United States Patent

[11] 3,618,101

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[21] Appl. No. **853,423**
[22] Filed **Aug. 27, 1969**
[45] Patented **Nov. 2, 1971**

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[32] Priority **Aug. 27, 1968**
[33] **Germany**
[31] **P 17 91 007.5**

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[54] **COLLAPSIBLE PARABOLIC ANTENNA**
9 Claims, 10 Drawing Figs.

[52] **U.S. Cl.** **343/705,** 343/DIG. 3, 343/840, 343/915
[51] **Int. Cl.** **H01q 15/20**
[50] **Field of Search** ..... 343/781, 840, 912, 915, 705, DIG. 3

[56] **References Cited**

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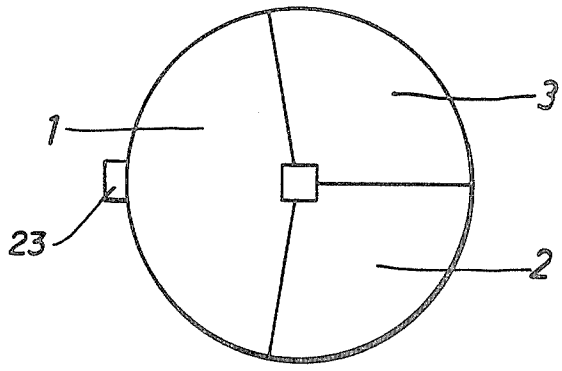
ABSTRACT: A collapsible parabolic antenna for use with a communications satellite. Two 100° reflector segments are rotated laterally by torsion springs and moved axially by a coil spring, so as to be brought into proper position with respect to a fixed 160° segment. The moveable segments are held in place in back of the fixed segment by electromagnetic or pyrotechnic devices that can be actuated by remote control to release the moveable segments at the appropriate time.



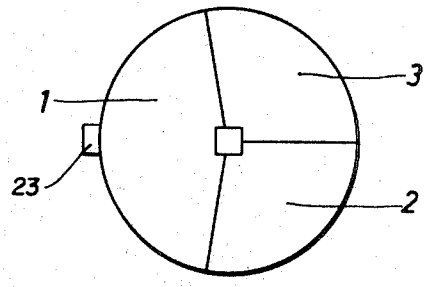


Fig. 1

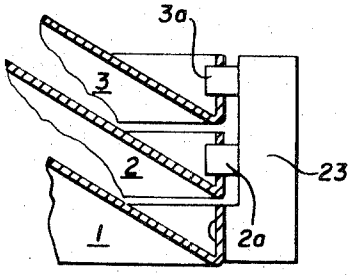


Fig. 2a

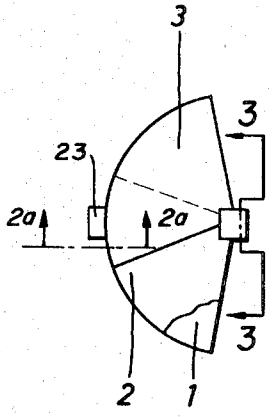


Fig. 2

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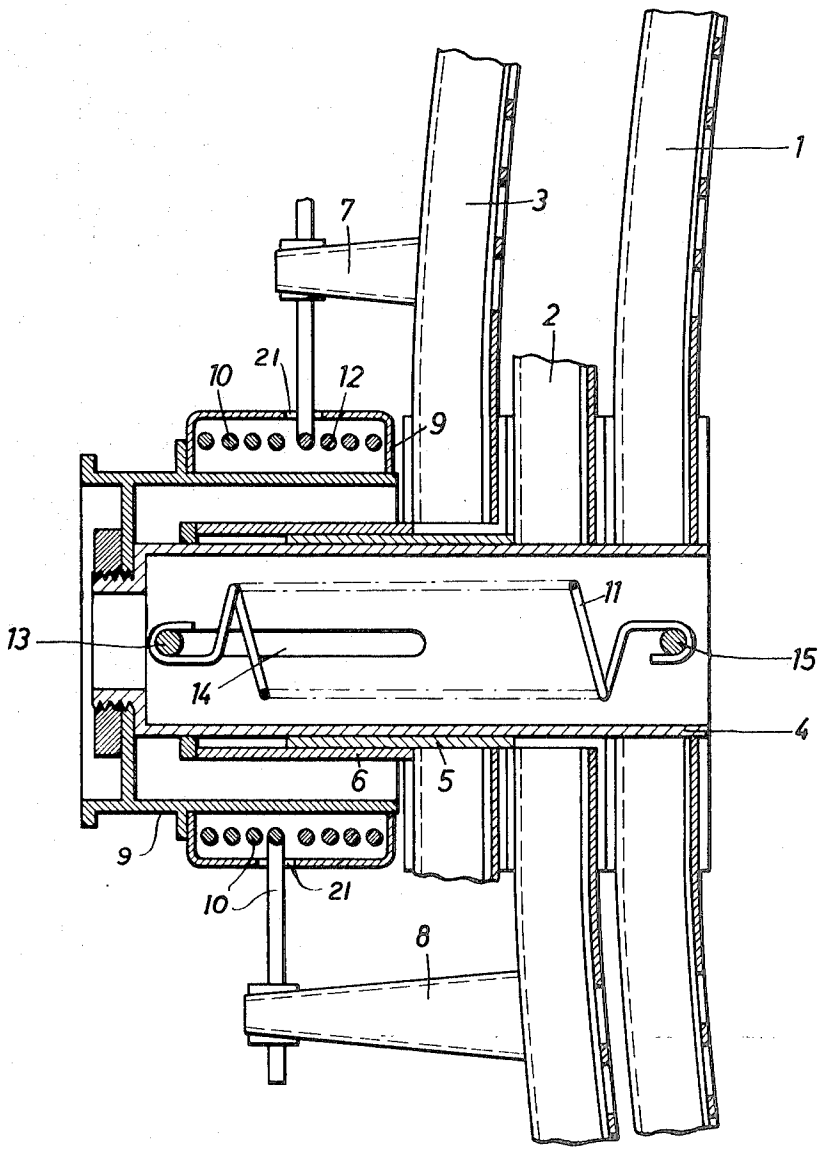

