N70-40202

Feb. 12, 1963 L. L. MITCHUM, JR., ET AL 3,077,599

COLLAPSIBLE LOOP ANTENNA FOR SPACE VEHICLE

Filed June 29, 1961 4 Sheets-Sheet 1

N70-40202 40%

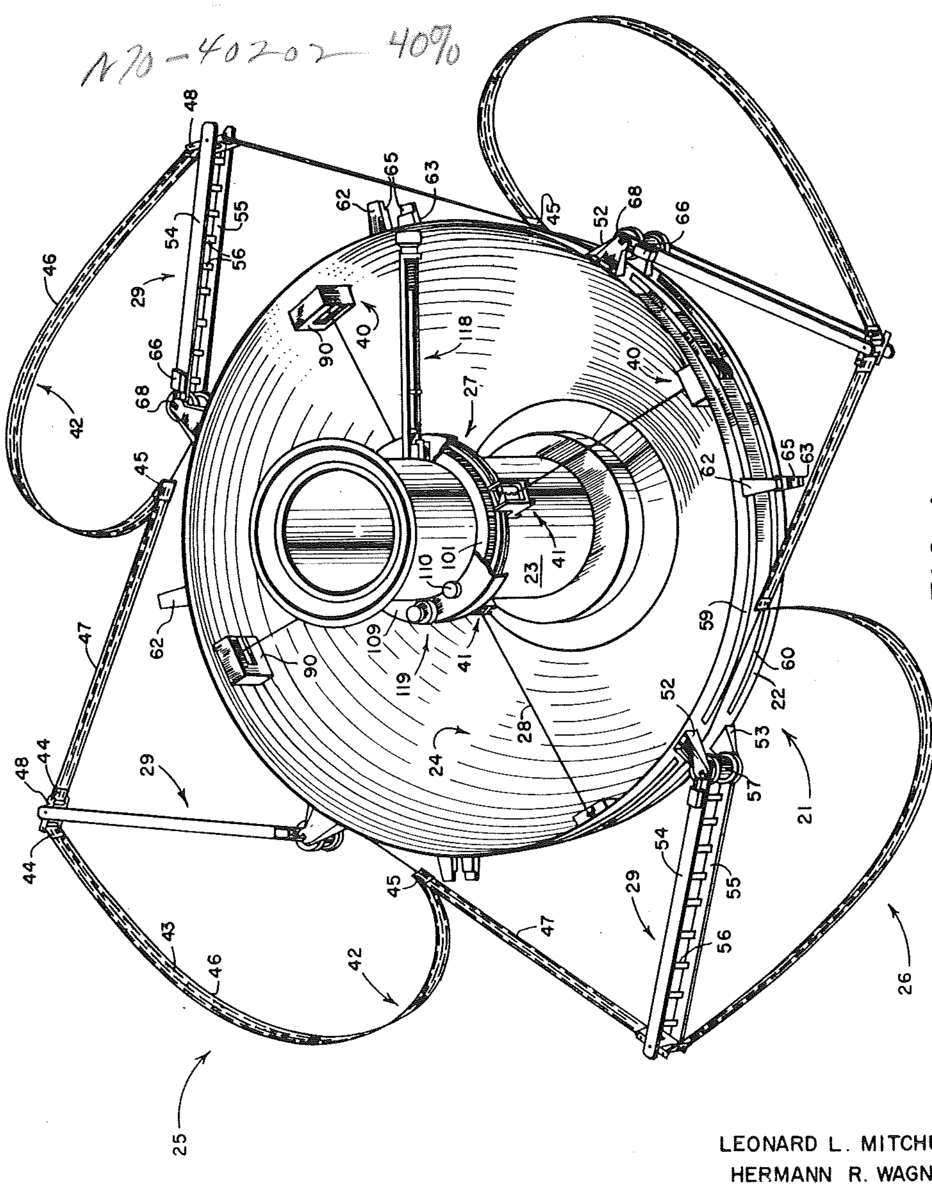

FIG. 1

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COLLAPSIBLE LOOP ANTENNA FOR SPACE VEHICLE

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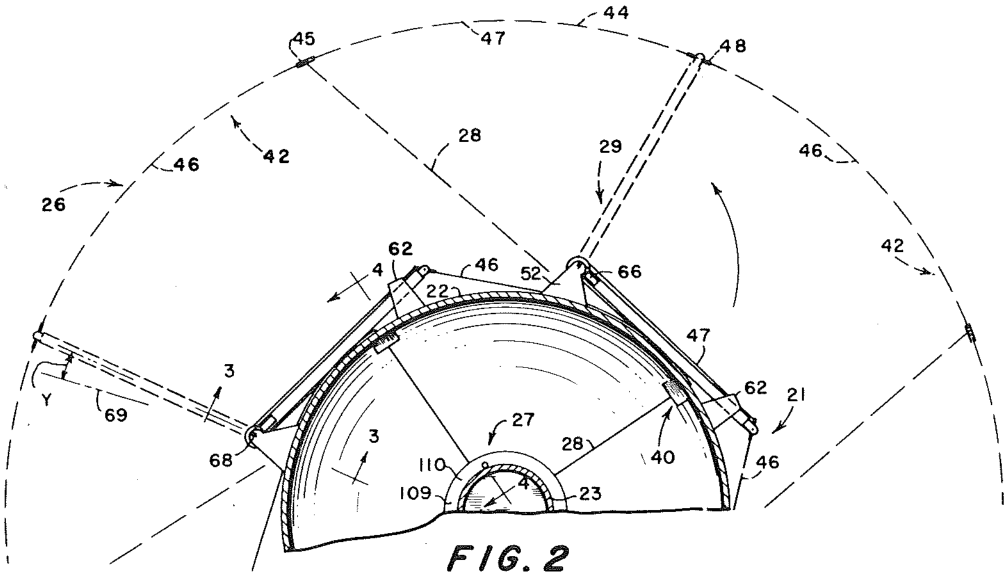

