

April 21, 1970

J. S. COOK

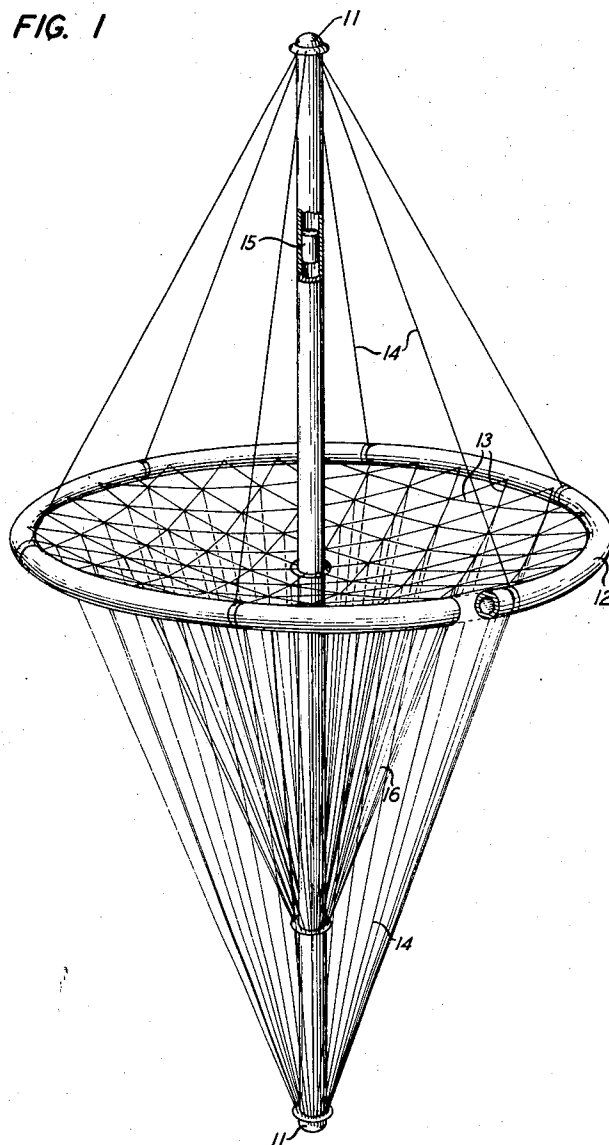
3,508,270

INFLATABLE COMMUNICATIONS ANTENNA SATELLITE

Filed Jan. 4, 1967

4 Sheets-Sheet 1

FIG. 1



INVENTOR
J. S. COOK
BY *G. E. Hirsch Jr.*
ATTORNEY

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J. S. COOK

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FIG. 2

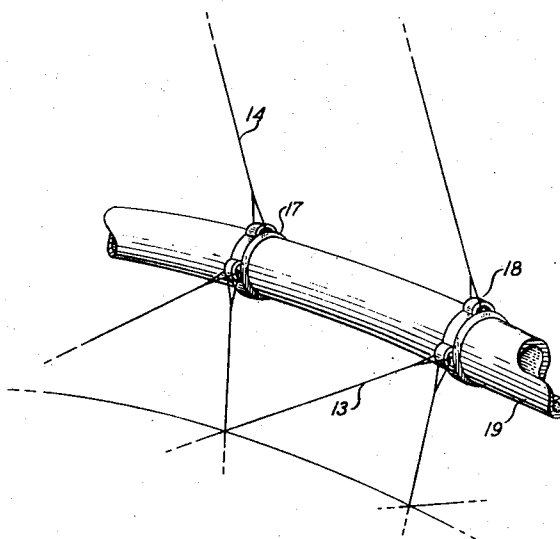
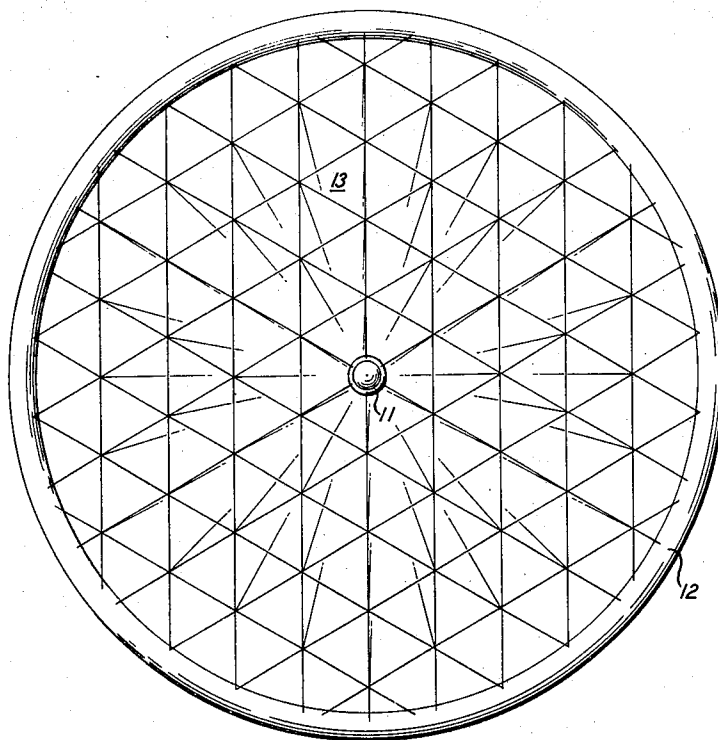


