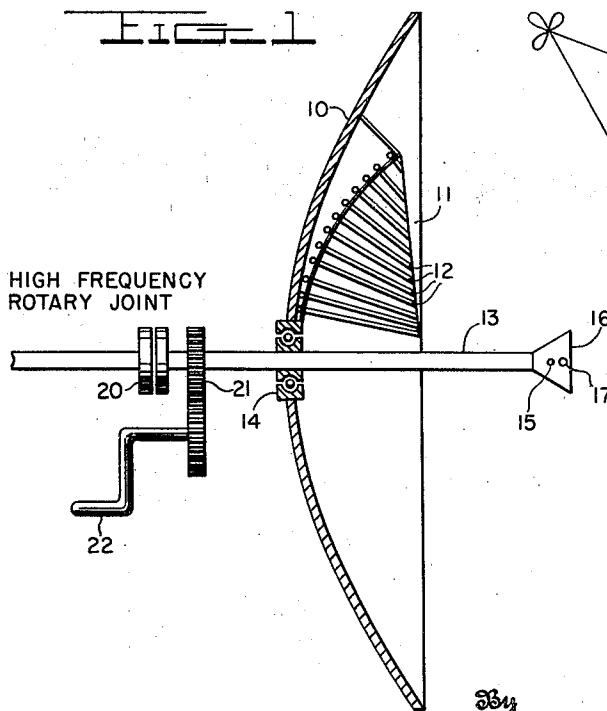
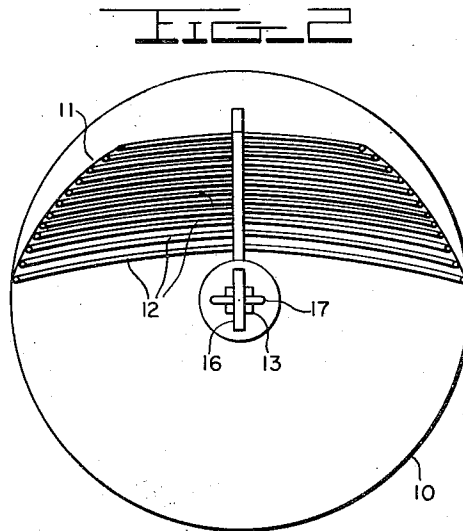
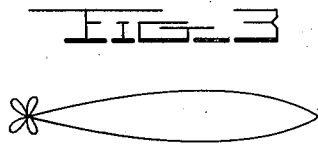
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DUAL PURPOSE ANTENNA

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## DUAL PURPOSE ANTENNA

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This invention relates in general to improvements in directive antennas and in particular to the problem of selectively providing two or more diversely shaped antenna patterns from a single antenna structure.

In many applications of high frequency radio equipment and particularly in the field of airborne radar it is frequently desirable to have available more than one type of antenna radiation and/or reception pattern for use in the operation of the system. In certain radar installations, for instance, it is desired to first use a wide angle specially shaped beam pattern to initially locate an object and thereafter use a narrow sharply defined beam for accurate angle or bearing determination of the object.

In the past separate antennae have normally been required to obtain the different beam patterns. Accordingly, it is an object of the present invention to provide a single antenna structure operative to selectively provide either of two or more diverse antenna patterns for electromagnetic wave transmission or reception.

It is another object of the present invention to provide a new and improved antenna structure for producing a specially shaped antenna pattern.

It is another object of this invention to provide a single antenna structure suitable for the selective production of either a sharply defined or a wide angle antenna pattern.

Other objects and features of the present invention will become apparent upon a careful consideration of the following detailed description when taken together with the accompanying drawings, in which:

Fig. 1 is a cross sectional view of an exemplary embodiment of the present invention;

Fig. 2 is a front elevational view of the embodiment shown in Fig. 1, and

Figs. 3 and 4 show in section the diverse types of antenna patterns obtainable from the embodiment illustrated in Figs. 1 and 2.

For the sake of illustration the present invention will be described as specifically applied to a radar system wherein it is desired to provide, for example, a cosecant squared pattern for first locating an object and then a pencil beam for subsequently determining the bearing of the object.

