

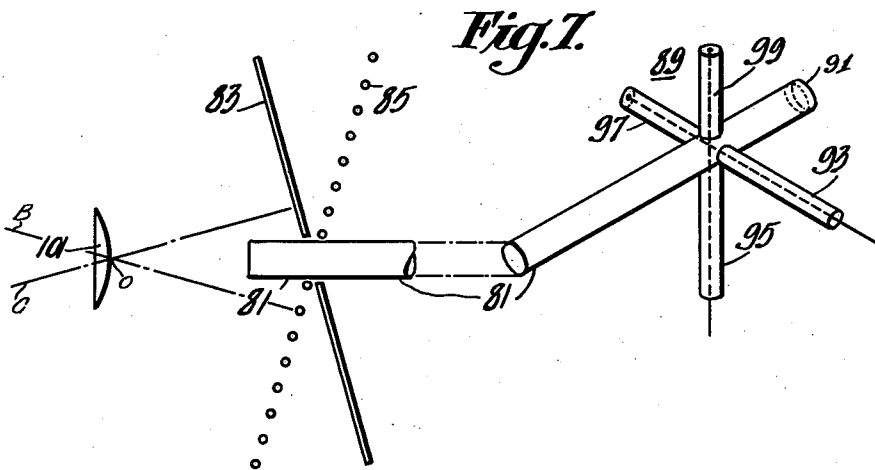
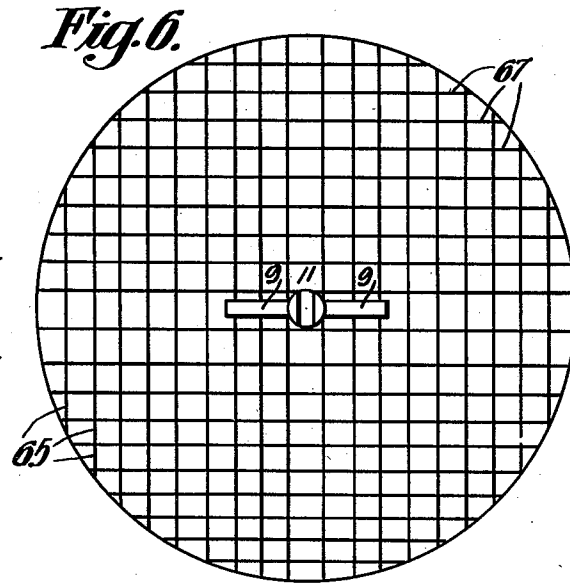
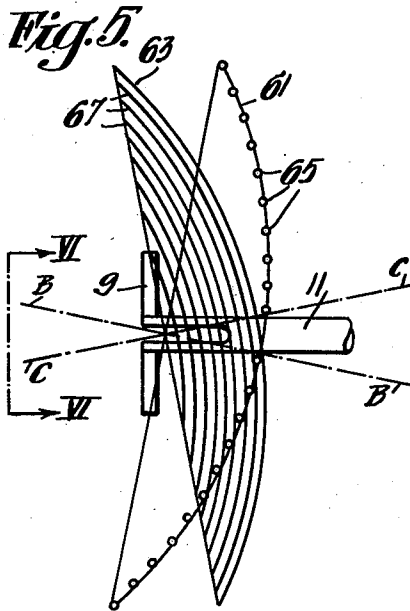
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ANTENNA SYSTEM

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ANTENNA SYSTEM

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9 Claims. (Cl. 250—33.65)

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This invention relates to antenna systems, and more particularly to directive antennas for providing selectively two or more differently oriented directive patterns.

The principal object of the present invention is to provide improved methods of and means for producing selectively different directive patterns for directive radio transmission or reception.

Another object is to provide improved methods of and means for selectively radiating or receiving radio energy in different directive patterns, by varying the polarization of the energy transmitted or received.

A further object is to provide improved lobe-switching antennas involving relatively few and simple elements, and requiring no adjustments of phase or amplitude to obtain proper operation.

These and other objects will become apparent to those skilled in the art upon consideration of the following description, with reference to the accompanying drawings wherein:

Figure 1 is a plan view of one embodiment of the instant invention,

Figure 2 is a side elevation of the structure of Figure 1,

Figure 3 is a polar graph showing typical directive patterns provided by the system of Figure 1,

Figure 4 is a schematic perspective diagram of an alternative radiator arrangement suitable for use in the system of Figure 1,

Figure 5 is a plan view of a modification of the system of Figure 1,

Figure 6 is a front elevation of the structure of Figure 5, and

Figure 7 is a plan view of a further modification of the system of Figure 1.

