In spite of that potential utility of radar antenna systems adapted to emit and receive only circularly polarized radiation, such antenna systems employing large linear arrays as primary radiators have previously been so cumbersome as to be impractical. Moreover, no satisfactory means was available for switching easily and rapidly from circular polarization to normal operation of the antenna system. The present invention solves that problem and provides a compact, rugged and convenient mechanism that can be converted from normal operation to circular polarization in only a few seconds.

That is accomplished in antenna systems of the type described by providing a circular polarizing grid in the primary radiation beam between the linear antenna array and the cylindrical reflector. That placement is such that the grid intercepts substantially the whole of the primary radiation beam, but is substantially wholly outside of the secondary beam reflected from the cylindrical reflector. It has been discovered that a circular polarizing grid can effectively be so positioned in the primary beam and outside of the secondary beam.

A particular advantage of that arrangement is that the polarizing grid may be placed relatively close to the antenna array, whereas the width of the beam is relatively narrow. The condition of polarization of the entire beam can therefore be controlled by a grid of compact form and light weight. It has been found that such a polarizing grid can be so mounted as to be selectively switchable to a stowed or idle position outside of both primary and secondary beams. A preferred location for that idle position is between the array and the reflector and substantially in the axial plane of the latter.

The invention further provides a circular polarizing grid of novel form, which is particularly well adapted for use in the primary beam from a linear antenna array. The form of that grid is such that it presents identically uniform structure to all portions of the wave front, regardless of the fact that the primary radiation beam is collimated in one coordinate and is divergent in the other coordinate, and hence has a cylindrical or conical wave front.

A full understanding of the invention and of its further objects and advantages will be had from the following description of an illustrative preferred embodiment of the invention in an antenna system adapted for radar operation. The particulars of that description, and of the accompanying drawings which form a part of it, are intended as illustration only, and not as a limitation upon the scope of the invention, which is defined in the appended claims.

In the drawings:

Fig. 1 is a partly schematic plan of an illustrative embodiment of the invention in a radar antenna system with vertical linear antenna array;
Fig. 2 is a fragmentary perspective illustrating a preferred type of grid structure;
Fig. 3 is an elevation, partly broken away, of an illustrative embodiment of the invention;
Fig. 4 is a section on line 4—4 of Fig. 3;
Fig. 5 is a section on line 5—5 of Fig. 3;
Fig. 6 is a section on line 6—6 of Fig. 5;
Fig. 7 is a section on line 7—7 of Fig. 6;
Fig. 8 is a section on line 8—8 of Fig. 7;
Fig. 9 is a developed section on lines 9—9 of Fig. 4, at an enlarged scale and illustrating a preferred manner of construction; and
Fig. 10 is a schematic diagram of an illustrative electric circuit for controlling the condition of the antenna system.

The antenna system of the figures includes a vertical linear array 20 of energy-radiating elements 21, which
is intended to be representative of various types of known means for producing linearly polarized radiation in the form of a beam, typically indicated at 30, that is collimated in its coordinate parallel to the array axis and that is divergent in its coordinate transverse of the array axis. Radiating elements 21 are shown illustratively as aligned dipoles which project from the electrically conductive front face 24 of the elongated rectangular array housing 22. That housing typically encloses means for supplying energy of suitable predetermined frequency to the respective dipoles of the array in correlated amplitude and phase. Such linear arrays of radiating elements and means for powering and controlling them are well known in the art, and need not be described in detail.

In the particular structure illustrated, the dipoles are so aligned that the radiation emitted by array 20 is then linearly polarized substantially parallel to the longitudinal axis of the array. The plane of Fig. 1, for example, is transverse of that direction of polarization.

The divergence of primary beam 30 in the plane of Fig. 1 is clearly shown in the figure. The primary beam is confined within an effective angle of substantially 90°; by reflection at front face 24 of array housing 22 and at the flat conductive face of reflecting fin 26, which extends parallel to the array and closely spaced from it in a plane face. For housing 22 and reflecting face 26, in the present description, the array of radiating elements 20 and the two reflective faces 24 and 26 may be considered to form a primary source of energy of known type from which the primary beam 30 is radiated. The effective axis of that energy source is midway between the array proper and its three images 25, 25' and 25" formed in the dihedral reflector 24, 26 (Fig. 4). That effective axis of the radiation source is at the corner of the dihedral angle, as indicated at 28, and will be referred to as the axis of the array.

