Marshall

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

REPLY TO ATTN OF: GP

TO: USI/Scientific & Technical Information Division
Attention: Miss Winnie M. Morgan

FROM: GP/Office of Assistant General Counsel for Patent Matters

SUBJECT: Announcement of NASA-Owned U. S. Patents in STAR

In accordance with the procedures agreed upon by Code GP and Code USI, the attached NASA-owned U. S. Patent is being forwarded for abstracting and announcement in NASA STAR.

The following information is provided:

U. S. Patent No. : 3,569,875

Government or Corporate Employee : Sperry Rand Corp. Huntsville, Ala.

Supplementary Corporate Source (if applicable) :

NASA Patent Case No. : MFS-20068

NOTE - If this patent covers an invention made by a corporate employee of a NASA Contractor, the following is applicable:

Yes ☒ No ☐

Pursuant to Section 305(a) of the National Aeronautics and Space Act, the name of the Administrator of NASA appears on the first page of the patent; however, the name of the actual inventor (author) appears at the heading of Column No. 1 of the Specification, following the words ". . . with respect to an invention of . . . "

Elizabeth A. Carter

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Enclosure
Copy of Patent cited above

Patented March 9, 1971 3,569,875

2 Sheets-Sheet 1

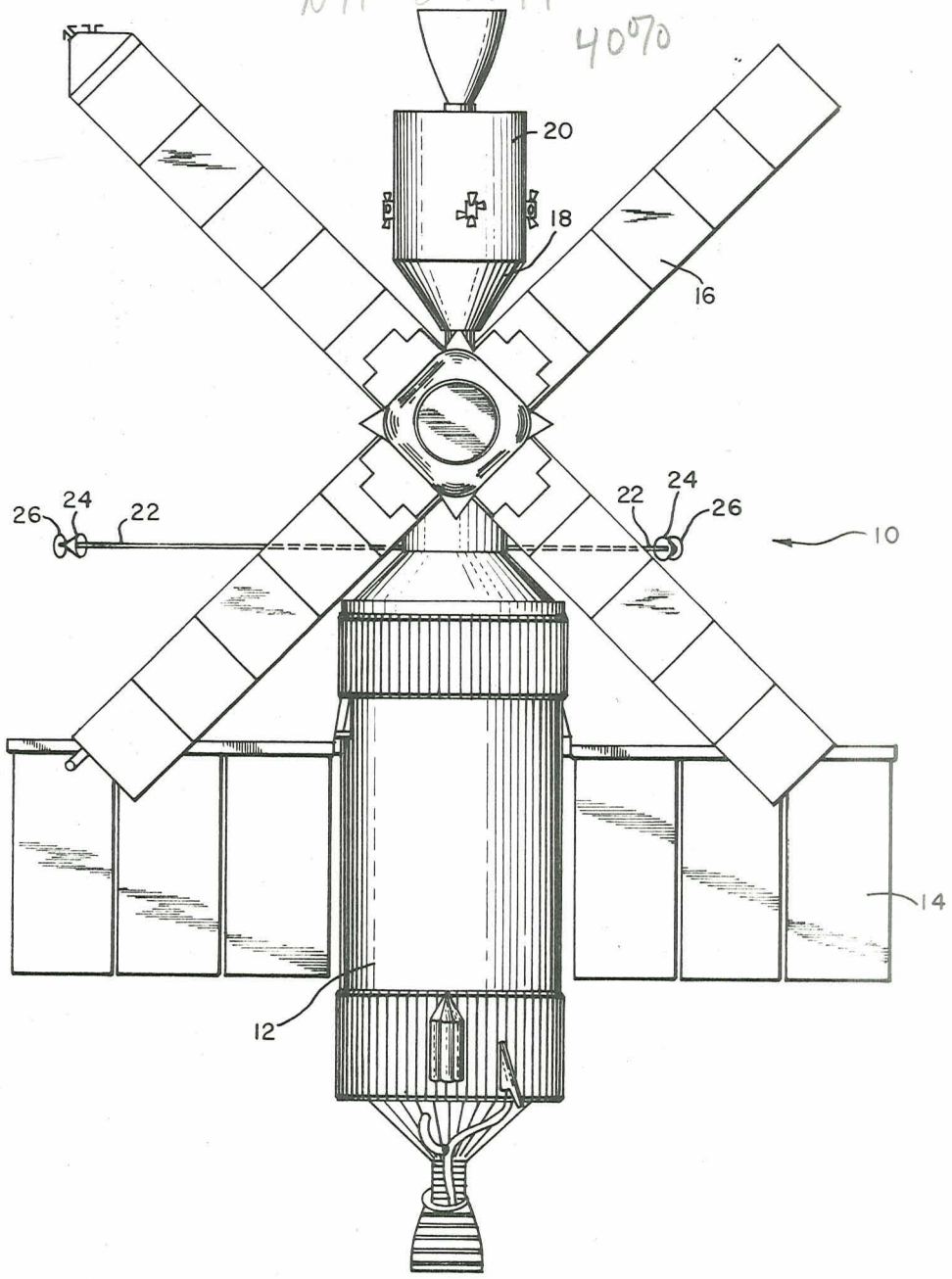

