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2,680,810

MICROWAVE ANTENNA SYSTEM

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FIG. 1

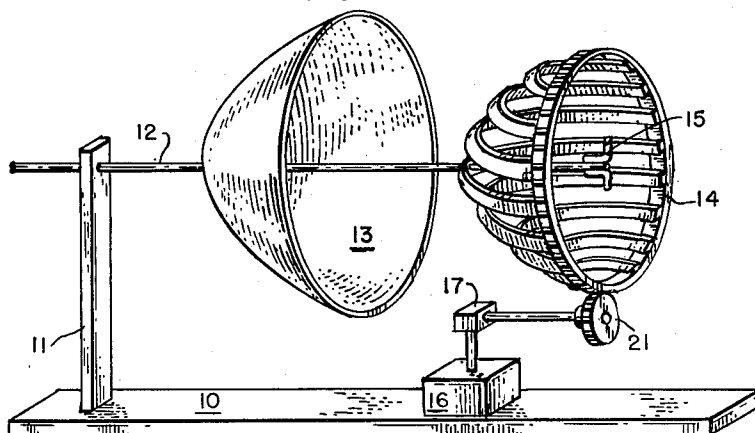


FIG. 2

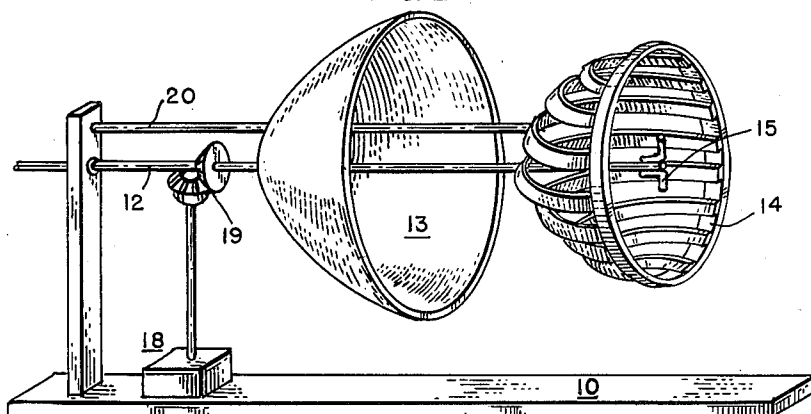
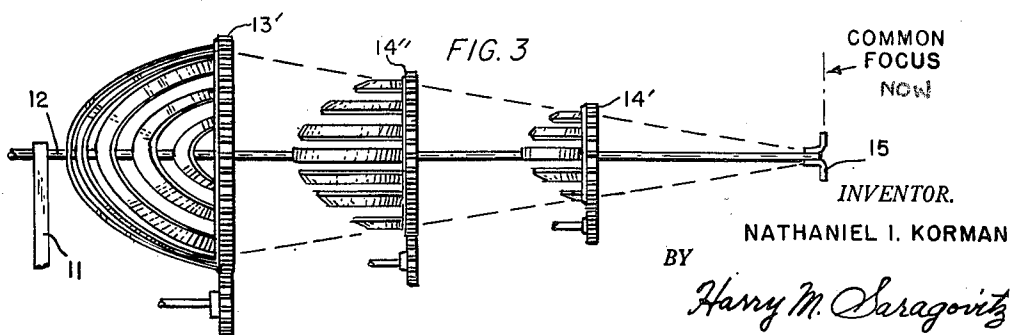


FIG. 3



UNITED STATES PATENT OFFICE

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This invention relates to antenna systems and more particularly to microwave directional beam antenna systems.

The object of this invention is to provide a simple antenna system whereby directional radio frequency energy beams of more than one width can be produced from the same transmitting source.

Other objects of this invention will appear in the following description and appended claims, reference being had to the appended drawings wherein Fig. 1 illustrates one embodiment of this invention wherein directed beam width is controlled by reflector rotation, Fig. 2 illustrates a second embodiment of this invention wherein directed beam width is controlled by rotation of a polarized transmitting source and Fig. 3 illustrates a third embodiment of my invention. Like reference numerals indicate like components in the figures.

Referring to Fig. 1, a supporting frame 10 has rigidly mounted thereon a supporting column 11 to which shaft 12 is rigidly fixed. Reflectors 13 and 14 are mounted on shaft 12 which also supports polarized transmitting means 15. Transmitting means 15 may be a dipole or any other microwave transmitter yielding polarized electro-magnetic waves. Reflector 13 is rigidly fixed to shaft 12 and shaft 12 is journaled in reflector 14 so that reflector 14 is free to rotate about shaft 12. Motor 16 is geared to reflector 14 through gear train 17 and gear 21 in such manner that it will successively and selectively rotate reflector 14 90° about shaft 12 and return it to its original position. Reflector 14 is of slatted polarized construction of the type described in Patent #2,522,562 so that in its normal position, it will reflect the polarized output of transmitting means 15 and when rotated 90° about shaft 12 by motor 16, no effect will be had on the said polarized output of transmitting means 15 by reflector 14. Reflectors 13 and 14 are preferably parabolic though they may take the form of other configurations, such as hyperbolas, without departing from the spirit of this invention. In any event, reflectors 13 and 14 are so mounted on shaft 12 that their axes and foci substantially coincide. Transmitting means 15 is placed at their coincident focus. One critical relationship that must be incorporated in the design of the two reflectors, is that the ratio of diameter to focal length of the reflector placed closest to the transmitting means must be as great or greater than the ratio of diameter to focal length of the reflector farthest removed from the transmitting