Briefly the present invention comprises a plane polarized feed and a reflector therefor made up as two reflecting elements. In the present specific embodiment the first reflecting element is preferably in the form of a paraboloid arranged

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to provide a sharply defined pencil beam. The second reflecting element is in the form of a segmentary reflector grating nested in the first reflecting element and operative in conjunction with the paraboloid to produce a cosecant squared pattern. The reflector grating is preferably made from a plurality of substantially parallel conductors, each conductor shaped in a parabolic form and spaced less than a half wavelength apart, and circularly positioned about the focal point of the first reflector to form a barrel like reflector surface nested in one half of the first (paraboloidal) reflector. Also provided is a means for changing the plane of polarization of the antenna feed relative to the direction of the conductors comprising the reflector grating whereby with one plane of polarization the barrel reflector grating is effective to act as a reflecting surface, but when the plane of polarization is rotated 90° in space the reflector grating is ineffective as a reflector. With this arrangement and when the reflector grating is effective the reflector grating cooperates with the uncovered half of the paraboloidal reflector to produce a so-called cosecant squared pattern. When the plane of polarization is rotated 90°, however, the reflector grating is no longer effective and the paraboloidal reflector alone is used to focus the antenna pattern producing a pencil beam.

Referring now in particular to Figs. 1 and 2 the exemplary embodiment of the invention will now be described in detail. As above briefly indicated and as shown in detail in the figures, the specialized embodiment herein exemplified comprises a paraboloidal reflector 10 operative to produce a pencil beam and a barrel like reflector grating indicated in general at 11 nested in the paraboloid. The reflector grating preferably has for its axis of rotation the line normal to the axis of the first reflector at its focal point and is made up of a plurality of near parallel conductors 12 spaced less than one half wavelength apart at the highest frequency of operation and shaped in parabolic form with the same focal length as that of the paraboloid.

The antenna feed comprises as here shown a hollow wave guide 13 extending axially through the paraboloid 10 and rotatably journaled thereto by bearing 14. The feed or active element of the feed comprises a small half wave dipole 15 mounted on a rectangular plate 16 inserted across the open end of the guide 13 transverse to the plane of the E vector. Also mounted on the plate 16 and directly behind the dipole 15

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is a small parasitic reflector dipole element 17 operative to cause substantially all the energy being radiated by dipole 15 to be focused on the paraboloid 10.

It is to be understood, of course, that any suitable conventional feed may be used instead of the dipole type here illustrated.

In operation the reflector grating being comprised of a plurality of near parallel conductors spaced less than one half wavelength apart act like a plurality of wave guides operating below cutoff frequency when the plane of polarization parallels the lengths of the conductors. In this condition no appreciable energy can penetrate the reflector grating and the reflector grating is thus effective in the operation of the system. When the polarization plane is transverse to the conductors however, the length of the conductors being longer than the spacing between them, the conductors act like wave guides operating within their frequency propagation limits. In this condition the energy is free to pass through the grating and be reflected by the paraboloid.

The dipole 15 operates to produce plane polarized waves the polarity of which corresponds to the axial orientation of the dipole. For example, as shown in Figs. 1 and 2, the E vector is parallel to the conductors of the grating and the reflector grating is hence operative to reflect the energy. Rotation of the dipole, or alternatively the reflector grating 90° causes the E vector to lie at right angles to the reflector conductors. The reflector grating is in this case no longer operative to reflect the energy.

As noted above either the reflector grating or the feed may be rotated. For purposes of illustration, however, the feed is here shown as being the rotatable element. To this end, a high frequency rotary joint 20 of conventional design is inserted at a suitable point in the guide and any suitable device such as a pair of gears 21 and hand crank 22 are added to effect manual rotation.

Fig. 3 shows in polar form a pencil beam as produced by the paraboloid alone. This pattern is symmetrical about its axis, being sharply focused in both the vertical and horizontal planes.

