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[54] COLLAPSIBLE ANTENNA ASSEMBLY

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[51] Int. Cl. H01q 9/28

[58] Field of Search 343/725, 730, 773, 817, 808, 343/881, 894, 896, 915

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[57] ABSTRACT

A collapsible antenna assembly for providing a broadband radiator similar to that of a biconical dipole antenna is disclosed. The antenna assembly provides upper and lower radiating cage structure joined by an insulating structure and fed at the insulated midpoint by a balanced transmission line. Each radiating structure has spring-loaded arms which are connected by flexible wire elements to the center or driving point of the assembly. Means are provided to permit the opening and closing of the radial arms when the antenna assembly is in the elevated position.

8 Claims, 9 Drawing Figures

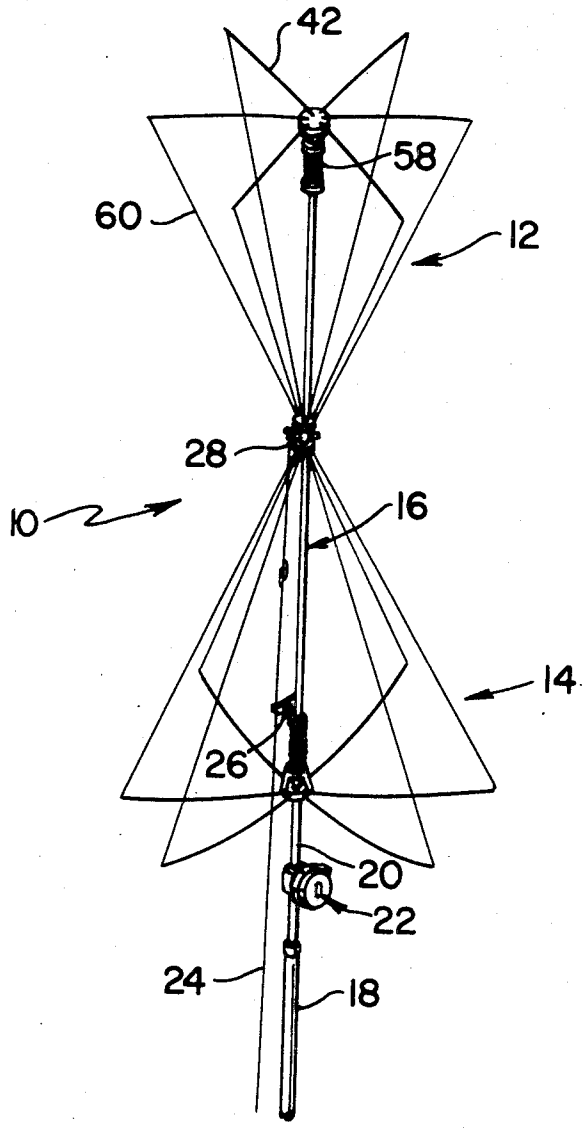
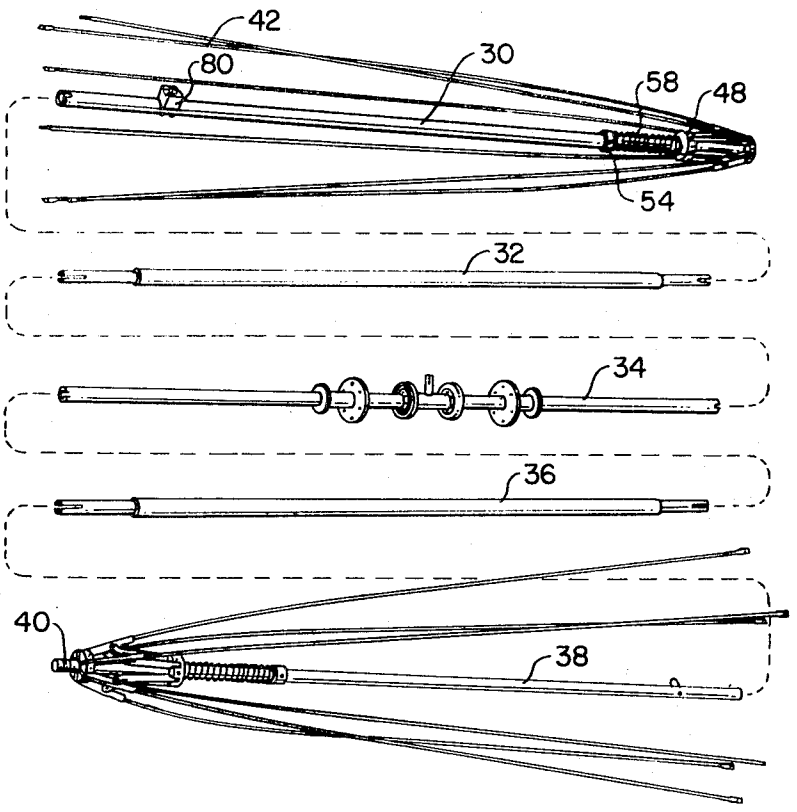


