July 21, 1953 B. J. FISHER, JR 2,646,508

NUTATING ANTENNA

Filed Oct. 26, 1945

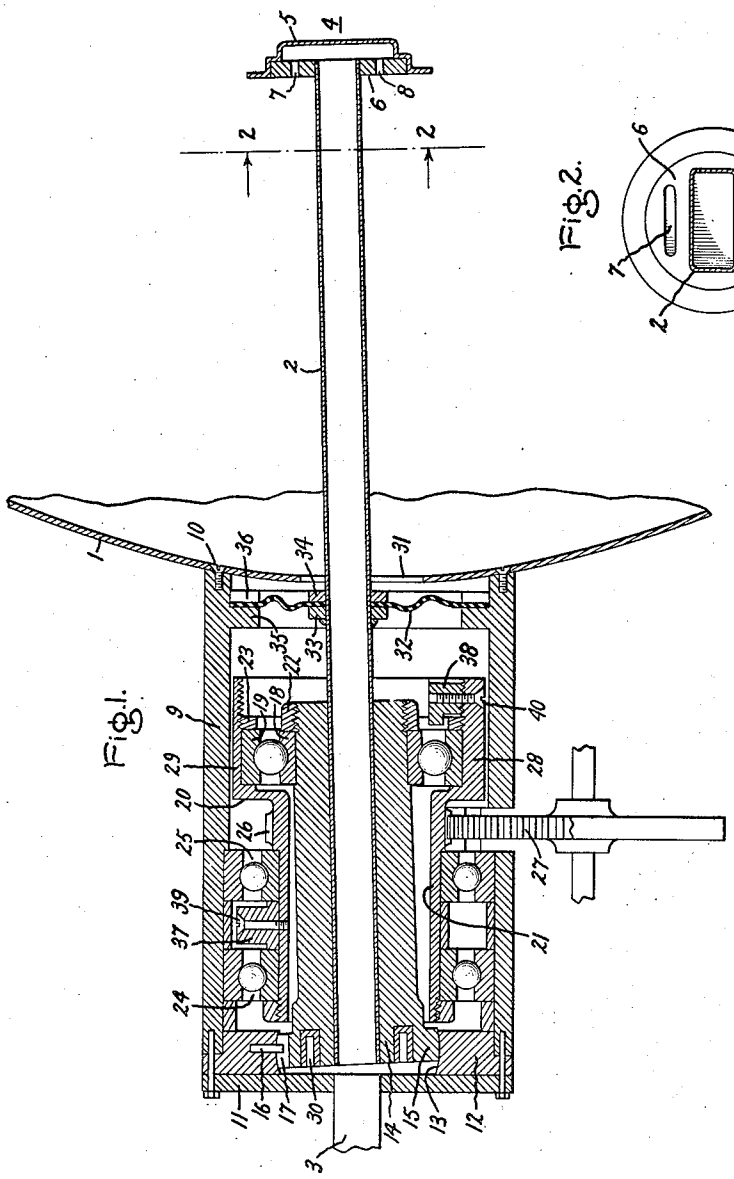


Fig. 1.

Fig. 2.

Inventor:
Benjamin J. Fisher, Jr.
by Merton D. Morse
His Attorney.

Patented July 21, 1953 2,646,508

UNITED STATES PATENT OFFICE

2,646,508

NUTATING ANTENNA

Benjamin J. Fisher, Jr., Utica, N. Y., assignor to General Electric Company, a corporation of New York

Application October 26, 1945, Serial No. 624,779

6 Claims. (Cl. 250—33.65)

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My invention relates to radio detection and ranging systems and it has for its primary object to provide a new and improved antenna for such a system.

In radio detection and ranging system in which high frequency signals are radiated from an antenna and are received after reflection from an object in the path of the signals, it has been observed that greater directivity of the radiated beam is obtained if a short conical beam is employed of the type which may be obtained when the signals radiated are of such a high frequency that wave guide systems are employed for transmitting these signals to the antenna. It has been further observed that the greatest amount of energy is reflected from an object in the path of the signals if the high frequency wave radiated from the antenna has a particular polarization characteristic and if this characteristic is maintained constant as the radiating element is rotated about the axis of a reflector to provide a conical beam, the apex angle of the cone of radiation being as small as possible. Accordingly, it is an object of my invention to provide a new and improved antenna for a system of this type in which the radiating element is nutated about the axis of a reflector.

It is a still further object of my invention to provide a new and improved nutating antenna which is diametrically balanced.

