May 3, 1966 G. T. JONES 3,248,831

TELESCOPING ANTENNA MAST

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FIG. 4

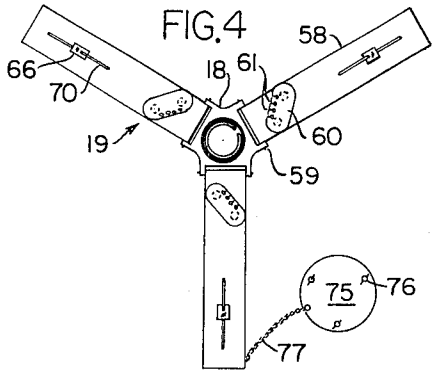

FIG. 2

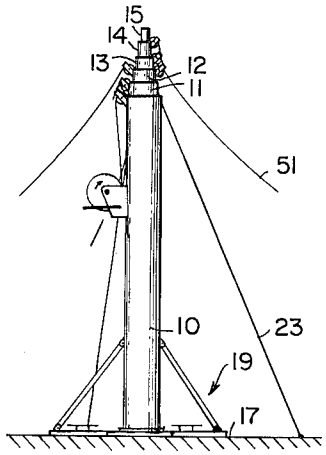

FIG. 3

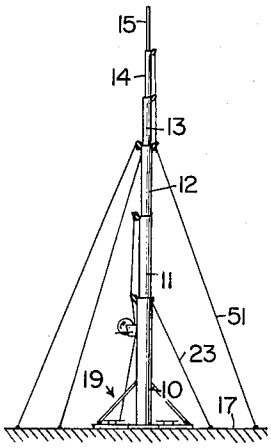

FIG. 1

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TELESCOPING ANTENNA MAST

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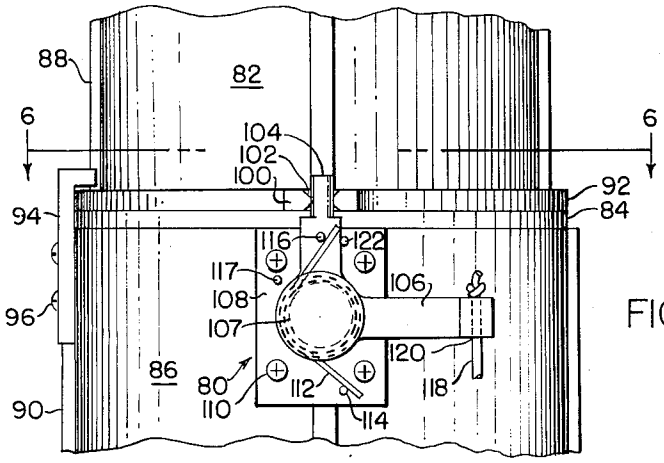

FIG.5

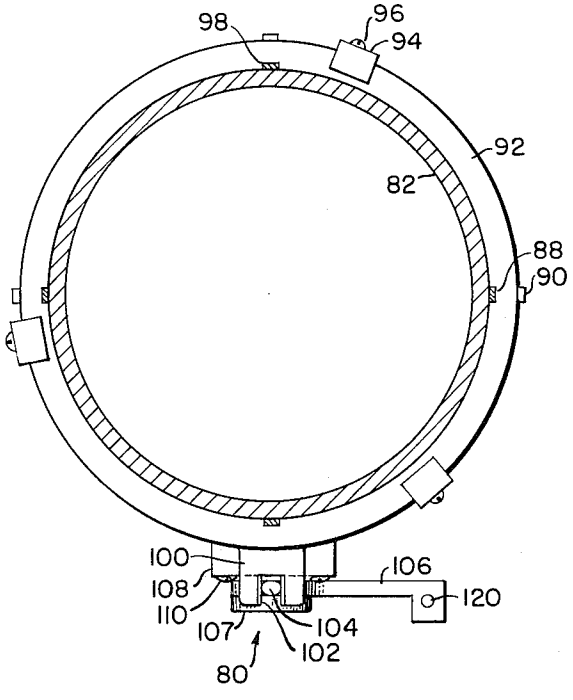

FIG.6

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TELESCOPING ANTENNA MAST

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Filed Jan. 3, 1962, Ser. No. 163,979
12 Claims. (Cl. 52—121)

This invention relates to telescoping antenna masts and the like, and more particularly to an improved portable telescoping antenna mast adapted for field use.