FIG. 2



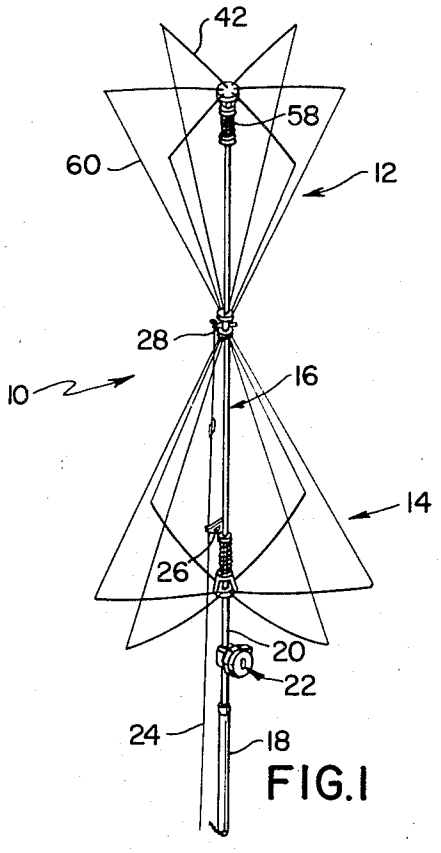


FIG. 1

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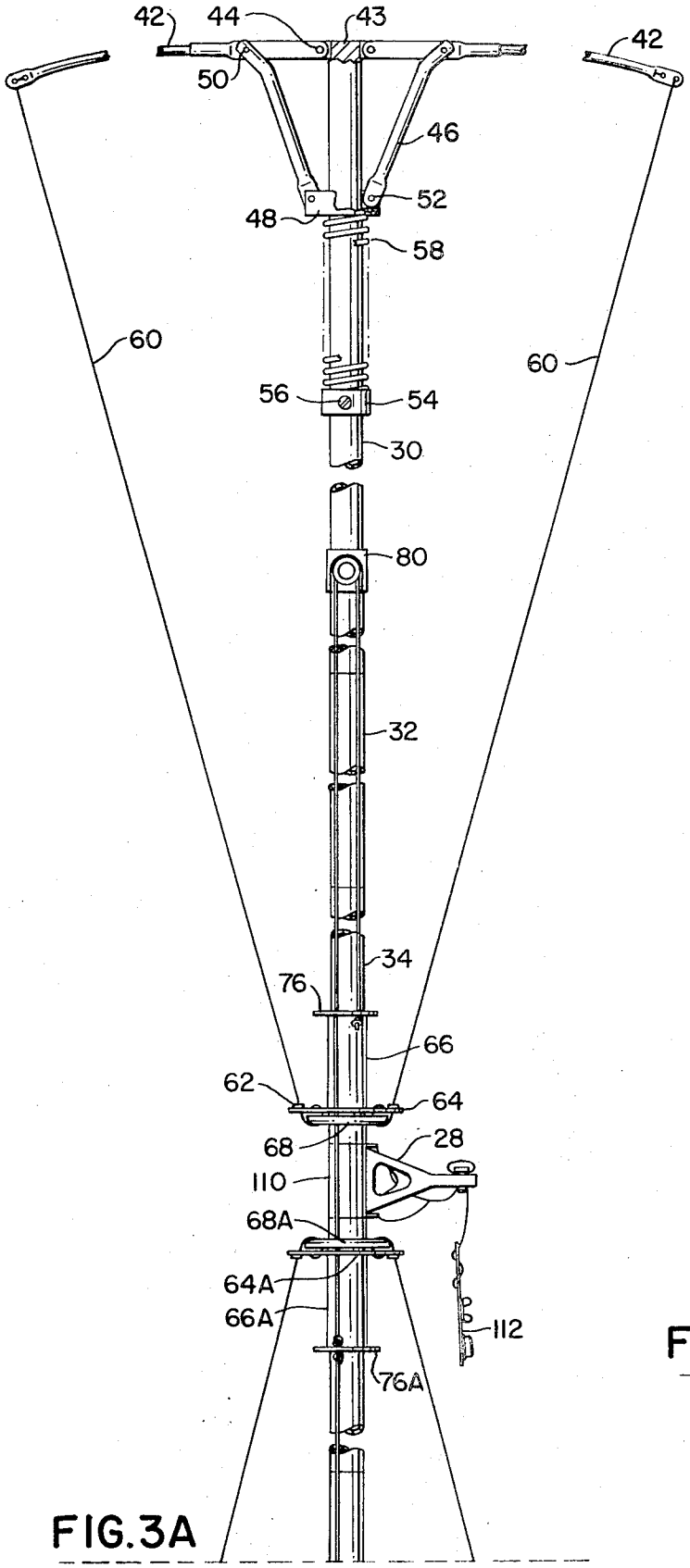


