

[54] AERIALS

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[51] Int. Cl..... **H01q 19/14**

[58] Field of Search..... 343/781, 781 C, 837, 782 A

[56] **References Cited**

UNITED STATES PATENTS

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[57] **ABSTRACT**

This disclosure relates to off-set or asymmetric aerial systems in which the main reflector which radiates into or receives from space a beam of energy is disposed to one side of the axis of the geometric body of which the main reflector forms part. The aerial system comprises a feed, a sub-reflector and a main reflector, the feed is displaced from the axis of the main reflector and the axis of the sub-reflector is transverse to the axis of the main reflector. This reduces the phenomena known as "bore-sight jitter" and "frequency sensitive squint."

5 Claims, 4 Drawing Figures

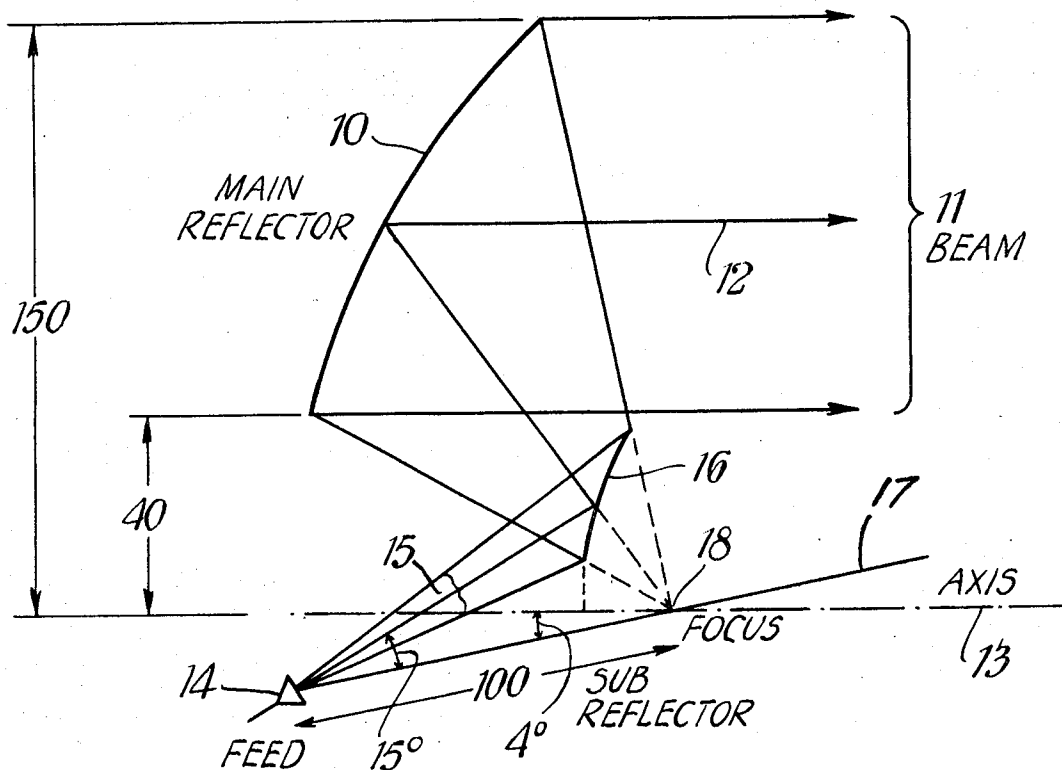


FIG. 1 PRIOR ART

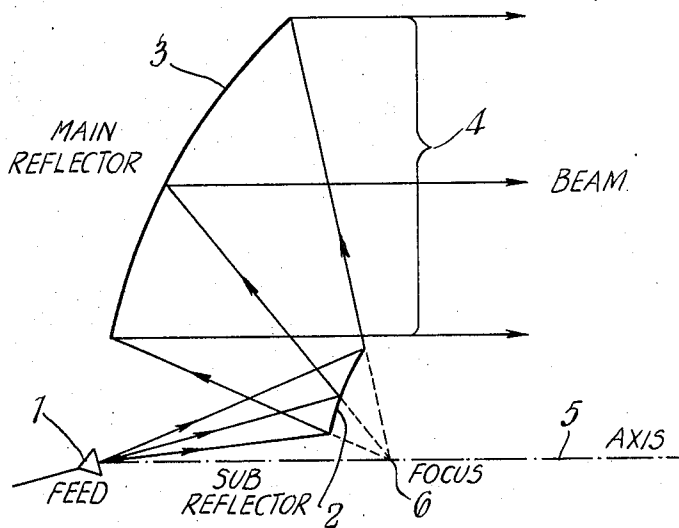
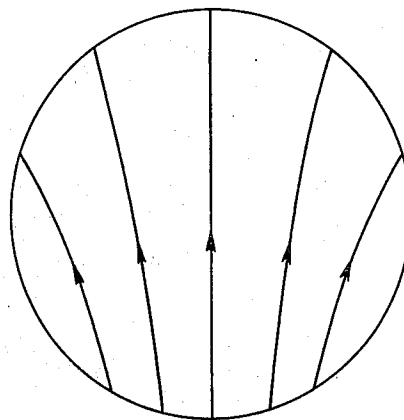