FIG. 2

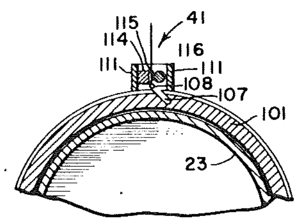

FIG. 5

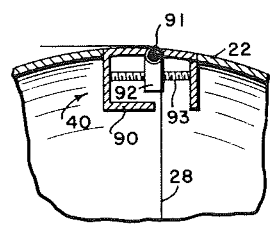

FIG. 6

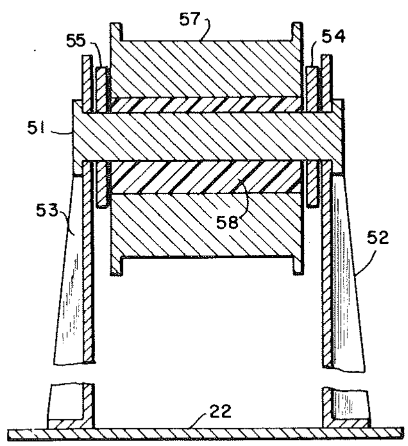

FIG. 3

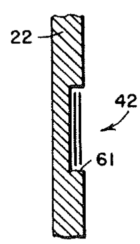

FIG. 7

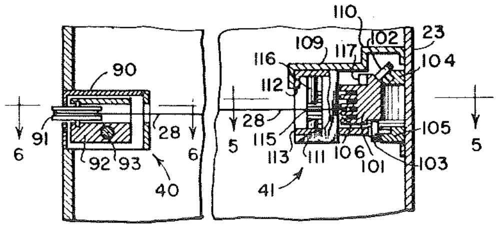

FIG. 4

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COLLAPSIBLE LOOP ANTENNA FOR SPACE VEHICLE

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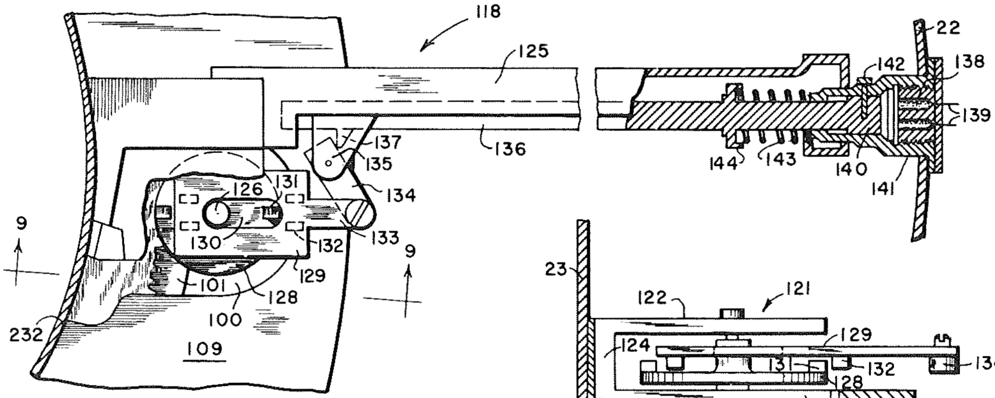

