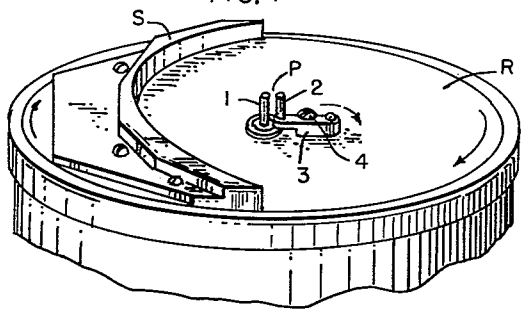
Nov. 13, 1962 L. HATKIN 3,064,258

DIRECTIVE ANTENNA SCANNING AND TRACKING DEVICE AND APPLICATIONS THEREOF

Filed Dec. 6, 1960

FIG. 1



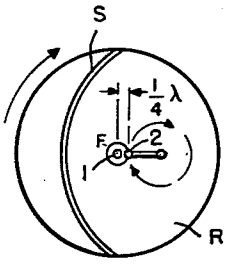
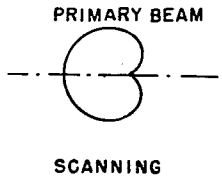
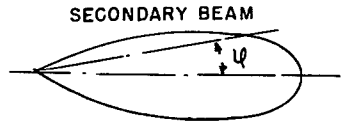


FIG. 2A





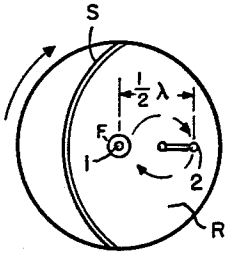
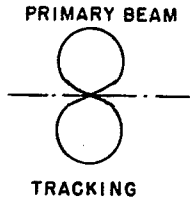


FIG. 2B



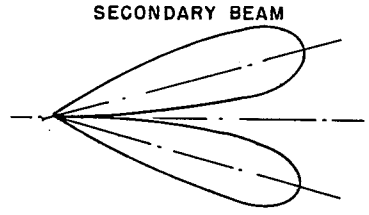
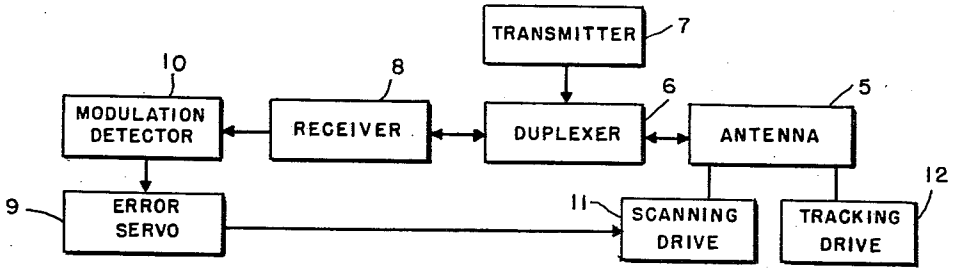


FIG. 3



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DIRECTIVE ANTENNA SCANNING AND TRACKING DEVICE AND APPLICATIONS THEREOF

Leonard Hatkin, Elberon, N.J., assignor to the United States of America as represented by the Secretary of the Army

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5 Claims. (Cl. 343—757)
(Granted under Title 35, U.S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment of any royalty thereon.

The invention relates to directive antenna devices for use in radar or like ultra-high frequency radio systems and particularly to such antenna devices with the components thereof controlled and shaped to enable their use both for locating and tracking objects in space.

A general object of the invention is to provide a directive antenna for such purposes that is simple in design and economical to produce.

A related object is to provide a simple antenna system for accurately locating a moving object in space and tracking that object.

Another object is to incorporate tracking by means of monopulse or off-set feed arrangements in a directive scanning system in such manner as to eliminate the need for rotating joints.

Another more specific object is to provide an improved directive scanning and tracking antenna system in which there is substantially no degeneration or deterioration of the azimuth characteristic of the emitted electromagnetic beam during the scanning or tracking operation.

In accordance with the invention, a low inertia directive antenna device for attaining such objects is produced by mounting the elements of a primary radiator and a secondary reflector on a balanced rotating plate in such relation with respect to each other and to a stationary feed line for feeding high frequency electromagnetic signal wave energy to the primary radiator as to produce a secondary radiated electromagnetic beam of the pencil type and a split lobe secondary beam for different operating positions of the antenna, which are respectively used for providing a search scan sequence to detect a moving target in space and to track that target.

The various objects and features of the invention will be better understood from the following detailed description of one embodiment thereof when it is read in conjunction with the several figures of the accompanying drawing in which:

FIG. 1 shows a perspective view of a directive antenna device embodying the invention;

FIGS. 2A and 2B respectively show diagrammatically different operating positions of the antenna device of FIG. 1 with the radiation patterns of the primary and secondary electromagnetic beams emitted for each of these positions; and

FIG. 3 shows a block diagram of the antenna device of FIG. 1 connected into a known arrangement for direction finding to locate a moving object and to track that object.