Primary radiation beam 30, which is divergent in its transverse coordinate, is intercepted and reflected by the cylindrical parabolic reflector 40. That reflector is of a type that reflects radiation polarized both parallel and perpendicular to the length of array 20. It is ordinarily preferred that those two components of the radiation be reflected equally, and the reflector may then, for example, comprise a smooth electrically conductive reflecting face. The reflector is mounted with its focal axis parallel to, and coinciding with, source axis 28. Consequently the reflected secondary radiation beam, indicated at 32, is collimated in its transverse coordinate by the parabolic reflector, as clearly represented in Fig. 1. The initial collimation of the primary beam in its axial coordinate is not disturbed by the cylindrical reflector, and secondary beam 32 is therefore fully collimated (within the physical capacity of the equipment) and is suitable, for example, as a precision radar beam.

As illustrated, reflector 40 is an off-axis parabola, with axial plane at 41, permitting array housing 22 to be located entirely outside of the secondary beam. Whereas that arrangement is preferred, it is well known that a radiation beam of the type represented by beam 30 may alternatively be collimated by a cylindrical reflector of symmetrical parabolic shape. With either type of reflector beam the production of an accurately collimated secondary beam demands that the dimensions of the reflector be large compared to the wave length of the radiation. That is particularly true when, as in the present illustrative instance, the effective origin of the radiation includes virtual images 25 as well as the actual energy-emitting elements of array 20. Hence, the cross-sectional area of secondary beam 32 is necessarily quite large, and any means that might be inserted in that beam to alter its condition of polarization would necessarily be cumbersome, inconvenient and expensive.

In accordance with the invention, a fully collimated beam of circularly polarized radiation can be produced from a linear source of the type described without the need of altering the condition of polarization of the collimated secondary beam itself. It has been discovered that the fact that the primary beam is collimated only in one coordinate and is sharply divergent in the other coordinate, does not prevent effective transformation of its condition of polarization. On the contrary, the divergence of the beam, far from preventing control of its polarization, makes possible such control with polarizing means of remarkably compact form and light weight. The linearly polarized radiation inherently emitted by linear array 20 is transformed into circularly polarized radiation by inserting in divergent primary beam 30 a polarizing grid of suitable form in a position spaced relatively closely to array 20 and relatively width of the linearly polarizing grid is indicated in illustrative preferred form at 50. It comprises a plurality of relatively thin electrically conductive vanes between which the radiation passes. By virtue of passing through grid 50 the divergent linearly polarized beam is transformed into circularly polarized radiation, and the condition of polarization is not disturbed by subsequent reflection and collimation of the beam by reflector 40. Fully collimated beam 32 therefore consists of circularly polarized radiation. The sense of that polarization depends, in a manner to be described, upon the detailed structure of grid 50. For either sense of polarization, however, the radiation passing through the grid is caused to converge upon grid 50 and is transformed by the grid into radiation linearly polarized in the same direction as radiation emitted by array 20. Such radiation is received by the array. Incoming radiation circularly polarized in the opposite sense is transformed by grid 50 into radiation linearly polarized normal to the direction of polarization of array 20, and the array is inherently insensitive to such radiation. Hence, the entire antenna system, with grid 50 in the position indicated, selectively emits only circularly polarized radiation of a predetermined sense, and responds to incoming radiation only if it contains circularly polarized radiation of that same sense.

Figs. 2 to 10 illustrate in detail a typical preferred embodiment of the invention. Reflector 40, shown partly schematically, is mounted rigidly, but preferably adjustably, with respect to the face of frame structure 44, only a portion of which is shown in the drawings. Array housing 22 is rigidly supported with respect to frame 44 by a plurality of relatively heavy brackets 60. As illustrated, those brackets comprise a support portion 62 that is rigidly mounted by means of the mounting pad 63 on the rear of frame structure 44; and an outer portion 64 that may be adjustably related to support portion 62 by means not shown in detail, and upon which array housing 22 is rigidly mounted. Array housing 22 typically comprises an assembly of relatively heavy and accurately formed aluminum members having the exterior form of an elongated rectangular box. Offset defining pads 65 of outer bracket portions 64 engage and are secured to inner side wall 66 of array housing 22. The housing is thereby supported with its front face 24 in axial plane 41 of reflector 40.

