NASA TECH BRIEF

NASA Pasadena Office

High-Gain Antenna with Singly-Curved Reflector

The problem:

To provide a large, unfurlable, high-gain antenna for long-distance spacecraft missions.

The solution:

Design a two-reflector system in which the main reflector is a segment of a cone.

How it's done:

The basic purpose of a reflector is to collect energy over a large region of space and focus it towards a small region where the antenna feed is located. When the incident energy is in the form of a plane wave, the logical choice for the shape of the reflecting surface is a paraboloid which converts the plane wave into a spherical wave that converges at a point. Paraboloid reflectors are very desirable from the standpoint of management of rf energy because a feed which couples well with a converging spherical wave can be readily constructed; the reflectors are troublesome, however, because they have doubly-curved surfaces which are difficult to construct within close tolerance limits.

In contrast, singly-curved surfaces are desirable from a structural standpoint, but they are not as efficient as doubly-curved surfaces inasmuch as they bring plane waves to focus in only one dimension; at best, singly-curved surfaces convert a plane wave into a cylindrical (or conical) wave which converges towards a line segment.

A cone will focus plane waves along a line in the form of a conical wave; for a cone with an included angle of 90°, the focused waves are cylindrical. By

employing a line-source feed, this reflector may be used by itself. Alternatively, a subreflector may be used to refocus the energy to a point, as illustrated in the Gregorian form shown in the diagram; there is
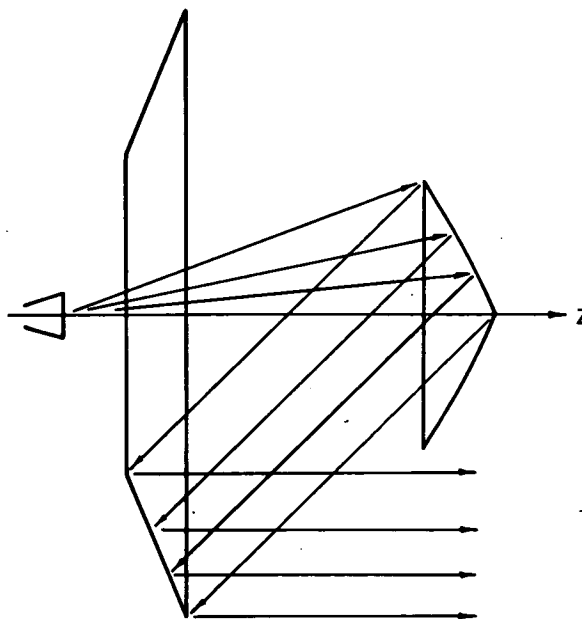
a corresponding Cassegrainian form. All surfaces are figure-of-revolution about the Z axis, and the contour of the secondary reflector is parabolic. Another feature is that the main reflector aperture illumination has a ring-like pattern, i.e., there is a hole in the center. This hole extends to slightly less than one-half the radius of the main reflector, and the illuminated portion has about 78% of the area of the full aperture.

Thus, this type of antenna has a maximum gain which is 78% of the maximum gain of a full circular aperture of the same diameter. However, in a conventional Cassegrainian or Gregorian system, the subreflector blocks an area of perhaps 1–2% of the total area; in addition, this area is illuminated by roughly 2–4% of the total feed power, so the net blockage loss in a conventional system is 3–6%. Therefore, the relative potential gain of this design is about 80–83% of the standard value. Further, the design has the interesting property of reflecting the center of the feed pattern to the outer edge of the main reflector; this results in improved illumination efficiency, which results in overall efficiencies equal to conventional paraboloids. However, since the basic consideration of this design is structural rather than electrical, any comparisons must include structural effects.

Note:

Requests for further information may be directed to:

Technology Utilization Officer
NASA Pasadena Office
4800 Oak Grove Drive
Pasadena, California 91103
Reference: TSP 73-10291

Patent status:

This invention has been patented by NASA (U.S. Patent No. 3,680,144). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to:

NASA Patent Counsel
Mail Code 1
NASA Pasadena Office
4800 Oak Grove Drive
Pasadena, California 91103

Source: Arthur C. Ludwig of
Caltech/JPL
under contract to
NASA Pasadena Office
(NPO-11361)