2-11 A2 BEAMSHAPING BY NEW PERIODIC STRUCTURES IN CONICAL HORNS

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INTRODUCTION

The use of multimode waveguide as a feed horn has stimulated considerable interest in the design of low noise antenna, e.g., in satellite communication systems.

One technique for achieving such a low noise antenna is the improvement of a feed horn. It has been done by means of a simple circular symmetric waveguide of discontinuity by joining two different diameters.(1)

This technique, although very simple, suffers from the frequency characteristics, because the relative phase velocity of TM_{11} and TE_{11} modes is seriously dependent of frequency.

Recently much attension has been taken a corrugated waveguide to the design of the feed horn to improve the frequency characteristics by the application of fast hybrid mode in corrugated periodic structure.(2)

As an extension of the corrugated conical horn, it has been presented by authors that the use of the hybrid mode in the posts loaded conical horn will also result in beam equalization and sidelobe suppresion with the benefit of crosspolarization reduction.

This paper describes the experimental results of the newly developed feed horn performances.

PRINCIPLE

The pattern synthesis is based on the utilization of the new periodic structure in the circular waveguide. The conical horn in which conductive posts are periodically loaded in its inside wall toward circumferential and axial directions is illustrated in Fig. 1. The loaded pitch between posts is selected small compared with the wavelength under consideration.

It is physically considered that a pair of posts constitutes two wire transmission line and is short-circuited by the wall of the conical horn. And in general, the hybrid mode can propagate if the conical horn is excited by the dominant mode in the circular waveguide.

For the practical pattern synthesis, the method of bounding the fast hybrid mode, EH_{11} mode, and guiding it to the radiating aperture is obtained by the following condition that the surface impedances defined by electric components must be capacitive.

Varying the length of posts, the following condition will give a necessary surface impedance;

$$\lambda/2 > L > \lambda/4$$

where λ and L are free space wavelength and length of posts respectively.

As a result, the E- and H-plane field distribution over the aperture of the conical horn are physically explained by the same procedure that dual modes, TE_{11} and TM_{11} modes, with the same phase velocity propagate in the circular waveguide.

This is consistent with the explanation of the dual mode conical horn.

The posts loaded conical horn, however, has the following advantages; the anisotropic boundary surface ensures the symmetrical and lowsidelobe radiation pattern and the independent generation of MT_{11} mode by the discontinuity is unnecessary.

As a result, the wideband characteristics is expected.

EXPERIMENT

The experimental model of the posts-loaded conical horn has been constructed. The aperture diameter is 74 mm and its flare angle is 9.17 degrees respectively. The posts of which diameter is 2.4 mm are axially aligned with pitch of 5 mm. The circumferential alignment of posts has been done with increment of 15 degrees.

The measurement has been carried out at the frequency of 15 GHz and 22.5 GHz within the near field region of 1 meter.

The measured amplitude and phase patterns are shown in Fig. 2 and 3 in case of the posts-loaded conical horn and the conventional conical horn respectively, and has proven that the technical approach can yield the impressive result in sidelobe suppression and beam equalization.

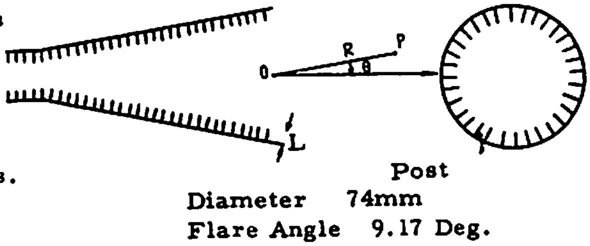

Fig.1 Structure of Posts-Loaded Horn

CONCLUSION

On the bases of these results, it is concluded that such a configulation shows promise as a design of low noise antenna, especially considering the spillover energy from the subreflector in the cassegrain antenna in addition to the illumination efficiency and cross-polarization reduction.

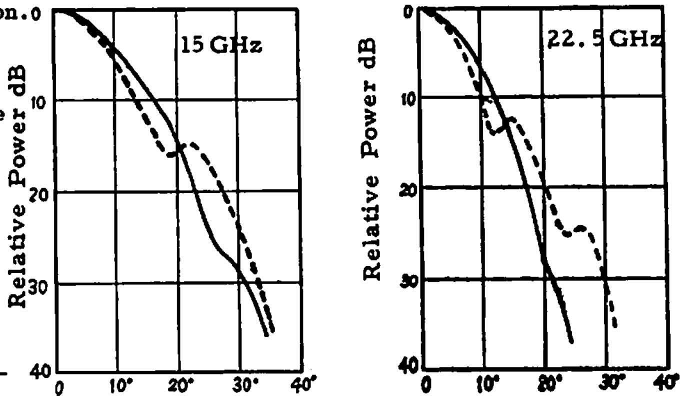

Fig.2 Radiation Pattern of Conventional Horn
(—— H-Plane, ---- E-Plane)

REFERENCES

(1) P.D. Potter, "A new horn antenna with suppressed sidelobes and equal beamwidth", Microwave J., vol. 6, pp 63.

(2) R.E. Lawrie, "Modification of Horn Antenna" IEEE. AP-14, No. 15, Sept. 1966.

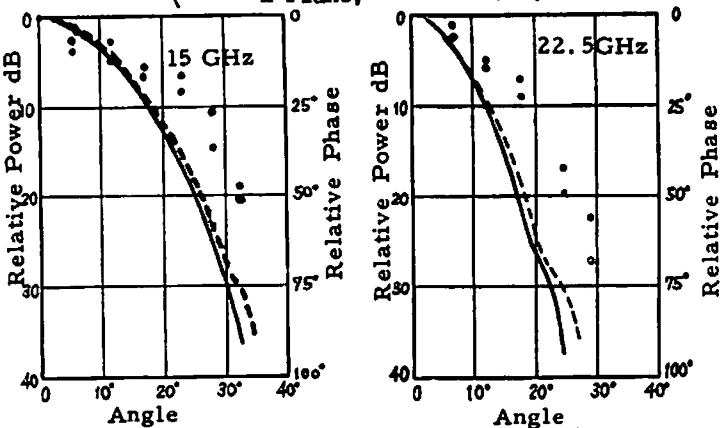

Fig.3 Radiation Pattern of Posts-Loaded Horn
(• H-Plane, • E-Plane)