The individual radiating elements of array 20 are illustratively shown as the dipoles 21 which may be of conventional construction and are shown somewhat schematically. As shown, those elements are aligned in closely spaced formation along a straight line closely spaced from the front face 24 of array housing 22. The longitudinal reflecting fin 26 is rigidly mounted normal to that face and closely spaced outwardly of the array of radiating elements. By bringing the reflecting face 24 and in the flat face of fin 26 produces the primary virtual images 25a and 25b, respectively, while successive reflection in those two faces produces a secondary virtual image 25c (Fig. 4). The geometrical center of those three linear images and of the array of radiating elements defines an effective axis 29 that lies in the vertex of the dihedral angle formed by the
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reflecting faces 24 and 26. That axis 28 represents the effective axis of the antenna array, and the radiation can for many purposes be considered to emanate from it. As has already been indicated, the array housing is preferably so mounted with respect to reflector 40 that array axis 28 coincides with the focal axis of the reflector. Polarizing grid 50 comprises a plurality of elongated and relatively thin electrically conductive vanes 52, which extend in uniformly spaced parallel formation across the path of primary beam 30 at an oblique angle to the direction of its linear polarization. The transverse dimension of the vanes is substantially perpendicular to the plane (cylindrical or conical) of the radiation, and hence parallel to the direction of propagation of the radiation. The radiation passes through the grid much as light is transmitted by a Venetian blind in open position. However, radiation polarized parallel to the vanes of the grid is transmitted at a higher phase velocity than radiation polarized perpendicular to the vanes. After passage through the grid, those two components of the primary beam are therefore out of phase by a definite phase difference, determined by the dimensions of the grid. Since the grid vanes are parallel to the direction of polarization of the radiation incident upon them, that radiation may be considered to be made up of two components polarized parallel to and perpendicular to the vanes, respectively, and initially in phase.

If the intensities of the parallel and perpendicular components of the radiation transmitted by the grid are equal, and if the phase difference between them is 90°, then linearly polarized radiation incident upon the grid is transformed by passage through it into circularly polarized radiation. It has been discovered that those two conditions can be effectively met, even for a radiation beam having a cylindrical or conical wave front (collimated in one plane only) by using for the first time to control the condition of polarization of a fully collimated beam by operating upon the divergent and relatively compact primary beam from which it is produced.

The ratio of the intensities of the parallel and perpendicular components entering the grid depends upon the effective degree of obliqueness of the inner vane edge with respect to the direction of polarization of the radiation. More exactly, it is found that the ratio depends upon the value of the oblique angle between the direction of linear polarization at any point of the plane wave front and the projection upon the plane of the vane edge. The two incident components are equal when that angle is 45°. However, the efficiency of transmission of the two components through the grid may be different; and the two components may further be reflected with different efficiencies by reflector 40. In order to compensate any such overall difference of transmission, reflection, and the like, it is ordinarily preferred that the described oblique angle differ from 45° in a direction to favor the more attenuated component, thereby leading to equal amplitudes of the parallel and perpendicular components actually emitted by the entire assembly. In accordance with the invention, the grid is so constructed that the described oblique angle has a substantially uniform value over the whole cross section of the incident cylindrical or conical wave front.