Directive antenna devices are known in which a secondary radiator, such as a parabolic reflector, and one parasitic dipole member of a primary radiator located at the focal point of the secondary reflector are rotated about a stationary feed line, and another fed dipole member of the primary radiator is maintained stationary. This system requires no rotating joints since the active element is stationary. If it is desired to incorporate tracking by means of monopulse on off-set feed arrangements, the symmetry of the system is destroyed and rotating joints will have to be used. The need for such

rotating joints is eliminated in the directive antenna of the invention as shown in FIG. 1. In that antenna, the secondary reflector S, such as a parabolic reflector, and one parasitic member of a primary radiator P are rotated in fixed relation with each other in circular orbits about a coaxial feed line F which is mounted on the axis of rotation and is stationary. The speed of rotation may be high if the rotating components are mounted as shown on a balanced rotating plate R. The coaxial line feed comprising a center conductor and an outer conductor is inserted in a hole in the center of the plate R. A stationary pin **1** extending in the direction of the axis of the coaxial line F and projecting above the plate R an appropriate distance forms the fed dipole member of the primary radiator P. The second, parasitic, dipole member **2** of primary radiator P comprises a second pin of appropriate length extending in parallel with the center pin **1** and mounted on an arm **3** which is arranged to rotate in a circle about an axis parallel to the axis on which the balanced plate R rotates. Member **2** is excited by member **1**, so as to act as a parasitic reflector. The pivot for the dipole member **2** is mechanically affixed to the plate R so as to rotate therewith. A locking device **4** in the arm **3** is used to affix that arm to the plate R at any point in its rotating cycle to maintain the spacing between the dipole members **1** and **2** constant. At the spacing between the dipole member **2** at its closest relation to the stationary dipole member **1** and the stationary feed line F, which is approximately a quarter-wavelength of the operating frequency, as shown in FIG. 2A, the radiator P sends out a primary unidirectional beam of the shape indicated in that figure directed into the reflector S; and at its farthest location from the stationary dipole member **1** and feed line F, which is approximately a half-wavelength of the operating frequency, as indicated in FIG. 2B, the radiator P forms a split lobe primary beam of the shape indicated in that figure directed toward the reflector S. The secondary beams reflected by the reflector S into space are respectively a pencil beam (FIG. 2A) and a split lobe beam (FIG. 2B).

The operation of the antenna of FIG. 1 using the particular combination of beam patterns shown in FIGS. 2A and 2B may be used for direction finding in a number of ways as follows:

The operation will be described with reference to the known radar or radio arrangement of FIG. 3 showing an antenna **5**, equivalent to that shown in FIG. 1, coupled by the duplexer **6** to the transmitter **7** and receiver **8**.

(1) With the primary radiator P locked in the pencil beam position by operation of the locking device **4** on the rotating arm **3** to attach that arm to the rotating plate R in the position indicated in FIG. 2A, the antenna may be rotated through a normal search scan sequence by rotation of the plate R thereat by the associated antenna scan drive means **11**. When a target is detected, the scan is stopped and the parasitic dipole member **2** of the primary radiator P of the antenna **5** is rotated by the associated tracking drive mechanism **12** which may be a manual or motor device. The signal is modulated because the target is on a maximum of the secondary pencil beam and a minimum of a secondary split lobe beam. The error servo **9** connected between the modulation detector **10** associated with the radio receiver **8** and the scan driving means **11** will act on the modulated signal so as to point the antenna **5** in the direction of maximum modulation. Spurious error signals can be eliminated by phase filtering the error signal relative to the rotating dipole element **2** of the primary radiator P by any suitable means (not shown) so as to allow only targets on the main beam of the antenna;

(2) After detecting a target in the search mode, the dipole member **2** of the primary radiator P is rotated to

the split beam position as shown in FIG. 2B by the track drive mechanism **12** associated with the antenna **5**, and the target is tracked until a null signal is received. The antenna can continue to follow the target on a null signal; and

(3) The antenna beam may be continuously scanned and the dipole member **2** of the primary radiator P continuously switched so that the secondary pencil beam may alternate with the secondary split beam during succeeding scans. The target will be detected during pencil beam scan and located during the split beam scan, thus providing a track-while-scan system.

The directive antenna system may be employed either as a receiver as in direction finding or both as a receiver and transmitter as in radar equipment.

Various modifications of the directive antenna system described above which are within the spirit and scope of the invention will occur to persons skilled in the art.

What is claimed is:

1. A directive antenna system comprising a balanced rotatable plate, means to rotate said plate, a secondary parabolic reflector fixed to and rotatable therewith, a primary radiator of the dipole type having a first rod like pole fixed at the axis of said plate, parallel thereto and extending outward from the surface of the plate, a second pole of said dipole radiator parallel to, spaced from said first pole and secured to said plate to be carried around said first pole when said plate is rotated to scan said secondary reflector, said second pole acting as a parasitic reflector in conjunction with said first pole to radiate energy to said secondary reflector, means to adjust said second dipole member toward and from said first dipole whereby at the shorter distances energy fed to the dipole pair will direct a primary beam into said secondary reflector which in turn reflects a pencil beam into space, and at the greater distances between said dipole a split lobe beam will be projected into space from said secondary reflector and means for locking said second dipole member in adjusted position.

2. The directive antenna system of claim 1, in which the spacing between said one fed dipole member and the second parasitic dipole member at the closest location to said stationary feed line is substantially equal to a quarter-wavelength of the operating frequency of the signal wave energy supplied to said primary radiator and at its farthest location from the stationary feed line is substantially equal to a half-wavelength of that frequency.

3. The directive antenna system of claim 1 together with a coaxial feed line for said primary radiator in which said first dipole member is an extension of the center conductor of said coaxial feed line, an arm carrying said second dipole member upon one end and pivoted upon said plate at its other end at a distance from said first dipole to swing said second dipole in a circle including the longest and shortest distance from said first dipole.

4. The directive antenna system of claim 3 and means to rotate said arm.

5. The directive antenna system of claim 3 and means to lock said arm in adjustable position.

References Cited in the file of this patent

UNITED STATES PATENTS

2,473,421 Fubini ..... June 14, 1949