Telescoping antennas have previously been known in which a series of tubular elements are nested in extensible relationship and interconnected by "boot-strap" cables in such a manner that hauling of a lowermost cable extends all of the sections simultaneously. Each boot-strap cable is secured to the lower end of one element, slidably supported over the top of the next outer element, as by a pulley, and secured at its opposite extremity to the upper end of the second outward element.

In practice, it is necessary to guy antennas of substantial height. The use of the aforementioned type of telescoping antenna has prevented guy cables from being tautened about the base of the antenna until erection has been completed. Furthermore, unless a sufficiently large crew is available to tauten and secure all of the guys simultaneously and uniformly, this operation has proven difficult and somewhat dangerous.

It is an object of my invention to afford an improved telescoping antenna mast having means for automatically and simultaneously tautening guys as the mast is extended, eliminating the need for a separate tautening operation.

It is another object of my invention to afford an improved telescoping antenna mast in which hauling of a single cable sequentially effects the partial erection of a first group of telescoping elements, automatic tautening of guys for securing the first group against canting, and full extension of the first and a second group of elements to complete erection of the mast while the guys are maintained in a taut condition.

It is still another object of my invention to afford an improved guyed telescoping antenna mast which may be safely erected by a single operator.

Further objects and advantages of the invention will become apparent as the following description proceeds. Briefly stated, according to a preferred embodiment of the invention, my improved antenna mast incorporates a series of tubular elements nested in extensible telescoping relationship, and forming outer and inner groups. A plurality of guy cables are slidably supported by pulleys upon the upper end of an intermediate one of the elements, comprising the innermost section of the outer group, and are secured to the lower end of the next inner element, comprising the outermost element of the inner group. Prior to the erection of the mast, it is positioned vertically on a supporting surface, and the free ends of the guys are secured by anchoring means in predetermined spaced relation about the base.

A hauling cable is slidably supported by a pulley upon the upper end of the outermost element, and engages the second outermost element in such a manner that hauling of the cable extends the latter element. While the hauling cable may be directly secured to the second element, I prefer to provide a pulley arrangement which affords a mechanical advantage to the hauling means. The free end of the hauling cable is arranged to be hauled by a winch, by hand, or by any other suitable means.

Finally, a plurality of boot-strap cables are each secured to the upper end of one of the elements, with the exceptions of the element next outward from the intermediate element, and the innermost element of the inner group. Each of the boot-strap cables is slidably supported, as by a pulley, over the upper end of the element next inward, and is secured to the lower end of the element second inward.

In operation, the antenna mast is initially set in a vertical position and the guys are anchored in predetermined spaced relation circumferentially about its base. The hauling cable is secured to a winch or the like. Hauling of the cable initially extends only the outer group of elements to an intermediate elevation, at which the guys become taut. The cables are of such lengths relative to one another and to the elements that the guys become taut when the outer group of elements are only partially extended. Further hauling of the cable causes the taut guys to extend the inner group of elements, and also causes the outer group of elements to extend further at an equal rate, until the mast is fully erected. In this manner, the mast is automatically guyed throughout the latter portion of its erection, that is as it is raised above the intermediate elevation at which the guys become taut. It is possible for a single operator to erect the mast in safety, since the guys are secured before the erecting operation proceeds to an intermediate phase at which they must be tautened to safely secure the mast, and become taut upon partial extension of only the outer group of elements. In the event that the mast is of such height that additional guys are required, they may be arranged in similar fashion at higher elevations, and secured to the outermost elements of further groups. It will be apparent that such a series of guys and groups of elements will be erected sequentially as each higher group of guys becomes taut.