To produce a 90° phase difference between the two transmitted components, a definite relation must be satisfied between a of adjacent vanes, the effective width D of the vanes and the wavelength L emitted by the array. With respect to a grid for use in fully collimated radiation (plane wave front), that relation may be expressed in approximate form, neglecting, for example, end effects at the blade edges:

\[ L = \frac{8D - L}{2\pi} \times \frac{A}{D^2} \quad (1) \]

To produce a 90° phase difference while maintaining efficient matching for the parallel component, it is preferred that the further approximate relation be effectively satisfied:

\[ D = \frac{L}{\sqrt{1 - \frac{L^2}{2}}}, \quad (2) \]

Relations (1) and (2) reduce to the very simple form,

\[ a = 0.67L \quad D = 0.75L \]

Further in accordance with the present invention, the approximate relations (1) and (2) can be effectively applied also to a grid for radiation of the type described, collimated in only one coordinate (cylindrical or conical wave front), but the vane width is then measured at any longitudinal position of the vane in the plane through the array axis rather than normal to the vane edge. (It will be understood that those two manners of measurement may, under special conditions, of blade form or of position of measurement, lead to the same value.) The grid is so constructed that the vane width, measured as just described in an axial plane, is substantially uniform over the entire effective area of the grid, and effectively satisfies relations (1) and (2).

An illustrative type of grid that satisfies the described conditions and is particularly satisfactory for the described purpose is illustrated in the drawings. Whereas that type of grid is presently preferred as to both form and structure, it is not intended that the scope of the invention be limited to such particular type. As illustrated, each of the vanes 52 is so formed and mounted (in operating position) as to lie in a helical surface about source axis 28, the inner and outer longitudinal edges 53 and 54 of the vanes forming segments of helices about that axis of different radius but of equal pitch. The pitch of the vanes is such that the angle of the helical inner edge 53 is typically approximately 45°; the helix angle of outer edge 54 is somewhat less, due to its greater radius. The different helix angles of the two vane edges results in a longitudinal twist of the fully formed vane, as is clearly indicated, for example, in Figs. 2 and 3. The edges of the untwisted segments lie on circular concentric curves, the radii of which are greater than the corresponding radii of the helices they will form when twisted, the exact relation of the radii depending geometrically upon the precise helix angles of the twisted vanes.

A particular advantage of the preferred helical form of the individual vanes of the grid is the uniformity of its effect upon the radiation over the entire cross section of the primary beam. That advantage is well illustrated by the developed section of Fig. 9. That figure may be thought of as showing a portion of the grid as it would be seen by the incident radiation of divergent primary beam 30. The effective uniformity of the grid structure as so seen by the radiation is clearly represented in the figure. Because of that effective uniformity inherent in the helical form of grid, the oblique angle between the inner blade edge and the direction of polarization is uniform over the whole grid, and is given a value approximating 45° and such as to compensate any difference of attenuation of the two components in the manner already described. Furthermore, with the preferred helical form of grid, the blade width D measured in an axial plane equals the width as usually measured normal to the vane edge. The width as ordinarily measured is therefore uniform over the entire length of the blades, enhancing the simplicity and economy of the structure.

The grid shown illustratively in the figures is such as to transform radiation polarized linearly parallel to array axis 28 into left-circular polarization, in which the electric vector may be considered to be of constant magnitude and to rotate counterclockwise when viewed along the direction of propagation. A similar grid having vanes extending obliquely with respect to the direction of initial
polarization, but in the opposite sense, that is, substantially perpendicular to the direction of vanes 52, will produce right-circular polarization.

Whether the vane shape is of the preferred helical type described or not, the vanes may be conveniently mounted by securing their ends to longitudinal grid frame members, shown illustratively at 70 and 72, respectively. Upper and lower end frame pieces may be provided if desired, rigidly joining the adjacent ends of the members 70 and 72 and forming an elongated rectangular frame. However, no such end pieces are shown, since vanes 52 ordinarily provide a sufficiently rigid relation between the side members. The latter will be spoken of as forming a frame even when no end frame pieces are used. Frame members 70 and 72 comprise essentially flat strips which are somewhat wider than the vanes 52 and which lie in radial planes with respect to the array axis 28. The frame members are deeply transversely slotted in a radial direction at 71 and 73, respectively, to receive the several vanes 52, each of which typically consists of metal having a high electrical conductivity and is in the form of a sheet that is either continuous or of sufficiently fine structure to be effectively continuous. The vane ends, after passing through those slots, are bent sharply and then lie flatly against the back face of the members, as shown at 74 and 75, where they are rigidly held by elongated keeper plates 76 and 77, respectively, and by rivets 80 or the like. Reinforcing flanges are preferably provided on the frame member 70 and 72. As shown, member 70 is thus reinforced along its radially outer edge by the flange 78 and member 72 is similarly reinforced along its inner edge by the flange 79.