Fig. 4 shows a cosecant squared pattern as produced by the antenna when the reflector grating is operative. In this type of operation and when the reflector grating is disposed in the upper half of the paraboloid, for instance, the pattern has a cosecant squared shape in the vertical plane. In the horizontal plane the beam is symmetrical as shown in Fig. 3.

As will be apparent from Fig. 4 this type of wide angle pattern is very useful in airborne installations where wide angle illumination in any given direction of the aircraft is desired. With this type of pattern those objects most distantly removed from the system receive the most energy with the power being distributed inversely with the square of the distance from the transmitter.

The angle through which the cosecant squared beam extends can be varied by varying the angle subtended by the reflector grating. As the angle subtended by the section of the grating is increased, the angle covered by the beam is increased, and vice versa.

Moving the feed off the focal point of the paraboloid will cause the usual deteriorations in the diffraction pattern.

The mathematical calculation of doubly curved reflectors suitable for the production of cosecant squared patterns may be found in the "Proceed-

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ings of the Institute of Radio Engineers," volume 36, No. 10, October 1948, by A. S. Dunbar.

From the foregoing it will be readily apparent there are many modifications possible of the present invention to obtain dual antenna patterns from a single antenna structure. Numerous other combinations of solid and grating reflecting surfaces can be employed to obtain various antenna patterns as desired other than cosecant squared. Therefore this invention is not to be limited except insofar as is necessitated by the scope of the present disclosure.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

What is claimed is:

1. An antenna comprising, a plane polarized feed, a reflector therefor disposed in reflecting relation to said feed including at least two dissimilar reflecting surfaces one of which is effective to reflect energy emitted by said feed irrespective of the plane of polarization thereof and the other of which is effective to reflect energy emitted by the feed having only one plane of polarization, said other reflecting surface comprising a plurality of near parallel conductors spaced less than one half wavelength apart at the highest frequency of operation, and means for rotating the plane of polarization of said feed relative to the orientation of said conductors.

2. An antenna comprising, a plane polarized feed, a reflector therefor including first and second reflecting elements located in reflecting relation to the feed, the first of said reflecting elements being effective to reflect energy emitted by said feed irrespective of the plane of polarization thereof, the second of said reflecting elements being interposed between said feed and said first reflecting element and being effective to reflect energy emitted from said feed having only one plane of polarization, said second reflecting element comprising, a plurality of near parallel conductors spaced less than one half wavelength apart at the highest frequency of operation, and means for rotating the plane of polarization of said feed relative to the orientation of said conductors.

3. An antenna comprising, a plane polarized feed, a reflector therefor including a first reflector element disposed in reflecting relation to the feed and a second dissimilar reflecting element interposed between the first element and said feed, said first reflector element being effective to reflect energy emitted by said feed having only one plane of polarization, said second reflector element, comprising a plurality of near parallel conductors spaced less than one half wavelength apart at the highest frequency of operation, and means for rotating the polarization plane of said feed relative to the orientation of said conductors.

4. An antenna comprising, a plane polarized feed, a paraboloidal reflector therefor disposed in reflecting relation to the feed, a reflector grating circular in one plane and parabolic in others interposed between the paraboloidal reflector and the feed, said reflector grating comprising a plurality of near parallel conductors spaced less than one half wavelength apart at the highest frequency of operation, and means for rotating the plane of polarization of said feeder relative to the orientation of said conductors.

5. An antenna comprising, a plane polarized feed, a paraboloidal reflector therefor disposed in

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reflecting relation to said feed, a reflector grating circular in one plane and parabolic in others nested in said paraboloidal reflector comprising a plurality of near parallel conductors spaced less than one half wavelength apart at the highest frequency of operation and arranged to form a barrel shaped reflecting surface having in one central plane a center of curvature substantially coincident with the focal point of the paraboloidal reflector and having in other planes normal to the central plane and through the focal point of the paraboloidal reflector, parabolic sections whose focal points are substantially coincident with the focal point of the paraboloidal reflector, and means for rotating the plane of polarization of said feed relative to the direction of said conductors.

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