The mast may be provided with a retractable base which improves its portability while sacrificing no degree of safety. The base comprises a plurality of legs pivotally secured to a base plate arranged to receive the lower end of the lowermost mast section, and cooperating struts pivoted on the legs for attachment at points spaced along the lowermost section preparatory to elevating the mast. Prior to this attachment, the legs are extended radially of the mast, to rest on the supporting surface. The elements of the base may be folded together when the mast is removed, to afford a compact portable carrying case for mast accessories such as a winch, guy cables, etc.

According to another feature of the invention, means may be provided for restraining relative movement of one or more pairs of adjacent sections as the mast is extended. These means may comprise braking means operable as the mast is raised, or locking means operable automatically or manually after the mast has been fully elevated. Without such means, the tension applied to each successively lower boot-strap cable will be found to increase in an increment greater than the weight of the additional section supported thereby; the restraining means interrupt this geometric progression, and thus more nearly equalize the tension in the series of cables. More or fewer pairs of sections may be provided with such restraining means, as required to satisfy desired load limits on the cables. In a preferred embodiment, improved locking means engage automatically as the sections are extended, and are preferably releasable from the ground for convenience in retracting the mast, by means such as lanyards.

While the specification concludes with claims particularly pointing out the invention, it is believed that a clearer understanding may be gained from the following detailed description of a preferred embodiment, referring to the accompanying drawings, in which:

FIG. 1 is a sectional view in elevation of the improved antenna mast, shown at an intermediate stage of erection;

FIG. 2 is a view in elevation showing the mast in a fully-contracted condition;

FIG. 3 is a view in elevation showing the mast fully erected;

FIG. 4 is a plan view of a retractable base for the mast, unfolded preparatory to erection;

FIG. 5 is a view in elevation of a fragmentary portion of a modified mast having locking means; and

FIG. 6 is a sectional view taken along line 5—5 in FIG. 5, looking in the direction of the arrows.

Referring to FIGS. 1–4 of the accompany drawings, the improved antenna mast includes a series of tubular elements **10**, **11**, **12**, **13**, **14**, and **15** arranged in a series of decreasing transverse dimensions, and nested in extensible telescoping relationship. Some radial clearance is afforded between adjacent elements for freedom of sliding movement, and a collar **16** of abrasion-resistant low-friction material slidably receives and guides each element, being secured upon the upper end of the next outer element for this purpose. In the embodiment shown, the elements **10**, **11**, and **12** comprise an outer group, of which the innermost member **12** may be referred to as an intermediate element. The elements **13**, **14**, and **15** comprise an inner group.

The mast is shown resting vertically on a supporting surface **17**, the lower end of the outermost element **10** being provided with a base plate **18** to afford an adequate bearing area. A retractable base generally designated **19**, to be more fully described hereinafter, is shown extended for supporting the mast securely during the initial stages of its erection.

The outermost element **10** is guyed before erection of the mast by means of three cables spaced circumferentially thereabout, including a hauling cable **20** secured on the drum of a winch **22**, and a pair of cables **23** each secured at an upper end of the element **10** by means of a swaged fitting **25**, received in jamming engagement in a suitable slot cut therein, and secured in spaced relation to the mast by an anchor **27** implanted or fastened in the surface **17**. The guys **23** are not essential to the practice of the invention, but afford increased security during the erection of the mast, and prevent it being pulled over by the winch. A pulley **29** is rotatably mounted in a bracket **31** at the upper end of the element **10**, and the hauling cable is trained over this pulley and passes thence into driving engagement with the lower end of the next inner element **11** for extending this element when the cable **20** is hauled. I prefer to afford a mechanical advantage by training the cable over a pair of pulleys **33** mounted in brackets **35** at the base of element **11**, and to secure the cable at the upper end by the element **10** by means of a swaged fitting **37** jammed in a suitable slot in the element. However, the pulleys **33** may be omitted, and the cable directly secured to element **11** if desired, provided the winch **22** has sufficient capacity to raise the weight of the remaining elements without multiplied mechanical advantage.

