VERTICAL SCANNING ANTENNA-REFLECTOR SYSTEM

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Fig. 1.

Fig. 2.

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VERTICAL SCANNING ANTENNA-REFLECTOR SYSTEM

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1. This invention relates to radio antennas and more particularly to a radiating antenna array which is the means for carrying out an effective method for producing an improved intermediate angular zone vertical field pattern.

In certain applications of the radio communication art and particularly in radio obstacle detection systems, periodically transmitted impulses which are reflected from the objects to be located, are employed, for instance, in locating aircraft approaching at various heights and angles with respect to an observer.

In previous systems of this type it was found that at certain given frequencies of transmission vertical coverage was obtained by means of various antenna arrays which were effective in covering an angle with respect to the horizon from the horizontal up to about 10 to 15 degrees.

These previous systems clearly lacked an adequate field coverage for aircraft approaching toward the observer, that is, one changing its angle with the horizontal from a low value say from 15 degrees to an angle increasing to 60 degrees as it approached and passed the observer.

In view of the aforesaid conditions in the prior art, various methods were tried in order to be able to follow an approaching plane as its angle with the horizon increased at its approach toward the observer. One method such as the variation of a given transmitting frequency is effective in causing the displacement in a vertical plane of a high intensity portion of a given vertical radiation pattern from a position of low angularity toward the vertical. However, variation in frequency of this type with conventional antenna arrays required apparatus, which became rather complicated if certain other necessary requirements were to be met. This drawback resulted in the preference for so-called antenna arrays involving a radiator with a paraboloid reflector. This, too, however, did not provide an adequate coverage of the desirable angular zone as it lacked in its radiation pattern the required vertical directivity.

It is accordingly an object of this invention to provide an antenna array which produces a radiation pattern having an improved field intensity in the middle and upper angular vertical zone.

It is another object of this invention to provide an antenna array including a paraboloid reflector which is so formed as to produce a vertical angular directivity in the resulting radiation pattern.

It is a further object to provide an improved method and means for scanning a given vertical angular zone by progressively displacing a directed portion of a given radiation pattern.

2. In accordance with a feature of my invention I provide an array which consists of a radiator and a reflector which in a particular case may be of modified paraboloidal form. This particular form may be regarded as a dished paraboloid from which there has been cut away a segment from an outer edge and the corresponding surface. This configuration of the reflector with the cutaway sector disposed on the top causes a bulging out of a vertical field intensity loop which is located in the intermediate angular zone between 15 and 75 degrees with respect to the horizontal. This middle angle loop of the radiation pattern in accordance with my invention may be varied in the location of its maximum intensity from the lower portion of this zone toward the vertical by means of a variation in the transmitting frequency causing a successive scanning of the entire middle angular zone. Thus, any craft approaching toward or receding from the observer may be closely and successively followed at the point of observation.

These and other features and objects of the invention will become apparent upon consideration of the following detailed description of an embodiment of the invention to be read in connection with the accompanying drawings in which:

Fig. 1 is a representation, partly in diagrammatic and partly in perspective form of a transmitter and an antenna array incorporating the present invention; and

Fig. 2 illustrates a type of radiation pattern obtainable with the transmitter of Fig. 1.

Referring to Fig. 1, a transmitter is indicated at 1 which by means of a connecting link 2 supplies radiating energy to a radiator or antenna 3 which is shown supported in a horizontal plane on an antenna tower 4 and which is disposed at the focus of a dished metallic paraboloid reflector 5.

The reflector 5 has a section thereof cut away at 6, the cutting plane being parallel to the axis, the resulting edge being shown disposed parallel to the ground. The cut-away portion of the reflector 5 is indicated at 7 in broken lines. The transmitter 1 may be provided with a means for adjusting its transmission frequency at 8.

The radiation pattern as obtained with the antenna array 3—5 of Fig. 1 is shown in Fig. 2, where the relative vertical field intensity is shown as a relation of distance to the angle of elevation from the horizontal. The observer at the location of the transmitter is to be visualized at a point 9, an aircraft 10 being shown approaching the transmitter in the direction indicated by an arrow 11. The vertical radiation pattern as pro-
duced by the array of Fig. 1 is indicated by the solid line defining an envelope 12. A dished paraboloid not formed in accordance with the invention would produce a pattern showing relatively small field intensities in the angular zone from 20 to approximately 80 degrees as suggested by the broken lines at 13, the actual maximum distance covered by the field being somewhat more extensive in the horizontal, that is, in the lower angular zone than shown.

In contrast thereto the additional vertical directivity obtained in the vertical radiation pattern due to the cut-off of segment 1 increases the relative field strength in this angular zone as indicated by the projection 14 in the general field pattern. By varying the frequency of the transmitter 5, the projection 14 representing the relative increased strength in a given angular zone may be moved along the dot-dash line 15 to enable the operator of the transmitter to cover substantially the entire middle angular zone between degrees 20 and 80, whereby an approaching or receding plane with respect to the observer at 9 may be followed on the observation screen of the detection system without the difficulties inherent in a regular paraboloid reflector.

The principle underlying this invention may be expressed in one manner by saying that the vertical field due to a given array is to be distorted or reshaped in such a way that while the power output remains substantially constant the horizontal distance covered by the vertical field has been cut in extent, the surplus power thus made available being diverted to increase the field intensity in the middle zone.

While I have shown a preferred form and method of a directed distortion of the radiation pattern of a reflector array, it is of course apparent that the radiation pattern may also be distorted by other shaping of the reflector so long as it enables the desired production of vertical field pattern in the forward direction. The distortion may be effected also by moving the antenna 3 out of the focus of the reflector which will cause a similar field distortion. A progressive distortion may also be obtained merely by progressively changing the frequency of the transmitter as above-mentioned. However, in this application a frequency of simpler form, whereas illustrated wherein the antenna has been placed at the focus of the paraboloid and an increased directivity is obtained by means of the formation of the reflector, the variation in frequency serving as a means for effectively scanning the middle angular zone.

While I have described above the principles of my invention in connection with specific apparatus it is to be clearly understood that this description is made only by way of example and not as a limitation on the scope of my invention as indicated in the objects and defined in the accompanying claims.

What I claim is:

1. A method for scanning a given vertical angular zone by means of the electromagnetic radiation of a transmitter, comprising producing a given vertical pattern at a given frequency and at a constant power output, introducing a distortion in said pattern to improve the radiation intensity in a given angular zone by diverting the radiation power to said zone, and progressively varying the frequency of transmission, whereby said distortion progressively changes its position with the change in frequency to scan said given zone.

2. An electromagnetic radiating energy system comprising a dished paraboloid metallic reflector having a segment thereof cut away on a plane parallel to its axis, a radiator disposed at the focus of said reflector, means operatively connected to said radiator for processing energy for radiation, said processing means comprising means for varying the frequency of transmission.

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