FIG. 3A

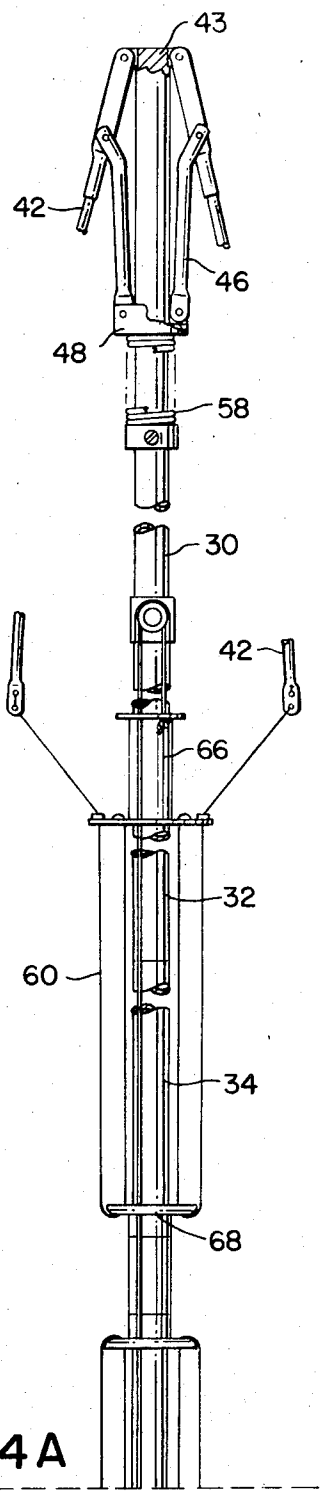


FIG. 4A

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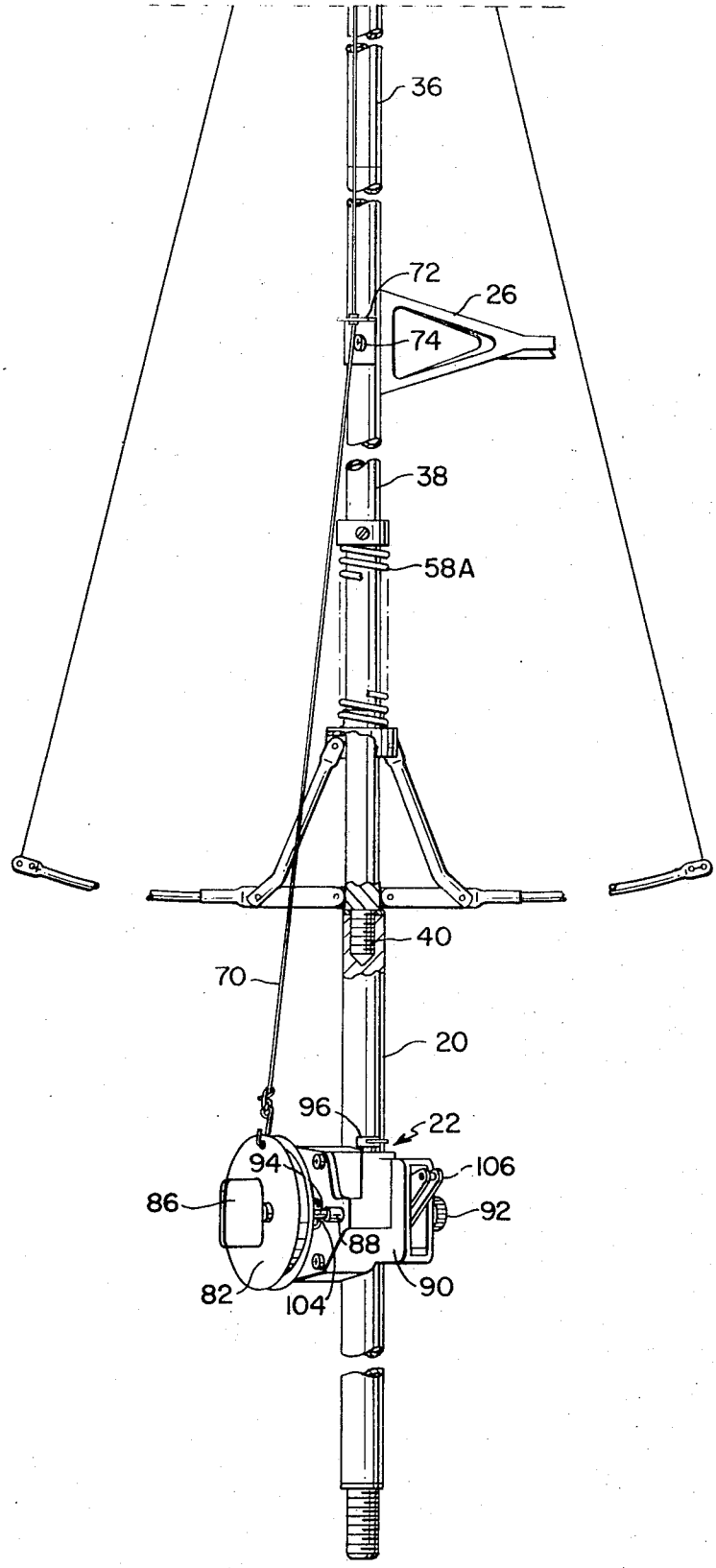