FIG. 2 PRIOR ART



→ FIELD LINES

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FIG. 3

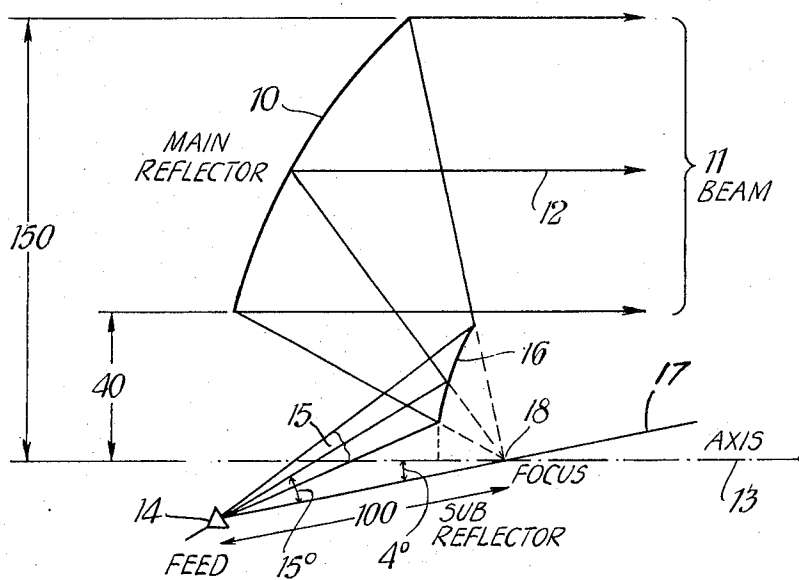
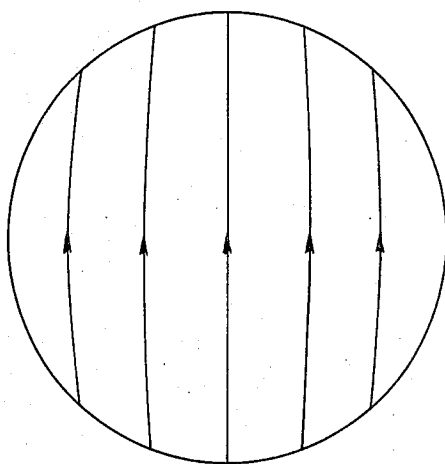


FIG. 4



AERIALS

BACKGROUND OF THE INVENTION

This invention relates to precision tracking aerials, particularly the microwave aerials of the type using a concave collimating reflector.

In particular, it relates to the class of reflector aerials known as "off-set" or "asymmetric" reflector aerials, i.e., those in which the reflector lies to one side of the axis.

This type is commonly used in radar and communication systems since it enables the feed system to illuminate the whole of the reflector and the whole of the energy thus reflected can be radiated from the aerial without shadowing or obscuration by any part of the feed system. This invention is particularly concerned with the arrangement in which an off-set sub reflector is used in conjunction with a main reflector. Such a system is known in which the beam from the main reflector is displaced from the axis of the said reflector and the focus of the main reflector and also the feed are located on the axis of the main reflector.

This type of off-set aerial suffers from a disadvantage compared with a symmetrical aerial, i.e., one in which the feed is on the centre line of the aerial, when used for accurate tracking of a distant source or radar target. The disadvantage is as follows: when the aerial feeder system is designed to receive "plane polarised energy" the direction of the beam axis is dependent upon the polarisation of the energy received. This is known phenomenon and is referred to as "boresight jitter." When such an aerial is designed to receive circular polarisation the direction of the radar axis is dependent upon the frequency of operation. This is also a known phenomenon and is referred to as "frequency sensitive squint." Both of these effects are due to the fact that when the electric and magnetic fields emanating from the feed have been reflected by the main reflector they are curved.

There are several known ways of straightening the field lines of the main reflector, for example, by using a specially designed feeder or by using a reflector composed of accurately parallel wires or strips, but these tend to have disadvantages, for example, they are difficult to manufacture or they only work with one sort of polarisation.

BRIEF SUMMARY OF INVENTION

We have found that the boresight jitter and frequency squint can be substantially eliminated by adjusting the positions of the sub reflector and feed relative to the main reflector.

Accordingly, the present invention provides an aerial system comprising a collimating main reflector, a sub reflector and a feed positioned relative to one another so that energy passing between the feed and the main reflector is reflected by the sub reflector and outwardly of the main reflector comprises a collimated beam having its axis offset from the axis of the main reflector, the feed being displaced from and the axis of the sub reflector being positioned transversely to the axis of the main reflector by such amounts as to substantially eliminate boresight jitter and frequency sensitive squint.