Refer to Figure 1. A pair of reflector screens 1 and 3 are provided, intersecting each other at an angle α in a vertical line 0—0 (see Figure 2) extending substantially through their centers. The reflector 1 comprises a large number of parallel vertical conductors 5 spaced at intervals of approximately $1/20$ wavelength or less at the lowest frequency at which the system is to operate. The reflector 3 is similar to the reflector 1, except that it is made up of horizontal conductors 7.

A doublet antenna 9 is provided in front of the reflectors 1 and 3, approximately one-quarter wavelength forward of the line 0—0. In the present illustration, the doublet 9 is of the type in which the radiator elements are secured to the end of the outer conductor 11 of a coaxial trans-

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mission line section. The conductor 11 is slotted at 13, between the radiator elements, to a point approximately one-quarter wavelength distant axially from the end of the line. The inner conductor 15 extends to the end of the line, where it is connected to the outer conductor 11 at one side of the slot 13.

The coaxial line 11, 15 extends through the reflectors 1 and 3 to a rotatable coaxial line joint 17, which may be of the type described in co-pending U. S. patent application Serial No. 494,617 filed July 14, 1943 by Donald W. Peterson and entitled Radio Frequency Rotating Joint, now Patent No. 2,465,922, granted March 29, 1949, or any other known device for coupling two coaxial line sections together for rotation relative to each other. A coaxial line 19 is connected to the coupling 17. The line 19 extends to a utilization device such as a radio transmitter or receiver, not shown. The conductor 11 is coupled by means of gears 21 and 23 to a motor 25. The motor 25 is connected to a power source, not shown.

The operation of the described system is as follows:

When the doublet 9 is in a horizontal position as shown in Figures 1 and 2, the screen 3 behaves substantially as if it were a homogeneous sheet of conductive material, reflecting energy radiated by the doublet in a relatively broad lobe generally perpendicular to the plane of the screen 3, along the line OC. This results from the fact that the electric vector of the field of the doublet 9 is parallel to the conductors 7 of the screen 3. The conductors 5 of the screen 1 are perpendicular to the electric field, and provide no paths for the flow of currents parallel to the electric vector. Thus the screen 1 is substantially "transparent" to horizontally polarized waves, and has no effect on the operation of the doublet 9 in its horizontal position.

The operation in reception is analogous to that in transmission. The reflector 3 acts to provide maximum pickup of horizontally polarized waves along the line O—C. The doublet does not respond to vertically polarized waves when in its horizontal position, and the reflector 1 has substantially no effect on horizontally polarized waves. The relationship of perpendicularity between the conductors 5 and 7 may be described as follows: Construct a plane normal to the bisector of angle BOC between the directive axes OB and OC of the radiation patterns respectively of each of reflectors 1 and 3 when operative with antenna 9. The projections on this plane of con-

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ductors 5 are normal to the projections on this same plane of conductors 7.

When the doublet is in its vertical position, the system operates with vertical polarization. The reflector 3 is "transparent," and the reflector 1 cooperates with the doublet 9 to provide a directive lobe along the line O—B, perpendicular to the screen 1 and inclined to the line OC. Referring to Figure 3, the directive pattern provided with vertical polarization is shown by the solid curve V, and the pattern provided with horizontal polarization is shown by the dash curve H.

The motor 25 continuously rotates the line section 11, 15, and with it the doublet 9. Thus the directive pattern is cyclically varied between the two lobes V and H, decreasing in one while increasing in the other, and vice versa.

Numerous modifications of the invention are possible. For example, two dipoles, crossed at right angles, may be used selectively, rather than a single rotating antenna. Referring to Figure 4, dipoles 9 and 9' are coupled through lines 41, 41' and 43, 43' respectively to points 45 and 47. The lines 41 and 41' differ in length by one-half wavelength, as do the lines 43 and 43'. Thus energy applied to the point 45 will supply the elements of the dipole 9 in opposite phase, providing a horizontally polarized field.

Energy applied to the point 47 will operate the dipole 9' to produce a vertically polarized field. The points 45 and 47 are connected by lines 49 and 51 respectively to a double-throw switch 53, which is connected to the main feed line 19. As the switch 53 is operated from one position to the other, the polarization is changed between vertical and horizontal, varying the directive axis as in the system of Figure 1.

Another crossed dipole arrangement suitable for use in the present system is that disclosed in copending U. S. patent application Serial No. 481,217 filed on March 31, 1943 by George H. Brown and entitled Antenna Systems, now Patent No. 2,374,271, granted April 24, 1945. As in the arrangement of Figure 3, the polarization may be changed by switching of a main feed line between two branch lines.

