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Large-size Transformable Antennas

The article is devoted to the types of reflectors of large-size transformable antennas. In the article different types of the forming surface of reflectors are analyzed. The main attention is paid to their design, the advantages and disadvantages.

Key words: reflector, large-size transformable antennas, inflatable reflector, cable-stayed reflector, umbrella reflector, truss reflector.

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Крупногабаритные трансформируемые антенны

Статья посвящена видам рефлекторов крупногабаритных трансформируемых антенн. В статье анализируются различные типы формообразующей поверхности рефлекторов. Главное внимание обращается на их конструкцию, достоинства и недостатки.

Ключевые слова: рефлектор, крупногабаритные трансформируемые антенны, надувной рефлектор, вантовый рефлектор, зонтичный рефлектор, ферменный рефлектор.

An essential component of work in aerospace engineering is directly related to the creation of the global communication systems (GCS). As a result of the recent development of decimeter and centimeter waves, it became necessary to create large space antennas, the diameters of which reaches 100 meters and more. With the

growing of power, the issue of creating large-size transformable antennas is becoming more urgent, that is of great interest in many countries. [1]

The first development of such antennas began in the 80s of the 20th century. Since then many different constructions have been proposed. [2] They can be divided into several types, differing in the type of formation of the shape of the reflecting surface. All of these antennas have two states: folded and unfolded. In the folded state they are sent into the orbit where they are unfolded before functioning.

1. ***Inflatable reflector.*** Being folded up it has a small size and mass. For its production, flexible materials are used, folding before launch and opening by inflation. The inflatable reflector can be imagined of as a cushion of paraboloid shape, in which the front surface is transparent, and the rear surface is reflective. On the edge of the antenna there is an inflatable torus. To ensure greater rigidity of the reflector, the material is impregnated with rosin, which gradually hardens when reaching high temperatures or irradiating it with ultraviolet. Therefore, it is necessary the reflector in orbit be facing the sun. The process of solidification of rosin occurs for 6 hours. After rejection, it is filled with gas.

The main disadvantage of such antennas is the complexity of obtaining a high accuracy of the shape of the reflecting surface. The advantage is the simplicity of construction and the high degree of reliability of the opening.

2. ***Cable-stayed (rim) reflector***. A collapsible peripheral annular rigid rim serves as a skeleton for these reflectors. The reflective surface is attached to a structure consisting of Cable-stayed stretch marks, or sheet profiles, which are fixed in the center and on the rim. When the reflector is opened, the Cable-stayed are stretched.

Cable-stayed reflectors with hard rim can be divided into groups:

- with radial-ring structure;
- with a triangular structure.

The main disadvantage of such reflectors is the location of the antenna devices on the rim, which can lead to its instability. The advantage is the simplicity of construction.

3. ***Umbrella reflector***. Umbrella reflectors contain a rigid central part, which the system of radial ribs is attached to. On the ribs there is a network-band, which forms a reflecting surface [3]. Depending on the type of ribs, umbrella reflectors can be divided into:

- Reflectors with rigid hinge folding fins;
- Reflectors with flexible deformable ribs.

Form-forming structure of umbrella reflectors can be either radial-circular or triangular.

The ribs of the umbrella reflector can be made in the form of parabolic tubular spokes. Which are made of Carbon fiber reinforced polymer (CFRP material). They are attached in the center. The reflective grid is fixed between them.

The special feature of this model is the high speed of antenna deployment in the orbit due to the breaking of the restraining cable. There is the possibility of rotating the spokes on the vertical hinge axes. The reflector can be folded up in the orbit by reversing the drive.

4. ***Truss reflectors***. Such reflectors consist of a three-dimensional spatial framework and a reflective surface attached to it. The support in the construction is the basic structural elements, made in the form of tetrahedral. Due to this, in the opened state the required rigidity of the carcass is achieved, but the dimensions in the folded state are small enough. Both surfaces of the shell are formed by folding rods. A grid is attached to the concave surface. It is reflective. Such structures, consisting of rigid rods, are maximally stable. [5]

Advantages and disadvantages of reflectors are given in Table 1.

Table 1 - Advantages and disadvantages of reflectors

Reflector type	**Advantages**	**Disadvantages**
Inflatable	Simplicity of construction; high degree of reliability of disclosure	The complexity of obtaining a high accuracy of the reflecting surface
Cable-stayed	Simplicity in designing	Arrangement of antenna devices on the rim; instability
Umbrella	High speed of opening; possibility of turning the reflector into orbit	The need to increase the number of spokes as the size increases

Truss	Stability; high stowage ratio; small volume and mass	Complexity of production and leveling; a large number of moving parts

The main feature of all the present antennas is the necessity to control the shape of their reflecting surface during preparation for work and during their operation.

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