A series of boot-strap cables **39** are each secured by means of swaged fittings **41** to the lower ends of the elements **12**, **14**, and **15**. The cables are trained over the upper ends of the next outer elements by means of pulleys **43**, which are rotatably supported in brackets **45** mounted on the upper ends of elements **11**, **12**, **13**, and **14**; and are secured at their outer ends by means of swaged fittings **47** to the upper ends of the brackets of the second outer elements (i.e., brackets **45**, or bracket **31** of element **10** in the case of the outermost boot-strap cable). Each of the boot-strap cables is substantially equal in length to that element to which its inner-end fitting **41** is secured.

Three guys **51** are secured by means of anchors **53** in circumferentially-spaced relation about the mast in the surface **17**, and are trained over three of the pulleys **43** mounted about the upper end of the intermediate element **12**. The guys are secured about the lower end of the element **13**, comprising the outermost element of the inner group, by means of swaged fittings **59** received in suitable slots formed in the element.

In use, the nested antenna mast is first set in a vertical position, the guys **23** are anchored in predetermined spaced relation in the supporting surface, and the cable **20** is secured to the winch or other hauling means. Initially, hauling of the cable **20** extends the elements **11** and **12** at equal rates toward the intermediate position shown in FIG. 1. While the guys **51** may be anchored prior to commencing erection, I prefer to set them after the mast is partially extended, so that uneven terrain may be accounted for. A suitable marking (not shown) may be placed on element **11** to indicate the stage of erection at which the guys **51** should be anchored.

During the initial hauling phase, the elements **13**, **14**, and **15** remain nested in element **12**. However, continued hauling after the position of FIG. 1 is attained, and the guys **51** have tautened, causes the inner group of elements to extend at the same rate as the continuing extension of elements **11** and **12**, until the fully erected condition of FIG. 3 is attained. While it is desired to transport the mast to another location, the cable **20** is slackened and all of the elements are retracted at an equal rate until the guys **51** slacken, the elements **13**, **14**, and **15** then being fully contracted. Further slackening of the cable **20** lowers the remaining elements until the fully collapsed condition of FIG. 2 is attained.

The improved mast construction enables a single operator to carry out its erection with safety, as is frequently necessary in field operations. At the same time, uniform and positive guying of the mast is achieved as soon as the intermediate phase of erection is achieved, and is maintained as the erection is completed. It should be noted that the extensible length of each of the elements of the second group is equal to the unextended length of each element of the first group when the intermediate stage of erection is achieved and the guys become taut. It will be apparent that additional series of guys may be secured to intermediate elements at higher elevations, forming additional series of sequentially extensible elements.

The retractable base **19**, when removed from the mast, may be folded for improved portability, and for containing accessories such as the guy cables, but at the same time provides secure support for the mast, especially during the initial phases of erection. A plurality of legs **58** extend radially from the base plate **18**, and are pivotally secured thereon by pins **59**. Each leg bears a bracket **60**, formed with series of keyhole-slots **61** for reeving of the cable ends to secure the cables when the mast is retracted.

Each of a series of struts **64** is adjustably secured to one of the legs **58** by means of a pivotal bracket **66** having a suitable threaded fastener **68** engaged in an elongated slot **70** formed in the leg, for adjusting the effective length of the struts to permit the legs to rest upon a non-planar surface. At their opposite ends, the struts are detachably secured to the mast section **10** by means of pins **72**, receivable in ears **74** spaced about the mast. When the mast is removed from the base plate **18** in a retracted condition, the struts are released from the ears **74** and the brackets **66**. The legs **58** are folded into a parallel bundle about the pins **59**, and are secured at their free ends to a cover plate **75** by means of threaded fasteners **76**, to form a compact carrying case for accessories. The cover plate is attached to one leg by a chain **77**, to prevent its loss.

In the mast of FIGS. 1–4, a consideration of the static forces acting on the elements will reveal that the tension applied to each successively lower boot-strap cable increases in a geometric progression, at a greater rate than would be indicated merely by the increased weight of the additional section supported thereby. The progressive increase of tension is incurred because of the mechanical

advantage of the system, provided by doubling of each cable over a pulley, so that the downward compression on the section to which the pulley is attached is doubled; this is reflected in tension in the next lower cable supporting the aforementioned pulley-attached section. A geometric progression of magnification of tension is therefore applied to successively lower cables.

