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(54) **Linearly polarized grid reflector antenna system with improved cross-polarization performance**

(57) A spectrum reuse antenna system comprises: (a) a linearly polarized reflector (13), which includes first grid conductors (13a) arrayed to reflect signals of one linear polarization mounted over (b) a second linearly polarized reflector (15), which includes second grid conductors (15a) arranged to reflect signals of an orthogonal polarization. A first array of feed horns (21) of the first polarization and a second array of feed horns (23) of said second polarization are disposed at focal points (F_1 , F_2) of respective reflectors. Improved rejection of cross-polarized signals at the respective arrays is achieved by providing (6) conductors (21a) comprising a third grid of said second polarization disposed over the aperture of said first array of horns and (b) conductors (23a) of a fourth grid of said first polarization disposed over the aperture of said second array of horns.

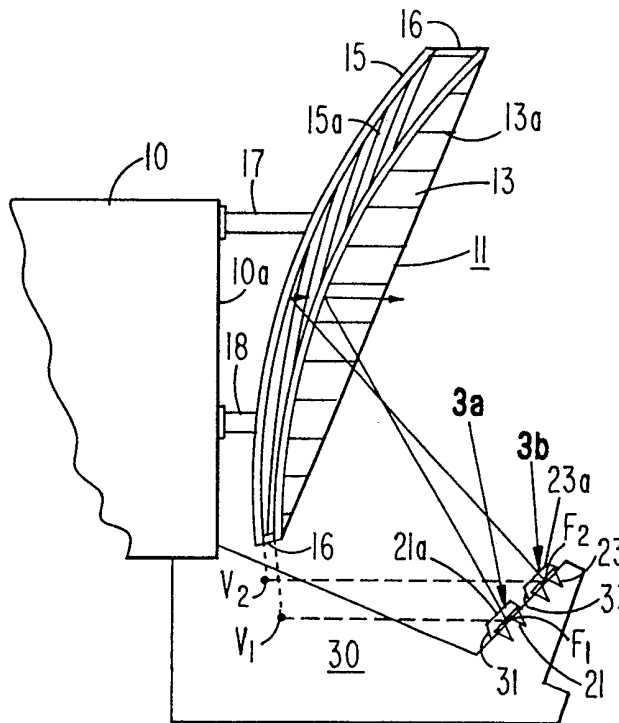
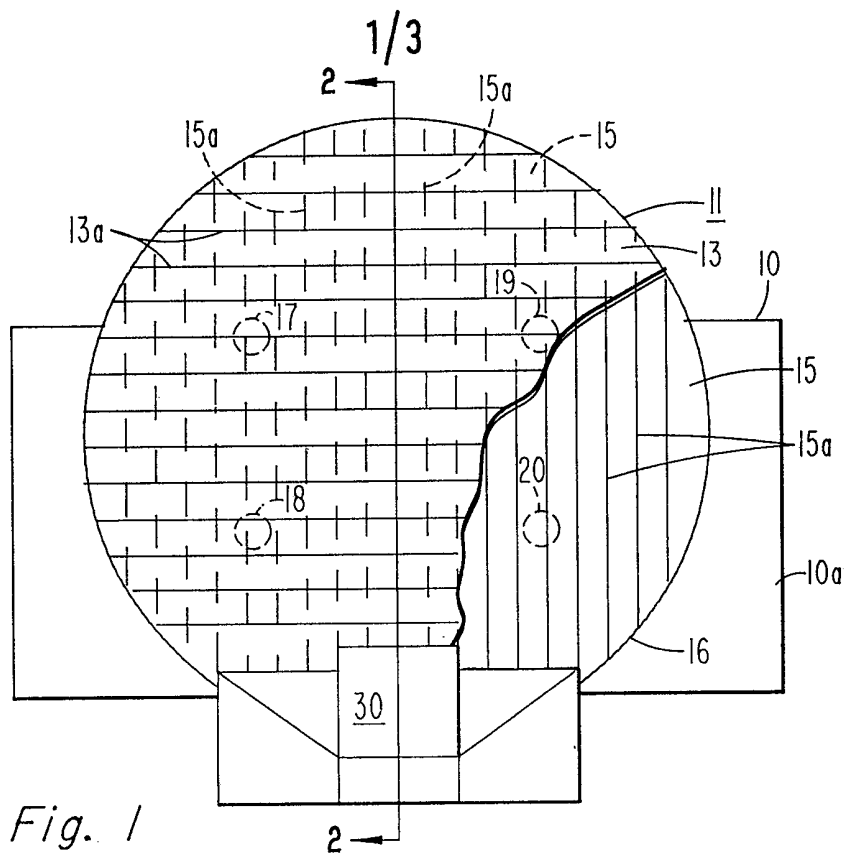