FIG. 4



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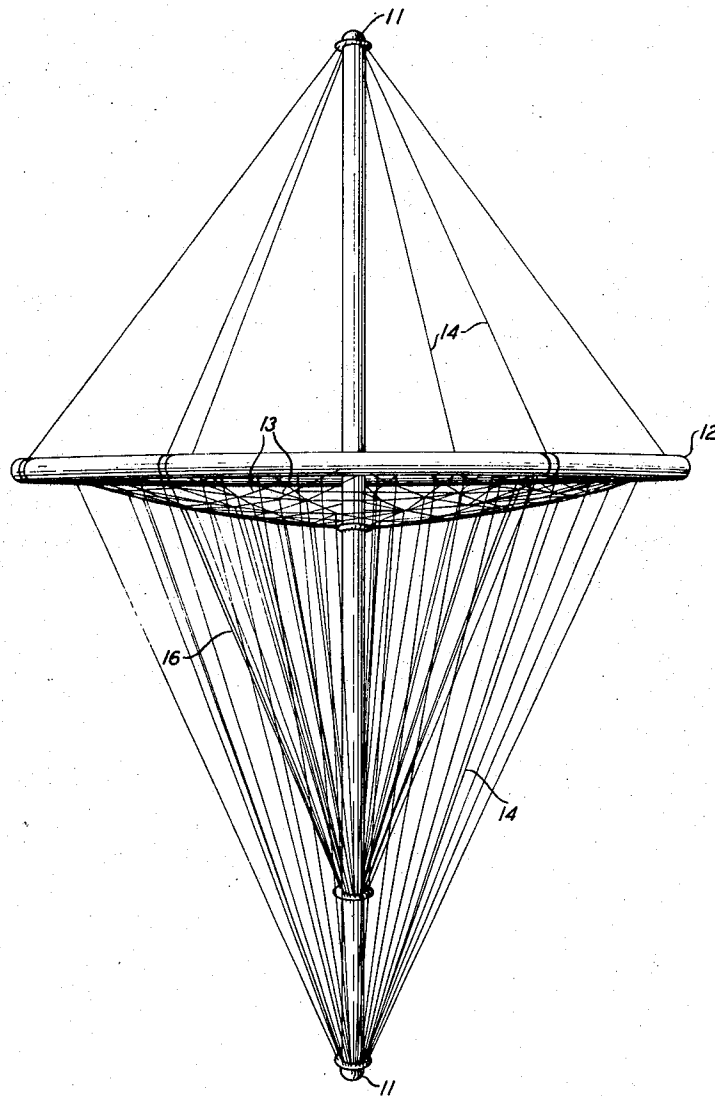
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FIG. 3



