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SCANNING SYSTEM
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SCANNING SYSTEM

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mesne assignments, to the United States of
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3 Claims. (Cl. 250—33.65)

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This invention relates to scanning devices, and particularly to highly directional radio antennas intended to scan a region in space.

The subject matter of the broad claims of this application is disclosed in the application of James E. Shepherd, Serial No. 483,698, filed April 19, 1943 now Patent No. 2,432,101 issued December 9, 1947.

Narrow beams are very much desired in radio object detecting and television equipment, where their high directivity permits a high degree of resolving power. However, when a directional radio antenna emitting an extremely narrow beam is used, it is necessary that the direction in which the beam is pointed be changed constantly in accordance with a plan if a large region in space is to be covered by the beam, since a narrow beam will of itself encompass only a small region. The process of moving a directional beam about to cover progressively a chosen region in space is known as scanning.

Various methods of scanning are possible. If it is desired to scan a region all around the antenna and of a certain angular height, the antenna may be rotated about a vertical axis through 360 degrees, at an initial angle of elevation, and then elevated by an amount that will raise the beam as desired, and rotated again through 360 degrees, the process being repeated until the upper limit of the region to be scanned is reached, whereupon a similar process of depressing or an instantaneous depression to the starting elevation may be employed. If only a sector of the region around the antenna is to be scanned, the antenna may be interrupted in its rotation when the desired sector has been swept through, elevation then being accomplished as outlined above. In addition, many other methods may be employed to cover sectors or regions of various shapes, all of these usually involving sudden changes in the motion of the antenna, and necessitating complicated and expensive gears, cams, and other parts.

My invention is directed to scanning a region of any chosen horizontal and vertical width about the scanning antenna, without the necessity of sudden changes in the motion of the antenna such as sudden elevation or reversal of direction. An object of my invention is to provide a highly directional radio antenna that can scan a region about it at high speed without having to be suddenly started, stopped, or reversed at any time.

Another object is to provide such an antenna that will scan the region around itself a multiplicity of times during one sweep around the region.

A further object is to provide such an antenna that is inexpensive and easy to construct by eliminating the necessity for quick action starting, stopping, and direction-reversing mechanism.

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Other and further objects will appear during the course of the following description, accompanied by the drawing in which:

Fig. 1 is a side elevation partly in section of an embodiment of my invention having associated therewith a diagrammatic representation of the scan of the radio beam, and

Fig. 2 is a representation of the scanning path traced out by the beam as the spinning antenna is revolved about its sweep axis.

A parabolic reflector 1 is mounted on a shaft 2, at an angle other than perpendicular thereto, so that its principal axis Y—Y makes an angle A with the axis X—X of shaft 2. A dipole radiator 3 is positioned in the focus of reflector 1 at the end of a coaxial transmission line 4, being coupled to line 4 through suitable coupling means 5. The radiator 3, reflector 1, line 4, and coupling means 5 together constitute a directional antenna assembly 15. A housing 6 has within it suitable bearings (not shown) to permit spinning rotation of shaft 2 with respect to housing 6 while at the same time holding shaft 2 firmly positioned otherwise. Also contained in housing 6 is a suitable rotating transmission line joint (not shown) for coaxial line 4. A gear 7 may be mounted on shaft 2 and driven by a motor 9, through a second gear 8, thus causing shaft 2 to revolve and spin the directive antenna assembly 15 about axis X—X. The beam of radiation 10 of the antenna 15 is directed along axis Y—Y, as in the conventional parabolic reflector type antenna. The width of beam 10 is normally measured at the half power points 11, and is here represented as B. As shaft 2 spins beam 10 is caused to trace out a cone, line Z—Z representing the side of this cone opposite to that represented by line Y—Y, being reached when shaft 2 has rotated through 180 degrees. Angle A' is the angle made by lines Z—Z and X—X, and is identical to angle A, being the image of angle A. Thus the cone traced out by beam 10 as shaft 2 spins on axis X—X is represented in plan by lines Y—Y and Z—Z, and has an angular width equal to 2A. Considering half-power points 11, it is apparent that the path traced out by beam 10 at its half-power points is an annular path 12, which is actually a cross-section at point 19 of the cone traced out by entire beam 10. Path 12 is shown here turned about 90 degrees with respect to its true position and appears in plan. Path 12 is of a thickness which for small values of angle A is substantially identical to the beam width B of beam 10, and is one form of the scanning path of my invention. Point 19 is midway between points 11, on axis Y—Y, and is herein used as a reference point to aid in tracing the motion of beam 10 during the course of this discussion.