Fig. 2



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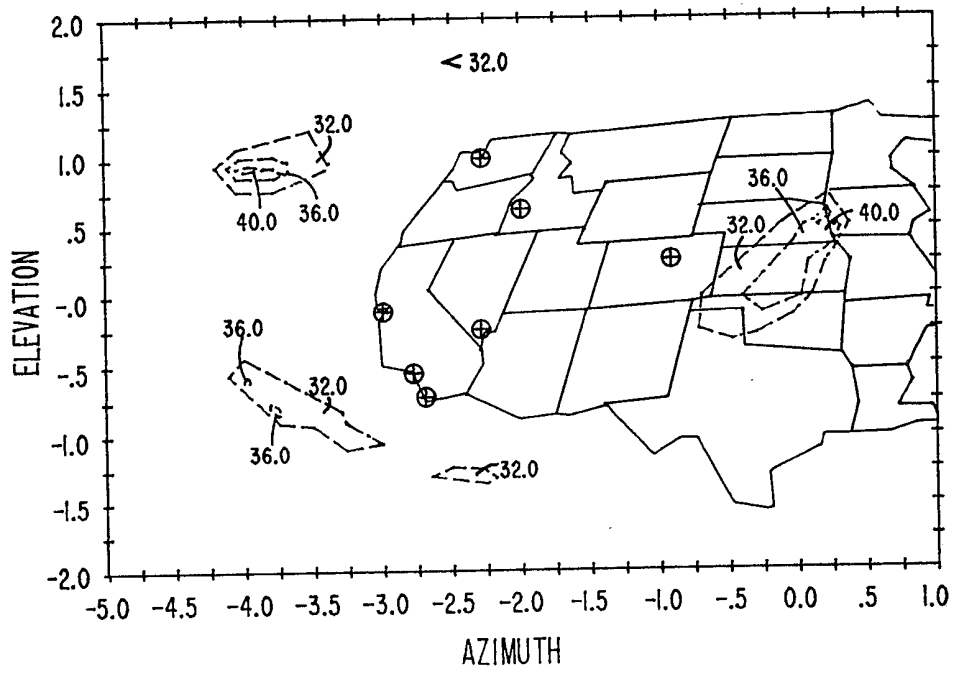


