United States Patent [19]

Owen

[11] **3,913,109**

[45] **Oct. 14, 1975**

[54] **ANTENNA ERECTION MECHANISM**

[75] Inventor: **Charles F. Owen,** Silver Spring, Md.

[73] Assignee: **The United States of America as represented by the Secretary of the Navy,** Washington, D.C.

[22] Filed: **Dec. 2, 1974**

[21] Appl. No.: **528,609**

[52] **U.S. Cl.** **343/880;** 343/895; 52/110

[51] **Int. Cl.**[2] **H01Q 1/08;** H01Q 1/36

[58] **Field of Search** 52/109, 110, 113; 343/880, 343/881, 895

[56] **References Cited**

UNITED STATES PATENTS

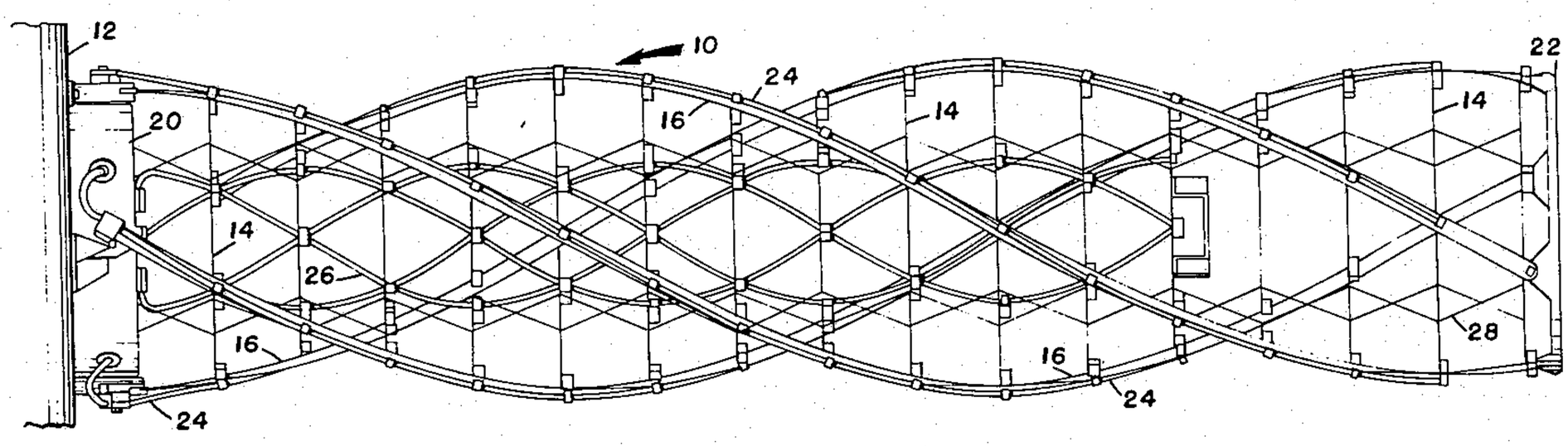
3,451,182	6/1969	Lodrick	52/110
3,524,193	8/1970	Auletta	343/895
3,836,979	9/1974	Kirland et al.	343/895

Primary Examiner—Eli Lieberman

[57] **ABSTRACT**

The invention is a collapsible, self-erecting boom comprised of flat annular segments disposed mutually parallel in a cylindrical conformation and held apart by flexible bands which helically wind about the structure, the bands acting to erect the structure in spring-like fashion, and thereby carrying antenna elements to a predetermined helical disposition.