In many applications, this type of loading will prove acceptable and will satisfy design load limitations. However, in relatively tall or heavy masts, the design stress limit of the cables would be exceeded, and in such instances it is preferred to provide means for restraining, by locking or braking, one or more pairs of adjacent sections relative to one another; this serves to interrupt the progressive increase in tension, and thus more nearly to equalize the tension through the entire series of cables. If all the sections are locked after the mast is fully erected, the cable tensions may be reduced to as low a figure as desired; but in most applications it is sufficient to use relatively few locks or brakes, spaced apart along the length of the mast and applied to intermediate pairs of sections.

While various conventional types of friction brakes or positive locking means may be utilized within the concept of the invention, I prefer to make use of an improved automatic locking device generally designated **80**, shown in FIGS. 5 and 6. The cables and pulleys are omitted from these views for the sake of greater clarity. The lock is associated with an adjacent pair of sections comprising an upper section **82** slidably received within a collar **84** mounted on the upper end of a lower section **86**. In this embodiment, the sections **82** and **86** are provided with circumferentially-spaced longitudinal splines **88** and **90**, respectively, the splines **88** being slidably received in mating recesses (not shown) in the collar **84**.

The lock includes an annular locking ring **92** rotatably supported upon the collar **84** and retained by a plurality of circumferentially-spaced retaining brackets **94** secured upon the upper end of section **86** by suitable fasteners **96**. The locking ring is formed interiorly with circumferentially-spaced recesses **98** positioned to receive the splines **88** in freely slidable relation when the locking ring is in the position shown. In this manner, the sections may be extended until the mast is fully erected.

The locking ring **92** is formed exteriorly with a protruding ear **100**, having a chamfered notch **102** formed therein for receiving an actuating pin **104** of a bell crank lever **106**. The lever **106** is pivotally supported on a stud **107** secured in a block **108**, which is attached by means of fasteners **110** on the lower section **86**, for angular displacement of the locking ring **92** by movement of the lever. A torsion spring **112** is placed over the stud **107** and engages a pin **114** on the block **108**, and a pin **116** on the lever, to bias the lever counterclockwise as viewed in FIG. 5. The engagement of the splines **88** in the recesses **98** of the locking ring retains the ring in the position shown against this bias, when the sections are retracted or only partially extended. However, the splines **88** are terminated above the lower end (not shown) of the section **82**, and as the ends of the splines rise out of the recesses **98**, the spring **112** automatically carries the locking ring **92** clockwise as viewed in FIG. 6, to lock the upper section **82** against downward retraction into the section **86**. The rotation of the lever **106** and the locking ring is limited by a stop pin **117** secured in the block **108**. In a manner previously explained, the cables supporting section **82** and the lower sections are thereby relieved of the excessive tension which would otherwise be applied.

If it is desired to retract the mast, the operator first pulls a lanyard **118**, which is knotted in an opening **120** at the free end of the lever **106**, to displace the locking ring **92** in a counterclockwise direction as viewed in FIG. 6, and this movement is terminated by a stop pin **122** secured in the block **108**, when the recesses **98** of the locking ring are aligned with the splines **88** of section **82**. The mast may then be lowered in a manner previously described.

Various changes and modifications will readily occur to those skilled in the art, and it is therefore my intention to define the invention in the appended claims without limitation to specific details of the preferred embodiment herein described by way of illustration.

What I claim is:

1. A telescoping mast comprising, in combination: a plurality of tubular elements receiving one another in longitudinally-extensible telescoping relation, said elements being arranged in an inner and an outer group; a plurality of cables, each of said cables being drivingly connected at a first end thereof to one of said elements other than an outermost element; each of said cables being slidably supported upon an upper end of the next outer element; the second end of at least a first one of said cables slidably supported upon the innermost element of said outer group being adapted to be anchored in spaced relation to said mast, the second end of a second one of said cables slidably supported upon the outermost element being arranged for hauling to erect said mast, and the second ends of each of the remaining cables being secured to the element next outward from that upon which each said remaining cable is slidably supported; whereby hauling of said second cable initially extends said outer group of elements to tauten said first cable, and further hauling of said second cable further extends all of said elements.