FIG. 1

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2 Sheets-Sheet 2

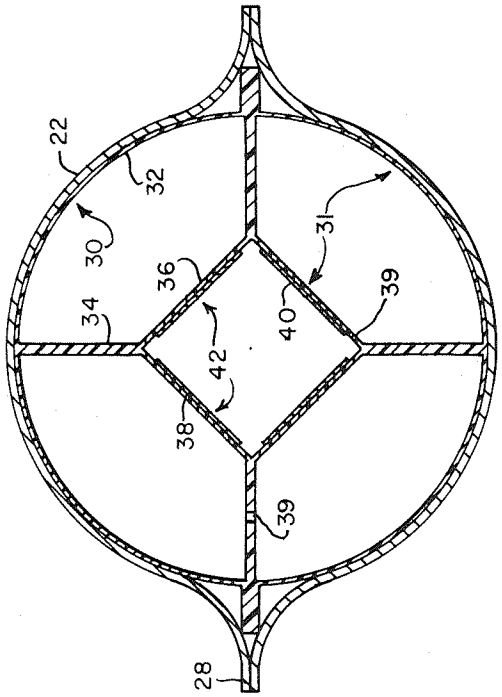

FIG. 3

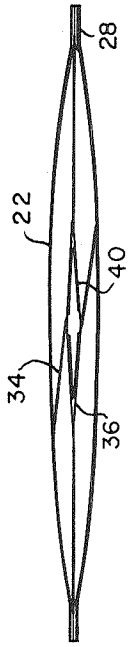

FIG. 4

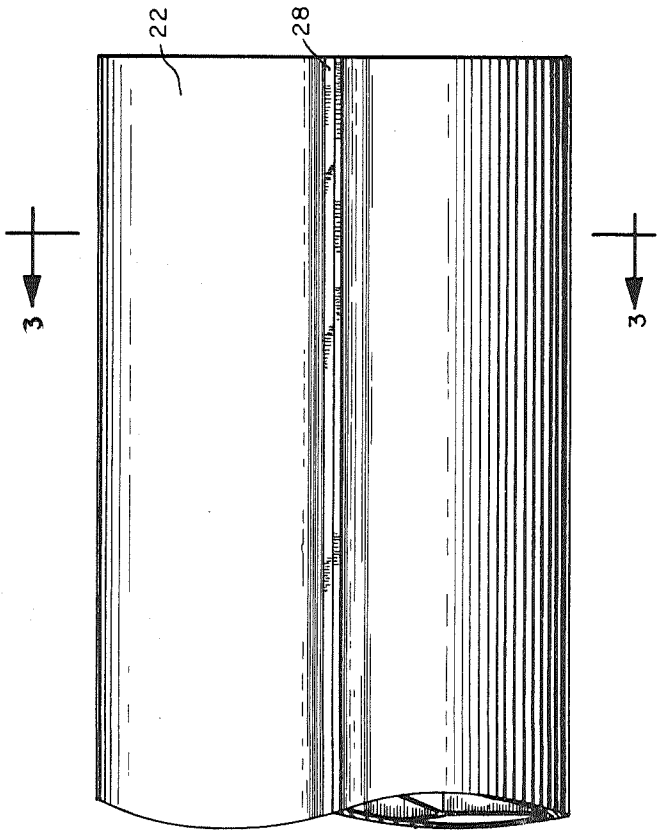

FIG. 2

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United States Patent

[11] 3,569,875

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[21] Appl. No. **797,795**
[22] Filed **Feb. 10, 1969**
[45] Patented **Mar. 9, 1971**

[54] **COLLAPSIBLE ANTENNA BOOM AND TRANSMISSION LINE**
5 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** ..... **333/96,** 333/95, 174/28 (Request), 343/884
[51] **Int. Cl.** **H01p 3/06,** H01p 3/14, H01q 1/22
[50] **Field of Search** ..... 343/881, 884, 705 (S), 915, 915 (A), 880, 723, 877; 333/96, 95 (A), 95, 3,000; 174/28, 29, 105, 99, 900; 29/600, 601; 52/108

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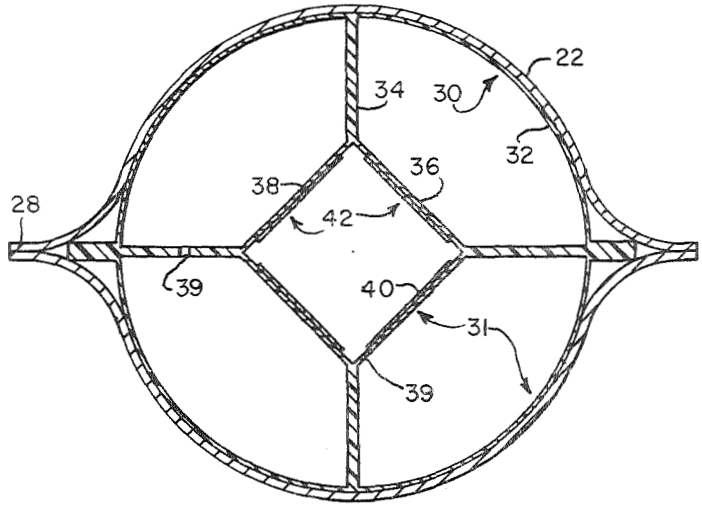
ABSTRACT: A collapsible antenna boom and coaxial transmission line having an inflatable inner tube. The tubular outer casing is made of two sheets of thin sheet metal butted together and seam welded to form two protruding flanges at opposite sides of the casing. The inner tube, which provides considerable strength to the boom, has four compartments spaced around its outer circumference and a center compartment all interconnected by ports. Four parallel transmission line inner conductors are all equally spaced around the inner wall of the center compartment. The outer casing serves as the outer transmission line conductor. The design of the tubular outer casing and the inflatable inner tube permits the boom to be folded and rolled on a reel when not in use.



COLLAPSIBLE ANTENNA BOOM AND TRANSMISSION LINE

ORIGIN OF THE INVENTION

The invention herein was made in the performance of work under a NASA contract and is subject to the provisions of Section 305 of the National Aeronautics and Space Act of 1958 Public Law 85–568 (State. 435; 42 U.S.C, 2457).

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to an antenna boom and transmission line and more particularly to a collapsible antenna boom and coaxial transmission line having an inflatable inner tube.

2. Description of the Prior Art

With the ever increasing use of vehicles of all types, such as automotive vehicles, boats, aircraft and particularly spacecraft, there has developed a need for a combination antenna boom and flexible transmission line which can be collapsed and rolled up on a reel when not in use and yet is exceptionally strong for its weight and capable of supporting one or more small antennas or antenna arrays for frequency ranges from VHF through S-Band.