6 Claims, 2 Drawing Figures



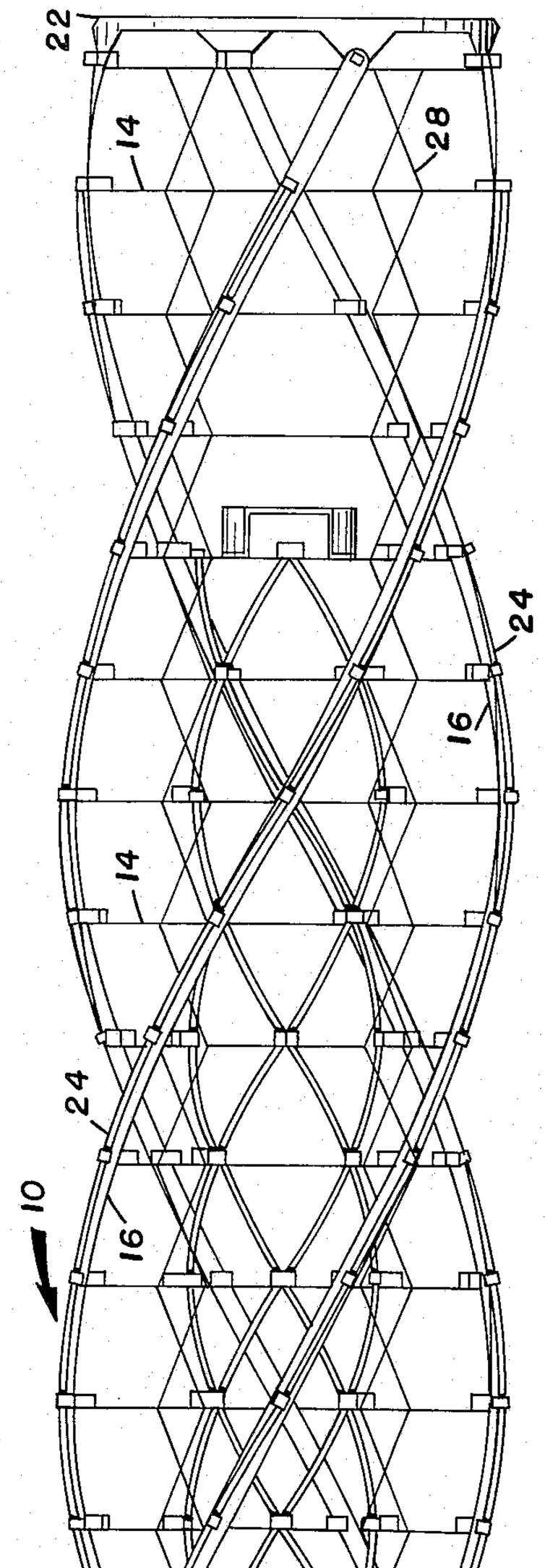
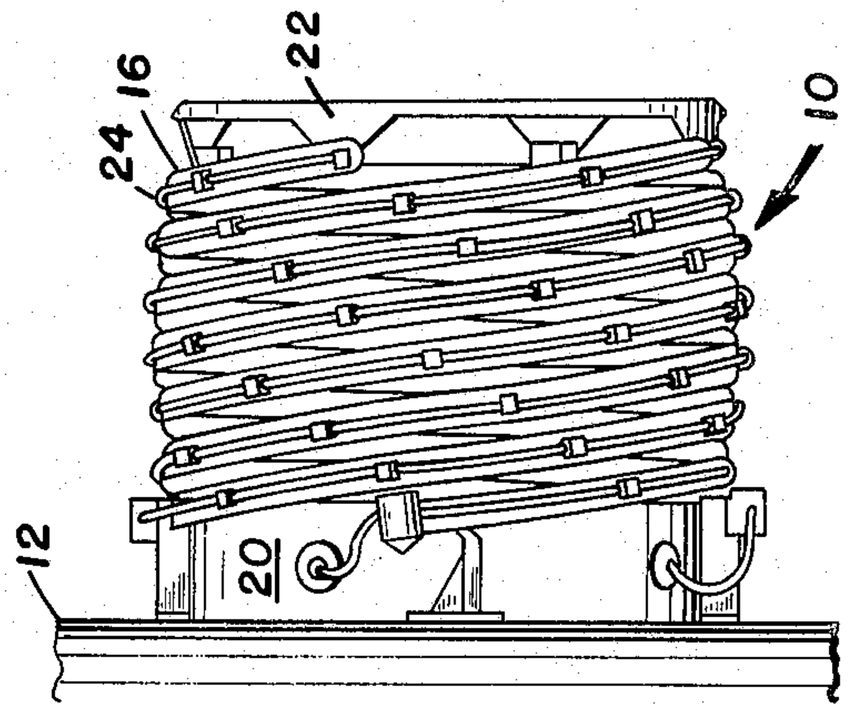


FIG. 2

FIG. 1



ANTENNA ERECTION MECHANISM

BACKGROUND AND SUMMARY OF THE INVENTION

Since the beginning of man's organized attempts to reach beyond the confines of his own planet, the utility of boom devices for space vehicles has been recognized. The great majority of space vehicles sent into the environs which surround the earth have used some type of boom, their function ranging from signal transmission to vehicle stabilization. Particularly useful have been erectable booms, that is, booms which are held in a restricted space during launch of a spacecraft and, on ejection of the spacecraft from the launch vehicle, are deployed from the craft. Such a boom is a necessity when deployment of a stabilizing mass or antenna to a substantial distance from the spacecraft is required. Volumetric constraints in such circumstances prevent the stowage of the full, extended length of the boom within the usually restricted space available aboard the spacecraft.

The present invention provides a compactly stowable boom structure which is self-erectable. In the non-deployed state, the present structure is collapsed into a reduced volume. When released from the collapsed state, helical bands held under tension deploy the boom structure to a predetermined conformation. The present structure finds particular use as an antenna erection mechanism useful particularly aboard spacecraft. The antenna elements, which may even assume the same physical positions as the helical bands on erection of the bands, are held by the bands and deployed to predetermined positions on erection of the bands.

The present invention thus provides a self-erecting boom particularly useful in space applications where a stabilizing mass, antenna, or the like is to be deployed to a predetermined position on achievement of orbit by a spacecraft of which the boom is a part. Mechanical constraints hold the boom in a stowed conformation during spacecraft launch, the boom deploying at a predetermined time by release of the mechanical constraints. The present boom essentially consists of a plurality of annular plastic segments disposed mutually parallel to each other in a cylindrical conformation and held apart by flexible bands which helically wind about the cylinder-like structure, the flexible bands acting to erect the structure by separating the segments from each other in a spring-like fashion.