In operating position of grid 50, shown in solid lines in the figure, frame member 70, or, more accurately, its keeper plate 76, rests flatly on front face 24 of array housing 22, while grid frame member 72 is supported in spaced relation to that housing, as by the brackets 82. Those brackets may conveniently be mounted on the back face of reflecting fin 26. If the antenna system is always required to be in circularly polarizing condition, grid 50 may be rigidly mounted in that position, as indicated schematically in Fig. 1.

However, in accordance with a further aspect of the invention, the polarizing grid is so mounted that it is readily shiftable between such an operating position as just described and an idle position in which it is substantially or wholly clear of both primary and secondary radiation beams. Figs. 3 to 10 show illustrative means for shifting the grid in that manner. Whereas that typical means, which involves swinging movement of the grid about an axis, is preferred, the swinging movement of the grid is not necessarily of that type.

In the present illustrative embodiment, a shaft 85 is journaled with respect to array housing 22 by the shaft brackets 90. As shown best in Figs. 3 and 5, brackets 90 include a large flat pad 92 adapted to be bolted to the rear face of array housing 22, and a defining boss 94 adapted to engage inner face 66 of the housing. A bracket arm 95 supports the journal 96, which comprises a recess for shaft 85 and a confining cover plate 97. The longitudinal position of the shaft is defined with respect to brackets 90 as by the collars 98 and thrust bearings 99. The shaft is thereby journaled on a vertical axis between array housing 22 and reflector 40 and slightly back of the plane of front face 24 of the housing, which is also the axial plane 41 of the reflector. In the particular arrangement illustrated, the shaft axis passes through the forward portion of brackets 60, which support the array housing 22 with respect to frame structure 65.

The shaft is offset in the neighborhood of those brackets, as indicated at 84, to prevent interference with the brackets within the required angular range of its movement.

The polarizing grid 50 is mounted on shaft 85 in any suitable manner for swinging movement about the shaft axis. The preferred mounting means illustrated is particularly advantageous in that it defines rigidly the radial position of the grid with respect to the shaft and defines a definite range of angular positions within which a normal angular position is resiliently urged but not rigidly maintained.

In the illustrative form shown, the grid is supported with respect to shaft 85 by a plurality of bracket assemblies 100. Each bracket assembly 100 includes an anchor member 102, which is fixedly mounted on shaft 85 as by the clamping plate 104 and the key 106 (Fig. 8); and a bracket member 110 upon which the grid is fixedly supported by the bracket plate 115. Bracket member 110 is rotatably mounted on shaft 85, as by a journal recess and a cover plate 112 that confines the shaft within the recess without clamping it. Cover plate 112 carries an arm 113 that extends longitudinally of shaft 85 and is supported by a web 114 on member 110. Arm 113 provides a longitudinal side face to which the bracket plate 115 is fixedly mounted (Figs. 6 and 8). Bracket plate 115 is bolted directly to the face of grid frame member 70, being slotted at 116 as may be required to clear grid vanes 52.

The rotational position on shaft 85 of bracket member 110 is resiliently related to that of anchor member 102 by the typical means now to be described. A generally circumferential recess 120 in bracket member 110 contains two coil springs 122 and 123, which are retained in the recess by the adjacent axial face 125 of anchor member 102 (Fig. 8). The latter member carries a post 105 that lies between, and is yieldingly positioned by, the adjacent opposed ends of springs 122 and 123. Members 102 and 110 may be retained in correct relation longitudinally of shaft 85 by the screw 108, which is received by a circumferentially elongated slot 125 in bracket member 110 and is threaded into the end of post 105. The length of slot 125 permits relative rotational movement of members 102 and 110 within a definite angular range, and cooperates with screw 108 to provide a positive stop at the limits of that range. Within that limited range, springs 122 and 123 yieldingly urge the members toward an equilibrium rotational relation, typically such that the springs are of equal length.

