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W. B. NOWAK

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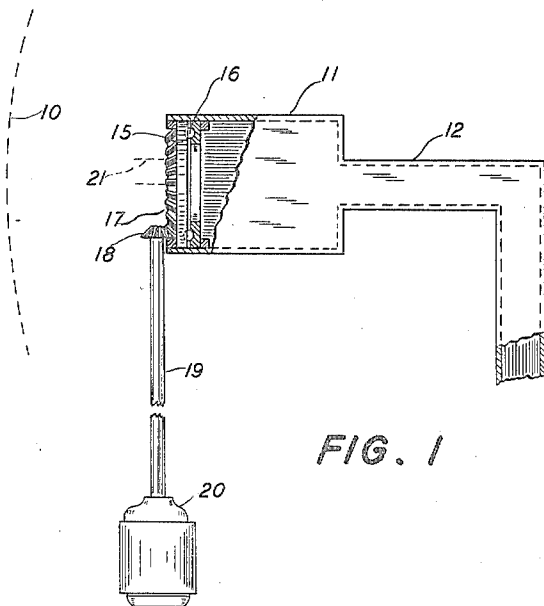


FIG. 1

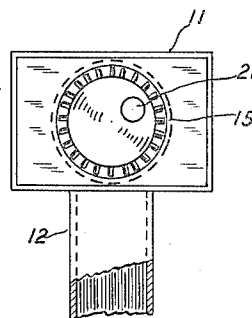


FIG. 2

FIG. 4

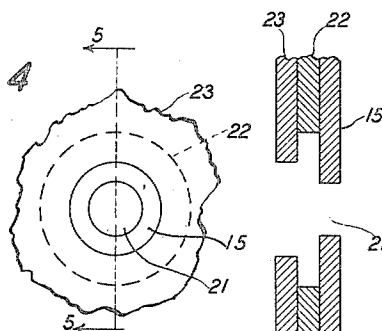


FIG. 3

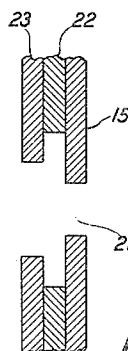
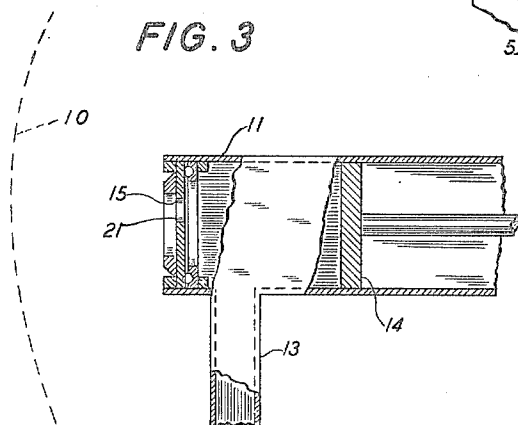


FIG. 5

INVENTOR.
WELVILLE B. NOWAK

BY *William D. Hall*
Attorney

UNITED STATES PATENT OFFICE

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ANTENNA

Welville B. Nowak, Boston, Mass., assignor, by
mesne assignments, to the United States of
America as represented by the Secretary of War

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7 Claims. (Cl. 250—33.65)

The present invention relates to an antenna for use with a high frequency communication system. The invention is particularly directed to an antenna having a parabolic reflector adapted to radiate electromagnetic energy in a highly directional beam which is adapted to scan through space in a conical or other desired manner.

Such scanning may be obtained by rotating the antenna feed and its radiating element relative to the axis of a fixed reflector, or by rotating the reflector itself. It has been found desirable to employ an antenna in which the feed elements remain fixed so that the polarization axis of the feed-radiated energy remains constant. With the polarization axis maintained constant, it has been determined that the over-all effective range of a system is somewhat higher than it is with rotating types of feed elements in which the axis of polarization rotates.

One of the objects of the present invention is to provide an antenna having a fixed element for feeding energy and which is adapted to radiate a rotating beam of energy with its axis of polarization maintained constant.

It is also an object of the invention to provide means for radiating constantly polarized electromagnetic waves in a narrow beam which scans a field in space in a conical or the like manner.

It is another object of the invention to provide a hollow wave guide through which energy is transmitted, which guide is in fixed position relative to a parabolic reflector and which has a rotating end wall provided with an orifice through which energy may be radiated toward the parabolic reflector.

It is still another object of the invention to provide a simple and inexpensive radiating antenna having the above type of radiation pattern together with a satisfactory gain characteristic.

