DESING OF TRANSFORMED REFLECTOR ANTENNAS

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The report deals with the conception of making transformed antennas for satellite and ground applications based on umbrella-type structures. Reflective umbrella antennas are the most widely used type of deployable antennas [1]. Their reflective surface is formed by rigid or flexible material (made of metal plate or metallized mesh) supported with a framework of appropriately curved ribs attached to the central hub with a cantilever. Reflective surface corresponds to paraboloid of revolution only at the junctions of mesh and ribs. It results in reduction of umbrella antennas efficiency.

Thus, the main research directions were as follows:

providing electrodinamic parameters of collapsible antennas to be compared to parameters of all-metal ones of the same size. This problem was solved with both constructive and electrodynamics methods;

developing constructions providing necessary performances of such antennas;

developing materials and technologies allowing to run manufacturing of comparatively cheap erectable antennas corresponding to imposed requirements.

In order to optimize the design providing efficient functioning of transformed reflector antennas a barycentric method [2] based on geometry-optical approach has been proposed. As an optimization criterion a moment of inertia of material points system in reflector's focal region has been used.

There are some examples of implementation of transformed construction reflector antenna models to illustrate the obtained results.

The first one is a working model of antenna with diameter 2,5 m, which has reflecting surface made of mesh (see Fig.1). Its reflector is formed with metal knitted mesh of special weave (steel + nickel) stretched on the folded framework consisting of 24 ribs attached to the

hub by a hinge. Each rib has box section and is made of 0,5 mm-thick steel plates. In a folded state the antenna can endure a load up to 200 kg/cm . Package diameter is 0,65 m. Antenna is constructed according to two-reflector design with elliptic shape of a small reflector and provides utilization factor of surface at the band of 4 GHz - 0,6; 6 GHz - 0,5; 8 GHz - 0,4. Mechanical tests have shown reliability of a reflector's design, good recurrence period of electrical performance data in conditions of multiplex folding-unfolding as well as high electrical and mechanical strength.

The second conception is based on the use of thin flexible metallic panels as a reflector surface. The panels are inserted in the grooves of the ribs of the umbrella type reflector. The application of panels instead of mesh for antennas used in the ground conditions make it possible to increase the band up to 15 -18 GHz in the case of antenna diameter up to 3 m. A sample of the antenna of 2,6 m diameter having such structure is shown in Fig.2. The test of the antenna on the satellite communication line at the band of 11/14 GHz using a standard receiving and transmitting module of Dornier as a feeder demonstrated results similar to those obtained for 2,44 m diameter rigid parabolic antenna.

The third concept of transformed antennas design called "cabbage-head" is advisable when there is a need to provide operation at frequencies higher than 20 GHz. The precision deployable reflector consists of rigid panels reinforced with radial ribs which are fastened to the central panel using cylindrical hinges. The ribs are attached to mobile hub through cylindrical hinges with braces. Braces are equiped with tension and press shock-absorbers. Fig.3 and 4 shows pictures of 2 m diameter "cabbage-head" deployable reflector at the different phase of deployment. The results of measurement of its section have shown that standard deviation from paraboloid of revolution provides an efficient functioning of antenna at frequencies up to 50 GHz.

References

1. Gryanik M.U., Loman U.I. Deployable reflective umbrella antennas. - Moscow: Radio and svyaz, 1987. - 72 p.

2. Gryanik M.U., Loman U.I. Baricentral method in the design of reflector antennas tasks // Telecommunications and Radio Engineering, 1994 , N 2.

