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CONICAL REFLECTOR

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FIG. 1

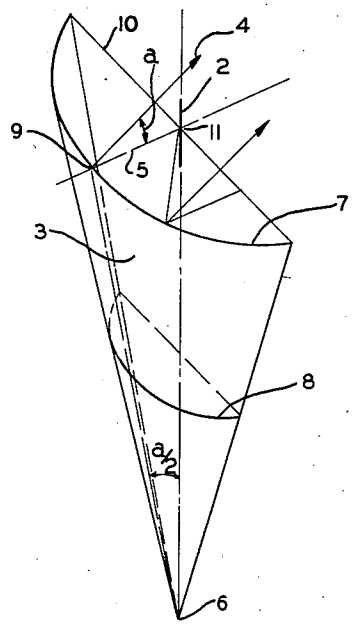
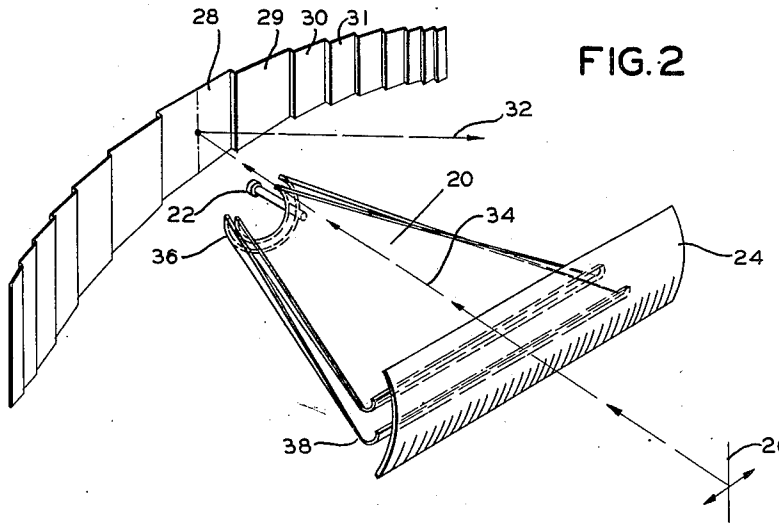


FIG. 2



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CONICAL REFLECTOR

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11 Claims. (Cl. 250—33.65)

This invention relates to directional microwave reflector type antennas and more particularly to reflectors which, when illuminated by a line source of radiation, reflect a beam having a plane wave front. By moving the line source normally to itself across the aperture, a scanning beam can be produced.

Two special cases of reflectors having this property are well known, namely, a parabolic cylinder and a 45° right circular cone. It is the object of this invention to provide a reflector of such shape that when illuminated by a line source it will reflect a plane wave front radiation in a direction at any desired predetermined angle with a reference line from the line source to the reflector. It is another object to provide a reflector adaptable for producing a scanning radiation beam when it is illuminated by a line source which is caused in effect to reciprocate back and forth normal to itself across the aperture. Other objects and features will be found in the following description and figures.

Fig. 1 shows one such reflector surface, being a cone whose sections by one set of parallel planes are ellipses; and

Fig. 2 shows another type of reflector composed of small plates or zones from a family of elliptical cones each similar respectively to Fig. 1.

Referring to Fig. 1, let a line source **2** radiate radially to itself a cylindrical wave front to feed a reflector **3** assumed to be of such shape that a plane wave comes off from it, with the beam direction line **4** making an angle a with the incident reference line **5**. In order for this to occur the reflector **3** must be a cone with apex **6** and having sections normal to the line **2—6** which are ellipses such as **7** and **8**. These ellipses must have an eccentricity equel to cos a and must each have one focus **11** on the line **2—6**. Hence the line **2—6** may be referred to as the focal axis. The conic element between the ellipse vertex **9** and the apex **6** should make an angle of $a/2$ with the focal axis **2—6**. For reference purposes attention is directed to the line **10** which is a latus rectum of the ellipse **7** since it passes through a focus **11** and is normal to the major axis **5**. Two special cases have been familiar heretofore. For $a=0$, the surface becomes a parabolic cylinder, while for $a=90°$ it becomes a right circular cone of 45° generating angle.

A family of these cones whose focal distance, such as **2—9**, differ by $N\lambda/(1+\cos a)$, where N is any integer and λ is the wave length of energy in free space, will have reflected wave fronts with the same phase. A zone plate reflector for a scan antenna illuminated by a movable line source can also be constructed in the form of a number of small plates or zones from such a family of elliptical cones as shown in Fig. 2 so as to approximate a circular cone of generating angle $a/2$ and with axis **2—6**. The beam can now be tilted by moving the line source normally to itself across the aperture. In general the wave front will be twisted by an amount which increases with both displacement and with angle a. However, with large fanning, that is, when the beam extends through a much greater angle in one plane than it does in a second plane perpendicular to the first plane, angle a may be small and the twist will not be serious. The scanning plane will be the plane which is parallel to the latus rectum **10** and which includes the line **4**, the center position of the beam.