Further objects and advantages of the invention will become apparent as the description proceeds, reference being made to the accompanying drawings in which:

Fig. 1 is a side elevation view, partly broken away, of the antenna embodying the present invention with a parabolic reflector shown diagrammatically;

Fig. 2 is a front elevation view, partly broken away, of the antenna embodying the present invention, looking in the direction from the parabolic reflector of Fig. 1;

Fig. 3 is a side elevation view, partly broken away, of an antenna similar to Fig. 1, showing a different manner of connection to a feed transmission line;

Fig. 4 is a front elevation view, broken away, of a modified type of radiating orifice according to the present invention;

Fig. 5 is a sectional view along the line 5—5 of Fig. 4.

In the drawings, 10 indicates a parabolic reflector of an antenna system. Suitably mounted in front of the reflector 10 is a chamber or hollow wave guide 11 disposed with its longitudinal axis substantially colinear with the axis of reflector 10. Wave guide 11 may be of any desired shape or dimension suitable for being excited by high frequency energy. However, it is preferable that wave guide 11 comprise a low Q type chamber, or be of relatively large dimension and preferably rectangular in shape, as shown.

Energy is fed to the guide 11 in any suitable manner, for example, by means of a transmission line 12. Line 12 may be a wave guide or a coaxial type transmission line suitably coupled to wave guide 11 so that energy transmitted from a source (not shown) through transmission line 12 will properly excite wave guide 11. As indicated in Fig. 1, transmission line 12 is shown as a wave guide entering wave guide 11 centrally through one end thereof.

Fig. 3 shows a transmission line 13 entering the wave guide 11 through one of the side walls thereof with one end of the guide 11 formed as a movable tuning plunger 14 for impedance matching. It will be understood that when the transmission line is the coaxial-cable type, provision is made for suitably coupling the cable to the wave guide, for example, by a probe or by coupling the outer conductor of the coaxial cable to the wave guide wall and extending the center conductor through the wave guide so that the center conductor acts as an antenna or exciting probe.

At the end of the wave guide 11 nearer to the parabolic reflector 10, in Figs. 1 and 3, a substantially circular disc 15 is rotatably mounted. The center of disc 15 lies on the axis of the reflector. The disc 15 is rotatable about the axis of the reflector in a plane through the focal point of, and perpendicular to the axis of, the reflector 10. Any desired means may be provided for permitting the disc 15 to rotate, for example by providing a ball-bearing raceway, generally indicated at 16. The disc may be rotated in any suitable manner, for example, by providing a ring gear 17 mounted on the peripheral portion of the disc 15 and driven by crown gear 18 and actuated through shaft 19 by motor 20.

Disc 15 is provided with a circular orifice 21

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disposed off-center with respect to its axis of rotation. When the wave guide 11 is properly excited, energy is radiated through orifice 21 toward the parabolic reflector 10, and therefore the orifice 21 is the source of illumination of the reflecting parabola. As orifice 21 is off-center with respect to the axis of the reflector 10, the beam of energy radiated from orifice 21 toward the reflector 10 will be directed from the reflector at an angle with the reflector axis. As the disc rotates, the beam will describe in space the surface of a cone.

In order that proper excitation and radiation be obtained, the orifice 21 must be approximately half the operating wave length in diameter. As noted above, the wave guide 11 is preferably of relatively large dimension with respect to the orifice and should comprise a low Q chamber. The axis of polarization of the energy in chamber or wave guide 11 is constant, determined merely by the excitation of the wave guide itself. Therefore, the polarization of the radiated beam is independent of the position of orifice 21, so that a constantly polarized beam will be obtained. If the chamber or wave guide 11 is properly designed, wave guide 11 and the exciting element constituting the orifice 21 will be desirably broadbanded. Accordingly, critical adjustments will not be necessary for small changes in the frequency of the feed energy.

With the simple orifice or aperture as indicated in Figs. 1, 2 and 3, there is a tendency for currents to flow on the face of disc 15 so that illumination of the parabola tends to occur from a relatively large area instead of just from the orifice 21 itself. This tendency may be overcome by providing a radio-frequency choke at the orifice so that the radio-frequency currents for exciting the reflector 10 are maintained within the orifice 21, and radiation will be effectively from a small source.

Figs. 4 and 5 show an improved type of orifice, indicating one means for providing such a radio-frequency choke. 15 indicates the rotating disc, and 21 indicates the orifice or aperture as described with reference to Figs. 1, 2 and 3. Suitably mounted on the outside face of disc 15 are two abutting plane members or discs 22 and 23. Disc 22 is provided with an orifice or aperture of substantially larger diameter than the diameter of orifice 21, and disc 23 is provided with an orifice or aperture having a diameter larger than that of orifice 21, but smaller than that of the orifice in disc 22. The respective orifices are concentric. Thus, an annular slot is provided between discs 15 and 23 of proper dimensions that it constitutes a choke effective for confining the radio-frequency currents of the radiated energy within orifice 21.

The above description has been principally directed to an orifice rotatable in a circular path around the axis of the reflector, so that conical scanning will be produced. It will be understood that other forms of scanning can be produced by moving the orifice relative to the axis of the parabola in a noncircular path.