A particular problem has arisen with regard to the development of transmission lines for use with collapsible or extendable antenna booms. Conventional coaxial cables have large attenuation at frequencies above L-Band and are difficult to install within either telescoping booms or reel booms. In addition, such cables are not flexible enough for use with collapsible booms which are currently available on the commercial market.

SUMMARY OF THE INVENTION

Accordingly, it is an object of this invention to provide an antenna boom with an improved transmission line.

Still another object of this invention is to provide a combination boom and improved transmission line.

Yet another object of this invention is to provide a combination boom and improved transmission line having lower attenuation at frequencies above 2000 MHz and having more flexibility than conventional coaxial cables. These and other objects are accomplished in the present invention which provides a collapsible tubular outer casing which furnishes great structural strength to the boom and which is also utilized as an outer transmission line conductor. The invention also comprises an inflatable inner tube having its outer walls shaped to fit the inner walls of the casing and at least one inner transmission line conductor attached to the inner tube.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be more fully understood by the following detailed description when taken together with the accompanying drawings in which:

FIG. 1 is a plan view of an orbiting space laboratory with the invention in its extended position, attached to the orbiting space laboratory.

FIG. 2 is a side view of a section of the boom.

FIG. 3 is a vertical sectional view of the boom which is taken along line 3–3 of FIG. 2 and showing the inner tube supporting the boom.

FIG. 4 is a vertical sectional view of the boom and inner tube in its collapsed configuration.

DESCRIPTION OF THE PREFERRED EMBODIMENT

With continued reference to the accompanying FIGS. wherein like numerals designate similar parts and with initial attention directed to FIG. 1, there is illustrated a space station designated generally by numeral 10 including an orbital workshop 12 in a spent rocket stage and having solar array 14, a second solar array 16, command module 18 and service module 20. Attached to a space station 10 are two antenna booms 22 illustrating one embodiment of the present invention. Attached to each antenna boom 22 is an antenna consisting of a ground plane element 24 and a radiating element 26.

FIG. 2 illustrates a section of tubular antenna boom 22 which constitutes the outer casing of the invention. Boom 22 is made from two strips of metal, made of titanium or beryllium copper, preferably 4 inches wide and 5 mils thick, which is seam welded so as to form two large protruding flanges 28 at either side of the boom. Boom 22 serves the dual purpose of providing great strength to the structure, considering its weight, and is also used as the outer conductor of the coaxial transmission line.

FIG. 3 is a vertical sectional view of the boom 22 with its plastic inner tub 30 inflated and supporting the walls of the boom 22. The inner tube 30 is divided into several outer compartments 31 spaced around the circumference of its outer wall 32. Compartment walls 34 separate the compartments 31. The inner walls 36 of the outer compartments 31 form a center compartment 38 which may have either a square (as in FIG. 3) or circular (not shown) cross-sectional area. The compartments 31 and 38 are interconnected by several ports 39 located in walls 34 and 36. A plurality of copper strips 40 are separately attached to the inner side of inner walls 36. When these copper strips 40 are excited in phase, the strips 40 operate electrically as one square center conductor 42.

The inner tube 30 of the transmission line is pneumatically sealed for pressurization up to 30 pounds per square inch. Pressurization stiffens the boom 22 and causes it to assume a uniform circular shape. More importantly, pressurization positions the center conductor 42 at the center of the boom 22 and holds it there. It also causes the center compartment 38 of the inner tube 30 to assume a square cross-sectional shape because of tension in the compartment walls 34.

The inflatable inner tube 30 is constructed of Kapton plastic, preferably having a thickness of about 3 mils. This material was selected over Mylar because of its excellent temperature characteristics, flexure strength and bonding properties. Kapton is a flame resistent material which does not char under 800° C. It does not melt and is infusible. In tests of this material known to the inventor, Kapton has been flexed over a one-half inch diameter mandrel 2800 times at 220° C. before breaking and over a one-half inch diameter mandrel 7,700 times at minus 63° C. before breaking the copper conductors. The Kapton dielectric did not break during the latter (low temperature) test.