FIG. 8

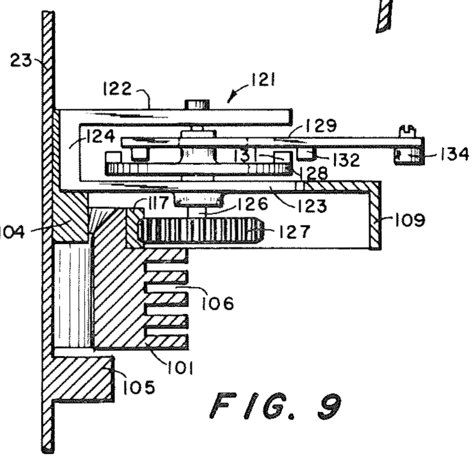

FIG. 9

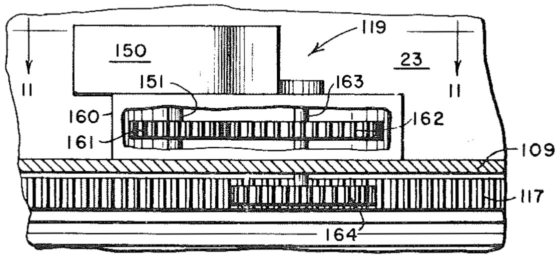

FIG. 10

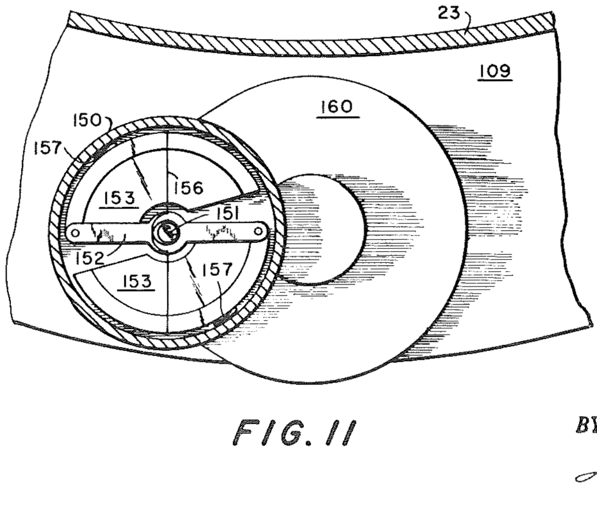

FIG. 11

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COLLAPSIBLE LOOP ANTENNA FOR SPACE VEHICLE

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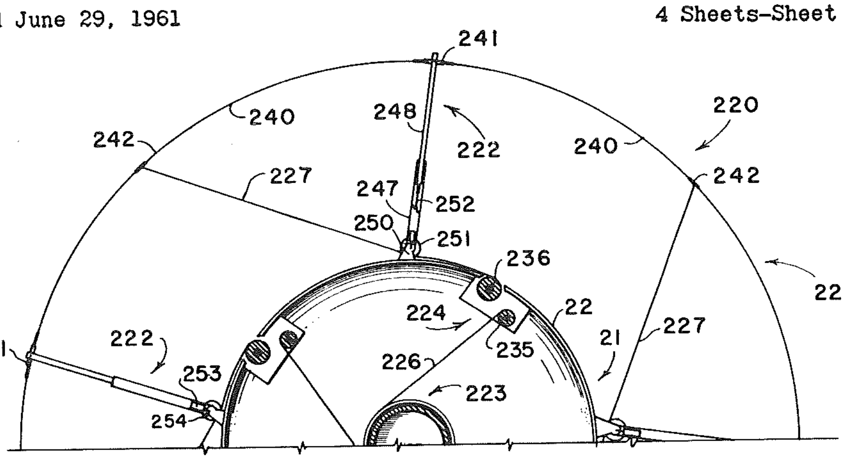

FIG. 12

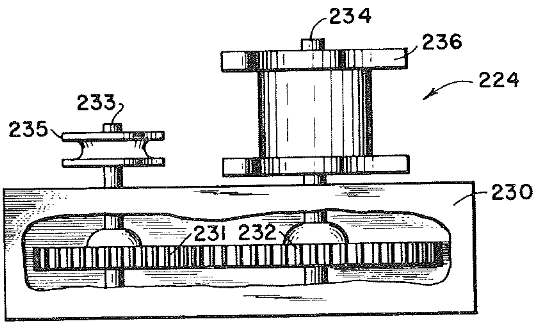

FIG. 13

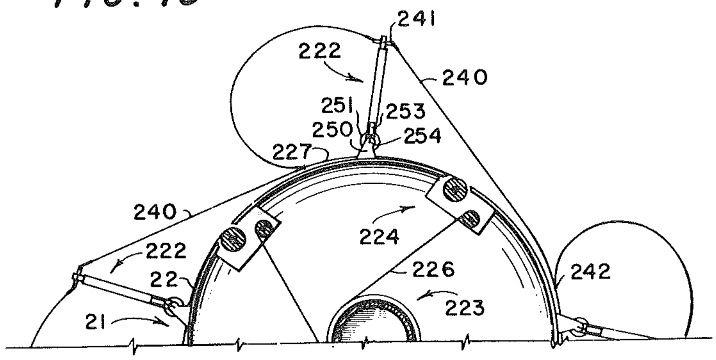

FIG. 14

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United States Patent Office

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Patented Feb. 12, 1963

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COLLAPSIBLE LOOP ANTENNA FOR SPACE VEHICLE

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Filed June 29, 1961, Ser. No. 120,795
11 Claims. (Cl. 343—705)
(Granted under Title 35, U.S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to a loop antenna system and more particularly to a collapsible loop antenna for space vehicles.

The exploration of outer space and the upper atmosphere of the earth has resulted in the development of space probes and artificial satellites with intricate communication instrumentation capable of sending and receiving intelligence in the form of electromagnetic waves. The necessity for an efficient antenna system to radiate and intercept energy in the form of electromagnetic waves is, therefore, a prime consideration in the design of an exploratory space vehicle. However, the physical and mechanical limitations related to the launching of a space vehicle from the earth has precluded the use of large fixed antennas and necessitated that antennas be collapsed or folded against the sides of the space vehicle. While antennas of the dipole type have been folded or pivoted against the sides of a space vehicle during the critical period of launch and successfully extended at a later desired time, no satisfactory system for packaging a loop antenna in a collapsed way to the body of a space vehicle which would later release the antenna whereby it could achieve its loop configuration has been known. This invention, therefore, fulfills the need for a large loop antenna on a space vehicle by providing a novel system for collapsing and extending a loop antenna.

It is, therefore, an object of this present invention to provide a space vehicle with a collapsible loop antenna.