In addition to the spin imparted to it by shaft 2, antenna assembly 15 has a revolutionary motion about a second axis at right angles to axis

X—X, imparted to it by motor 13, through gears 14 and 16, a shaft 17, and a yoke 18 attached to housing 6. This second axis, which coincides with the axis of shaft 17, is preferably vertical to impart a horizontal sweep motion to the spinning antenna 15 and cause antenna 15 to scan the region around itself, its conical scan and horizontal sweep motion being combined in the process to enable the antenna 15 to scan thoroughly a belt or region of a height equal to 2A, as shown in Fig. 2.

Conceivably, the second or revolutionary axis could be disposed otherwise than vertically, and it is not intended that the hereinabove described preferred disposition be regarded as the sole manner in which my invention may be practiced or used, but only illustrative.

Fig. 2 represents the path that will be traced by point 19 as beam 10 moves in conformity with the spin imparted to antenna 15 by shaft 2 and with the revolutionary sweep motion imparted to antenna 15 by shaft 17. For the purposes of this discussion only, it will be assumed that the sweep motion is horizontal. As antenna 15 spins on axis X—X but not about the axis of shaft 17, and beam 10 traces out annular path 12, the point 19 will trace out a circular path 23, concentric with path 12 and midway between the inner and outer boundaries of path 12. As antenna 15 sweeps horizontally about the axis of shaft 17, this circular path of point 19 will be altered to have the form of what might be termed a flattened helix 20. The horizontal sweep path 21 followed by center 22 of ring 12 is marked to represent degrees of arc around the scanning system. Approximately 200 degrees of horizontal sweep revolution is represented. If thickness C represents a beam width of 10 degrees, for example, it will be desirable that the corresponding points on adjacent coils of the path 20 be no more than 10 degrees apart, in order to assure complete scanning of the region being scanned. Thus, the distance between adjacent coils of path 20 is represented in Fig. 2 as C. By proper adjustment of the speeds of motors 9 and 13, and by proper choice of gears 7, 8, 14, and 16, this condition may be realized.

It will be noted that as each succeeding coil of path 20 is generated, its latter half retraces the region traced by preceding coils. Thus during one horizontal sweep revolution, antenna 15 scans the region around itself a multiplicity of times.

It will be appreciated that antenna 15 need not be swept through 360 degrees of path 21, but could be made to oscillate back and forth in such a manner as to cover any chosen number of degrees. Further, it is within the teachings of this invention that motors 9 and 13 may be varied in speed with respect to each other to render the coils of path 20 closer to each other or further apart, as desired. The hereinabove described embodiment of my invention is illustrative only, and not the sole manner in which my invention may be practiced. I regard the scope of my invention to be defined in the appended claims.

I claim:

1. A scanning device for a radio echo detection system comprising, a directive antenna having an axis of orientation producing a narrow beam of energy having a beam directive axis disposed at an acute angle to said axis of orientation, means for rotating said antenna about said axis of orientation thereby to rotate said directive

axis about said axis of orientation, the angular width of said beam at its half-power points being small compared to said acute angle whereby upon rotation of said directive axis about said axis of orientation said beam scans at said half-power points an annular area in space of a mean diameter proportional to twice said acute angle, and means for uniformly rotating said antenna about a second axis which is perpendicular to said axis of orientation at a rate to move said orientation axis through an azimuthal angle equal to the angular width of said beam at said half-power points during a single rotation of said directive axis about said axis of orientation.

2. A search scanning device for a radio echo detection system comprising, a directive parabolic antenna mounted to spin about an orientation axis for producing a beam of energy of a first predetermined small width angle measured at the half-power points, said antenna being arranged to direct the axis of said beam at a second predetermined angle to said orientation axis greater than one-half said beam width angle, means for rotating the axis of said beam about said orientation axis whereby said beam scans an annular area at said half-power points in a plane perpendicular to said orientation axis, and means for simultaneously uniformly rotating said antenna about a vertical axis at a rate to move said orientation axis through an azimuthal angle equal to said first beam width angle during each rotation of said beam about said orientation axis.

3. A search scanning device for a radio echo detection system comprising, a directive antenna for producing a beam of electromagnetic energy of a first predetermined small width angle measured at the half-power points, said antenna being mounted to spin about a substantially horizontal spin axis and positioned to direct said beam at a predetermined acute angle to said spin axis of substantially greater magnitude than one-half said beam width angle, means for rotating said beam about said spin axis to cause said beam to scan an annular area at said half-power points in a plane perpendicular to said spin axis and having a mean diameter proportional to twice said acute angle, and means for simultaneously uniformly rotating said antenna about a vertical axis at a rate to move said spin axis through an azimuthal angle equal to said beam width angle during each rotation of said beam about said spin axis.

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