It is still another object of my invention to provide a new and improved nutating antenna employing a wave guide having a flexible joint so that it may be easily connected to an associated wave guide system.

One of the features of my invention consists in the use in a nutating antenna of a wave guide which is inclined at an angle to the axis of the reflector, one point on the wave guide being fixed with respect to the axis of the reflector and eccentric means being provided at another point of the wave guide to move the end of the guide in a circular path without rotation about its own axis.

The features of my invention which I believe to be novel are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawing, in which Fig. 1 is a vertical sectional view of an antenna embodying my invention, and Fig. 2 is an end view of the radiating element of the antenna of Fig. 1

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Referring to Figs. 1 and 2 jointly, there is shown an antenna suitable for use in a radio detection and ranging system and which comprises a parabolic reflector element 1 and a section of rectangular wave guide 2 which is inclined at an angle to the axis of the reflector 1 and which has one of its ends connected to a stationary wave guide 3, which may be connected to any suitable source of high frequency signals and which, on its other end, carries a radiating element 4. The reflector 1 may comprise a suitable metallic member which is parabolic in cross-section and which may be either solid or perforated, as desired. The wave guide 2 is of the hollow pipe type, rectangular in cross-section and formed of a suitable metal, such as copper or brass. The radiating element 4 comprises a metallic disk-shaped plate or baffle 5 which is spaced outwardly from the open end of the wave guide 2 and a metallic flange member 6 which surrounds the wave guide 2 at its open end and supports the baffle member 5. As may be seen in Fig. 2, the flange member 6 is provided with a pair of parallel slots 7, 8 spaced from the wave guide 2 and lying parallel to the larger dimension of the wave guide 2. The slots 7, 8 are so positioned with respect to the wave guide 2 and the baffle plate 5 that high frequency energy transmitted along the wave guide 2 is reflected by the baffle 5 through the slots 7 and 8 and directed substantially parallel with the outer surface of the wave guide.

The reflector 1 is supported from a circular housing 9 by any suitable means, such as the screws 10, the reflector 1 substantially closing one end of the housing 9. The opposite end of the housing 9 is closed by an end plate 11 which supports the end of the stationary wave guide 3. Disposed between the end plate 11 and the housing 9 is a stationary bearing member 12 having a spherical bearing surface 13. A tubular sleeve member 14, which surrounds the wave guide 2 near its left-hand end, has a spherical ball surface 15 which is journalled in the surface 13. Means are provided for preventing rotation of the sleeve 14 in the spherical surface 13 and comprise the pin 16 located in the bearing member 12 and extending into a longitudinal slot 17 in the sleeve 14.

At its opposite end, the sleeve 14 is supported by a ball bearing construction having an inner race member 18 affixed to the sleeve 14 and a second or outer race member 19 supported in a cup-shaped end 20 of a hollow shaft 21. Lock nuts 22, 23 are provided, respectively, to secure the races 18 and 19 to the members 14 and 20.

The hollow shaft 21, in turn, is rotatably supported by a pair of ball bearings 24, 25 having outer races secured to the housing member 9. The outer surface of the hollow shaft 21 is likewise provided with a gear 26 which engages a suitable driving pinion 27.

In order that the wave guide 2 nutate about the axis of the reflector 1 as the hollow shaft 21 is rotated by the gears 26, 27, the cup-shaped end 20 is bored eccentrically with respect to the main portion of the shaft 21. This is illustrated in the drawing by the wall portion 28 on the cup end 20 which is shown to be larger than the opposite wall portion 29. Preferably, the ball bearing structure 18, 19 is of the self-aligning type so that, as the shaft 21 rotates, the radiating element 4 at the end of the wave guide moves in a circular path about the axis of the reflector 1. At the same time, the pin 16 provides a fixed point at the pivot end of the wave guide 2 so that the wave guide nutates about the axis of the reflector without rotating about its own axis.

Means are provided for conducting high frequency energy from the wave guide 3 to the wave guide 2 without loss at the pivoted end and comprise a half wave choke 30 formed by a longitudinal slot in the fixed end of the sleeve 14. Likewise, means are provided for preventing moisture from entering the housing 9 through the opening 31 in the reflector 1 and comprise a flexible gasket 32 which is clamped at its inner edge between a flange 33, secured to the outer surface of the wave guide 2, and a ring 34 and, at its outer edge, between the inwardly directed flange 35 within the housing 9 and a ring 36. The rings 34, 36 may be secured to the flanges 33, 35 in any suitable manner, such as by screws, not shown.

