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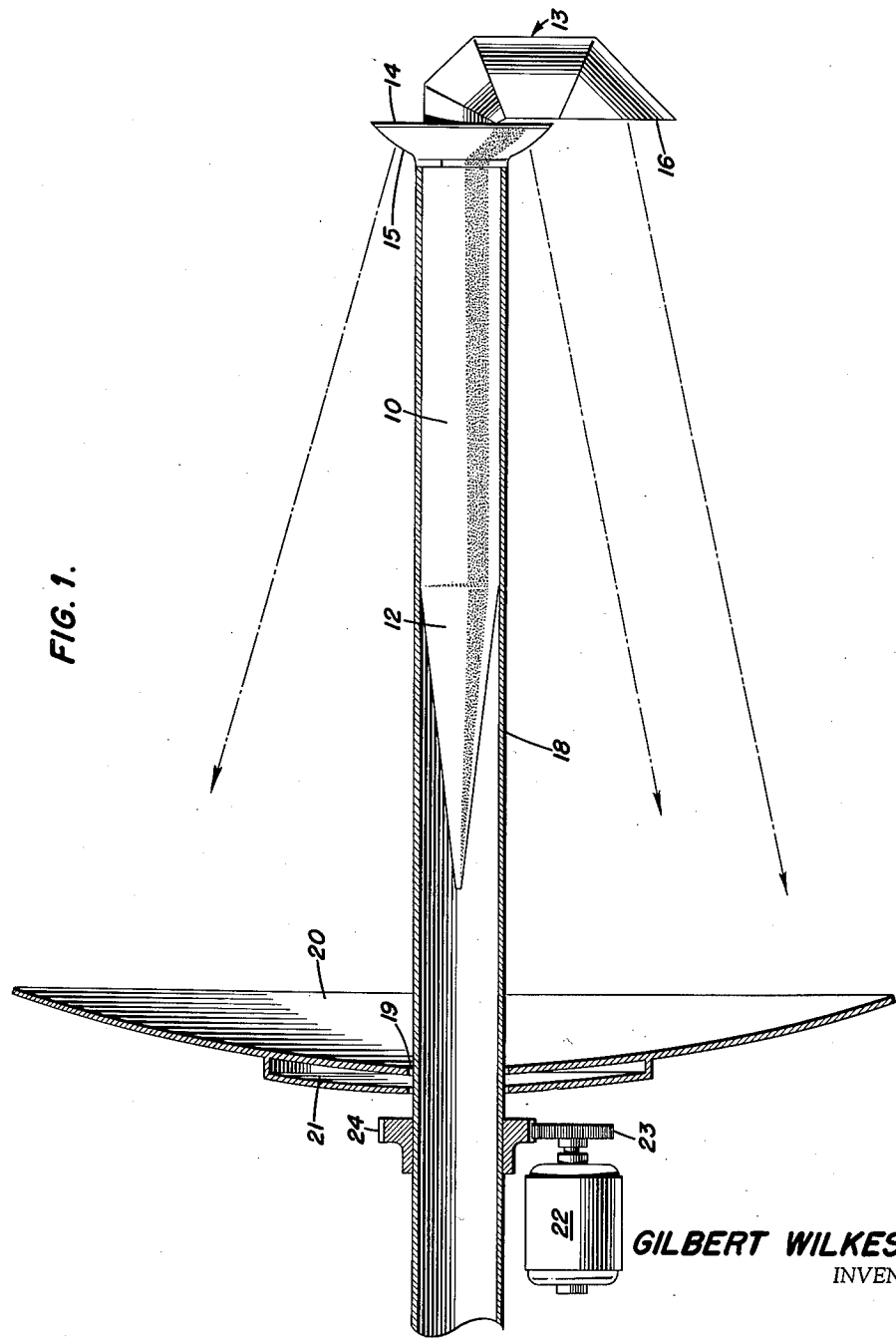
3,072,905

UNSYMMETRICAL ANTENNA FEED FOR CONICAL SCANNING ANTENNA

Filed July 20, 1953

2 Sheets-Sheet 1

FIG. 1.



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FIG. 3.

