TDF ANTENNA FOR MULTISATELLITE RECEPTION USING FRESNEL PRINCIPLE IN THREE DIMENSIONS

Jean-Jacques DELMAS - Conseiller du Directeur de la Recherche et de l'Innovation
pour les techniques spatiales (TéléDiffusion de France - 21/27 rue Barbès - 92120 Montrouge - France)
Alain SARREMEJEAN - Ingénieur de Recherche
(Centre d'Etudes et de Recherche de Toulouse
2 avenue Edouard Belin - BP 4025 - 31055 Toulouse cedex - France)

ABSTRACT

This paper deals with a Three Dimension Fresnel (TDF) antenna using the Fresnel zone principle for Ku-band satellite reception between 10.7 GHz and 12.75 GHz. In addition this antenna gives a focal line corresponding to the geostationary orbit. In order to confirm the viability of the concept, a preliminary prototype has been built and TV-programmes have been simultaneously received in Paris from three different geostationary orbital locations :

. 19 degrees WEST (TDF1, TDF2, TV-SAT, OLYMPUS),
. 5 degrees WEST (TELECOM 1),
. 19.2 degrees EAST (ASTRA).

The main interest of this antenna consists in a simple design which allows to avoid several antennas for a multisatellite reception purpose. This could lead to a significant improvement for SMATV and cable head-end facilities.

Futhermore, this design could be used for individual reception.

INTRODUCTION

During the last decade, satellite technology and receiving equipments have been improved so that fixed-service satellite systems and broadcasting satellite systems are used for direct-to-home reception.

The major part of traffic concerns today the television and radio broadcasting and distribution services. Consequently, the number of satellite orbital locations to consider has increased and a new demand exists for multisatellite reception. Up to now, when multisatellite reception has been needed, three different solutions were mainly proposed to the users :

- place one antenna for each orbital location to be used,
- use of motorized antenna,
- use of toric antenna.

By considering the Fresnel zone plate, the work done on the theoritical approach, and explanations given by James C. WILTSE and James E. GARETT [1], a new configuration has been proposed to solve the multisatellite reception problem.

ANTENNA DESIGN

A Fresnel zone plate with a reflecting plane or mirror may be fed on-axis or off-axis. It is an antenna equivalent to a paraboloïd. This system has only one focal point. The reception of many satellite is possible by moving the feed around the focal point. But, in this case, the scanning angle is limited by diffraction effect.

In order to increase the scanning angle, a new design has been imagined by considering the Fresnel zone in a three dimension structure which can be approximatively represented by a parabola.

The first idea was to add a second focal point on a classical parabolic antenna. But after computation of the Fresnel zone, a symetrical axis was identified and two focal points depending on direction of the power flux density radiated towards the reflector appear. On the other hand, the focal point of the classical parabolic antenna was not found.

The preliminary prototype which is a non-optimized version gives multibeam reception. It is based on a parabolic reflector with concentric annular rings paralled to the reflector at a quarter of wavelength. Annular rings have been computed with a method similar to the half-wavelength method in Fresnel zone.

With pratical results, we verify that a focal line have been produced and multisatellite reception was possible, when the Fresnel principle was applied to this three dimension structure.

ANTENNA EXPERIMENTS

First of all, the antenna was used to receive simultaneously 3 TV programmes : one from TDF1 (19 degrees WEST), one coming from TELECOM 1 C (5 degrees WEST) and the other one coming from ASTRA (19.2 degrees EAST). The picture quality was satisfactory on the 3 TV sets.

Then, the antenna measurement have been done. The result of the antenna pattern is given Figure 2. The axis of the angle correspond to a scan of the focal line.

This measurement has been made in the 10.2 - 12.75 GHz band.

The antenna efficiency is greater than 50 %.

The 3dB beamwidth is around 2.2° computed from the measured patterns (in comparison for a centered paraboloid antenna of 0.9 m diameter, the 3dB beamwidth is around 2.08°). It is interesting to note that a last circular ring can partially add and in this case the 3 dB beamwidth will be the same in both caser.

CONCLUSION

A new concept of multisatellite reception has been proposed and results confirm the viability of the three dimension Fresnel antenna. The next steps concern the optimization and the industrialization of the product.

It is interesting to note that a few manufacturers have been working on the zones plate antennas and their industrialization [2].

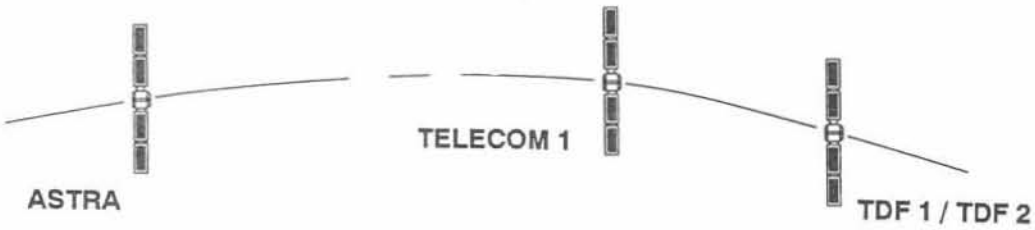
This technology seems very promising and the production of such device could be cost effective and attractive for the public.