As shown, particularly in Figs. 6 and 7, shaft 85 and anchor member 102 are in such rotational position as to compress spring 122 more than spring 123, thereby yielding a clockwise torque upon member 110 and hence upon the entire polarizing grid. The grid is thereby yieldingly urged into accurately defined position against positive stops. Such a stop may be provided by the forward edge of plate 82, which is fixedly, and preferably adjustably, mounted on reflecting fin 26 in position to engage flange 79 of grid frame member 72. A stop formation such as plate 82 is preferably provided adjacent each of the respective grid bracket assemblies 100, so that the torque exerted by the latter upon the grid frame is in each instance taken up by a stop directly opposite the point of its application, thereby minimizing distortion of the grid frame. Alternatively, for example, stops 82 may comprise a single continuous member extending substantially the entire length of the array. As illustrated, the other grid frame member 70 may also be positioned by abutting front face 24 of array housing 22.

With the described illustrative structure, the polarizing grid may be shifted out of operating position by rotation of shaft 85 through a definite arc, as may be seen in Figs. 4-5, for example, that rotation is counterclockwise, and is somewhat less than 180°. The grid is thereby shifted to an idle position, typically shown in phantom lines at 50c in Fig. 4. In that idle position, the grid is between array 20 and cylindrical reflector 40, closely adjacent the latter, and lies close to axial plane 41 of the reflector. The preferred idle position is substantially back of that plane (above it as seen in Fig. 4), so that no appreciable part of the grid or its supporting
structure extends into the radiation field of the antenna system. That radiation field, including both primary and secondary beams 30 and 32, is somewhat spaced from axial plane 41 because of the shielding action of reflecting fin 26, which necessarily extends somewhat forward of that plane. Positive stops may be provided to define accurately a definite idle position such as 50a. However, since that position is ordinarily not critical, no such stops are usually required.

Illustrative means are indicated at 130, linked to shaft 85 by the coupling means 129, for selectively shifting the grid between operating and idle positions. The means 130 may be considered to represent schematically any suitable mechanism for manually rotating the shaft selectively between its two positions. Alternatively, and in preferred form, an electrical actuator is provided at 130, comprising typically a reversible electric motor linked via suitable reduction gearing to shaft coupling 129 and provided with suitable movement limiting devices. Such a typical control system is shown schematically in Fig. 10. The reversing dual winding direct current motor is indicated at 132, with mechanical connection to shaft 85 indicated at 133. Energization of winding 134 of motor 132 drives shaft 85 in a direction to carry grid 50 from its operating position, indicated in solid lines, to its idle position, indicated in phantom lines at 50a. Energization of motor winding 135 drives the opposite direction. Double throw limit switches are indicated at 136 and 137, having their switch arms normally in upper position and being selectively actuated to lower position by shaft 85 when in active and idle positions, respectively. A source of electric power, shown illustratively as 28 volts direct current, is connected via a push button control switch 140 and the winding of a first relay 142 to ground; via the switch of relay 142 and the coil of a second relay 144, which is a stepping relay having two steps, to ground; and to the switch arm of the stepping relay. The step contacts 145 and 146 of the stepping relay are connected to the respective arms of limit switches 136 and 137. The normally closed contacts of those switches are connected to the motor windings 135 and 134, respectively; and their normally open contacts are connected through signal lamps 147 and 148, respectively, to ground.

Fig. 10 shows the apparatus in normal operating condition, with grid 50 in polarizing position. Signal lamp 147 is relay switch contact 145 and limit switch 136, which is actuated by presence of shaft 85 in its operating position. The system is stable in that condition, since power circuits to motor coils 134 and 135 are open at relay contact 146 and at limit switch 136, respectively. To shift the system to idle condition, with grid 50 in position 50a out of the radiation field, it is only necessary to press momentarily control switch 140, which, with signal lamps 147 and 148, may be remotely positioned from the rest of the apparatus. Relay 142 is thereby energized, actuating stepping relay 144 and shifting its switch arm from contact 145 to contact 146. Signal lamp 147 is immediately turned out and power is supplied via limit switch 137 to motor winding 134. The motor drives shaft 85 until the polarizing grid reaches idle position 50a and the shaft trip limit switch 137. That cuts off power to the motor and lights signal lamp 148, indicating idle position of the grid. A second momentary closure of control switch 140 returns the system to the condition shown in Fig. 10.