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means. This is necessary in order that when the reflector closest to the transmitting means is operating as a reflector, it effectively blocks off any and all generated electro-magnetic waves from the reflector farthest removed from the transmitting means. It will be readily apparent from a discussion of the operation of the antenna system here described that more reflectors may be added to increase the number of beam widths which may be attained as long as the ratio of diameter to focal length of each reflector in the system remains the same or the ratios of the several reflectors are arranged in descending order as they progress away from the common focus.

In the operation of a system according to this invention and as illustrated in Fig. 1, a polarized electro-magnetic wave is propagated by transmitting means 15. The electro-magnetic wave is reflected by reflector 14 which is so oriented on shaft 12 that its conductors are parallel to the electric field produced by transmitting means 15 and consequently a relatively wide beam is produced. Such a beam is suitable for scanning in typical radar units. Once an object is located roughly by the wide beam produced in the above manner and a narrow beam is desired for more exactly locating the object, or for any other reason, motor 16 is energized to rotate reflector 14 90° about shaft 12 by means of gear train 17 and thus cause the conductors of reflector 14 to become perpendicular to the polarized electric field produced by transmitting means 15, which in turn causes reflector 14 to be transparent with respect to said electric field whereupon the electro-magnetic waves propagated by transmitting means 15 are allowed to flow unimpeded to reflector 13 and be reflected by said reflector 13. Reflector 13 having a larger diameter produces a narrower directional beam. In order to return the system to wide beam operation, motor 16 is again energized and operating through gear train 17 rotates reflector 14 about shaft 12 to its original position causing said reflector 14 to again reflect thus blocking off reflector 13 and returning the system to wide beam operation.

The above description indicates the expedient of using a number of slatted reflectors mounted on the same shaft one behind the other, as illustrated in Fig. 3, in order to secure a number of beam widths and only two conditions are necessary to produce satisfactory operation with a plurality of reflectors greater than two. They are, first, all reflectors closer to the common focus than the reflector producing the desired

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beam width must be so rotated on the common supporting shaft that their conductors are perpendicular to the polarized electric field produced by the transmitting means and second, the reflectors must all have the same ratio of diameter to focal length or the reflectors must be arranged so that the ratio of diameter to focal length of any reflector is equal to or greater than the ratio of diameter to focal length of any reflector further from the common focus than itself. This second requirement is necessary in order that any reflector, when actually operating as a reflector, will block off all other reflectors more distant from the focus than itself and thus prevent possible interference from the more distant reflectors.

All reflectors utilized in a system according to this invention may be of slatted construction, if such construction is desirable for lightness or to reduce wind resistance, but only one reflector of any such system may be of solid construction and such solid reflector must be the furthest removed from the common focus in order to preserve the possibility of intermediate reflectors acting in the dual capacity of reflectors and transparent screens dependent only on their relative angular position.

Fig. 2 illustrates a second embodiment of this invention wherein selection of beam width is dependent on angular position of a transmitting source of polarized electro-magnetic waves. In Fig. 2 the system of slatted reflectors is mounted on the same type of frame as in Fig. 1, but shaft 12 is journaled in both reflectors so as to be free to rotate while said reflectors remain in fixed angular position. Transmitting means 15 is again rigidly fixed to shaft 12 and shaft 12 is journaled in support column 11 so as to be free to rotate. Motor 18 is geared to shaft 12 through gear train 19 so as to successively and selectively rotate shaft 12 90° with respect to reflectors 13 and 14 and return it to its original position. Rigid support 20 is provided to maintain reflectors 13 and 14 in fixed angular relation to support column 11 and to one another. Reflector 13 may be of either slatted or solid construction and reflector 14 is of slatted construction. If slatted construction is used for reflector 13, reflectors 13 and 14 are positioned relative to one another by rigid support 20 so that their conductors lie in planes perpendicular to each other.