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FIG. 5a



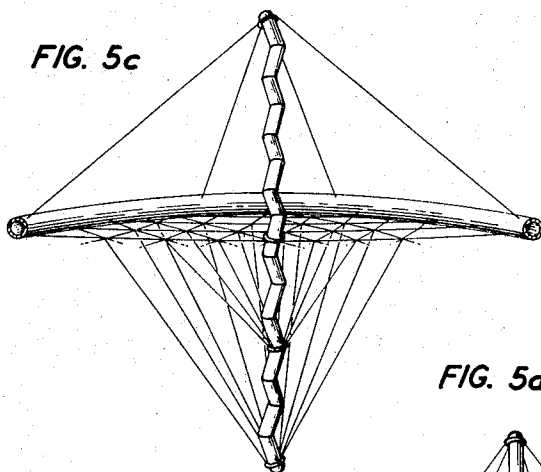
FULLY COLLAPSED ANTENNA

FIG. 5b



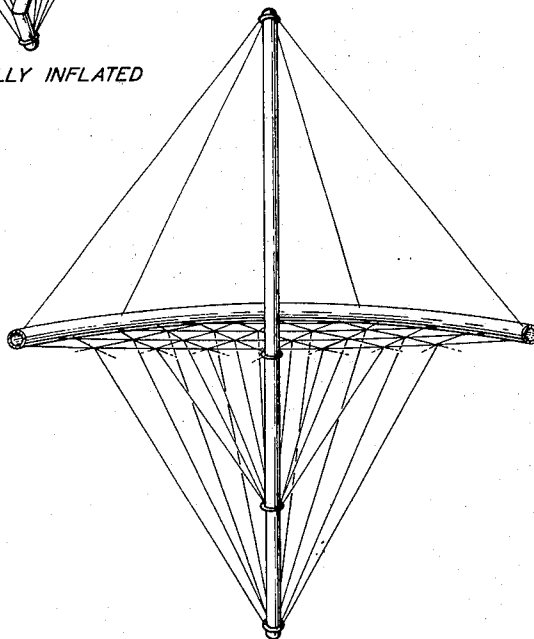
RING INFLATED

FIG. 5c



MAST PARTIALLY INFLATED

FIG. 5d



ANTENNA FULLY ERECTED

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INFLATABLE COMMUNICATIONS ANTENNA SATELLITE

John S. Cook, New Providence, N.J., assignor to Bell Telephone Laboratories, Incorporated, Murray Hill and Berkeley Heights, N.J., a corporation of New York
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U.S. Cl. 343—705

4 Claims

ABSTRACT OF THE DISCLOSURE

An antenna comprising an inflatable torus disposed about an inflatable mast connected, one to the other, by a guy wire system. Weight of the antenna is significantly reduced by using a reflective surface comprising a network of wire members suspended between the torus and the mast.

BACKGROUND OF THE INVENTION

Field of the invention

This invention pertains to communications satellites and, more particularly, to inflatable antenna satellites for receiving and/or transmitting communication signals.

In the last few years communication engineers have directed their attention to the use of satellites for various sorts of communications. Faced, particularly, with the limited transmission capabilities of transoceanic cables and the intermittent nature of ionospheric communication, the resort to space communications was a necessary, though not immediately practicable solution.

Situated in a synchronous or non-synchronous orbit a communications satellite, or a plurality thereof, may serve to relay information signals from one continent to another or intracontinental, as the case may be. Recent scientific and engineering endeavors have therefore been directed to maximizing the usefulness of this new capability.

Description of the prior art

The Bell System's Telstar® active communication satellite and "Project Echo," a passive space vehicle, are but two examples of recent successful attempts to communicate via the medium of space. Project Echo, in particular, utilized an inflatable spherical vehicle one hundred feet in diameter, for relaying signals from one distant station to another. The details of this vehicle may be found in Patent No. 2,996,212, issued in August 1961, to W. J. O'Sullivan. Although successful in the limited purposes for which it was designed, numerous practical limitations, e.g., discussed in Patent No. 3,220,004, issued in November 1965, to W. Gillespie, Jr., presented themselves.

