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DIRECTIONAL ANTENNA WITH CONICAL SCANNING

Filed April 22, 1954

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Fig. 1

Fig. 2

Fig. 3

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Application April 22, 1954, Serial No. 424,893
7 Claims. (Cl. 343—756)

The present invention relates to the art of radiating electromagnetic energy. More particularly, this invention relates to conical scanning antenna systems as used in radar.

In the prior art many systems have been proposed for developing a conical beam of electromagnetic energy by causing beam rotation about the axis of the antenna system. This beam rotation is familiarly termed "conical scanning" in the art, and is to be distinguished from the azimuth and elevation scanning functions of the system as a whole.

Conical scanning systems as developed in the prior art are characterized by essentially unbalanced mechanical rotational systems. The speed of the scanning required by modern radar techniques is unattainable by such systems.

It is therefore an object of the present invention to provide an improved antenna system providing high speed conical scanning.

It is a further object of the present invention to provide a conical scanning antenna system that is electrically and mechanically balanced.

A still further object of the present invention is to provide an improved conical scanning antenna system that is especially reliable in operation.

Other and further objects of the invention will be apparent from the following description of a typical embodiment thereof, taken in connection with the accompanying drawings.

In accordance with the invention, there is provided an antenna system. Included in the antenna system is a combination of a source of plane-polarized, electromagnetic energy characterized by an electric vector having a predetermined direction of polarization, a shaft, and a means for rotating the shaft. A rotating means responsive to the energy is coupled to the source and carried by the shaft. The rotating means comprises three radiating elements arranged substantially in the form of an equilateral triangle.

In the accompanying drawings:
Fig. 1 is a schematic diagram illustrating conical scanning as provided by the present invention;
Fig. 2 is a side view of a preferred embodiment of the present invention;
Fig. 3 is an enlarged, detailed end view of a portion of the embodiment in Fig. 2; and
Fig. 4 is a series of schematic diagrams illustrating the operation of the invention.

Referring now in more detail to the drawings and with particular reference to Fig. 1, an antenna system indicated at 1 is depicted as radiating a beam 2 of electromagnetic energy as shown. The main axis 3 of the beam is caused to rotate about the antenna system axis or boresight axis 4, as shown. The rotating or circular motion of the beam axis 3 is illustrated by the path 5. The extreme lower position of the beam is illustrated by the phantom lines 6. This rotation of the beam thus provides what is known as "conical scanning."
placed from the electric vector 15 by 30 degrees and also radiates .75k units of energy. The element C is precisely perpendicular to the electric vector 15 and radiates substantially zero energy. The main axis of the resultant beam is deflected down, since the radiation centers of the elements A and B are disposed below the horizontal axis of the radiator. Again, the total amount of energy radiated is equal to 1.5k units of energy.

In the diagram (c), the element A has been rotated 60 degrees with respect to the electric vector 15. The element B is precisely parallel to the electric vector 15, and accordingly radiates k units of energy. The radiation center of the element B is left of the center O. The elements A and C radiate a total of .5k units of energy with a resultant radiation center to the right of the center O less than a maximum amount. Since the element B is controlling, the main axis of the resultant beam will be deflected left.

In the diagram (d), the element A is shown rotated 90 degrees with respect to the electric vector 15 and radiates no energy. The elements B and C radiate a total of 1.5k units of energy and their radiation centers are displaced above the center O; hence, the resultant beam is displaced as shown at 3 in Fig. 1. In the diagram (e), the element A is shown rotated 120 degrees with respect to the vector 15. The element C is now positioned such that the operation of the system as described with respect to the element A above is repeated.

In the diagram (f), the locus of the main axis of the resultant beam due to the rotation of the tripole radiator through an angle of 120 degrees is illustrated. The points W, X, Y, and Z relate to the positions as illustrated by the diagrams (a), (b), (c), and (d), respectively. By this analysis, it is clear that the main axis of the beam rotates through 360 degrees three times while the tripole radiator mechanically rotates through 360 degrees once.

From the above description it is to be noted that the system as described is inherently electrically and mechanically balanced. The tripole radiator may be readily fabricated in accordance with typical etched circuit or printed circuit techniques. Since the motor, shaft, and tripole radiator may be very light and are mechanically balanced, the physical speed of rotation may be so increased that conical scanning rates may be increased from a typical value of 50 cycles per second to as high as 1,000 cycles or more per second.

The present invention greatly enhances the effectiveness of modern radar techniques as used in the detection and control of supersonic aircraft. While there has been hereinbefore described what is at present considered a preferred embodiment of the invention, it will be apparent that many and various changes and modifications may be made with respect to the embodiment illustrated, without departing from the spirit of the invention. It will be understood, therefore, that all those changes and modifications as fall fairly within the scope of the present invention, as defined in the appended claims, are to be considered as a part of the present invention.

What is claimed is:

1. In a conical scanning antenna system, the combination of a source of plane-polarized electromagnetic energy characterized by an electric vector having a predetermined direction of polarization; a shaft; means for rotating said shaft; and a radiating means coupled to said source and responsive to said energy and carried by said shaft, said radiating means comprising three radiating elements arranged substantially in the form of an equilateral triangle in a plane substantially perpendicular to the direction of propagation of said energy.

2. In an antenna system, the combination of a source of plane-polarized electromagnetic energy characterized by an electric vector having a predetermined direction of polarization; a shaft; means for rotating said shaft; and a radiating means coupled to said source and responsive to said energy and carried by said shaft, said radiating means comprising three radiating elements arranged substantially in the form of an equilateral triangle.

3. In an antenna system, the combination of a source of plane-polarized electromagnetic energy characterized by an electric vector having a predetermined direction of polarization; a disk; means for rotating said disk; and a radiating means coupled to said source and responsive to said energy and carried by said disk, said radiating means comprising three radiating elements being arranged substantially in the form of an equilateral triangle in a plane substantially perpendicular to the direction of propagation of said energy.

4. In an antenna system, the combination of a source of electromagnetic energy; a primary radiating means coupled to said source for providing a beam of plane-polarized electromagnetic energy characterized by an electric vector having a predetermined direction of polarization; a shaft; a secondary radiating means coupled to said primary radiating means and responsive to said energy and carried by said shaft, said secondary radiating means comprising three radiating members being arranged substantially in the form of an equilateral triangle and adapted to re-radiate energy received from said primary radiating means.

5. In an antenna system, the combination of a source of plane-polarized electromagnetic energy characterized by an electric vector having a predetermined direction of polarization; a shaft; a radiating means coupled to said source and responsive to said energy and carried by said shaft, said radiating means comprising three radiating elements arranged substantially in the form of an equilateral triangle; and reflector means disposed adjacent said radiating means and adapted to reflect the radiated energy in the form of a beam.

6. In an antenna system, the combination of a source of plane-polarized electromagnetic energy characterized by an electric vector having a predetermined direction of polarization; a parabolic reflector; a variable shaft carried by said reflector along its central axis; a radiating means coupled to said source and responsive to said energy and carried by said shaft, said radiating means being positioned at the focal point of said reflector and comprising three radiating elements distributed substantially in the form of an equilateral triangle in a plane substantially perpendicular to the direction of propagation of said energy.

7. In an antenna system, the combination of a source of plane-polarized electromagnetic energy characterized by an electric vector having a predetermined direction of polarization; an antenna; supporting means; means for rotating said supporting means; a radiating means coupled to said source and responsive to said energy and carried by said supporting, means, said radiating means comprising three radiating elements arranged substantially in the form of an equilateral triangle.

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