Fig. 3

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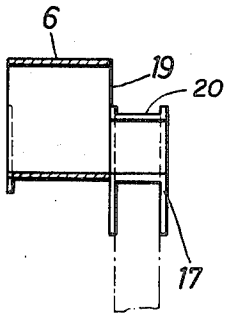

Fig. 4

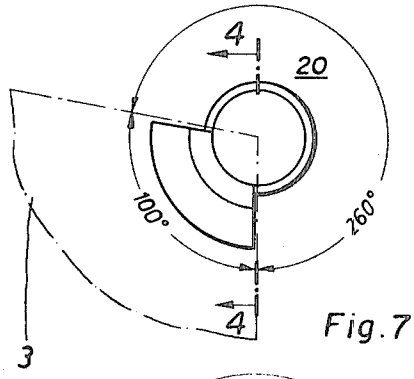

Fig. 7

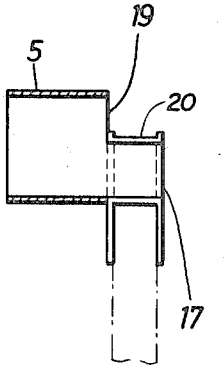

Fig. 5

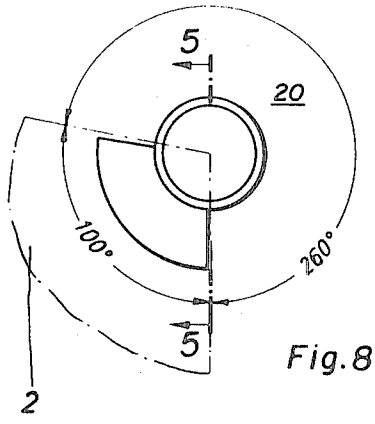

Fig. 8

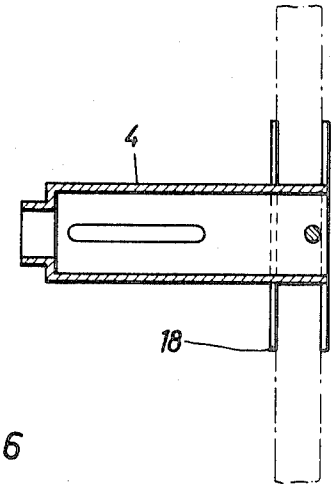

Fig. 6

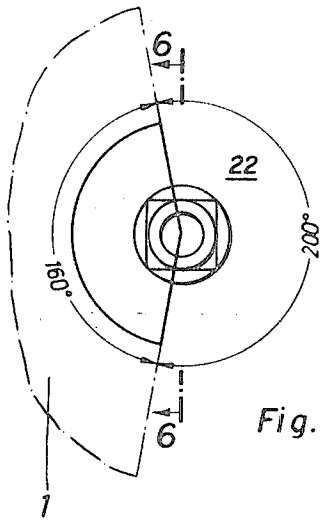

Fig. 9

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COLLAPSIBLE PARABOLIC ANTENNA

BACKGROUND OF THE INVENTION

The present invention relates to a collapsible satellite antenna which is preferably constructed in the form of a parabolic reflector.