Fig. 4

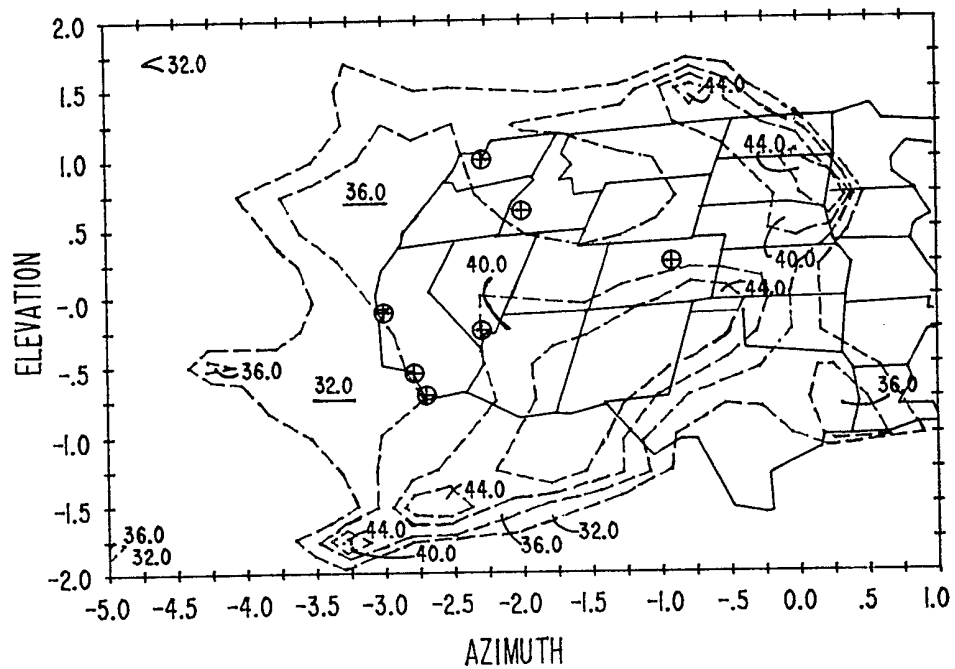


Fig. 5

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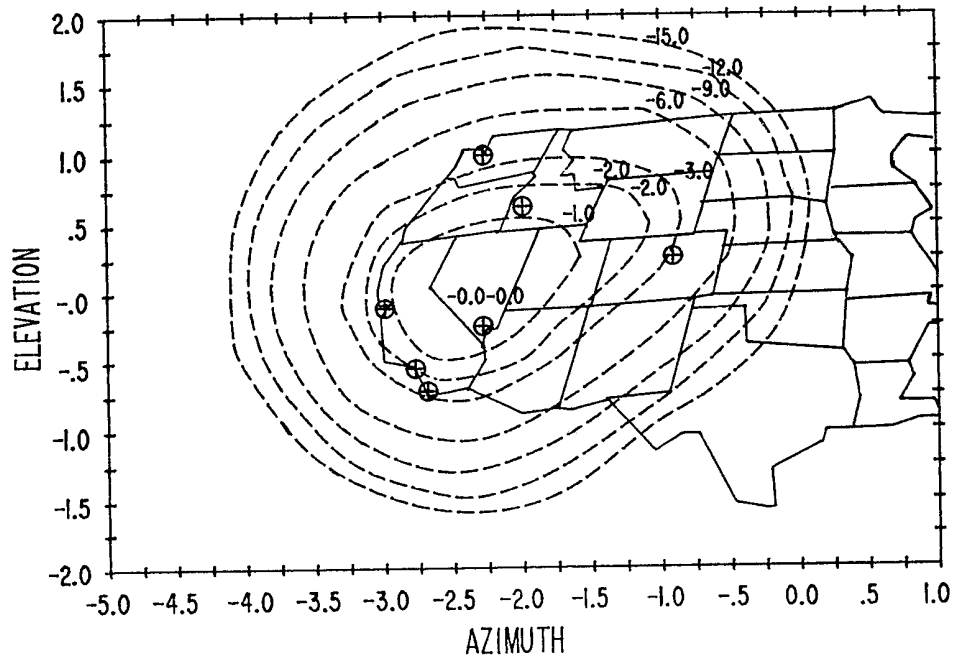