While preferred embodiments of the present invention have been illustrated and described, it will be understood these are capable of modification and improvement without departing from the spirit of the invention. Therefore, it is not desired that the scope of the invention be limited to the precise details set forth.

What is claimed is:

1. An antenna for a high frequency communi-

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cation system having, in combination, a reflector, a closed hollow chamber mounted in fixed position in front of said reflector with its longitudinal axis substantially colinear with the axis of said reflector, a transmission line for conducting high frequency energy to said chamber to excite the same, a plane member rotatably mounted in the end of said chamber nearer to said reflector, the plane of said member being substantially perpendicular to said reflector axis and substantially at the focal point of said reflector, said member being rotatable relative to said chamber about said reflector axis, said member being provided with an orifice located off-center with respect to said axis, and means for rotating said member.

2. In a directional antenna, a reflector, a wave guide associated with and directed at said reflector substantially in the direction of the axis thereof, means for feeding electrical energy to said wave guide, an apertured member disposed in and closing the end of said wave guide adjacent to said reflector and movable in a plane perpendicular to the axis of said wave guide, said aperture in said member being disposed eccentrically about said axis, whereby there is directed at said reflector upon movement of said member a beam of electrical energy whose source is at said aperture and follows a prescribed path about said axis and in said plane perpendicular thereto, and means coupled to and imparting movement to said member.

3. In a directional antenna, a reflector, a wave guide associated with and directed at said reflector substantially in the direction of the axis thereof, means for feeding electrical energy to said wave guide, an apertured member disposed in and closing the end of said wave guide adjacent to said reflector and supported for rotation with respect to said wave guide substantially about and in a plane perpendicular to said axis, said aperture in said member being disposed eccentrically about said axis, whereby upon rotation of said member there is directed at said reflector a beam of electrical energy whose source is at said aperture and follows a circular path about said axis in said plane perpendicular thereto, and means coupled to and rotating said member.

4. In a directional antenna, a reflector, a wave guide associated with and directed at said reflector substantially in the direction of the axis thereof, means for feeding electrical energy to said wave guide, an apertured disc disposed in and closing the end of said wave guide adjacent to said reflector and supported for rotation with respect to said wave guide and substantially about said axis in a plane substantially perpendicular thereto, the aperture in said disc being disposed eccentrically with respect to said axis whereby there is directed at said reflector upon rotation of said disc a beam of such energy whose source is at said aperture and travels in a circular path about said axis, and means for rotating said disc.

5. In a directional antenna, a reflector, a wave guide associated with and directed at said reflector substantially in the direction of the axis thereof, means for feeding electrical energy to said wave guide, an apertured member extending substantially about and in a plane perpendicular to said axis and movable with respect to said wave guide, said member being disposed in and closing the end of said wave guide adjacent to said reflector, said aperture in said member being disposed eccentrically about said axis, whereby there is directed at said reflector by way of said aperture a beam of electrical energy whose source

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is at said aperture and follows a prescribed path about said axis and in said plane perpendicular thereto, means connected to said member, for producing a radio-frequency choke surrounding said aperture to prevent radio-frequency currents from flowing over the outer surface of said member, and means coupled to and imparting movement to said member.

6. In a directional antenna, a reflector, a wave guide associated with and directed at said reflector substantially in the direction of the axis thereof, means for feeding electrical energy to said wave guide, a disc disposed in and closing the end of said wave guide adjacent to said reflector and supported for rotation with respect to said wave guide substantially about said axis in a plane substantially perpendicular thereto, said disc being provided with an orifice disposed eccentrically with respect to said axis whereby there is directed at said reflector upon rotation of said disc a beam of such energy whose source is at said orifice and travels in a circular path about said axis, means associated with said disc at said orifice and constituting a radio-frequency choke effective to maintain within said orifice occurring radio-frequency currents and to oppose a tendency for such currents to flow on the surface of said disc, and means for rotating said disc.

7. In a directional antenna, a reflector, a wave guide associated with and directed at said re-

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flector substantially in the direction of the axis thereof, means for feeding electrical energy to said wave guide, a disc disposed in and closing the end of said wave guide adjacent to said reflector and supported for rotation with respect to said wave guide and substantially about said axis in a plane substantially perpendicular thereto, said disc being provided with an orifice disposed eccentrically with respect to said axis whereby there is directed at said reflector upon rotation of said disc a beam of such energy whose source is at said orifice and travels in a circular path about said axis, two plane members disposed at one and the same side of said disc and each provided with an orifice registering with and of larger diameter than said first-named orifice, the diameter of the orifice in the plane member immediately adjacent said disc being larger than that of the orifice in the other plane member, and means for rotating said disc.

WELVILLE B. NOWAK.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,420,264	Rost et al.	May 6, 1947
2,429,601	Biskeborn et al.	Oct. 28, 1947