Preferably, the sub reflector and main reflector are part hyperboloid and part paraboloid respectively but may be any suitable coaxing pair of surfaces.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates a known form of off-set aerial system,

FIG. 2 shows the curved electric and magnetic fields emanating from the main reflector of FIG. 1.,

FIG. 3 shows diagrammatically an aerial arrangement, and

FIG. 4 shows resultant field lines produced by such an aerial.

The known off-set aerial system shown in FIG. 1 comprises a feed 1 which directs energy on to a sub reflector 2 where it is reflected to a main reflector 3 to produce the emergent main beam of energy 4. The axis of the main reflector 3 is shown at 5 and it will be seen that the beam 4 is displaced from the axis 5 and that the focus 6 of the main reflector 3 and also the feed 1 are located on the axis 5.

The disadvantages of this known arrangement are discussed above and illustrated in FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

An improved system according to the present invention is shown in FIG. 3. This system can, in the usual way, be used both to receive and to radiate energy.

In this arrangement the main reflector 10 is a part paraboloid concave collimating reflector and the final offset collimated beam 11 leaving this reflector has an axis 12 parallel to the axis 13 of the main reflector. The feed 14 is effectively a point source radiating a divergent beam 15 which is reflected from the surface of a part hyperboloid sub reflector 16 onto the main reflector to produce the beam 11. The feed 14 is located on the axis 17 of the hyperboloid, the latter having one of its foci coinciding with the feed and its other focus coinciding with the focus 18 of the main reflector. It will be seen that in this arrangement, as compared with the arrangement of FIG. 1, the sub reflector 16 and the feed 14 have been rotated about the focus 18 so that the feed is displaced from and the axis of the sub reflector is transverse to the axis 13 of the main reflector. This necessitates extending the upper edge of the hyperboloid surface so that a different portion of the sub reflector 16 is used. As seen in FIG. 4, the distortion produced in the field lines shown in FIG. 2 has been substantially eliminated.

In an aerial according to the invention the following parameters may be adjusted to achieve the desired performance:

- Focal length of the main reflector
- Eccentricity of the sub reflector
- Region of the main reflector to be used
- Distance of the feed from the focus
- Displacement of the feed from the axis
- Orientation of the feed
- Type of feed

The sub reflector 16 and main reflector 10 would normally be hyperbolic and parabolic respectively and only this type is described by way of example, however, this is not essential and any suitably coaxing pair of surfaces could be used.

In general terms the values of these parameters are chosen from the following considerations:

- Increasing the focal length of the main reflector reduces the polarisation distortion but is wasteful of

space, and tends to increase the weight and inertia of the system.

b. Increasing the eccentricity of the sub reflector reduces the distortion but also reduces the capability of scanning the beam by movement of the sub reflector. 5

c. Reducing the operational region of main reflector reduces the distortion but leads to poor space utilization.

d. Increasing the distance of the feed from the focus reduces the distortion and increases the capability of scanning the beam by movement of the sub reflector. 10

e. The displacement of the feed from the axis can be optimised to give the minimum distortion consistent with the other chosen parameters. 15

f. The feed is normally orientated so that the energy is directed towards the centre of the reflectors.

g. A horn feed is normally used since it may be designed to illuminate the reflectors efficiently. 20

An example of an aerial arrangement according to the invention with minimal polarisation distortion has the following parameters:

a. Focal length of main reflector : 100 units

b. Eccentricity of sub reflector : 1.85 25

c. Region of main reflector : extending from 40 to 150 units from the axis 13

d. Distance of feed from the focus of the main reflector : 100 units

e. Displacement of feed from the main reflector axis : 4° rotation about main reflector focus 30

f. Orientation of feed : beam axis of feed inclined 15° with respect to the sub reflector axis

g. Type of feed : horn.

What I claim is:

1. An aerial system comprising a collimating main reflector, a sub reflector and a feed positioned relative to one another so that energy passing between the feed and the main reflector is reflected by the sub reflector and outwardly of the main reflector comprises a collimated beam, having its axis offset from the axis of the main reflector, the feed being displaced from and the axis of the sub reflector being positioned transversely to the axis of the main reflector by such amounts as to substantially eliminate boresight jitter, and frequency sensitive squint.

2. An aerial system according to claim 1 in which the sub reflector and the main reflector are part hyperboloid and part paraboloid respectively.

3. An aerial system according to claim 2 in which the sub reflector has one focus coinciding with the focus of the main reflector and a second focus coinciding with the location of the feed.

4. An aerial system according to claim 3 in which the focal length of the main reflector is 100 units, the eccentricity of the sub reflector is 1.85, the region of the main reflector extends from 40 to 150 units from its axis measured in a direction normal thereto, the distance of the feed from the focus of the main reflector is 100 units, the feed is displaced from the axis of the main reflector by a 4° rotation about the main reflector focus and the feed is orientated to have a beam axis inclined at 15° with respect to the sub reflector axis.

5. An aerial system according to claim 4 in which the feed is a horn.

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