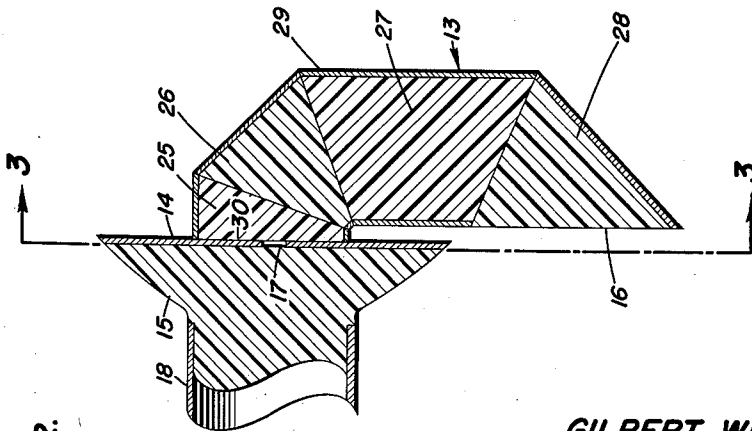
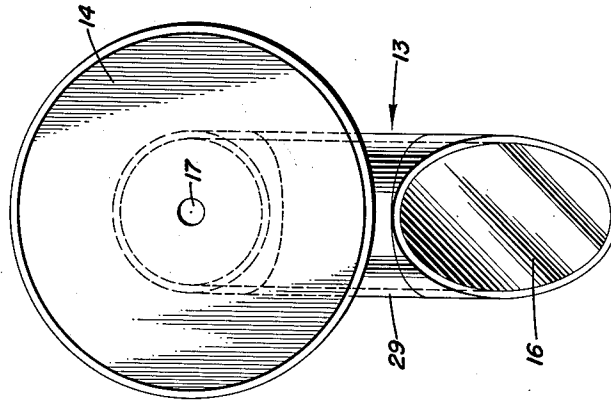


FIG. 2.

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UNSYMMETRICAL ANTENNA FEED FOR CONICAL SCANNING ANTENNA

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5 Claims. (Cl. 343-754)

The present invention relates generally to antennae for use in ultra-high frequency transmitting and receiving systems such as radar, and more particularly to unsymmetrical antenna feeds for use with receivers and transmitters in guided missiles.

An object of this invention is to provide an unsymmetrical antenna feed for use with a circular waveguide and a dish or reflector.

Another object of this invention is to provide an unsymmetrical antenna feed for obtaining a lobe pattern that extends beyond the substantially circular scan pattern produced by conventional means.

Still another object of this invention is to provide an arrangement for turning electromagnetic energy through substantially 180° to its former direction.

These and other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

FIG. 1 is an axial section through a waveguide and a parabolic dish or reflector, and showing features of the invention;

FIG. 2 is an enlarged fragmentary axial section through the outer end of the dielectric element; and

FIG. 3 is a corresponding view in the nature of a cross section, showing the structure to the right of plane 3-3 of FIG. 2.

In accordance with the invention, there is provided in combination with a transmitter having a circular waveguide for passing electromagnetic energy a parabolic dish or reflector, and motor means for driving the waveguide and dish as one unit, an antenna feed comprising a dielectric lens of cylindrical shape including a conical impedance matching portion at its inner end for receiving electromagnetic energy from the waveguide, the cylindrical lens being mounted within the waveguide, and a convex dielectric lens mounted at the outer end of the cylindrical lens. There is also provided a reflecting means mounted on the face of the convex lens opposite the dish and including an orifice, with the reflecting means being arranged to reflect the major portion of the electromagnetic energy back through the convex lens to the radar dish. In addition, means are mounted adjacent the reflecting means for turning the portion of the electromagnetic energy that passes through the orifice through substantially 180° to its former direction.

Referring to the drawings in detail, and more particularly first to FIG. 1, the invention comprises an antenna feed consisting of a dielectric lens 10 of cylindrical shape, having a conical impedance matching portion 12 at its inner end and carrying a plane reflector 14 and a convex lens 15 at its outer end. Beyond the reflector 14 is a specially shaped dielectric lens 13 which is designed to turn a beam of electromagnetic energy through nearly 180°. As shown in FIGS. 2 and 3, there is a small opening or aperture at 17 in the center of reflector 14, through which a correspondingly small proportion of the electromagnetic energy passing outward through the lens 10 enters lens 13 and finally emerges through the face 16 of lens 13. This is discussed in detail hereinbelow, but first it may be desirable to describe the remaining features of FIG. 1.

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The antenna feed is associated with a section of a circular waveguide 18 which passes through the central opening 19 of a suitable dish or reflector 20. A choke 21 may be provided around this opening 19, if desired. It will be understood that the waveguide section 18 is mounted for rotation about an axis, carrying the feed along in such rotation. A motor 22 carrying a drive gear 23 on its shaft may serve to rotate section 18 by means of a driven gear 24 secured to waveguide section 18. However, these elements may be conventional, as they do not form novel parts of the present invention.

Referring again to FIGS. 2 and 3, it will be seen that the outer end of the feed is formed as a lens 13 by cementing together a number of pieces of cylindrical dielectric material as shown at 25, 26, 27 and 28. The entrance surface of lens 13 is cemented to the outer surface of reflector 14 and centrally of said surface. This reflector 14 may be a thin disk of metal or even a mere coat of metallic conducting paint, such as silver paint. In order to allow some of the electromagnetic energy to pass through the reflector 14, said reflector has the small hole or aperture 17 at its center, as shown best in FIG. 3. Lens 13 has a reflecting coating 29 on the cylindrical surfaces thereof, to prevent escape of electromagnetic energy through such surfaces. End surfaces 16 and 30, of course, are not silvered or otherwise coated with reflecting material, so that the electromagnetic energy may enter at 30 and leave through surface 16.