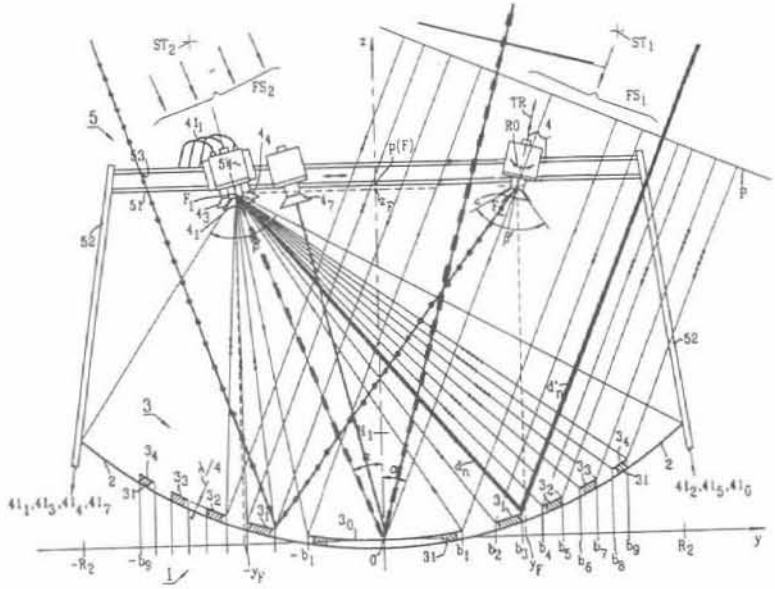
REFERENCES

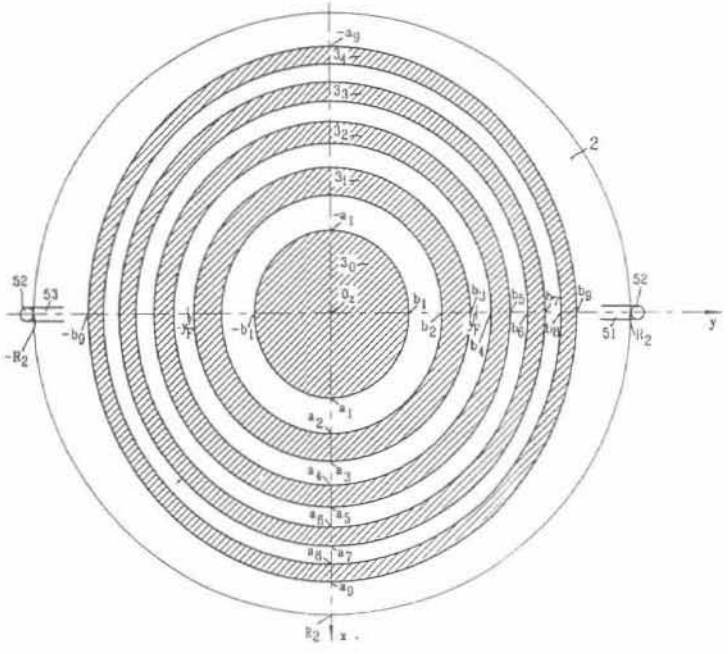
[1] "Performance characteristics of phase-correcting Fresnel zone plates", James E. Garett and James C. Wiltse, IEEE Microwave symposium 1990.

[2] "Zone plate antennas for satellite signal reception", by Mike Wright, Mawzones limited and Nr Baldock, Herts United Kingdom.

Fig 1 - TDF Antenna for multisatellite reception







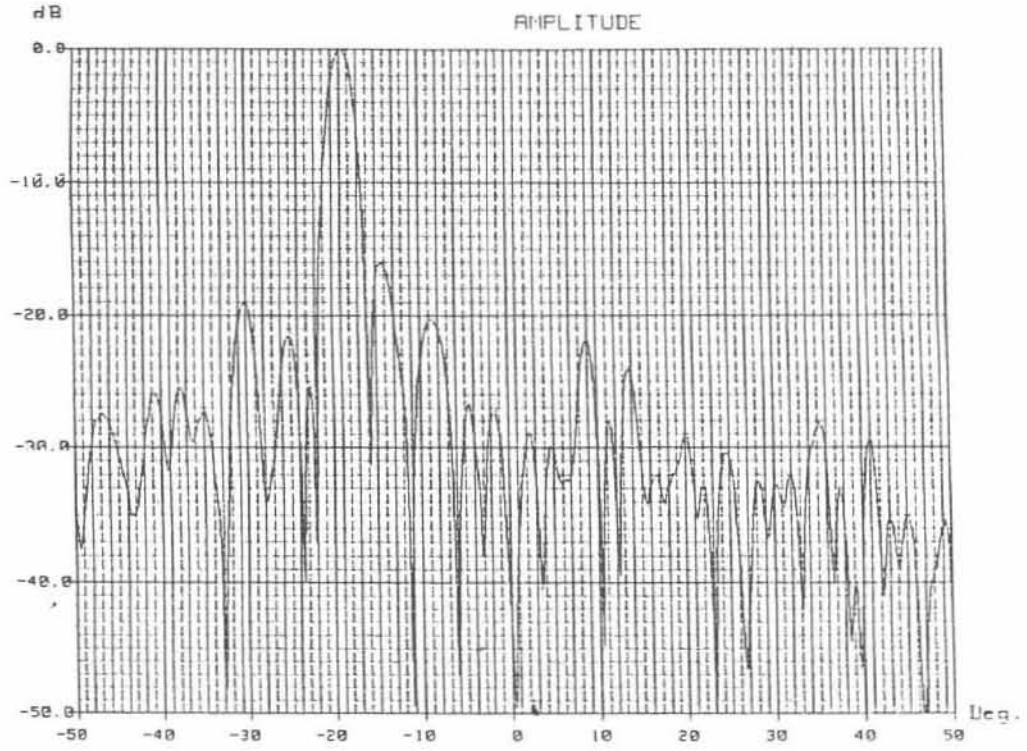


Fig 2 - Typical Antenna pattern