Fig. 6

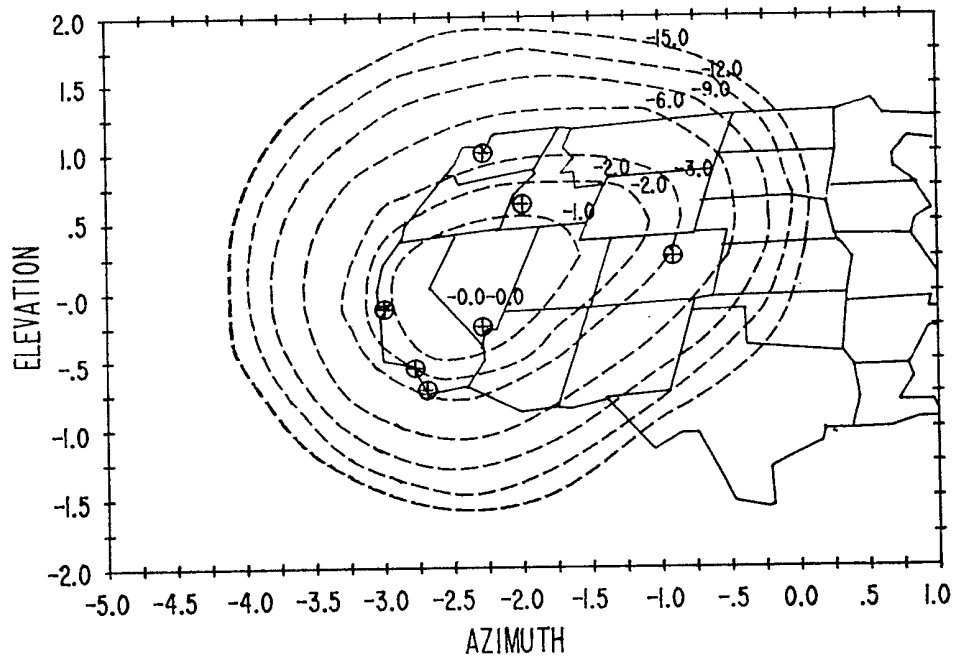


Fig. 7

SPECIFICATION

Linearly polarized grid reflector antenna system with improved cross-polarization performance

This invention relates to a linearly polarized reflector antenna system and, more particularly, to a orthogonally polarized dual gridded reflector antenna system fed by feed horns. Such a dual gridded reflector system includes a first reflector comprising a first grid of linear conductors in one orientation to match the polarization from a first of the feed horns. The first reflector overlaps a second reflector comprising a second grid of linear conductors, which are oriented orthogonal to the one orientation and to match the orthogonal polarization from a second of the feed horns.

An antenna system of this type, where each of the first and second feed horns comprises an array of horns, finds wide use in communication satellites for achieving shaped beams with frequency reuse by orthogonal linear polarization. It is desirable in such an application that the antenna be compact and light weight. Each of the reflectors is a section of a paraboloid of revolution with a grid of closely spaced parallel conductors or elements which are oriented parallel to one of two orthogonal linear polarizations. The reflectors are disposed so that their axes are offset from and parallel to each other. The grid of conductors in each of these sections or parabolic dishes is arranged so the conductors appear parallel at a distance in the direction of propagation, in the direction of the parallel axes. The horns are located at the focal points of the corresponding reflectors. An example of such a system is described in U.S. Patent No. 3,898,667 of Raab.

The reflectors of the prior art antenna system, as illustrated in the above-identified Raab patent, with its offset reflector axes and focal points, cause cross-polarized (unwanted) signals from the parallel elements in the surface of one reflector to be scattered away from the horn/copolarized (wanted) signal associated with the other beam reflector.

It is desirable to find a low cost, light weight means for further improving the cross-polarization rejection of such an antenna system.

In accordance with one embodiment of the present invention, in a spectrum reuse antenna system comprising: a first reflector, which contains a first grid of linear conductors of one orientation, overlapping a second reflector, which contains a second grid of a second, orthogonal orientation, and feed horns or arrays of feed horns with corresponding polarizations at or very near respective offset focal points of these reflectors, the improvement for providing improved cross polarization performance comprises: a grid of linear conduc-

tors adjacent the aperture of each of the horns, with the aperture grid conductors oriented orthogonal to the conductors on the reflector associated with the particular feed horn.