Gillespie teaches that an antenna comprising an inflatable ring encircling an inflatable mast, connected one to the other by a plurality of spoke members, may prove more advantageous. In addition, a spherical sectional inflatable member is used which defines a continuous reflecting surface between the outer periphery of the ring and one end of the mast. To properly define the reflecting surface, Gillespie finds it necessary to inflate the reflecting surface member and stabilize it by using inflatable rib structures.

One inherent limitation in the use of an inflatable reflecting surface is the weight required to provide an adequate reflective surface. Not only does the necessary stabilizing rib structure increase the weight of the antenna, but the reflecting member, itself, may increase the weight of the structure by a ton or more when an antenna of the size contemplated herein is utilized. The increase in booster rocket payload capabilities is severe, without any compensating advantages.

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In addition, the use of a solid sheet reflector increases the area-to-weight ratio thereby compounding any instability introduced by solar radiation pressure.

Furthermore, the configuration and structure of the Gillespie antenna restricts it to use solely as a passive reflector of received signals. The need for a lightweight inflatable antenna which actively retransmits received signals is thus self-evident.

SUMMARY OF THE INVENTION

It is therefore an object of this invention to improve the construction of communications satellites.

Another object of this invention is to reduce the weight of an inflatable active antenna.

In accordance with the principles of this invention, these and other objects are accomplished by utilizing an antenna comprising an inflatable, substantially cylindrical member, i.e., mast, and an inflatable encircling torus, e.g., ring, connected one to the other, by a guy wire system, from points on the torus to points on the mast. A paraboloidal reflective surface, approximately by a network of small diameter wire members, is suspended between the ring and mast. The network of wire members is tied to the pole, i.e., mast, by a secondary guy wire system, thereby defining the desired reflective surface. A transceiver may be located at the focal point of the reflector, in the mast, for actively regenerating received signals. If a passive antenna is desired, the network of wires may be constrained to provide a reflecting surface of some other controlled geometry. The dimensions of the several members of the antenna may, in a particular embodiment, be measured in units of fractions of a mile. For example, in one such antenna, the diameter of the ring member is two thousand feet in diameter. Because of the large size of the antenna, any increase in weight due to the use of additional inflatable materials for the reflector and stabilizing ribs would be prohibitive. On the other hand, the weight of the network of wire members used in the present invention is negligible relative to the weight of the ring and mast.

These and further features and objects of this invention, its nature and various advantages, may be more fully understood by reference to the appended drawings.

DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates the configuration of the antenna of this invention;

FIG. 2 shows a method of connecting the diverse members of the antenna of this invention;

FIG. 3 illustrates a different view of the antenna of this invention;

FIG. 4 is an illustration of the reflective member of this invention; and

FIG. 5 illustrates a method of erecting the antenna of this invention.

DETAILED DESCRIPTION OF THE INVENTION

One embodiment employing the principles of the instant invention is shown in FIG. 1. An inflatable mast 11, shown in its erected position, is encircled by an inflated torus 12. A series of guy wires 14, connecting the mast 11 and ring 12, constrain the mast to lie in the desired plane, as illustrated. Reflecting surface 13, comprising a network of small diameter wires, is suspended between the ring 12 and mast 11. A secondary system of guy wires 16, connecting reflector 13 and mast 11, stabilize the reflector and constrain it in such a manner that the desired surface, e.g., paraboloidal, is properly defined. A transceiver 15, of any well-known type for actively regenerating applied signals, is located at the focal point of the reflector, inside the mast 11. If so desired, the mast

may be shortened and transceiver 15 located at one end thereof.

As well known by those skilled in the art, the materials of the various members may be of diverse types. Preferably, the ring and mast members are made of a polyester material such as that known by the trade name Mylar, and comprise two layers or skins approximately one-half mil in thickness. The use of two layers has been found satisfactory for protection against meteoroids. Inflatable members need not, of course, be used. For example, extendible lightweight tubular members have also been found satisfactory. Sufficient strength and negligible weight are provided by the use of high strength steel wires, for the guy members, with a diameter of approximately ten mils. A lighter wire mesh superimposed on reflector network structure 13 may be used to optimize its electrical characteristics.