Another object is to provide a space vehicle with a collapsible loop antenna which is erected by centrifugal forces.

Still another object is to provide an antenna release system for a rotating housing.

Yet another object is to provide a system for mounting a collapsible loop structure to a housing.

A further object is to provide a system for erecting and folding a collapsible loop structure.

Other objects and many attendant advantages of the present invention will be apparent from the following detailed description when taken together with the accompanying drawings in which:

FIGURE 1 is a perspective view of the loop antenna partly extended and mounted on a space vehicle which has its top portion removed and parts broken away;

FIGURE 2 is a partial plan cross-sectional view of the loop antenna and space vehicle shown in FIGURE 1 with the loop antenna in a folded position and with phantom lines indicating the position of the loop antenna in a fully extended position;

FIGURE 3 is a cross-sectional view taken along line **3—3** of FIGURE 2;

FIGURE 4 is a partial elevation cross-sectional view taken along line **4—4** of FIGURE 2;

FIGURE 5 is a partial plan cross-sectional view taken along lines **5—5** of FIGURE 4;

FIGURE 6 is a partial plan cross-sectional view taken along line **6—6** of FIGURE 4;

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FIGURE 7 is a partial elevation cross-sectional view showing a modification in the space vehicle's housing shell for guiding a folded antenna section;

FIGURE 8 is an enlarged plan view showing the control spool locking mechanism with portions in cross-section and broken away;

FIGURE 9 is a cross-sectional view taken along line **9—9** of FIGURE 8 and with parts broken away;

FIGURE 10 is an enlarged elevation view showing the control spool braking mechanism with portions in cross-section and broken away;

FIGURE 11 is a cross-sectional view taken on line **11—11** of FIGURE 10;

FIGURE 12 is a partial plan cross-sectional view of the modified loop antenna system mounted on a space vehicle and in an extended position and with parts removed;

FIGURE 13 is an elevation view of the storage drum assembly with parts broken away; and

FIGURE 14 is a partial plan cross-sectional view of the modified loop antenna system partially extended and mounted on a space vehicle.

The embodiments of the present invention herein disclosed by way of illustration are shown mounted on a space vehicle **21** of the artificial satellite type in FIGURES 1, 2, 12, and 14. The space vehicle **21** is one of a proven design which has a housing shell **22** with a configuration resembling a pair of truncated cones joined base to base by a flat cylindrical center band. As shown in FIGURE 1, the upper portion of the housing shell **22** is removed to reveal the lower portion of its inside chamber **24** and a cylindrical hollow column **23** which normally spans the chamber **24** coextensively and concentrically with the housing shell's, and thus the space vehicle's, spin axis and is fixedly secured by both of its ends to the inner surface of the housing shell **22**. The spin axis of a space vehicle of this type being that axis about which a rotational spin is imparted to its body to prevent it from tumbling as it goes into orbit about the earth. The novel collapsible loop antenna systems **25** and **220** hereinafter described as mounted on the space vehicle **21** are designed to use this rotational spin to provide the operating force to erect their circular loop antennas from a folded position.

As best shown in FIGURE 1, the antenna system **25** comprises a loop antenna **26** collapsibly supported about and encircling the circumference of the housing shell **22** of the space vehicle **21**, a central control mechanism **27** mounted within the housing shell **22**, and a plurality of control cords **28** suitably attached to the central control mechanism **27** and extending on through the housing shell **22** to select points of the antenna **26** where they are also attached. A plurality of support arms **29** are used to collapsibly support the loop antenna **26** from the housing shell **22**. While in this embodiment a total of four equally spaced arms **29** are illustrated, it is apparent that the number of support arms **29** needed may vary and should be increased if the diameter of the housing shell **22** is unduly large. Each control cord **28** is guided through the housing shell **22** approximately midway between adjacent support arms **29** by pulley means **40**, and led from the central control mechanism **27** by guide means **41**.

The antenna system **25** is erected from its folded position by the centrifugal forces created within the support arms **29** when the space vehicle **21** is rotating. Centrifugal forces cause the support arms **29** to pivot or swing outward from the spin axis of the space vehicle **21** and drag the antenna **26** from its folded position as illustrated in FIGURE 2 to its extended position as illustrated by the phantom lines of the same figure. Because the rotational speed of the space vehicle **21** may be sufficiently fast to create centrifugal forces large enough to quickly snap the arms 29 outwardly and cause damage, the control mechanism 27 is adapted to pay out the control cords 28 at a rate whereby the arms 29 will swing slowly outward.

It is apparent that the arms 29 will swing outward regardless of the direction of rotation of the space vehicle 21 about its spin axis. However, it is preferred that the arms 29 swing outward in the same direction as the direction of rotation of the space vehicle 21 because of the smaller loading on the control cords 28 and control mechanism 27. In those instances when the speed of rotation of the space vehicle 21 is slow, it may be found advantageous to eliminate entirely the control cords 28 and the control mechanism 27.