FIG. 3B

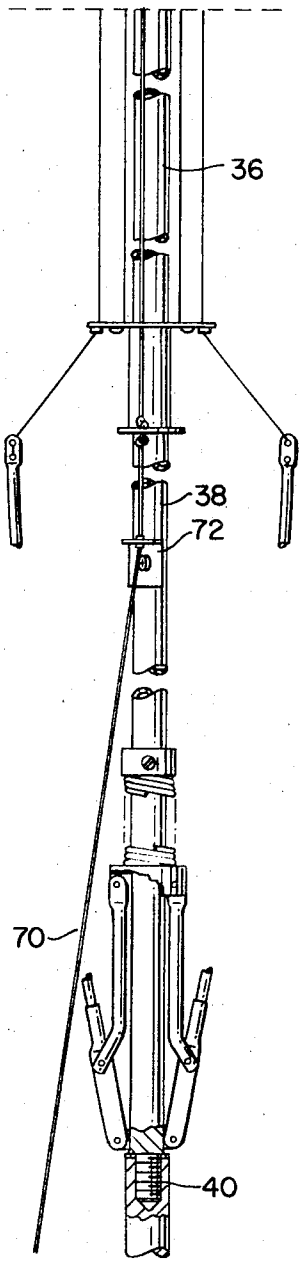


FIG. 4B

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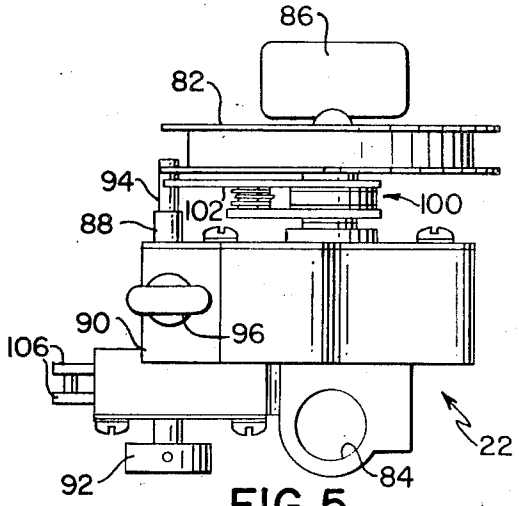