Hence, the present invention provides a self-erecting boom particularly useful on spacecraft and the like and which is compactly stowable and self-deployable to a predetermined configuration, such advantages forming a primary object of the invention.

It is a further object of the invention to provide a self-erecting boom capable of supporting bending moments of relatively large magnitude and capable of high torsional stiffness.

It is similarly an object of the invention to provide a boom having a known, predictable, and repeatable torsional alignment upon erection.

A still further object of the invention is to provide an erectable boom having a controllable rate of deployment which, under light loading, is stable during deployment.

Other objects and advantages of the invention will become more readily apparent on reference to the following description of the preferred embodiment.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an elevation of the present boom in the compressed, pre-deployed configuration; and,

FIG. **2** is an elevation of the present boom in the deployed configuration.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The self-erecting boom structure described hereinafter can be utilized for a variety of applications both on the ground or in space. The description herein will be primarily directed for purposes of illustration to the use of the invention as a self-erecting boom for spacecraft, and particularly as an antenna erection mechanism useful aboard space vehicles.

Referring now to the drawings, the invention comprises a boom generally shown at **10,** the boom **10** being in a compactly stowed, non-deployed configuration in FIG. **1** and in a fullydeployed configuration in FIG. **2.** The boom **10** is seen to be attached at its inner end to a portion of a satellite **12** and, in FIG. **1,** is held in a compact comformation by suitable mechanical constraints (not shown). The boom **10** is comprised essentially of a plurality of annular segments **14** which may be formed of plastic or the like. The segments **14** are held in an aligned, substantially cylindrical conformation by at least two flexible bands **16.** The bands **16** are each attached to an annular collar **20** at their inner ends and to a cap **22** at their outer ends. The bands **16** wind helically about the cylindrical contour of the structure as defined by the aligned segments **14** and are attached to the segments at points of intersection with the peripheries thereof. The structure shown in the drawings has four of the bands **16,** the bands being attached to the collar **20** at equal 90° arcs taking the collar **20** as defining a circle. The use of two of the bands **16** would necessitate attachment of the bands at points on the collar **20** diametrically opposite from each other, or at spacings of 180° arcs. Similarly, three bands **16** would be positioned at 120° arcs from each other. The use of four of the bands **16** as shown provides a greater degree of torsional stiffness to the structure and provides adequate support for the segments **14.**

The bands **16** must be formed from a material which is laterally flexible. A metallic material such as beryllium-copper or certain plastic materials are suitable. The bands **16** effectively comprise flat band springs which are compressed and store energy when in the stowed configuration of FIG. **1.** On release of the mechanical constraints (not shown) used to hold the boom **10** in the stowed configuration, the bands **16** are forced by the energy stored therein to a predetermined position, such as is shown in FIG. **2.** The present structure is particularly suited to erection of a helical antenna formed by coaxial cables **24.** The cables **24** are attached to the bands **16** at points along their length and thus deploy to the position assumed by the bands **16.** Coaxial cables **26** disposed in the interior of the boom **10** may also be deployed on erection of the boom by the bands **16.** The cables **26** may extend the full length of the structure or may extend only between certain of the segments **14.** An interior network of restraining strings or wires **28** are employed to prevent the bands **16** from deploying to full extension, in which case the bands **16** would straighten and lose their helical character. The strings or wires **28** are attached between successive segments

14 and between the innermost segment 14 and the collar 20 to provide efficient tensioning of the deployed boom structure.

It is to be understood that the invention may be practiced in a manner otherwise than has been expressly described herein. For example, the use of the invention for supporting masses along its length as well as for antenna erection will be readily apparent upon interpretation of the invention in light of the appended claims.

What is claimed is:

1. A self-erecting boom comprising:

a plurality of mutually parallel annular supporting segments spaced apart from each other and aligned to define spatially a cylinder; and,

at least two flexible bands extending generally in a direction essentially parallel to the cylinder defined by the segments and winding helically about the cylindrically defined contour of the boom, the bands each being attached to the segments at the point of intersection of each band with the periphery of each of the segments,

compression of the boom into a compact, non-deployed configuration storing energy in the bands, which energy is released on extension of the bands to erect the boom to a deployed configuration.

2. The self-erecting boom of claim 1 and further comprising:

co-axial cables attached to the bands and erectable therewith to a helical conformation to form an antenna.

3. The self-erecting boom of claim 1 and further comprising:

collar means disposed at one end of the cylinder defined by the segments and spaced from and parallel to the segment adjacent thereto, the bands being attached to the collar means at points equidistant about the periphery of the collar means.

4. The self-erecting boom of claim 3 and further comprising:

cap means disposed at the end of the cylinder defined by the segments which is opposite from the collar means, the cap means being spaced from and parallel to the segment adjacent thereto, the bands being attached to the cap means at points equidistant about the periphery of the cap means.

5. The self-erecting boom of claim 1 and further comprising:

restraining means for allowing extension of the bands to a predetermined helical pitch, thereby to allow erection of the boom to a predetermined length.

6. The self-erecting boom of claim 5 wherein the restraining means comprise means joined between adjacent segments.

* * * * *