The loop antenna 26 is composed of a plurality of flexible tape sections 42 pivotally joined together and provided with spaced slots 43 therein to prevent the total shading of any solar cells (not shown) which may be mounted on the housing shell 22. The terminal portions 44 of each antenna section 42 are pivotally joined and supported by arm hinges 48 whereby adjacent antenna sections 42 are pivotally attached to opposite extremities of the same arm hinge 48. Each antenna section 42 includes an intermediate hinge 45, approximately midway between its terminal portions 44, which divides the antenna section 42 into two end parts 46 and 47 whereby together with the expedient of a pivotal connection to the arm hinges 48 the loop antenna 26 may easily be folded to the housing shell 22. By attaching the control cords 28 to the intermediate hinges 45, the loop antenna 26 may be extended from its folded position in an orderly manner to achieve its circular loop configuration.

The support arms 29 are composed of two elongated portions 54 and 55 separated by a plurality of rails 56, and their distal ends are each pivotally attached to the central portion of one of the arm hinges 48 and their supported ends are each pivotally attached by an axle pin 51 as shown in FIGURE 3 to a pair of brackets 52 and 53 which are secured to the housing shell 22. A circular adjustable antenna guide 57 which includes an eccentric bushing 58 is rotatively mounted on each pin 51 between the elongated arm portions 54 and 55 for adjusting the position of the antenna sections 42 when they are in a folded position. The spaced pairs of brackets 52 and 53 are secured to the large circumferential equatorial middle portion of the housing shell 22 whereby the moment of inertia of the antenna system 25 about its spin axis will be the maximum. Raised adjacent antenna guides 59 and 60, secured to the outer surface of the housing shell 22 between adjacent pairs of brackets 52 and 53, form a channel to guide and protect the antenna sections 42 when they are in a folded position. However, use of the raised guides 59 and 60 is not critical and they may be eliminated or replaced by a groove 61 formed within the housing shell 22 as illustrated in FIGURE 7. To support the arms 29 in their folded position, a pair of raised supports 62 and 63 are also secured to the outer surface of the housing shell 22 between adjacent pairs of brackets 52 and 53 for receiving the arms 29 on ledges 65 formed therein. Spring activated plungers 66 are secured near the inner ends of the support arms 29 whereby when the arms 29 pivot outwardly from the housing shell 22, each plunger 66 is adapted to slide over the edge surface of one of the brackets 52 and 53 and automatically spring forward into a notch 68 when its arm 29 reaches its extended position. As shown in FIGURE 2, the notches 68 are located whereby the arms 29 are locked in their extended position at an angle Y of 5 to 10 degrees from a line 69 radial to the spin axis of the space vehicle 21. An extended position for the arms 29 which would be located radially to the spin axis of the space vehicle 21 would be unfavorable for a positive locking motion because the moment of forces which rotates the arms 29 becomes zero at that position.

The pulley means 40 are also located at spaced intervals about the large equatorial middle section of the housing shell 22 and each includes, as best illustrated in FIGURES 1, 4 and 6, a box housing 90, a pulley wheel 91, a frame 92 mounting the pulley wheel within the housing 90, and a screw axle 93 which is journaled to the housing 90 and extends through a threaded bore within the frame 92. The pulley wheel 91 leads the control cord 28 through the housing shell 22 whereby it exits substantially adjacent the outer surface of the housing shell 22. By rotating screw axle 93 the frame 92 may position the pulley wheel 91 in its most advantageous location for the proper operation of the control cord 28.

The central control mechanism 27 stores and pays out the control cords 28 whereby each antenna section 42 and each support arm 29 moves simultaneously and with equal velocity so that the balance of the space vehicle 21 will not be disturbed. As shown best in FIGURES 4 and 9, the control mechanism 27 includes a central spool 101 rotatively supported about the circumference of the cylindrical hollow column 23 by spaced upper rollers 102 and spaced lower rollers 103 which are journaled to the upper projecting ledge 104 and lower projecting ledge 105, respectively, of the column 23. The lower part of the control spool 101 has a plurality of peripheral grooves 106 on its outside circumference. Each groove 106 is adapted to have wound therein one of the control cords 28 and is therefore provided with a recess 107 as shown in FIGURE 5, in which an enlarged end 108 of one of the control cords 28 is inserted to enable the control cord 28 to be wound and unwound without slippage. The upper part of the central spool 101 is provided with peripheral gear teeth 117 whereby a locking mechanism 118 and a brake mechanism 119 (see FIGURES 8 to 11) may be geared thereto as described hereinafter. The locking mechanism 118 prevents the central spool 101 from rotating until it is desired to erect the antenna 26, and the brake mechanism 119 controls the rotating speed of the central spool 101 during the erection of the antenna 26. A cover plate 109 is secured to the outer surface of the column 23 above the central spool 101 to protect the rotating parts. Enlarged portions 110 of the cover plate 109 provide the additional space needed for the upper rollers 102.

