343-750 CROSS REFERENCE SEARCH ROOM

Oct. 24, 1961 C. H. CHANDLER 3,005,983

FOCUSSING AND DEFLECTION OF CENTIMETER WAVES

Filed Oct. 30, 1947

Fig. 1.

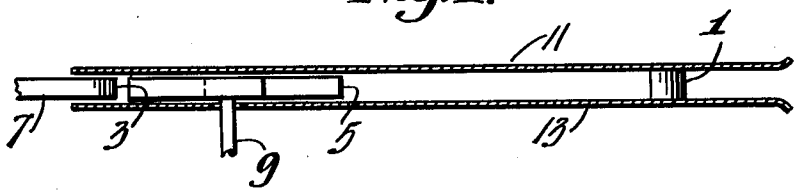


Fig. 2.

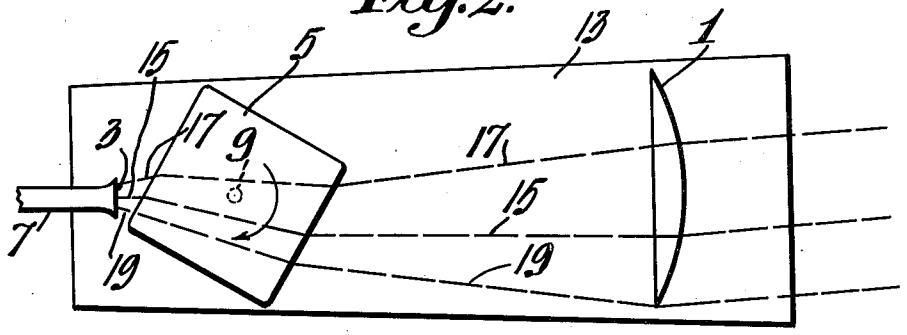


Fig. 3.

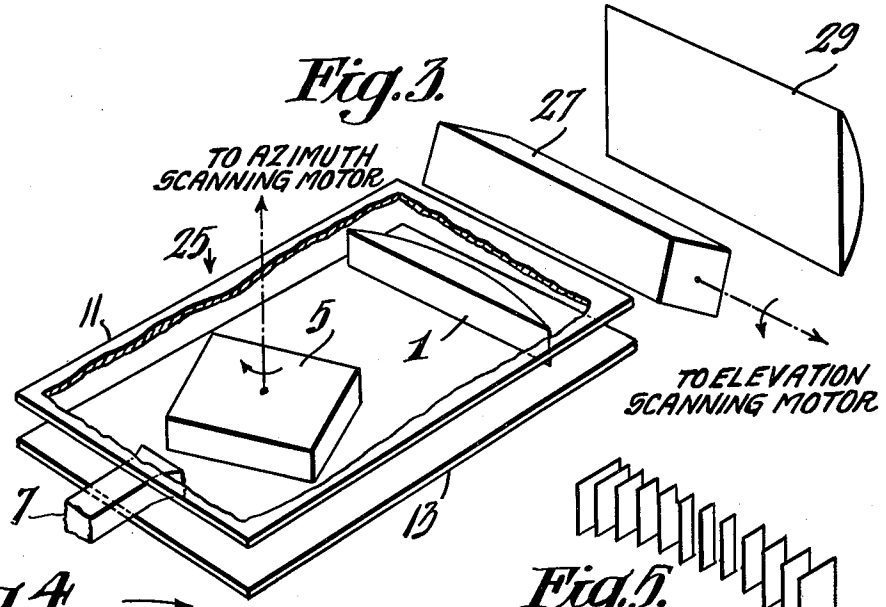


Fig. 4.

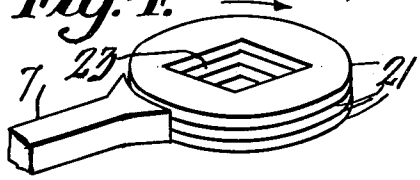


Fig. 5.

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United States Patent Office 3,005,983 Patented Oct. 24, 1961

3,005,983

FOCUSSING AND DEFLECTION OF CENTIMETER WAVES

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Filed Oct. 30, 1947, Ser. No. 783,174
6 Claims. (Cl. 343—753)

This invention relates to improvements in scanning antennas, more particularly to antennas for use with wave lengths of the order of one to ten centimeters. For radar and similar purposes it is sometimes required to scan with a radio beam, moving the beam cyclically throughout a certain angle. Ordinarily the beam must be as narrow as possible, at least in its direction of scanning motion, in order to provide good angular definition.

It is the principal object of this invention to provide improvements in methods and apparatus for producing and cyclically varying the direction of a radio beam.

Another object is to provide a system of the described type wherein the scanning is such that the beam moves continuously from one of its extreme positions to the other, then starts immediately at the first position and repeats the motion. Such scanning is referred to as "saw-tooth" fashion because a graph of the angular position of the beam as a function of time looks like an unsymmetrical saw-tooth.

A further object of this invention is to provide apparatus for effecting the foregoing objects without involving any reciprocatory or vibratory motions.

The invention will be described with reference to the accompanying drawing, wherein:

FIGURE 1 is a view in elevation of a scanning antenna system which embodies the invention,

FIGURE 2 is a plan view of the structure of FIG. 1 with a portion removed to disclose the internal construction,

FIGURE 3 is a pictorial view of a modification of the device of FIG. 1 for scanning in two orthogonal coordinates simultaneously,

FIGURE 4 shows a modification of one of the elements of FIG. 1, and

FIGURE 5 shows a modified lens structure.

The apparatus of FIGS. 1 and 2 includes a lens 1, a radiator (or collector) 3, and a refracting member 5. The lens 1 is a section of a vertical cylinder of material such as polystyrene, sulphur, paraffin, or other dielectric material. The radiator 3 is, in the present example, the mouth of a wave guide 7 flared somewhat to act as a horn. The term "radiator" in the present discussion is intended to mean a structure or device which can radiate or transmit, even though it may be used to collect, or receive.