FIG. 5

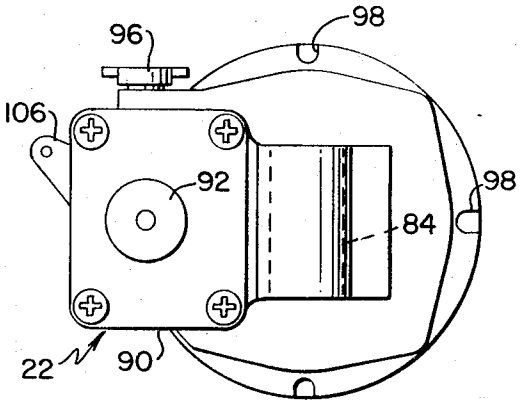


FIG. 6

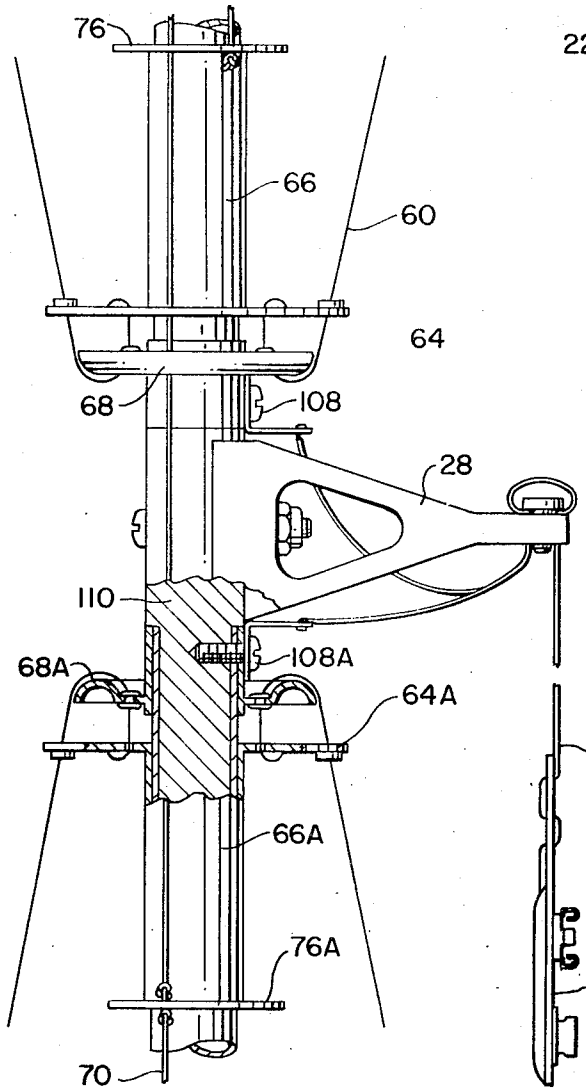


FIG. 7

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COLLAPSIBLE ANTENNA ASSEMBLY

BACKGROUND OF THE INVENTION

This invention relates to antennas and more particularly to a collapsible broadband radiator antenna.

In a dense forest environment, it is difficult to establish radio communications unless the antenna extends above the leafy canopy of the forest or jungle. It is difficult to raise a fully assembled and operable antenna through the wooded canopy because of the danger of the various radiating elements being broken by branches. In order to overcome this problem, it is necessary than an antenna be raised through the canopy and then opened to operating position. It is also necessary that the antenna be collapsed to a closed position before lowering the antenna back through the wooded canopy. Because the height of the forest canopy may vary from area to area, the antenna must also be sufficiently lightweight so that a large mast or structure is not required to support the antenna.

Accordingly, it is an object of this invention to provide a lightweight collapsible antenna which may be used in wooded environments.

A further object of this invention is to provide an antenna which may be maintained in a collapsed closed configuration while being erected, opened when above the tree level and collapsed again before being lowered to the ground.

Yet another object of this invention is to provide a collapsible biconical dipole antenna driven at its midpoint.

SUMMARY OF THE INVENTION

This invention provides a collapsible antenna assembly for permitting the antenna to be erected in a closed configuration and opened when the assembly is at a desired height above ground and also permits collapsing of the antenna to its closed configuration before being lowered to the ground. The antenna assembly comprises two radiating structures, each forming a conical half of a biconical dipole antenna. Spring-loaded radial arms are pivotally mounted on a central shaft at each end of the shaft. Wire elements extend from the ends of the radial arm through sliding collars, over a rolled edge of fixed collars and are returned to the sliding collars for termination. The fixed collars serve as quasi-pulleys for the radiating wires. The radial arms of the antenna are collapsed by moving the sliding collars toward the end of the antenna.

Other details, uses, and advantages of this invention will become apparent as the following description of the exemplary embodiment thereof presented in the accompanying drawings proceeds.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings show a present exemplary embodiment of this invention in which:

FIG. 1 is a perspective view illustrating one exemplary embodiment of this invention showing the antenna extended for operation;

FIG. 2 is a view showing the antenna of FIG. 1 disassembled;

FIGS. 3*a* and 3*b*, when aligned together, are an elevation view of the antenna with the radial arms extended for operation;

FIGS. 4*a* and 4*b*, when aligned together, are an elevation view similar to FIG. 3 but showing the radial arms in a substantially closed position;

FIG. 5 is a top view of the windup mechanism;

FIG. 6 is a side view of the windup mechanism; and

FIG. 7 is a fragmentary elevation view, partially cut away, showing the feed terminals of the antenna.

DESCRIPTION OF THE ILLUSTRATED EMBODIMENT

Reference is now made to FIG. 1 of the drawings which illustrates a perspective view of the antenna assembly of this invention, which is designated generally by the reference numeral **10**. The antenna assembly comprises two radiating cage structures, **12** and **14**, each forming a conical half of a biconical dipole antenna. The radiating structures are mounted on a central shaft **16**. The antenna assembly **10** is attachable to a support shaft or mast **18** by an insulating shaft **20**, such as a section of fiber glass tubing so as to electrically isolate the antenna **10** from the supporting mast **18**. A windup mechanism **22** is mounted on shaft **20** and is used to permit opening and closing of the antenna assembly **10**. The antenna **10** is fed at its centerpoint through a transmission line **24**. The transmission line **24** is held away from the central shaft **16** by dielectric spacers **26** and **28**.