Due to space limitations in the transport vehicles presently available, antennas for communications satellites must be collapsible so that they take up a minimum of space during the transport phase. When the satellite has reached its orbit, the antennas are brought into their operating position by suitable drive means.

SUMMARY OF THE INVENTION

One of the objects of the present invention is to construct an antenna reflector in such a manner that it takes a relatively small amount of space and can be easily and reliably brought into its final operating position.

In the antenna reflector according to the present invention this is achieved by dividing the reflector into a fixed and one or more moveable segments. In the transport phase the segments are superimposed on one another in order to save space. The moveable segments can be rotated out of their basic positions with respect to the fixed segment by means of torsion springs, which are actuated electromagnetically or pyrotechnically by remote control. The moveable segments can also be axially displaced with respect to the fixed segment after completion of the rotary movement by means of a tension spring. In this manner the several segments combine to form the antenna reflector.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic front view of an antenna reflector according to the present invention. FIG. 2 is a schematic front view of the antenna reflector of FIG. 1 in a folded position. FIG. 2*a* is a cross-sectional view generally taken along the plane defined by line 2*a*—2*a* of FIG. 2.

FIG. 3 is a cross-sectional view generally taken along the plane defined by line 3—3 of FIG. 2.

FIG. 4 is a cross-sectional view generally taken along the plane defined by line 4—4 of FIG. 7.

FIG. 5 is a cross-sectional view generally taken along the plane defined by line 5—5 of FIG. 8.

FIG. 6 is a cross-sectional view generally taken along the plane defined by line 6—6 of FIG. 9.

FIG. 7 is a schematic back view of one moveable segment of the antenna.

FIG. 8 is a schematic back view of another moveable segment of the antenna.

FIG. 9 is a schematic back view of the fixed segment of the antenna.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 shows a parabolic antenna made up of three segments. A large segment 1 is rigidly connected in a fixed position to the structure of a communications satellite. Smaller segments 2 and 3 are mounted so as to be rotatable with respect to fixed segment 1. While the satellite is being transported into its orbit the moveable segments 2 and 3 are disposed behind or overlap fixed segment 1, as shown in FIGS. 2 and 3. The size of the reflector segments will be determined by the availability of space in the satellite transport vehicle. If possible, however, the fixed segment 1 will be selected of such a size that its antenna surface would be sufficient for communication between the communications satellite and ground station. This is desirable as insurance against the possibility that the antenna will not unfold properly. To be consistent with the objective of the present invention it is necessary for each moveable segment to be no larger than the fixed segment 1. In the preferred embodiment shown in the drawings the fixed segment 1 has 160° of arc, and each moveable segment 2, 3 has 100° of arc.

As can be seen in FIG. 3, a hollow post 4, preferably in the form of a thin-walled cylinder, is rigidly connected in a rearward direction at the apex of fixed segment 1. Sleeves 5 and 6 are rigidly and rearwardly connected to the apexes of moveable segments 2 and 3 respectively. Sleeve 5 is seen from FIG. 3 to be rotatable about post 4 and sleeve 6 is seen to be rotatable about sleeve 5. Thus, both sleeves 5 and 6 are rotatable with respect to post 4. The sleeves 5 and 6 are also axially displaceable with respect to post 4. FIGS. 4 through 9 show the particular construction of the sleeves 5 and 6 that makes this axial movement possible. Sleeves 5 and 6 are furnished with flanges 17 that hold the reflector segments 2 and 3 in position. That portion of the sleeves 5 and 6 not necessary to grip the segments 2 and 3 has been removed to a distance equal to the combined thickness of a reflector segment and a pair of flanges 17 so that a cutout area 20 is formed. For example, in the preferred embodiment each moveable segment 2 and 3 has 100° of arc. This means that 360°−100°=260° of arc will be cut from the circumference of sleeves 5 and 6 (see FIGS. 7 and 8). In the same manner, post 4 will have a cutout portion 22 similar to 20 of sleeves 5 and 6 where the arc in the preferred embodiment will be 360°−160°=200°,as shown in FIG. 9. As can be seen from FIGS. 6 through 9, when the moveable segments 2 and 3 have moved laterally, or rotated, to their unfolded positions they are then free to move axially until the surfaces 19 of the sleeves 5 and 6 come in contact with upper flange surface 18 of post 4.