Limit switch 136 is preferably set to be tripped by shaft 85 when the latter has reached such a position as is shown in Fig. 6, with grid 50 held against stops 82 by relative compression of spring 122, as already described. The operating position of the grid is thus determined by the position of stops 82, which are accurately adjustable and of rugged construction, rather than by the setting of limit switch 136, which therefore does not require precise adjustment.

The axial length of the antenna array and reflector may vary widely within the scope of the invention, being determined in practice by such factors as the degree of collimation that is required of the emitted radiation in the axial coordinate. Such variability is indicated schematically by the horizontal break in Fig. 3. Whatever the length of array 20, grid 50 is correspondingly dimensioned to intercept substantially the whole of the primary beam. Whereas Fig. 3 shows explicitly only two array supports 60, two shaft journals 90 and two grid support assemblies 100, further such units may be provided as required.

It is typical of linear arrays of the type described that their emitted beam radiation collector is in its axial coordinate as already stated, may not be directed exactly normal to the array axis, and may even form an appreciable, and perhaps a variable, oblique angle with respect to a plane normal to the array axis. Whereas that circumstance may affect the condition of polarization of the radiation in radian degree, it does not affect the fundamental principles of the invention nor appreciably alter the action of the antenna system as described.

We claim:

1. Antenna means for producing a beam of substantially circularly polarized radiation of a predetermined radio frequency, comprising a linear antenna array acting to project a primary radiation field that is linearly polarized and that is collimated in its axial dimension and divergent in its transverse dimension, a concave cylindrical reflector spaced from the array in the primary radiation field, the array axis lying substantially in the focus of the reflector, whereby the secondary radiation field reflected by the reflector is collimated in both said dimensions, and a grid between the array and the reflector, the grid being spaced relatively close to the array and relatively far from the reflector and intercepting substantially all of the primary radiation field and lying substantially outside of the secondary radiation field, said grid acting to transform the linearly polarized radiation of the primary field from plane polarized into substantially circularly polarized radiation, and the cylindrical reflector acting to alter the condition of collimation of that radiation while maintaining its condition of circular polarization.

2. Antenna means for producing selectively either linearly or circularly polarized beam radiation of a predetermined radio frequency, comprising a linear antenna array acting to project a primary radiation field that is linearly polarized parallel to the axis of the array and that is collimated in its axial dimension and divergent in its transverse dimension, a concave cylindrical parabolic reflector spaced from the array in the primary radiation field, the array axis lying substantially in the focus of the reflector, whereby the secondary radiation field reflected by the reflector is collimated in both said dimensions, and a grid selectively switchable between an operating position in the primary radiation field and substantially outside of the secondary radiation field and an idle position substantially outside of both primary and secondary radiation fields, the grid acting when in its said operating position to transform the linearly polarized radiation of the primary field into circularly polarized radiation.

3. Antenna means as defined in claim 2 and in which the grid in idle position lies substantially in the axial plane of the reflector between the array and the reflector.

4. Antenna means as defined in claim 2 and in which the grid is mounted for selective pivotal movement about a pivot axis parallel to the array axis and spaced from the array toward the reflector substantially along the axial plane thereof.

5. Antenna means for producing selectively either linearly or circularly polarized beam radiation of a predetermined radio frequency, comprising a linear antenna array acting to project a primary radiation field that is...
linearly polarized parallel to the axis of the array and that is collimated in its axial dimension and divergent in its transverse dimension, a concave cylindrical parabolic reflector spaced from the array in the primary radiation field, the array axis lying substantially in the focus of the reflector, whereby the secondary radiation field reflected by the reflector is collimated in both said dimensions, and a grid mounted for swinging movement about a pivot axis parallel to the array axis between an operating position in the primary radiation field and substantially outside of the secondary radiation field and an idle position substantially outside of both primary and secondary radiation fields, stop formations positively mounted with respect to the said array and cooperating with the grid to define its said operating position, and yielding means for swinging the grid about the pivot axis into engagement with the stop formations, the grid act- ing when in its said operating position to transform the linearly polarized radiation of the primary field into circularly polarized radiation.

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