Referring now to FIG. 2, the antenna assembly **10** is shown disassembled. The antenna central shaft **16** is seen to comprise five sections respectively numbered **30, 32, 34, 36** and **38**. The ends of intermediate sections **32** and **36** slidingly engage in a telescoping manner into the ends of sections **30, 34** and **38**. To insure proper alignment of the respective sections, any suitable means, such as bayonet fittings or mating pin and notch, may be used. Bottom section **38** terminates in a threaded end **40** which threadably engages complementary threads in one end of insulating section **20**.

The radiating structures **12** and **14** are identical and, therefore, only cage structure **12** is being described. Like elements of cage structure **14** will be numbered the same as corresponding elements of cage structure **12** with the addition of the letter A and not described again. Referring in particular to FIGS. **3** and **4**, it is seen that a plurality of radial arms **42** are pivotally mounted to a plug or collar **43** by pivot pins **44**. The collar **43** is fixedly secured to the end of shaft section **30**. A connecting arm **46** connects each respective radial arm **42** to a collar **48** which is slidably mounted on shaft **30**. Each connecting arm **46** is pivotally connected by pin **50** to a radial arm **42** at one end and pivotally connected by pin **52** to the sliding collar **48** at the other end.

A collar **54** is secured to the shaft **30** by any suitable means such as a setscrew or the like **56**. A spring **58** is mounted over shaft **30** between fixed collar **54** and sliding collar **48**. Spring **58** provides the biasing force to urge the radial arms **42** outward to the open position as will be described more fully below. Individual radiating wire elements **60** are connected to the end of each radial arm **42**. Each wire element **60** extends from the end of the radial arm through individual apertures **62** formed in a radial flange **64** of the sliding collar **66**. The radiating wire **60** is folded back over the rolled edge of a fixed collar **68** and is returned to flange **64** of sliding collar **66** where the ends of the wire **60** are terminated by any suitable means such as soldering. The fixed collar **68** serves as a quasi-pulley for the wire **60** and as a terminal for transmission line **24**.

In the open or operating condition, shown in FIGS. **3***a* and **3***b*, it is seen that the sliding collar **66** is positioned adjacent the fixed collar **68**. To close or fold the cage structure, i.e., radial arms **42**, the sliding collar **66** is urged away from the fixed collar **68**. As the sliding collar **66** is moved away from fixed collar **68** (FIGS. **4***a–b*), the radiating wire **60** is folded back on itself. Because of the pivotal connections **44, 50** and **52** of the radial and connecting arms **42** and **46**, the radial arms **42** are pivoted inward to the collapsed position. At the same time, the sliding collar **48** is urged towards the center of the central shaft **16** to compress spring **58**.

A lanyard **70** connects the windup mechanism **22** with the respective sliding collars **66** and **66A**. The lanyard **70** passes through a guide **72** which is mounted on bottom section **38** opposite dielectric spacer **26**.

The same means, such as a screw **74** and nut (not shown) will serve to mount both the guide **72** and spacer **26** to the central shaft. The lanyard **70** is secured by any suitable means, such as a knot on either side of the radial flange **76A** of sliding collar **66A**. The lanyard **70** passes through apertures in sliding collar flange **64A**, fixed collars **68A**, and **68**, flanges **64** and **76** of sliding collar **66**, and around a pulley **80** mounted on the central shaft **30** by any suitable means. The lanyard **70** is secured by any suitable means to flange **76** of sliding collar **66**. Thus, when the windup mechanism **22** is engaged to close the

antenna, the lanyard 70 will be wound on a takeup spool 82. As the lanyard 70 is being wound, sliding collars 66 and 66A will respectively be pulled away from the fixed collars 68 and 68A of FIG. 3 to the substantially closed position shown in FIG. 4. The sliding collars may be pulled until the ends of radial arms 42 engage the radial flange 64 of the collar.

The windup mechanism 22 is mounted on the fiber glass adapter tube 20 by any suitable means such as a bore 84 through which the tube 20 is passed and secured. The windup mechanism 22 comprises a conventional spring motor which supplies the necessary power to windup the lanyard 70 on the takeup spool 82 to collapse or close the antenna. Key 86 is used to windup the spring motor. A leadscrew 88 extends through the housing 90 of the windup mechanism 22. The leadscrew may be positioned by rotating positioning knob 92 which causes leadscrew extension 94 to advance or retract from the housing. Rotation of a release knob 96 permits engaging and disengaging of a locking pin (not shown) with the leadscrew to prevent relative movement of the leadscrew 88.

One side of takeup spool 82 is formed with a plurality of slots 98. The leadscrew extension 94 engages one of the slots 98 at its outer position (FIG 5) to prevent rotation of the takeup spool 82. When the leadscrew extension 94 has been retracted slightly so as to disengage the slot 98, the takeup spool 82 will be free to rotate.