Fig. 2 shows a rapid scanning antenna constructed according to these principles. A moving line source is generated by a rolled throat feet horn **20**, itself fed by a revolving or oscillating feed guide **22**, as disclosed and described in patent application of Roy C. Spencer for Rolled Throat Scan Horn, executed October 15, 1945, Serial No. 628,283, filed November 13, 1945. This feed horn **20** itself feeds a parabolic cylinder **24** for an auxiliary reflector. This creates an apparent moving line source **26** on the opposite side of the parabolic cylinder **24** which moves normal to itself across the aperture of the zone plate reflector **28**. The radiation from this is then used to feed a conical zone plate reflector **28**. The various zones or plates such as **29**, **30**, **31** are from a family of cones related to cone **28** as described above. This reflector **28** has its axis on the source and of sufficient angle a so that the radiation **32** from it misses the parabolic cylinder **24**. This reduces the problems of matching and frequency sensitivity which occur when radiation is reflected back into a primary feed. Sending the reflected radiation **32** over a different path from the incident **34** also separates throat **36** and mouth **38** to permit rotary feed motion **22** at the throat of rolled feed horn **20**. Since the zones are portions of cones they can be made of sheet metal, making possible a much simpler manufacturing process than the forming of non-developable antenna surfaces.

Other uses and adaptations of the elliptical cone reflectors are possible and the principle of the invention should not be deemed limited by the fact that specific embodiments are illustrated here.

What is claimed is:

1. In an antenna, a reflector characterized by the property of reflecting a substantially plane wave front making an angle a with an illuminating line source, said reflector being a conical surface having elliptical sections normal to said line source, each of said elliptical sections having eccentricity equal to cos a and having a focus on the line source.

2. In an antenna, a reflector composed of a plurality of zones, each zone being constructed as a portion of an elliptical cone as described in claim 1, and each zone differing from the zone adjacent thereto by having the focal length thereof different by an amount of

$$N\lambda/(1+\cos a)$$

where N is any integer and λ is the wave length in free space of the energy said antenna is adapted to radiate.

3. In antenna, a reflector characterized by the property of reflecting a substantially plane wave front making an angle a with an illuminating line source, said reflector being a portion of a conical surface having sections in parallel planes normal to said line source that are portions of ellipses, each of said ellipses having a focus on said line source and a major axis disposed in a fixed plane including said line source, the vertices of said ellipses to one side of said line source being coincident with a straight line in said last-mentioned plane, said straight line making an angle of $a/2$ with said line source, each of said ellipses further having an eccentricity equal to cos a, angle a being of a magnitude greater than 0° and less than 90°.

4. Apparatus as in claim 3 wherein each of said elliptical sections is that portion of an ellipse included between the vertex of the ellipse coincident with said straight line and the latus rectum of the ellipse closer to said last-mentioned vertex.

5. In an antenna, a reflector composed of a plurality of zones, each of said zones being constructed as a portion of a conical surface as described in claim 3, wherein the focal length of the elliptical section of one zone differs from the focal length of the elliptical section of an adjacent zone by an amount of $N\lambda/(1+\cos a)$, where N is an integer and λ is the wave length of the energy to be radiated in the propagating medium included between said line source and said reflector, said focal lengths being measured along one predetermined line transverse to said line source.

6. In an antenna, a reflector characterized by the property of reflecting a substantially plane wave front in predetermined relationship to a fixed preselected line, said reflector being a conical surface having elliptical sections in planes normal to said line.

7. In an antenna, a reflector characterized by the property of reflecting a substantially plane wave front in predetermined relationship to an illuminating line source, said reflector comprising a conical surface having elliptical sections in planes normal to said line source.

8. In an antenna, a reflector characterized by the property of reflecting a substantially plane wave front in predetermined relationship to an illuminating line source, said reflector comprising a surface that is a portion of an oblique elliptical cone and that has elliptical sections in planes normal to said line source.

9. A directional microwave reflector-type antenna for producing a scanning radiation beam comprising a line source of radiation, means directing said line source in a reciprocating motion normal to said line source thereby to produce a scan, a parabolic cylinder fed by said line source in the region of the focus of said parabola thereby to reflect said radiation in a predetermined direction, and a reflector comprising a plurality of zones fed by said parabolic cylinder, each zone being constructed as a portion of an elliptical cone as described in claim 1, and each zone differing from the zone adjacent thereto by having the focal length thereof different by an amount of $N\lambda/(1+\cos a)$, where N is any integer and λ is the wave length in free space of the energy said antenna is adapted to radiate.

10. A directional microwave reflector-type antenna for producing a scanning radiation beam comprising a line source of radiation, means directing said line source in a reciprocating motion normal to said line source thereby to produce a scan, a first parabolic cylindrical reflector having a focus on said line source thereby to reflect said radiation from said line source in a predetermined direction, and a second reflector comprising a plurality of zones fed by said first reflector, each of said zones being constructed as a portion of a conical surface as described in claim 6 wherein the focal length of the elliptical section of one zone differs from the focal length of the elliptical section of an adjacent zone by an amount $N\lambda/(1+\cos a)$, where N is any integer and λ is the wave length of the energy to be radiated in the propagating medium included between said line source from said first reflector and said second reflector, said focal lengths being measured along one predetermined line transverse to said line source.

11. A directional microwave reflector-type antenna for producing a scanning radiation beam comprising, a first parabolic cylindrical surface for reflecting a line source of radiation, a second reflector composed of a plurality of zones fed by said line source from said first reflector, each of said zones being constructed as a portion of a conical surface having sections in parallel planes normal to said source that are portions of ellipses, wherein the focal length of the elliptical section of one zone differs from the focal length of an adjacent zone by an amount $N\lambda/(1+\cos a)$, where N is any integer and λ is the wave length of the energy to be radiated in the propagating medium included between said line source and said second reflector, said focal lengths being measured along one predetermined line transverse to said line source, and an illuminating line source of radiation directed to traverse said first concave surface in a direction normal to said line source thereby to produce a scan.

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