The guide means 41 secured to the bottom surface of the cover plate 109 and to the outer surface of the column 23 at spaced intervals are adapted to lead each control cord 28 from its groove 106 on the central spool 101 toward the pulley means 40 in a direction radial to the spin axis of the space vehicle 21. Each guide means 41, as shown in FIGURES 4 and 5 is composed of two flat sides 111 joined by an upper plate 112 and a lower plate 113, a fixed guide 114 extending between the upper plate 112 and the lower plate 113 which has along one side thereof spaced grooves 115 whereby each control cord 28 coming from a central spool groove 106 is led through a corresponding guide groove 115, and a resilient roller 116 journaled to the upper plate 112 and to the lower plate 113 and located adjacent the guide grooves 115 whereby each control cord 28 is prevented from leaving its particular guide groove 115. Because the guide grooves 115 are smaller than the enlarged ends 108 of the control cords 28, the control cords 28 are prevented from passing through the guide means 41 and becoming loose after becoming unwound from the central spool 101. Thus there will not be any slack in the control cords 28 after the support arms 29 are locked in their extended position if the control cords 28 have only the minimum length necessary to allow the support arms 29 to pivot to that position. If desired, the guide means 41 could be eliminated by bringing the control cords 28 off the central spool in a tangential manner as is done for the modified embodiment described hereinafter.

The locking mechanism 118 is best illustrated in FIGURES 8 and 9 and it prevents the central spool 101 from rotating about the cylindrical hollow column 23 until the antenna 26 may be safely extended. The locking mechanism 118 has a housing 121 composed of an upper side 122 and a lower side 123 joined together by a connecting side 124 and an elongated channel frame 125 secured to a portion of the upper side 122. The lower side 123 and connecting side 124 are secured to the upper ledge 104 and to the outer surface of the column 23 through a slot 100 within the cover plate 109. The channel frame 125 extends toward the inner surface of the housing shell 22 and is secured thereto by a squib assembly 141. A shaft 126 is journaled to the upper and lower sides 122 and 123 and extends completely through the lower side 123 whereby a gear 127 on its end will mesh with the peripheral gear teeth 117. A circular spinner 128 is fixed to the shaft 126 between the upper and lower sides 122 and 123, and above the spinner 128 is a slide 129 having an elongated slot 130 through which the shaft 126 passes and which allows the slide 129 to be shifted to and fro in a longitudinal direction. The spinner 128 and slide 129 have cooperating locking lugs 131 and 132 on their opposed surfaces whereby when the slide 129 is in its forward position one lug 131 on one of the surfaces is adapted to fit between two adjacent lugs 132 on the other of the surfaces to prevent the spinner 128 and thus the central spool 101 from rotating. The slide 129 has a reduced end 133 pivotally connected to an end of a crank 134 which in turn is pivotally connected between its ends to a cantilevered support 135 on the channel frame 125. A bar 136, supported for longitudinal movement by the channel frame 125, has a cam 137 adjacent the distal end of crank 134 and a piston-like end 140 mounted within the squib assembly 141. Thus when the bar 136 is shifted longitudinally forward toward the center of the space vehicle 21, the cam 137 strikes the distal end of the crank 134 and pivots it whereby the slide 129 is pulled back and the lugs 131 and 132 are shifted away from their cooperating locking relationship. The bar 136 is shifted forward at the desired time by the action of compression spring 143, which abuts a ridge 144 integral with the bar 136 and the squib assembly 141, and an explosive force, acting on the piston-like end 140 of the bar 136, caused by the firing of squibs 138 within the squib assembly 141. The squibs 138 are exploded by an electric signal transmitted through wires 139 from either a timer or a command receiver (not shown). To prevent the bar 136 from being pushed forward until the desired time by spring 143, the enlarged piston-like end 140 is held fast within the squib assembly 141 by a pin 142. When the squibs 138 are fired, sufficient explosive force is exerted on the piston-like end 140 to shear the pin 142 and push the bar 136 forward toward the center of the space vehicle 21.

The operation of the locking mechanism 118, therefore, consists in exploding the squibs 138 which causes bar 136 to push forward and pivot the crank 134 which pulls back the slide 129 and its lugs 132 whereby the spinner 128 and the central spool 101 is free to rotate.

The velocity sensitive brake mechanism 119 is best illustrated in FIGURES 10 and 11. It comprises a circular housing 150 having centrally located therein an upper portion of a driven shaft 151, a rigid tie member 152 centrally fixed to the upper portion of the driven shaft 151 within the housing 150, two semi-circular weights 153 pivotally attached by their diagonal opposite portions to the extreme ends of the tie member 152 whereby upon rotation of the driven shaft 151 the weights 153 will pivot outwardly from the driven shaft 151, an elongated spring 156 loosely fitted about the driven shaft 151 and resting upon tie member 152 and tending to pull the weights 153 toward each other, and brake shoes 157 on the outer peripheral surface of the weights 153. The lower part of the driven shaft 151 extends through the circular housing 150 and into a gear housing 160 whereby its gear 161 meshes with the gear 162 of the upper portion of a drive shaft 163 which also extends into the gear housing 160. The lower part of drive shaft 163 has a gear 164 which meshes with the peripheral gear teeth 117 of the central spool 101. The circular housing 150 is secured to the top of gear housing 160 and the gear housing 160 is secured to the cover plate 109.

The centrifugal forces acting on semi-circular weights 153 when they rotate in response to the rotation of the central spool 101 cause them to move outwardly from the driver shaft 151 in a pivoting manner from tie member 152 and to stretch the elongated spring 156 until finally the brake shoes 157 are placed in contact with the inner peripheral surface of the circular housing 150 and a typical braking reaction occurs which slows the rotational speed sufficiently for the semi-circular weights 153 to move back inward toward the driven shaft 151 in response to the stretched spring 156 and shift the brake shoe 157 away from the inner peripheral surface of the circular housing 150. If the rotational speed of the central spool 101 and thus the semi-circular weights 153 become too fast again, then the above movements of the semi-circular weights 153 would reoccur. It is apparent then that as the rotational speed of the central spool 101 becomes too fast for the antenna system 25, the brake mechanism 119 will automatically apply a braking force which will slow the rotational speed to within the designed limits.