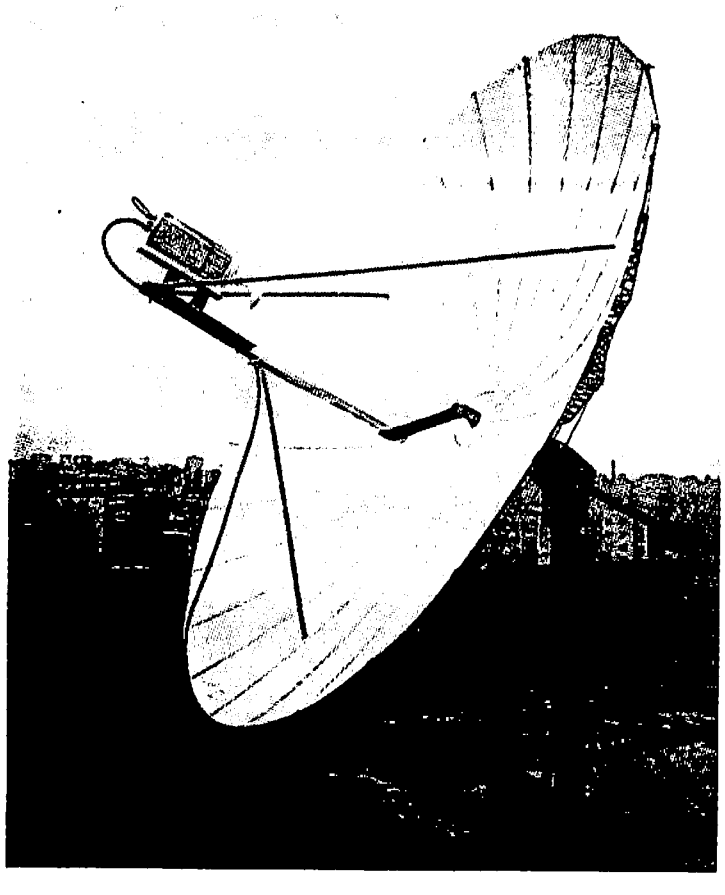

Fig. 2

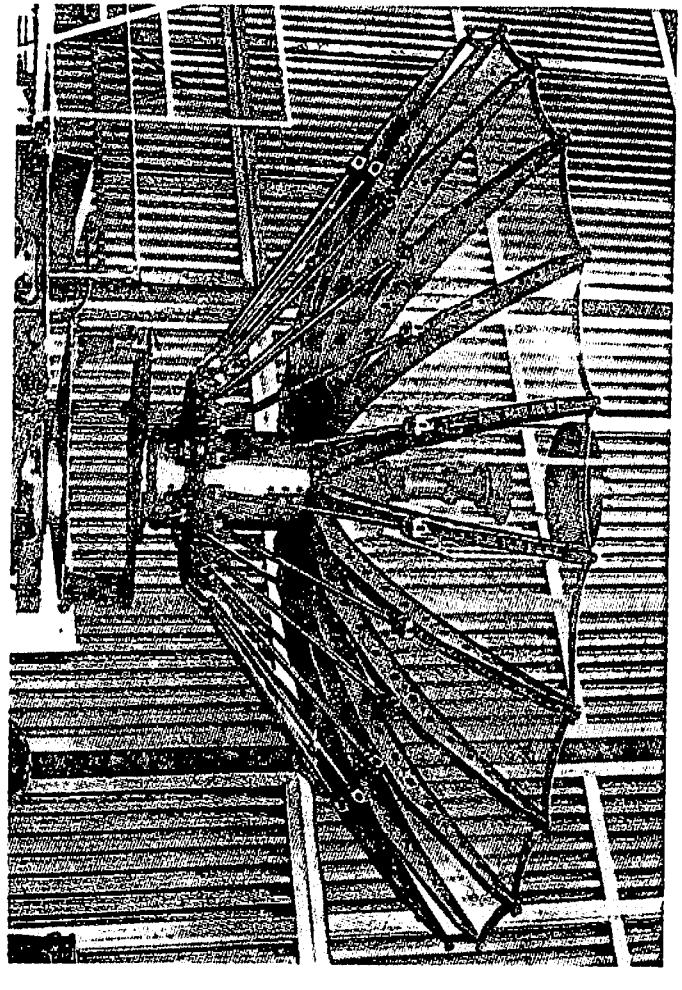

Fig. 1