Curved or parabolic reflectors may be substituted for the flat screens of Figures 1 and 2. Referring to Figures 5 and 6, a dish-shaped reflector 61 is disposed with its focal axis along the line B—B. The reflector 61 comprises a plurality of substantially vertical conductors 65 disposed in substantially parallel planes. A reflector 63, similar to the reflector 61 but composed of substantially horizontal conductors 67, is disposed with its focal axis along the line C—C. A rotatable dipole 9, like that of the system of Figure 1, is supported by its feed line 11 at or near the intersection of the lines BB and CC. The operation of the system of Figure 5 is similar to that of the system of Figure 1, with the exception that the directive lobes are narrower owing to the concentration of the energy into beams by the curved reflectors.

Although doublet, or dipole antennas have been shown in the foregoing description of the invention, other radiator means may be substituted. Referring to Figure 7, a wave guide 81 extends through a pair of crossed reflectors 83 and 85, arranged as described above to operate with horizontally and vertically polarized waves respectively.

The wave guide 81 extends to a terminating structure 89, comprising a closure 91 and a pair

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of feed lines 93 and 95. The inner conductors of the lines 93 and 95 extend across the wave guide 81, terminating in short-circuited stub lines 97 and 99 respectively. The line 93 crosses the guide 81 horizontally, and the line 95 crosses the wave guide 81 vertically. If the line 93 is energized, horizontally polarized waves are emitted at the open end of the wave guide 81, producing a directive pattern along the line O—C. Similarly, energization of the line 93 provides maximum radiation along the line O—B. An auxiliary reflector 101 may be provided in front of the open end of the guide 81 to redirect the energy travelling directly forward, back to the reflectors.

Thus the invention has been described as an improved type of antenna system, employing differently aligned reflectors, each operative with energy polarized in a different plane. By varying the polarization of energy radiated by an antenna element in cooperative relationship with the reflectors, the axis of maximum directivity is varied.

I claim as my invention:

1. An antenna system comprising two reflectors each comprising a plurality of parallel conductors, and an antenna element, said element having, respectively with each reflector, a radiation pattern with a directive axis inclined at an angle with respect to the other said axis and intersecting therewith substantially at said element, the conductors of one reflector being arranged with the projections thereof in a plane normal to the bisector between said axes normal to those of the other reflector conductors in the same plane.

2. The antenna system claimed in claim 1, and means to vary the polarization of energy radiated or received by said element.

3. An antenna system comprising two reflectors each comprising a plurality of parallel conductors, a reflecting antenna element, and a waveguide having an opening facing said reflector element, said reflector element having, respectively with each reflector, a radiation pattern with a directive axis inclined at an angle with respect to the other said axis and intersecting therewith substantially at said open end, the conductors of one reflector being arranged with the projections thereof in a plane normal to the bisector between said axes normal to those of the other reflector conductors in the same plane, and means for varying the polarization of energization of said waveguide to vary the polarization of energization of said reflector element.

4. An antenna system comprising two reflectors each comprising a plurality of parallel conductors, and an antenna element, said element having, respectively with each reflector, a radiation pattern with a directive axis inclined at an angle with respect to the other said axis and intersecting therewith substantially at said element, the conductors of one reflector being inclined at a predetermined angle to those of the other reflector, and means for varying the polarization of said element.

5. An antenna system comprising two reflectors each comprising a plurality of parallel conductors perpendicular to those of the other of said reflectors, a doublet antenna element having, respectively with each reflector, a radiation pattern with a directive axis inclined at an angle with respect to the other said axis and intersecting therewith substantially at said doublet element, means supporting said doublet element perpen-

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dicular to the bisector of the angle formed by said axes, and means for rotating said doublet element about said bisector whereby said doublet element cooperates selectively with said reflectors to provide alternately two overlapping directive radiation patterns.

6. An antenna system comprising two reflectors each comprising a plurality of parallel conductors, and an antenna element, said element having, respectively with each reflector, a radiation pattern having a directive axis inclined at an angle with respect to the other said axis and intersecting therewith substantially at said element, the conductors of each reflector lying substantially on the surface of an idealized dish reflector and the said element lying substantially at the focal point of each said dish reflector, the conductors of one reflector being arranged with the projections thereof in a plane normal to the bisector between said axes normal to those of the other reflector conductors in the same plane.

7. The antenna system claimed in claim 6, further comprising means for varying the polarization of said element.

8. The antenna system claimed in claim 6 com-

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prising means for rotating the polarization of energization of said element about said bisector.

9. The antenna system claimed in claim 6, said element being a dipole, and further comprising means for rotating said dipole about said bisector as an axis.

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