In order that the nutating antenna be dynamically balanced as the shaft 21 is rotated by means of the gears 26, 27 to nutate wave guide 2, a pair of balance weights 37, 38 are provided, the weight 37 being attached to the hollow shaft 21 by a screw 39 between the pivoted end of the wave guide and the gear 26, and the weight 38 being attached by a screw 40 near the open end of the cup-shaped end 20.

In the operation of the antenna described, as the hollow shaft 21 is rotated by means of gears 26, 27, the bearing structure 18, 19 supported within the cup-shaped end 20 of the shaft carries the sleeve 14 in a circular path about the axis of the shaft 21. The pin 16, at the same time, prevents rotation of the fixed end of the sleeve 14 in the bearing surface 13. The high frequency waves transmitted over the wave guides 3 and 2, therefore, are reflected from the baffle plate 5 and pass through the opening 7, 8 in the flange 6 to describe a conical beam of radiation about the axis of the reflector 1.

An important advantage of the nutating antenna described is that it permits the use of a rectangular wave guide for transmitting high frequency waves, so that waves of a desired polarization may be radiated by the antenna. It has been found in certain applications, for example when high frequency waves are radiated over a body of water, that waves having a particular polarization are especially suited for use in radio detection and ranging systems in that such systems do not require filters to remove the harmonic frequencies which would be generated were the polarization allowed to vary.

A further advantage of my improved wave guide system is that it permits the use of higher frequency waves in generating a conical beam of radiation by employing a rectangular wave guide with its desirable energy transmission and polarization characteristics.

While the invention has been described by reference to a particular embodiment thereof, it will be understood that numerous modifications may be made by those skilled in the art without departing from the invention. I therefore aim in the appended claims to cover all such equivalent variations as come within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. In an antenna of the type having a stationary reflector having an axis, a section of wave guide extending through said reflector, and means for nutating said section about said axis comprising, means for maintaining one end of said guide substantially stationary with respect to said axis, means for preventing rotation of said one end about said axis, means eccentric to said axis surrounding said guide at a point spaced from said one end, means for rotating said last means, and rotatable means supporting said guide within said eccentric means.

2. In an antenna of the type having a stationary reflector having an axis, a section of wave guide extending through said reflector, means for maintaining a first point of said guide substantially stationary with respect to said axis, said point being spaced from said reflector, means for preventing rotation of said first point of said guide about said axis, a rotating sleeve surrounding said guide between said point and said reflector, and eccentrically rotatable means disposed between said sleeve and said guide whereby the portions of said guide spaced from said point are nutated about said axis.

3. In an antenna of the type having a stationary reflector having an axis, a section of wave guide extending through said reflector, means for maintaining a point of said guide spaced from said reflector substantially stationary with respect to said axis, means for preventing rotation of said point of said guide about said axis, a rotatable sleeve member surrounding said guide between said point and said reflector, said sleeve being rotatable about said axis, said sleeve having a portion eccentric to said axis, and means journalling said guide in said portion, whereby as said sleeve is rotated said guide is nutated about said axis.

4. In an antenna of the type having a stationary reflector having an axis, a section of wave guide extending through said reflector, a housing member supported from said reflector, means within said housing member for maintaining a point of said guide substantially stationary with respect to said axis, means for preventing rotation of said point of said guide about said axis, a rotatable sleeve member within said housing and surrounding said guide, said sleeve being rotatable about said axis, said sleeve having a portion eccentric to said axis, and means journalling said guide in said portion, whereby as said sleeve is rotated said guide is nutated about said axis.

5. A nutating antenna comprising a stationary reflector having an axis, a wave guide inclined at a small angle to said axis and having a portion extending in front of said reflector, said guide having one end substantially fixed with respect to said axis, means for preventing rotatoin of said one end about said axis, and means for nutating the other end of said guide about said axis comprising a rotatable sleeve surrounding

said guide, said sleeve having an eccentric portion rotatably supporting said guide.

6. An antenna comprising a stationary reflector having an axis, a rectangular wave guide extending through said reflector, said guide being oriented to transmit waves of a desired polarization, said guide having one end substantially fixed with respect to said axis, means for preventing rotation of said one end about said axis, and means for nutating the other end of said guide about said axis, whereby said orientation is maintained and waves of said polarization may be transmitted through said guide substantially without reflection therein as said other end is nutated about said axis.

BENJAMIN J. FISHER, JR.

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