The energy to rotate moveable segments 2 and 3 is stored in torsion springs 10 and 12 (see FIG. 3). Torsion springs 10 and 12 are disposed adjacent each other in a suitable housing 9. Housing 9 is supported by post 4, and is thus rigidly connected to the satellite structure. One end of each torsion spring 10 and 12 is rigidly connected to housing 9 in a well-known manner (not shown). The other or free end of each torsion spring 10 and 12 is passed out of housing 9 through openings 21. The free end of spring 10 is connected to bracket 8, which is attached to the rear surface of moveable segment 2. In the same manner, the free end of torsion spring 12 is connected to bracket 7, which is attached to the rear surface of moveable segment 3. The force for the axial movement of segments 2 and 3 is stored in coil spring 11. One end of coil spring 11 is rigidly attached to post 4 by means of pin 15, and the other end is moveably attached to post 4 by means of slideably mounted pin 13 (see FIG. 3). Pin 13 is slideably mounted in opposing slots 14 formed in the walls of post 4 (only one of slots 14 can be distinguished in FIG. 3), and pin 13 is of a length sufficient to extend past the adjacent end wall portions of sleeves 5 and 6.

The moveable segments 2 and 3 are held in their folded positions behind fixed segment 1 by means of locking devices 23. Locking device 23 includes locking members 2*a* and 3*a* (see FIG. 2*a*) which are either pyrotechnic e.g., exploding bolts) or electromagnetic devices capable of being unlocked by remote control. When locking members 2*a* and 3*a* are unlocked, springs 10–12 move segments 2 and 3 into their operating position. Torsion springs 10 and 12 are arranged so that they are deflected sufficiently when moveable segments 2 and 3 are in their folded position to store the energy required for rotating the moveable segments 2 and 3. In the same manner, coil spring 11 is in tension when moveable segments 2 and 3 are folded behind fixed segment 1. By proper selection of the tension on coil spring 11, the tension remaining after the moveable segments 2 and 3 have moved axially into position is sufficient to hold segments 2 and 3 in their operating position without additional locking means being required. If desired, however, resilient locking members can be mounted on the edges of the fixed segment 1.

The operation of the device is apparent from the above description and the drawings. When the satellite is in orbit and it is time to unfold the antenna, locking devices 23 are unlocked by remote control. The moveable segments 2 and 3 are then free to rotate with respect to fixed segment 1 as springs 10 and 12 untwist. When the moveable segments 2 and 3 have

rotated to their proper position with respect to fixed segment 1, they are moved axially by the force exerted on them by coil spring 11 through a pin 13 to form an operating parabolic antenna. While the preferred embodiment of the present invention is shown with two moveable segments, it is to be noted that the scope of the invention only requires at least one moveable segment.

It will be understood that the above description of the present invention is susceptible to various modifications, changes and adaptations.

We claim:

1. A collapsible antenna comprising, in combination: at least one fixed reflector segment and at least one moveable reflector segment, mounting means defining a common axis for permitting said at least one moveable segment to move first laterally and then axially relative to said fixed segment from a folded position overlapping said fixed segment to an operative position adjacent said fixed segment, and means including spring means to move said moveable segment from said folded position to said operative position, said spring means including at least one torsion spring and one coil spring, said at least one torsion spring causing said at least one moveable segment to move laterally, and said coil spring causing the axial movement of said at least one moveable segment.

2. The antenna defined in claim 1, wherein said segments in operative position are arranged to form a parabolic reflector.

3. The collapsible antenna defined in claim 1 wherein said means to cause said at least one moveable segment to move further includes locking means to hold said at least one moveable segment in its folded position, said locking means being unlocked by remote control to permit said at least one moveable segment to move on its open position.

4. The collapsible antenna defined in claim 1 wherein said fixed segment is rigidly attached to an antenna exciter.

5. The collapsible antenna defined in claim 4 wherein the antenna exciter is a communications satellite and said fixed segment is of such a size that its reflector surface is sufficient for communications between said satellite and a ground station.

6. The collapsible antenna of claim 1 further comprising clamping and locking means on said fixed segment to hold said at least one moveable segment in operative position.

7. A collapsible antenna comprising, in combination: at least one fixed reflector segment and at least one moveable reflector segment, mounting means defining a common axis for permitting said at least one moveable segment to move first laterally and then axially relative to said fixed segment from a folded position overlapping said fixed segment to an operative position adjacent said fixed segment and including a post rigidly attached to said fixed segment and a sleeve attached to said at least one moveable segment, said sleeve being rotatably mounted on said post, and cutout portions in said at least one sleeve, said cutout portion permitting said sleeve to move axially until said at least one moveable segment forms a continuous reflector surface with said fixed segment, and means including spring means to move said moveable segment from said folded position to said operative position.

8. The collapsible antenna defined in claim 7 wherein there are two moveable segments, each having a sleeve attached and a cutout portion, one of said sleeves being rotatably mounted on the other of said sleeves.

9. The collapsible antenna defined in claim 8 wherein said spring means includes two torsion springs to rotate said moveable segments with respect to said fixed segments, and a coil spring to cause said moveable segments to move axially with respect to said fixed segment.

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