The antenna system 25 is normally folded to the housing shell 22 of the space vehicle 21 before launching by pivoting the support arms 29 inwardly until they rest upon the ledges 65 of their raised supports 62 and 63, pulling intermediate hinges 45 by their attached control cords 28 back to the control cord's pulley means 40 whereby each antenna part 47 of an antenna section 42 lies against the outwardly directed side of its attached support arm 29 and is wrapped about a portion of the adjustable guide 57 of the same support arm 29 and extends on between the brackets 52 and 53 of the same support arm 29 to its intermediate hinge 45 which is adjacent the control cord's pulley means 40, and whereby each antenna part 46 of the same antenna section 42 extends from the same intermediate hinge 45 back underneath a portion of the antenna part 47 of the same antenna section 42 toward and to its attached support arm 29, and storing or winding the control cords 28 within the central control mechanism 27 until the antenna sections 42 and control cords 28 are held taut.

After launching of the space vehicle 21 and the squibs 138 of the locking mechanism 418 are fired, the antenna system 25 is automatically extended in a manner reversed to the manual folding thereof.

A modification of the present invention wherein the space vehicle 21 may be provided with a collapsible loop antenna of extraordinary diameter is illustrated in FIGURES 12 to 14. The modified antenna system 220 comprises a circular loop antenna 221 encircling the peripheral surface of the housing shell 22 on telescoping arms 222, a central control mechanism 223 mounted within the housing shell 22, a plurality of spaced storage drum assemblies 224 mounted on the housing shell 22, a plurality of primary cords 226 suitably attached to the central control mechanism 223 and to the storage drum assemblies 224, and a plurality of secondary control cords 227 suitably attached to the storage drum assemblies 224 and to select points of the loop antenna 221.

The central control mechanism 223 is similar to the central control mechanism 27 of the previously described embodiment and differs in that guide means 41 of the previously described embodiment has been eliminated by leading the primary control cords 226 from the central control mechanism 223 in a tangential manner.

The storage drum assemblies 224 mounted on the housing shell 22 each comprises a gear housing 230 secured to the inner peripheral surface of the housing shell 22, two meshing gears 231 and 232 within the housing 230 and fixed to shafts 233 and 234, respectively, which extend through the housing 230, a small storage drum 235 fixed to the outside portion of shaft **233**, and a large storage drum **236** fixed to the outside portion of shaft **234**. The small drum **235** receives and stores the primary control cords **226** from the central control mechanism **223** and the large drum **236** stores and pays out the secondary control cords **227** as well as portions of the loop antenna **221**. Thus it is apparent that as the primary control cords **226** are received and stored on the small storage drum **235** the secondary control cords **227** and portions of the antenna **221** stored on the large storage drum **236** will be payed out at a corresponding rate.

The loop antenna **221** is similar to the loop antenna **26** of the previous described embodiment and comprises a plurality of flexible tape sections **240** pivotally joined together at adjacent ends by arm hinges **241**. Each antenna section **240** includes the intermediate hinge **242** substantially midway between its ends to which a secondary cord **227** is attached.

The support arms **222** are each composed of an inner portion **247** which telescopes over an outer portion **248**. The supported end of each inner arm portion **247** is forked to receive the adjustable antenna guide **251** and both the supported end of the inner arm portion **247** and the antenna guide **251** are pivotally attached to a pair of brackets **250**, secured to the outer surface of the housing shell **22**, in the same manner as the inner ends of support arms **29** and the adjustable antenna guide **57** of the previously described embodiment are attached to their brackets **52** and **53**. The distal ends of the outer arm portion **248** are each pivotally attached to the central portion of an intermediate hinge **241** of an antenna section **240**. Spring activated plungers **253** are secured near the supported ends of the inner arm portions **247** whereby when the arms **222** pivot outwardly from the housing shell **22**, each plunger **253** will slide over the edge surfaces of one of the pair of brackets **250** and automatically spring forward into a notch **254** when its arm **222** reaches its extended portion. A suitable cooperating latch (not shown) may be provided on the two arm portions **247** and **248** to lock them in their extended telescopic position or a cord **252** may be suitably attached to the two arm portions **247** and **248** to limit the outward telescopic movement of the outer arm portion **248**. It is also envisioned that the outer arm portion **248** may be extended in an additional controlled manner when subjected to centrifugal forces by attaching the limit cord **252** only to the outer arm portion **248** and leading the cord **252** through the inner arm portion **247** and housing shell **22** to the central control mechanism **223** whereby it also will be payed out at a controlled rate.

The modified antenna system **220** is manually folded to the housing shell **22** by telescoping outer arm portion **248** within the inner arm portions **247**, pivoting the shortened arms **222** to the outer surface of the housing shell **22**, folding each antenna section **240** about its adjacent arms **246** and leading each folded antenna section **240**, intermediate hinge **242** first, by its secondary control cords **227** to the control cord's storage drum assemblies **224** in the same manner as each antenna section **42** is led to the pulley means **40** in the previously described embodiment, winding the secondary cords **227** and the overlapped portions of each antenna section **240** about the large storage drum **236** until the remaining outside portion of each antenna section **240** is held taut, and storing the primary control cords **226** within the central control mechanism **223** until they are held taut, and locking the central control mechanism **223** whereby the antenna system **220** is prevented from unfolding.