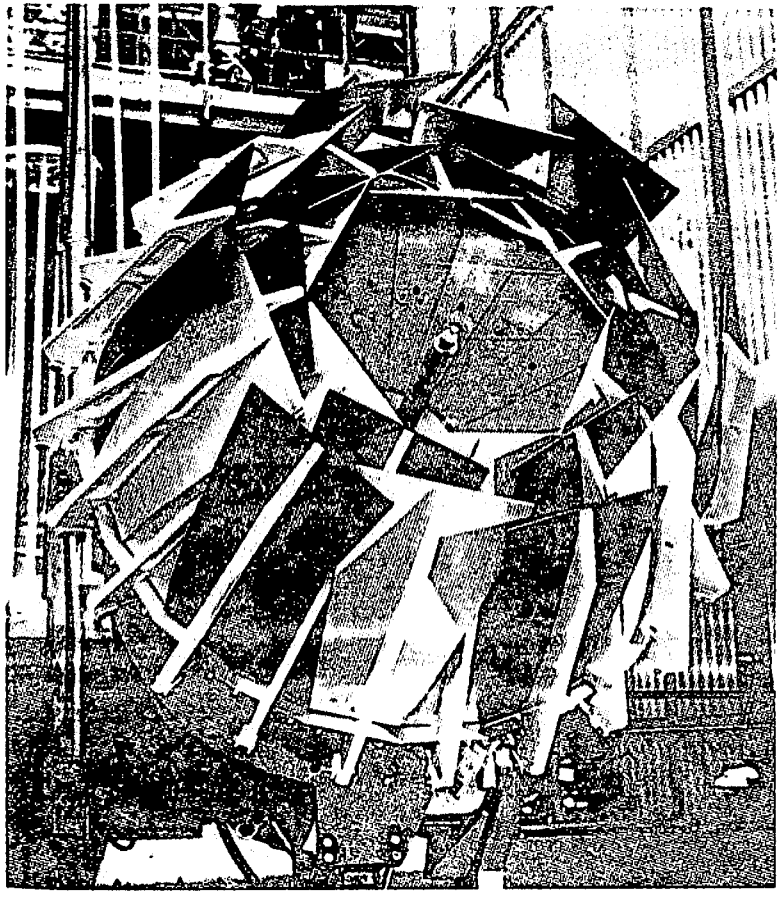

Fig. 3

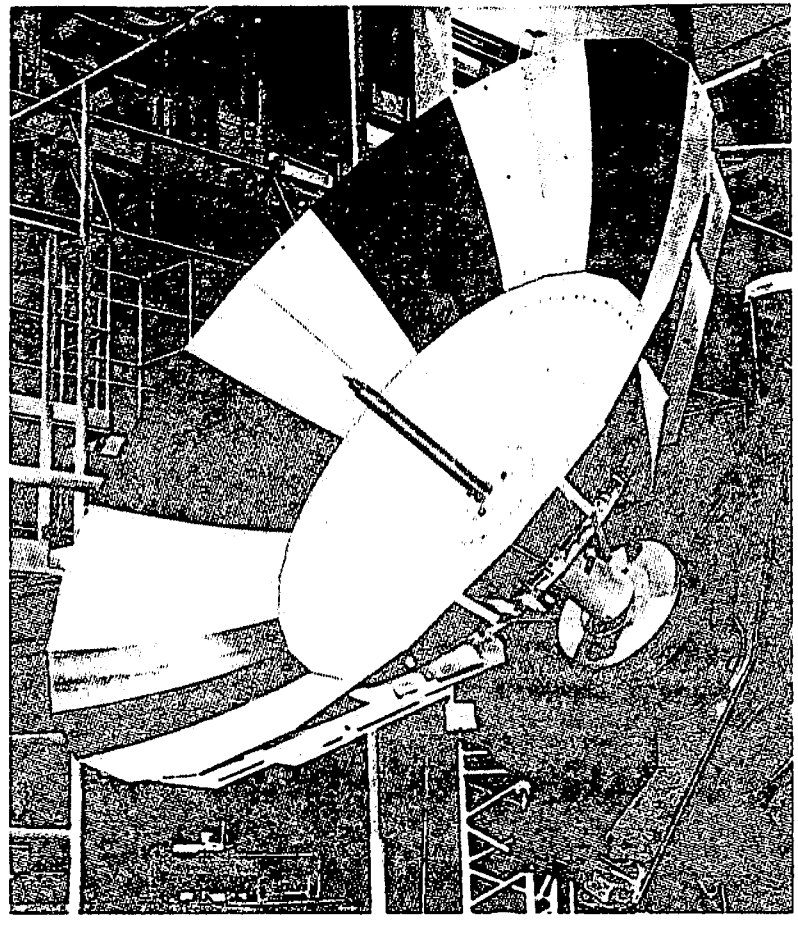

Fig. 4