In the accompanying drawings:

Figure 1 is a front view of the dual gridded antenna system for use on a satellite in accordance with one embodiment of the present invention;

Figure 2 is a view of the reflector structure of Fig. 1 taken along lines 2-2 of Fig. 1;

Figure 3a is a view of the horizontally polarized array of horns as seen from the reflectors;

Figure 3b is a view of the vertically polarized array of horns as seen from the reflectors;

Figure 4 illustrates isolation contours without grids over the horns;

Figure 5 illustrates isolation contours with grids over horns in accordance with the present invention;

Figure 6 illustrates the co-polarized measured patterns for the beams of Fig. 4 without the grids in front of the horn; and

Figure 7 illustrates the co-polarized measured patterns for the beams of Fig. 3 with the grids in front of the horn.

Figs. 1 and 2 illustrate an antenna system 11 mounted to a wall of a satellite 10. The antenna system 11 comprises a parabolic reflector 13 comprising a parabolic shaped dielectric dish and a grid of horizontally polarized conductors 13a with the reflector 13 mounted in an overlapping manner over a second parabolic reflector 15 comprising a parabolic shaped dielectric dish and a grid of vertically polarized conductors 15a.

In Fig. 1 part of the forward reflector 13 is cut away to show the rear reflector grid 15. The antenna system 11 is mounted to the one surface 10a of the main satellite body 10 by mounting posts 17, 18, 19 and 20. These posts amount the rear parabolic reflector 15 to the surface 10a of the main satellite body 10. The forward or outboard parabolic reflector 13 is mounted to the reflector 15, for example, by a peripheral dielectric ring 16 which extends between the reflectors 13 and 15. These reflectors may be further mounted to each other via stiffening ribs. A typical example of such stiffening ribs is described in patent application No. GB 2166001A.

The reflectors 13 and 15 are sections of a paraboloid of revolution where the vertex of the reflectors lies near the bottom edge as illustrated in Fig. 2. The vertex for the parabolic reflector 13 is located at V1 and the vertex for the second reflector 15 is located at V2. The two parabolic reflectors are mounted offset from each other such as shown by the vertex points V1 and V2, and the focal axes are slightly offset and parallel to each other. This is in correspondence with

the above-identified Raab patent, so that the cross-polarized fields generated by the parallel elements on a surface of each reflector from one or more feed horns of an array associated

5 with that reflector are scattered away from the copolarized beam of the other reflector.
The antenna system includes beam-shaping feed horn arrays 21 and 23 as illustrated in Figs. 3a and 3b for respective polarizations.
10 The offset between the two reflectors is sufficient to assure enough space around each of the focus points to accomodate both horn arrays.

The horizontally polarized horn array 21 is located at the focus F1 of the parabolic reflector 13, which includes the horizontal grid conductors 13a. See Figs. 2 and 3a. The array 21 is generally centered with respect to the focus point F1 as illustrated in Fig. 3a. The
20 vertically polarized array of horns 23 is located at focus point F2 for the reflector 15 that includes the vertical grid conductor 15a. The array 23 is generally centered with respect to focus point F2 as illustrated in Fig. 3b. Each array of horns is directed to point to the center of a respective reflector, in order to fully illuminate the reflector primarily at its center.

Each of the horizontally polarized feed horns of array 21 is adapted for radiating and receiving horizontally polarized RF signals. Similarly, each of the vertically polarized feed horns of array 23 is adapted for radiating and receiving vertically polarized RF signals. Figs. 3a and 3b also show the input waveguides at the throats of the horns. The input waveguides 22 of horns in array 21 are narrower in width than in height so as to propagate signals with the E fields perpendicular to the vertical broad surfaces and hence excite horizontally polarized signal waves. The input waveguides 24 of horns in array 23 are broader in width than in height so as to excite vertically polarized signal waves. The arrays 21 and 23 are mounted to the satellite body 10 by support arm 30 in Fig. 2.

According to the teachings of the present invention, a grid 21a of vertical conductors is placed across the aperture of the array of horizontally polarized horns 21. Thus, grid 21a is adjacent each horn in array 21. See Figs. 2 and 3. This grid 21a of vertical conductors (shown in Fig. 3a) may be provided by a sheet of dielectric such as mylar or other dielectric material with shallow depth conductors printed or otherwise formed thereon. These conductors can be, for example, 0.0076 mm (0.0003-inch) thick copper foil. The sheet may be mounted to a frame 21b, which is fixed to the horn support arm 30 via flange 31 such that the sheet is held flat against the horns. See Fig. 2.