The Kapton dissipation factor is high at room temperatures, varying widely toward lower values at both higher and lower temperatures. For this reason, Kapton is not often used as a dielectric in a device for the transmission of radio frequency signals. However, the radio frequency losses are small within the dielectric, if the dielectric is thin relative to the total space within the conductors.

The vertical sectional view in FIG. 4 shows the boom 22 with its inner tube 30 in collapsed configuration. The cross-sectional long axis of the illustrative embodiment of the collapsed boom 22 is about 4 inches long. A fifty-foot length of this collapsed boom 22 could be wound on a two-foot diameter reel (not shown), if desired. When the boom 22 is unwound from a reel, the spring action of the boom 22 expands it into a nearly elliptical cross section. Pressurization of the inner tube 30 after expansion of the boom 22 to assume a circular cross section. Pressurization also forces the square center conductor 42 into the center of the boom 22, which assures a constant characteristic impedance of 50 ohms along the length of the boom.

As may be computed by those skilled in the art of transmission lines, at 2270 MHz., the resistance of the titanium outer conductor is 0.537 ohm/meter and the resistance of the square inner conductor is 0.716 ohm/meter.

The attenuation of the line is

$$a=\frac{R}{2Ro}=\frac{.716}{100}=.00716 \text{ Neper/meter}=.0622 \text{ db/meter}$$

An RG-9 coaxial cable, by comparison, has a much greater attenuation of 0.6 db/meter at 2270 MHz.

As will be understood by those skilled in the art, a complete system for the use of this invention might include a reel, means for sealing the boom and transmission line, radio frequency connectors, and a pressure valve for inflating the inner tube. However, such additional elements, while they may be used with the invention, are not considered part of the invention being claimed here. Therefore, no further disclosure of these additional elements is deemed necessary.

From the foregoing it may be seen that applicant has invented a combination collapsible antenna boom and coaxial transmission line which is a considerable improvement over such devices known in the prior art. The inflatable inner tube supports the inner walls of the boom so as to make the structure exceedingly strong for its weight. The device may be collapsed and rolled up if desired. In addition, the attenuation of the coaxial transmission line is considerably lower than in conventional coaxial cable at frequencies on the order of 2300 MHz. Thus the invention represents a major improvement over previously known structure for radio frequency transmission within flexible booms.

I claim:

1. a collapsible antenna boom and coaxial transmission line comprising:
   a. a collapsible tubular outer casing said casing having two protruding seams at opposite sides of its circumference, said casing being effective for use as an outer transmission line conductor;
   b. an inflatable inner tube having its outer wall shaped to fit the inner wall of said casing for supporting and strengthening said casing;
   c. at least one inner transmission line conductor attached to said inner tube;
   d. said seams permitting said casing and said inner tube to fold down to a substantially flat configuration.

2. The collapsible antenna boom and coaxial transmission line of claim 1 wherein said inflatable inner tube has a plurality of outer compartments spaced around its outer circumference and a center compartment positioned inside said outer compartments.

3. The collapsible antenna boom and coaxial transmission line of claim 2 having at least one said transmission line conductor attached to the wall of said inner tube center compartment.

4. A collapsible tubular outer casing and coaxial transmission line comprising:
   a. a collapsible tubular outer casing having two protruding seams at opposite sides of its circumference, said casing being effective for use as an outer transmission line conductor;
   b. an inflatable inner tube having its outer wall shaped to fit the inner wall of said casing, said inner tube having a plurality of outer compartments spaced around its outer circumference and a center compartment positioned inside said outer compartments;
   c. four parallel inner transmission line conductors equally spaced around the inside of the wall of said inner tube center compartment and extending longitudinally along the inside wall of said center compartment;
   d. said seams permitting said casing and said inner tube to fold down to a substantially flat configuration.

5. The collapsible antenna boom and coaxial transmission line of claim 4 wherein said center compartment has a square cross-sectional area.