The various wire members may be attached to the mast and ring by any conventional connecting means. For example, FIG. 2 illustrates one method. Rings 17 and 18, which encircle inflated member 19, serve to connect the illustrated guy and reflective member wires.

FIG. 3 presents a slightly different view of the antenna of this invention in order to emphasize the paraboloidal surface defined by member 13. An identical numerical designation to that used in FIG. 1, is utilized to facilitate comprehension of the antenna configuration.

FIG. 4 illustrates one example of the reflective surface 13 of the instant invention. Surface 13 comprises a grid of wires connected to define a surface within the interior of torus 12. The surface may be planar, or more desirably, paraboloidal. It is approximated by a series of planar facets with the junctions of the facet intersections tied back to the mast 11 as shown in FIGS. 1 and 3. The individual facets which make up the paraboloidal surface may be either regular or random in shape and size. Random facets give rise to side lobes randomly distributed over a wide angular area. If the facets are regular and the dish is relatively shallow, grating lobes of a predictable nature will be formed. The location and amplitude of these grating lobes will, of course, depend on the size and disposition of the facets. Of the many patterns usable, three regular facet configurations are triangles, squares and hexagons. It has been found that the use of triangular facets is the most efficient in terms of grating lobe separation versus total structure weight. Such a configuration is shown in FIG. 4. Fortunately, the use of triangular facets is also superior from a structural viewpoint.

The method of placing the antenna of this invention into orbit forms no part of this invention; any of the conventional techniques known to those skilled in the art may be utilized. In addition, means for inflating said antenna are so diverse and well known that no attempt will be made to repeat what has been well said before. See, for example, the above-cited Gillespie patent.

FIG. 5 schematically illustrates by cutaway views the mode of erecting the instant antenna in space. As shown in FIG. 5(a) the antenna, when folded, is a compact package suitable for storage in the nose cone of a launch rocket. In FIG. 5(b), the torus is shown inflated, thereby extending the guy wires and reflective surface wire members connecting the folded mast and inflated ring. FIG. 5(c) illustrates the configuration of the antenna, when

the mast is partially inflated, and FIG. 5(d) shows the antenna fully erected.

It is to be understood that the embodiments shown and described are illustrative of the principles of this invention only, and that further modifications of this invention may be implemented by those skilled in the art without departing from the scope and spirit of the invention. For example, sundry and diverse materials and techniques exist for constructing, uniting and erecting the antenna of this invention.

What is claimed is:

1. A communications antenna satellite comprising:
 - an inflatable mast member,
 - an inflatable torus disposed about said mast member,
 - a reflective surface comprising a network of conductive members suspended between said torus and said mast member,
 - a plurality of guy wires connecting said mast member and said torus for stabilizing said torus and mast members,
 - and a secondary guy wire system constraining the conductive members of said reflective surface to said mast member to define a paraboloidal reflecting surface.
2. The satellite as defined in claim 1 wherein said reflective surface comprises a network of triangular planar facets.
3. An inflatable communications antenna comprising:
 - an inflatable mast member,
 - an inflatable toroidal member concentric with said mast member,
 - a plurality of guy wires connecting said mast member and said toroidal member,
 - a paraboloidal reflective surface comprising a network of planar wire facets connected between said mast member and said toroidal member,
 - and signal regeneration means disposed in said mast member at the focal point of said paraboloidal reflective surface.
4. A relay satellite comprising:
 - an inflatable, substantially cylindrical member,
 - an annular inflatable member encircling said cylindrical member,
 - a network of wires suspended between said annular member and said mast member,
 - a first plurality of means connecting said cylindrical member and said annular member for stabilizing said members against deformation,
 - and a second plurality of means constraining said network of wires to said cylindrical member to define a predetermined geometrical sectional reflecting surface.

References Cited

UNITED STATES PATENTS

2,798,478	7/1957	Tarcici.
3,220,004	11/1965	Gillespie.
3,326,624	6/1967	Maydell et al.

HERMAN KARL SAALBACH, Primary Examiner

F. P. BUTLER, Assistant Examiner

U.S. Cl. X.R.

343—840, 915