The refracting member 5 is a square plate or block of dielectric material similar to that of the lens 1. The member 5 is supported at its center on a vertical shaft 9 whose axis intersects the principal axis of the lens 1. The radiator 3 and the refracting member 5 are so placed that the apparent source of radiation is substantially at the focus of the lens 1, and the member 5 lies between the radiator and the lens. Sheets 11 and 13 of conductive material are provided above and below the assembly to confine the field substantially to a plane.

The operation of the described device for directive transmission is as follows: Energy emerging from the mouth of horn 3 diverges somewhat in the horizontal plane, but is confined vertically between the sheets 11 and 13.

With the refractive element 5 in the position shown in FIG. 2, the central ray 15 strikes it obliquely and is refracted as shown, emerging at a line parallel to its

incidence but displaced with respect thereto. Other diverging rays such as 17 and 19 from the source 3 are likewise refracted, being displaced in the same direction and by substantially the same amount as the ray 15. The rays 15, 17 and 19 after refraction appear to come from a source to the right of the actual source 3. The apparent displacement of the source depends upon the angular position of the element 5, being zero when the surfaces where the rays enter and leave are perpendicular to the line between the center of the source 3 and the center of the element 5.

The lens 1 operates like any other convex lens to bring the divergent rays 15, 17 and 19 into parallelism, thus providing a beam which is extremely narrow in azimuth. Owing to the fact that the aperture between the sheets 11 and 13 is relatively small, the beam provided by the structure of FIGS. 1 and 2 is wide in elevation. As the refracting member 5 is rotated continuously, this fan-like beam is swung in azimuth from one extreme position to the other. With the element 5 rotating clockwise as shown in FIG. 2 the fan beam starts at a position to the left of the principal axis of the lens 1, moves continuously to the extreme position to the right of the principal axis, then reappears at the extreme left position. The instantaneous azimuth of the beam is approximately proportional to the angular displacement of the member 5 from a reference position.

The lens 1 need not be of the solid dielectric type shown in FIG. 1, but may comprise a plurality of parallel metal fins or sheets, as shown in FIG. 5. The parallel sheets behave somewhat like a body of dielectric having a refractive index less than unity. Accordingly, the curvature of the surface is made concave as shown in FIG. 5 to provide the characteristics of a converging lens. The planes of the sheets are parallel to the direction of propagation and to the electric vector of the energy.

The principle of the metal fin lens may be applied also to the rotating refractive member. FIG. 4 shows a stack of parallel metal plates 21 each provided with a square central opening 23. The structure of FIG. 4 acts like a body of material having a dielectric constant less than 1 surrounding a prismatic space having unity dielectric constant. The device of FIG. 4 will operate substantially like the solid dielectric body described in FIG. 1 to deviate the incident rays by an amount which depends upon its angular position. This structure has the advantage of requiring less material and having less weight than the solid dielectric block.

Although the structure of FIG. 1 scans only in azimuth it will be apparent that a substantially identical arrangement may be used for scanning in elevation. Referring to FIG. 3, an assembly 25 like that of FIG. 1 is directed toward a further block 27 of refractive material which rotates about a horizontal axis. The cylindrical lens 29 is positioned in front of the block 27. The lens 29 is curved about a horizontal axis and thus serves to concentrate energy vertically i.e. within substantially a horizontal plane.

The fan beam emerging from the structure 25 illuminates the block 27. The apparent horizontal position of source 7, considering energy emergent from block 5, goes from one side to the other as the member 5 rotates. The block 27 displaces the apparent source of the fan beam in a vertical direction, the displacement being in saw-tooth fashion as the block 27 rotates continuously. The resultant radiation from the lens 29 comprises a narrow beam, sharp both in azimuth and in elevation, which swings from side to side as the block 5 rotates and swings up and down as the block 27 rotates. In order to scan successively through substantially all directions within a solid angle, the rotation of one refractive member may be at a much greater rate than that of the other.

We claim as our invention:

1. A scanning system for radiant electromagnetic energy comprising a focusing device, a transducer radiator element, said radiator element and focusing device being arranged for the passage of said energy therebetween, and a stack of spaced metallic plates parallel to a component of the polarization of said energy, said plates having openings therein with aligned polygonal oppositely parallel straight edges and being positioned for the passage of said energy therethrough in a direction parallel to said plates between said focusing device and said radiator element.

2. A scanning system for radiant electromagnetic energy comprising a focusing device, a transducer radiator element substantially at the focal point of said focusing device, said element and device being arranged for the passage of said energy therebetween, and a stack of spaced metallic plates parallel to a component of the polarization of said energy, said plates having openings therein with aligned polygonal oppositely parallel straight edges and being positioned for the passage of said energy therethrough in a direction parallel to said plates between said focusing device and said radiator element.

3. The scanning system claimed in claim 2, said openings and said plates being rectangular.

4. The scanning system claimed in claim 2, said openings of said plates being square.

5. A scanning system for radiant electromagnetic energy comprising a focusing device, a transducer radiator element substantially at the focal point of said focusing device, said element and focusing device being arranged for the passage of plane polarized electromagnetic energy therebetween, and a stack of spaced metallic plates parallel to the plane of polarization of said energy, said plates having aligned circular outer edges the centers of which are substantially on an axis normal to said plane of polarization and having aligned square openings the centers of which lie substantially on said axis, said stack of plates being positioned for the passage of said energy therethrough in a direction parallel to the plates between said focusing device and said radiator element.

6. The scanning system claimed in claim 5, said stack of plates being unitarily rotatable about said axis.

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