In the operation of a system according to this invention and as illustrated in Fig. 2, a polarized electro-magnetic wave is propagated by transmitting means 15. The electro-magnetic wave is reflected by reflector 14 which is so oriented on shaft 12 that its conductors are parallel to the electric field produced by transmitting means 15 and consequently a relatively wide beam is produced. When a narrow beam is desired, motor 18 is energized to rotate transmitting means 15 90° with respect to reflectors 13 and 14 by means of gear train 19 and shaft 12, which causes the electric field produced by transmitting means 15 to become perpendicular to the conductors of reflector 14. The perpendicular relationship of the electric field to the conductors of reflector 14 causes reflector 14 to become transparent to the electro-magnetic wave produced by transmitting means 15 so that the wave flows through reflector 14 to reflector 13. Reflector 13 being of either solid construction or slatted construction with its conductors displaced 90° from the conductors of reflector 14, then acts as a reflector to the generated wave, which passes through reflector 14, and

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produces the desired narrow beam. To return the system to wide beam operation, motor 18 is again energized which rotates shaft 12 through gear train 19 causing transmitting means 15 to return to its original position which in turn causes reflector 14 to become operative and wide beam operation to be resumed.

When transmitting means rotation is utilized to select beam width, a maximum of two reflectors can be used, as reflectors in the system must operate in either a fully reflecting capacity, or as a transparent screen.

As many apparently widely different embodiments of this invention may be made without departing from the spirit and scope hereof, it is to be understood that the invention is not limited to its specific embodiments except as defined in the appended claims.

What is claimed is:

1. In a microwave antenna system, the combination comprising a plurality of slatted parabolic reflectors of different diameter having the same ratio of focal length to diameter, means for positioning said reflectors relative to one another so that their axes and foci coincide, and means to rotate said reflectors relative to one another for control by polarization of radio frequency energy reflection by said reflectors.

2. In a microwave antenna system, the combination comprising a plurality of parabolic reflectors at least one of which is of solid construction, the remaining reflectors being of slatted construction, means for positioning said reflectors relative to one another so that their axes and foci coincide, and means to rotate said reflectors relative to one another for control by polarization of the radio frequency energy reflection by said reflectors.

3. In a microwave antenna system, the combination comprising a plurality of slatted parabolic reflectors of different diameters having the same ratio of focal length to diameter, means for positioning said reflectors relative to one another so that their axes and foci coincide and so that their directrices lie on the same side of their common foci, and means to rotate said reflectors relative to one another for control by polarization of the radio frequency energy reflection by said reflectors.

4. In a microwave antenna system, the combination comprising a first directional reflector and a second directional reflector, said second directional reflector being of slatted construction and having a ratio of diameter to focal length at least as great as the ratio of diameter to focal length of said first directional reflector, said first and second reflectors being axially positioned relative to one another so that their foci and axes coincide, polarized transmitting means directed by said first and second reflectors, and means to rotate said second directional reflector relative to said first directional reflector.

5. In a microwave antenna system, the combination comprising a first directional reflector and a second directional reflector, said second directional reflector being of slatted construction and having a ratio of diameter to focal length at least as great as the ratio of diameter to focal length of said first directional reflector, said first and second reflectors being axially positioned relative to one another so that their foci and axes coincide; polarized transmitting means directed by said first and second reflectors, and means to rotate said polarized transmitting means relative to said directional reflectors.

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6. In a microwave antenna system, a plurality of axially aligned parabolic reflectors of different diameter and having substantially the same ratio of focal length to diameter, at least one of which is of solid construction, the remaining reflectors being of slatted construction, said reflectors being so spaced relatively to each other that their foci coincide, polarized radio-frequency energy transmitting means mounted at said coincident focus, and means for relatively positioning said reflectors with respect to said polarized energy source whereby only one of said reflectors is responsive to said polarized radio-frequency energy.

7. In a microwave antenna system, a plurality of axially aligned parabolic reflectors of different diameter and having substantially the same ratio of focal length to diameter, at least one of which is of solid construction, the remaining reflectors being of slatted construction, said reflectors being so spaced relatively to each other that their foci coincide, polarized radio-frequency energy transmitting means mounted at said coincident focus, and means for rotating said reflectors relative to one another whereby only one of said reflectors is responsive to said polarized radio-frequency energy.

8. A microwave antenna system for producing relatively wide and narrow beams comprising, a plurality of axially aligned reflectors of successively increasing diameter, all except the largest of said reflectors being of slatted construction, said reflectors being so spaced relative to each other that their foci coincide, a polarized radio-

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frequency energy source mounted at said coincident focus, said reflectors having the same ratio of diameter to focal length, and means for axially rotating said reflectors relative to one another whereby only one of said reflectors is responsive to said polarized radio-frequency energy.

9. A microwave antenna system for producing relatively wide and narrow beams comprising, a plurality of axially aligned reflectors of successively increasing diameter, all except the largest of said reflectors being of slatted construction, said reflectors being so spaced relative to each other that their foci coincide, a polarized radio-frequency energy source mounted at said coincident focus, said reflectors being so arranged that the ratio of diameter to focal length of any one reflector is at least equal to the ratio of diameter to focal length of any reflector further from said coincident focus than said one reflector, and means for axially rotating said reflectors relative to one another whereby only one of said reflectors is responsive to said polarized radio-frequency energy.

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