After launch of the space vehicle **21** with the modified antenna system **220**, the central control mechanism **223** is unlocked whereby the centrifugal forces acting on support arms **222** cause them to pivot outward from the housing shell **22** dragging the antenna **221** from its folded position to its extended position illustrated in FIGURE 12. The inner arm portions **247** will probably reach their extended position and be locked by the spring activated plungers **253** when the antenna **221** is only partially extended as illustrated in FIGURE 14, but the centrifugal forces acting on the outer arm portions **248** and the antenna **221** will continue the telescoping out of the outer arm portion **248** until the circular loop configuration of the antenna **221** has been achieved. The secondary control cords **227** attached to the intermediate hinges **242** of the antenna sections **240** will restrain the pivoting movement of the support arms **222** by slowly unwinding from the large storage drum **236** at a rate determined by the central control mechanism **223**.

It will be apparent to those skilled in the art that the present invention is not necessarily limited to loop antennas and space vehicles but includes within its concept other flexible loop structures and other rotating housings.

Obviously, many modifications and variations of the present invention are possible in the light of the above teachings. It is, therefore, to be understood that within the scope of the appended claims the invention may be practiced other than as specifically described.

What is claimed is:

1. In combination with a housing shell having an axis about which it is adapted to rotate: a central control mechanism mounted within said housing shell, a flexible loop structure encircling said housing shell, arm means connecting said housing shell and said flexible loop structure whereby said flexible loop structure is adapted to be folded to said housing shell and later extended outwardly from said housing shell, and means connecting said central control mechanism and said flexible loop structure whereby said flexible loop structure is extended outwardly at a controlled speed.

2. A system, comprising: a housing shell having an axis about which it is adapted to spin, a central control mechanism mounted within said housing shell, said central control mechanism having a velocity sensing braking mechanism and a locking mechanism, a plurality of flexible tape sections encircling and spaced from said housing shell, a plurality of hinge means pivotally connecting said flexible tape sections, arm means connecting said housing shell and said hinge means whereby said flexible tape sections are adapted to be folded to said housing shell and later extended outwardly from said housing shell, and a plurality of control cord means connecting said central control mechanism and said flexible tape sections whereby said flexible tape sections are adapted to be extended at a controlled speed.

3. A system, comprising: a housing shell enclosing a chamber and having an axis about which it is adapted to rotate, a column spanning said chamber concentric to said axis, a central control mechanism mounted on said column, said central control mechanism including a spool rotatively mounted about the circumference of said column, a flexible loop structure encircling said housing shell, arm means connecting said housing shell and said flexible loop structure whereby said flexible loop structure is adapted to be folded to said housing shell and later extended outwardly from said housing shell, and control cord means adapted to be unwound from said spool whereby said flexible loop structure will be extended outwardly at a controlled speed.

4. A system as defined by claim 3 wherein said central control mechanism includes a brake mechanism adapted to control the rotational speed of said spool.

5. A system for erecting a collapsible loop structure by centrifugal forces, comprising: a housing shell enclosing a chamber and having an axis about which it is adapted to spin, a central control mechanism mounted within said chamber, said central control mechanism having a spool concentric to said spin axis and adapted for rotational movement, said spool having a plurality of peripheral grooves, a flexible loop structure encircling said housing shell, arm means connecting said housing shell and said flexible loop structure whereby said flexible loop structure

is adapted to be folded to said housing shell and later extended outwardly from said housing shell, and control cord means wound within said peripheral grooves of said spool and extending to and connected to said flexible loop structure.

6. A system as defined by claim 5 wherein said spool has peripheral gear teeth and wherein said central control mechanism includes a brake mechanism geared to said peripheral gear teeth of said spool whereby the rotational speed of said spool is controlled.

7. A system as defined by claim 5 including pulley means mounted on said housing shell for guiding said control cord means through said housing shell.

8. A system as defined by claim 5 including storage means mounted on said housing shell and adapted to receive portions of said flexible loop structure therein when the flexible loop structure is folded to said housing shell.

9. A system as defined by claim 5 wherein said arm means comprises telescoping inner and outer portions.

10. A system as defined by claim 5 including raised supports on said housing shell which are adapted to support said arm means when folded to said housing shell.

11. A collapsible loop structure, comprising: a control mechanism having a spool adapted for rotation about an

axis, said spool having a plurality of peripheral grooves and peripheral gear teeth, a flexible loop structure, a plurality of arm means connected to said flexible loop structure whereby said flexible loop structure is adapted to be folded in a compact package and later when subjected to centrifugal forces to be extended to achieve a loop configuration, a plurality of control cord means wound within said peripheral grooves of said spool and extending to and attached to said flexible loop structure, whereby when said flexible loop structure is extended to achieve a loop configuration said spool will be forced to rotate, velocity sensitive braking means geared to said peripheral gear teeth of said spool, and a locking means geared to said peripheral gear teeth of said spool.

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