A windup spring release assembly 100 has an arm 102 formed with a slot 104 (FIG. 3B) at the outer end. When the arm 102 is aligned with the leadscrew 88, the leadscrew extension 94 will engage slot 104. In this position, the spring is locked into position and the spring may be wound by key 86. After the spring has been wound, the energy is stored due to the immobility of arm 102. Thus, when the leadscrew extension 94 is retracted out of the slot 104, the stored energy of the spring is released which permits the unwinding of the spring. A one-way clutch (not shown) engages the takeup spool 82 so that the unwinding of the spring motor causes the takeup spool 82 to wind the lanyard 70 thereon.

A ratchet arm 106 engages the leadscrew 88 by means of a threaded ratchet and pawl assembly. Actuation of the ratchet arm 106 will cause the leadscrew extension 94 to be moved toward the housing 90 and out of engagement with slots 98 and 104. To prevent accidental or premature disengagement of the leadscrew extension 94 with the respective slots, a plurality of ratchet arm actuations is required in order to effect each such disengagement. Thus, in the position of FIG. 5, it will require six to eight actuations of the ratchet arm 106 to retract the leadscrew extension 94 from the position shown until the extension 94 is disengaged from slot 98. It will then take another six to eight actuations of the ratchet arm 106 to further retract the leadscrew extension 94 sufficiently far so as to disengage the extension 94 from slot 104. A lanyard or actuating line (not shown) is attached to the ratchet arm 106 to permit actuation of the ratchet arm 106 when the antenna assembly is elevated above tree level.

The antenna is fed by a balanced two-conductor line 24 running from ground level to the center of the dipole radiating cage structures 12 and 14. Referring to FIG. 7, it is seen that the transmission line 24 is attached to dielectric spacer 28. The line 24 is connected to feed terminals 108 and 108A which are electrically connected with fixed collars 68 and 68A. The radiating cage structures 12 and 14 are electrically isolated by suitable means, such as a fiberglass bushing 110 at the center. Suitable RF snap connectors 112 are used along the transmission lines 24 so as to provide necessary additional lengths of the transmission line as the antenna is being elevated above ground level.

The antenna assembly 10 may be carried in disassembled form due to the sectioned central shaft 16. The disassembled antenna assembly may be carried in a special compartmented carrying kit (not shown) which will keep the wire elements from being tangled.

When it is desired to use the antenna, the special carrying kit is unfolded and the sections, as seen in FIG 2, are aligned and assembled. During this phase, the lanyard 70 is held taut so that the antenna is held in the collapsed position. The windup mechanism 22 is secured to the insulating tube 20 and the tube 20 is threaded onto the threaded portion 40 of central section 38. The tension on lanyard 70 may be released to allow the antenna to open slowly to insure that there is no entanglement of the wire elements or radial arms.

The lanyard 70 is then attached to takeup spool 82. The leadscrew release knob 96 is turned to disengage the locking pin from the leadscrew 88 and the windup spring release mechanism 100 is rotated until slot 104 of arm 102 is aligned with the extension 94 of the leadscrew 88. The positioning knob 92 is now rotated until the extension 94 protrudes through slot 104. The release knob 96 is rotated to engage the locking pin in the leadscrew 88 at which point the spring may be wound by rotating key 86. The ratchet arm 106 is now actuated to retract leadscrew extension 94 from slot 104. This releases the spring motor to cause the antenna assembly to collapse. The windup spring mechanism 100 is now reset and rewound as just described. When the spring has been wound, the takeup spool 82 is turned a few degrees counterclockwise to disengage the one-way clutch of the spring mechanism. The takeup spool 82 is then rotated until the nearest slot 98 is in alignment with leadscrew extension 94. The positioning knob 92 is then further rotated causing leadscrew extension 94 to protrude through the slot 98 of takeup spool 82. The release knob 96 is turned so that the locking engages the leadscrew 88. The transmission line 24 is attached and connected with snap connector 112. An actuating lanyard is secured to the ratchet arm 106 and the antenna 10 is elevated to the desired height. Additional lengths of transmission line are attached as required. When elevated to the desired operational height, the actuation lanyard attached to the ratchet arm 106 is pulled a sufficient number of times to retract the leadscrew extension 94 from the slot 98. Springs 58 and 58A will then cause the radial arms 42 to pivot outwardly thereby opening the antenna to the operating configuration of FIG. 3. As the arms 42 open, the wire elements 60 are pulled across the curved portion of the fixed collars 68. Any dirt, oxidation, etc., will be scraped off by the wire 60 and bare metal of collar 68 is exposed to radiating wires 60. This insures that a good electrical connection will exist between the transmission line 24 and the antenna 10.

To lower the antenna, the actuating lanyard secured to the ratchet arm 106 is again pulled a sufficient number of times to retract the leadscrew extension 94 from slot 104. This permits operation of the spring motor which causes takeup spool 82 to windup lanyard 70 thereon causing the antenna to collapse due to the outward movement of sliding collars 66 and 66A. The collapsed antenna 10 may now be lowered and disassembled.