The spacing between the conductors on the grid 21a and the size of the conductors is like
65 that of the grids 13a and 15a on the reflectors

13 and 15. This is arranged so as to couple signals between the horn and reflector 13 with low attenuation and yet provide optimum rejection of vertically polarized signals from the grid of conductor 15. The width of the conductors is, for example 0.076 mm (0.003 inch) with a center to center spacing of 0.51 mm (0.02 inches) for one tested embodiment at frequencies of 11 and 14 GHz.
75 The geometry of the grids (spacing and width) is selected to provide the best compromise between the lowest transmission loss with the copolarized component and the highest reflectivity for the cross-polarized component.

Across the aperture of the vertically polarized horn array 23 is a grid 23a of horizontally oriented conductors that are of the same spacing and width as the conductors in the reflectors 13 and 15. Again, grid 23a is adjacent each horn in array 23. See Fig. 3b. This grid, again, is preferably a sheet of dielectric such as mylar with the shallow depth conductors printed or otherwise formed thereon. The sheet may be mounted to a frame 23b which is fixed to the horn support arm 30 via flange 33.

The cross-polarization rejection has been experimentally shown to improve when using grids at the aperture of the horn feed arrays. Fig. 4 illustrates this cross-polarization effect without the grids at the horns for a western-half United States beam and Fig. 5 illustrates the reduction in cross-polarization effects with the grids at the horns. What is plotted in each of these figures is the copolarization minus the crosspolarization—i.e., the isolation contours. The operating frequency is 11.76 GHz. The 44db, 40db, 36db and 32 db isolation contours are plotted in both figures. To illustrate the improvement by mounting the grids in front of the horns the following observations are made:

1). In Fig. 4 for the case where there is no grid in front of either horn, the isolation is worse than 32 db for most of the western United States, as represented by the area outside all of the dashed contours;

2) In Fig. 5 where grids are used in front of the horns, the isolation is better than 32db over the western part of the United States and is 36db over a major portion of the coverage area.

Further, Figs. 6 and 7 show the co-polarized measured patterns for the two beams with and without the grids in front of the horns. These indicate that the grids in front of the horns do not substantially affect the co-polarized signal.

125 CLAIMS

1. A spectrum reuse antenna system comprising: a first linearly polarized reflector having a first grid of linear conductors of a first polarization orientation overlapping a second linearly polarized reflector having a second grid
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- of linear conductors of a second polarization orientation orthogonal to said first orientation; a first feed horn adapted to couple electromagnetic signals in said first linear polarization orientation over a given frequency band located at or near a focus of said first polarized reflector; a second feed horn adapted to couple signals in said second linear polarization orientation over said given frequency band located at or near a focus of said second polarized reflector; and,
- for reducing coupling of cross polarized signals:
- a third grid of linear conductors of said second orientation adjacent said first feed horn; and
- a fourth grid of linear conductors of said first orientation adjacent said second feed horn.
2. An antenna system as set forth in claim 1, wherein: the center-to-center spacing between and the width and the thickness of the linear conductors in each of said third and fourth grids cause reflection of undesired cross-polarized signals without introducing any significant measurable amount of attenuation to desired polarized signals.
3. An antenna system as set forth in claim 1 or 2, wherein the spacing between and the width of the conductors of each of said third and fourth grids are substantially equal to the spacing between and width of conductors of the respective one of said reflectors.
4. An antenna system as set forth in any preceding claim, wherein each of said third and fourth grids comprises said conductors formed on a thin dielectric sheet.
5. An antenna system as set forth in claim 4 wherein each of said third and fourth grids are thin metallic foils.
6. An antenna system substantially as hereinbefore described with reference to the accompanying drawings.