In operation, as part of a transmitter, the electromagnetic energy is conducted through the rotating waveguide 18 toward the right in FIG. 1; when the feed element is encountered, the said electromagnetic energy enters the dielectric through the conical impedance matching tip 12, passes through the cylindrical stem 11 to the reflector 14, and then returns through dielectric lens 15 to the front surface of the radar dish 20. If the reflector 14 and lens 15 are symmetrical, no beam shifting effect is produced thereby upon rotation of the feed element, while if waveguide 18 forms a small angle with its rotation axis, a useful conical scan of the main beam of electromagnetic energy is obtained.

However, the small amount of electromagnetic energy that passes through hole 17 is refracted by the lens 13 and turned through almost 180°, so that it will be directed toward the dish 20, but not exactly from the same point as the electromagnetic energy reflected by reflector 14. Thus the lens 13 provides a lobe that extends beyond the substantial conical scan pattern produced by the main beam of electromagnetic energy delivered by reflector 14. This lobe travels around the pattern at the same rate as the rate of rotation of the feed element and may be used in missile control and for other purposes, wherein an unsymmetric beam of electromagnetic energy is desired.

While the lens 13 is here shown as made of separate cylindrical pieces cemented together, obviously a single-piece bent or molded lens could be substituted. It is likewise clear that the invention is equally applicable to receivers and transmitters.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. In a transmitter having a circular waveguide for passing electromagnetic energy, and a parabolic reflector, in combination with a feed comprising a dielectric lens of cylindrical shape including a conical impedance matching portion at its inner end for receiving electromagnetic energy from said waveguide, said cylindrical lens being mounted within said waveguide, a convex dielectric lens

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mounted at the outer end of said cylindrical lens, reflecting means mounted on the face of said convex lens opposite said reflector and including an orifice, said reflecting means being arranged to reflect the major portion of said electromagnetic energy back through said convex lens to said reflector, and additional means mounted adjacent said reflecting means for turning the portion of electromagnetic energy that passes through said orifice through substantially 180° to its former direction.

2. In combination, a transmitter having a circular waveguide for passing electromagnetic energy, a parabolic reflector, and a feed comprising a dielectric lens of cylindrical shape including a conical impedance matching portion at its inner end for receiving electromagnetic energy from said waveguide, a convex dielectric lens mounted at the outer end of said cylindrical lens, a metal disk mounted on the face of said convex lens opposite said reflector for reflecting said electromagnetic energy, said disk including an orifice and being arranged to reflect the major portion of said electromagnetic energy back through said convex lens to said reflector, and additional means mounted adjacent said disk for turning the portion of electromagnetic energy that passes through said orifice through substantially 180° to its former direction.

3. In a transmitter having a circular waveguide for passing electromagnetic energy, a parabolic reflector for said electromagnetic energy, and a feed comprising a dielectric lens of cylindrical shape including a conical impedance matching portion at its inner end for receiving electromagnetic energy from said waveguide, said cylindrical lens being mounted within said waveguide, a convex dielectric lens mounted at the outer end of said cylindrical lens, a second reflector on the face of said convex lens opposite said parabolic reflector and including an orifice, said second reflector being arranged to reflect the major portion of said electromagnetic energy back through said convex lens to said parabolic reflector, and a dielectric lens that refracts said portion of electromagnetic energy through said orifice in said second reflector substantially 180° to its former direction, whereby a lobe is produced that extends beyond the substantially circular scan pattern produced by the electromagnetic energy re-

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flected from said second reflector to said parabolic reflector.

4. In a transmitter having a circular waveguide for passing electromagnetic energy, and a parabolic reflector, in combination with a feed including a dielectric lens of cylindrical shape and having a conical impedance matching portion at its outer end for receiving electromagnetic energy from said waveguide, a convex lens being mounted at the outer end of said cylindrical lens, the face of said convex lens opposite said parabolic reflector being coated with a reflecting surface, said surface including an orifice, said surface being arranged to reflect the major portion of said electromagnetic energy back through said convex lens to said parabolic reflector, and a plurality of cylindrical dielectric lens pieces secured together, said pieces of lenses having a reflecting coating on their cylindrical surfaces, whereby said portion of electromagnetic energy that passes through said orifice in said reflecting surface is refracted through substantially 180° to its former direction and thereby produces a lobe that extends beyond the substantially circular scan pattern produced by the electromagnetic energy reflected by said reflecting surface to said parabolic reflector.

5. In a transmitter having a waveguide for passing electromagnetic energy, and reflector, in combination with a feed comprising a dielectric lens including an impedance matching portion at one of its ends for receiving electromagnetic energy from said waveguide, said lens being mounted within said waveguide, a convex lens mounted at the outer end of said cylindrical lens, reflecting means mounted opposite said reflector and including an orifice, said reflecting means being arranged to reflect the major portion of said electromagnetic energy back through said convex lens to said reflector, and means for turning a portion of electromagnetic energy that passes through said orifice in said reflecting means through substantially 180° to its former direction.

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