It can be seen that an antenna assembly has been provided which may be elevated to a desired height in the collapsed position, facilitating use in wooded areas where the antenna must be elevated above treetop level. The antenna may be opened by an operator from ground level and subsequently closed for retrieval by lowering through the treetops.

While a present exemplary embodiment of this invention has been illustrated and described it will be recognized that this invention may be otherwise variously embodied and practiced by those skilled in the art.

What is claimed is:

1. A collapsible antenna assembly comprising:

a central mast;

a first radiating cage structure mounted on said central mast, said radiating cage structure having an open and closed position;

a second radiating cage structure mounted at the other end of said central mast, said second radiating cage structure having an open and closed position;

said first and second radiating cage structures each including a plurality of radial arms pivotally connected to said central mast to permit folding of said radial arms from the

open position to the closed position at the center of said central mast;

a plurality of wire radiating elements, one each of said wire elements being connected at one end to the other end of said radial arms and the other end of said wire elements being electrically connected to a center feed point;

feed terminals connecting the center feed point with a power source;

spring means acting against said pivotally connected radial arms to urge said arms outwardly from the closed position to the open position; and

means for closing each of said radiating cage structures from the open position to the closed position.

2. An antenna as set forth in claim 1 further comprising:

a fixed collar secured to said central mast against which one end of said spring means acts;

a movable collar mounted about said central mast and against which the other end of said spring means acts; and

a plurality of linking arms, each linking arm being pivotally connected at one end to a radial arm and at the other end to said movable collar.

3. An antenna as set forth in claim 1 in which said means for closing each of said radiating structures comprises:

a collar having a rolled edge being secured to said central mast, said collar having a plurality of apertures formed therethrough;

a sliding collar mounted about said central mast between said rolled edge collar and said pivotally mounted radial arms, said sliding collar having a plurality of apertures formed therethrough, each of said radiating wire elements passing respectively through said sliding collar aperture and said rolled edge collar aperture and terminating at said sliding collar; and

means for urging said sliding collar away from said rolled edge collar wherein each of said wire elements is doubled on itself to collapse said radial arms to a closed position.

4. An antenna as set forth in claim 3 in which said means for urging said sliding collar away from said rolled edge collar comprises:

a lanyard connected with each of said sliding collars;

a source of motive power attached to an extension of said central mast;

a takeup spool connected to said source of motive power, said lanyard being attachable to said takeup spool;

said source of motive power having a first operating condition in which said takeup spool is locked against rotation;

said source of motive power having a second operating condition in which said takeup spool is freely rotatable wherein said radial arms may be pivoted outwardly to the open position;

said source of motive power having a third operating condition wherein said takeup spool is rotationally driven to wind up said lanyard wherein said radial arms are collapsed to the closed position; and

means for respectively changing said source of motive power from said first operating condition to said second operating condition and from said second operating condition to said third operating condition.

5. An antenna as set forth in claim 4 in which each of said radiating cage structures further comprises:

a fixed collar secured to said mast;

a spring mounted about said central mast between said fixed collar and said radial arms;

a movable collar mounted about said central mast between said spring and said radial arms wherein said spring acts against said collars; and

a plurality of linking arms, each linking arm being pivotally connected at one end to said movable collar and at the other end to a radial arm, said spring being compressed when said radial arms are in the collapsed position and wherein said spring urges said radial arms outwardly when said source of motive power is in the second operating condition.

6. The antenna as set forth in claim 5 in which said central mast comprises a plurality of detachable sections.

7. In a collapsible antenna assembly, the combination of:

a central mast;

a radiating cage structure mounted on said central mast having an open and closed position, said radiating cage structure including a plurality of radial arms pivotally mounted to said central mast and a plurality of radiating wire elements connecting the outer ends of said radial arms with a feed point;

spring means for moving said radial arms outwardly to the open position;

a collar having a plurality of apertures securedly mounted to said central mast;

a sliding collar having a plurality of apertures mounted about said central mast between said first collar and said radial arms, said radiating wire elements respectively passing through said sliding collar apertures and fixed collar apertures and terminating at said sliding collar;

a source of motive power attached to an extension of said central mast;

a lanyard connecting said source of motive power with said sliding collar for urging said sliding collar away from said fixed collar when said source of power is actuated wherein such movement of said sliding collar causes each radiating wire elements to double on itself whereby said radial arms are pivotally moved inward to a closed position; and

means connecting said fixed collar with a source of transmission power wherein said fixed collar is the feed point.

8. The combination as set forth in claim 7 further comprising:

a second radiating cage structure identical with said first radiating structure, said second radiating cage structure being mounted in inverted position on said central mast relative to said first radiating cage structure; and

insulating means separating said first and second radiating cage structures.

* * * * *