2. A telescoping mast as recited in claim **1**, together with means for releasably restraining at least one adjacent pair of said elements against telescoping one into the other, to reduce the tension applied to those of said cables drivingly connected to the elements of said pair and the elements outward thereof.

3. A telescoping mast as recited in claim **2**, in which said restraining means comprises means for automatically locking said adjacent pair of elements to one another upon their extension to a predetermined juxtaposition, together with means for releasing said locking means for retracting said elements into one another.

4. A telescoping mast as recited in claim **3**, in which an inner one of said pair of elements is formed with a longitudinal spline having an interruption and an outer one of said pair of elements is provided with recess-forming means normally receiving said spline in longitudinally-slidable relation, and said locking means comprises a ring rotatably supported on said outer element and formed with a recess normally receiving said spline in longitudinally-slidable relation, and means for rotating said ring to misalign said recess from said spline operable when said pair of elements is extended to a juxtaposition in which said ring is longitudinally aligned with said interruption.

5. A telescoping mast comprising a series of tubular elements nested in extensible telescoping relationship, a series of cables, a first end of each of said cables engaging the lower end of one of said elements other than an outermost element, each of said cables being slidably supported upon the upper end of the element next outward from the element engaged by said first end, at least a first one of said cables slidably supported upon the upper end of an intermediate one of said elements being arranged to be anchored upon a supporting surface in spaced relation to said mast when said mast is supported vertically on said surface, a second one of said cables engaging the lower end of the second outermost element being arranged to be hauled to extend said mast, and the remainder of said cables having their second ends secured to the upper ends of elements next outward from the elements upon which said cables are slidably supported, such that hauling of said second cable initially extends a group of said elements including said outermost and said intermediate elements and the elements disposed therebetween to tauten said first cable, and fur-

ther hauling of said second cable subsequent to tautening of said first cable extends all of said elements while maintaining said first cable taut.

6. A telescoping mast comprising: a series of tubular elements nested in extensible telescoping relationship and arranged in an inner and an outer group; a plurality of guys slidably supported upon the upper end of an intermediate one of said elements comprising the innermost element of said outer group, each of said guys being secured to the lower end of the next inner element comprising the outermost element of an inner group, said guys being adapted to be anchored upon a supporting surface in spaced relation to said mast when said mast is supported vertically on said surface; a hauling cable engaging the second outermost element, slidably supported upon the upper end of the outermost element, and arranged to be hauled to extend said second outermost element; and a plurality of boot-strap cables each secured to the upper end of one of said elements other than the element next outward from said intermediate element and the innermost element of said inner group, each of said boot-strap cables being slidably supported over the upper end of the next inward element and secured to the lower end of the second inward element; whereby hauling of said hauling cable is effective initially to extend said outer group of elements to tauten said guys, and subsequently to extend said inner and outer groups of elements fully.

7. A telescoping mast comprising: a series of tubular elements nested in extensible telescoping relationship and arranged in an inner and an outer group; a plurality of guys, a plurality of pulleys slidably supporting said guys upon the upper end of an intermediate one of said elements comprising the innermost element of said outer group, one end of each of said guys being secured to the lower end of the next inner element comprising the outermost element of an inner group, the second end of each of said guys being adapted to be anchored upon a supporting surface in spaced relation to said mast when said mast is supported on said surface; a hauling cable having a first end drivingly engaging the second outermost element, a pulley slidably supporting said hauling cable upon the upper end of the outermost element, the second end of said hauling cable being arranged to be hauled to extend said second outermost element; and a plurality of boot-strap cables each secured at a first end thereof to the upper end of one of said elements other than the element next outward from said intermediate element and the innermost element of said inner group, a plurality of pulleys each slidably supporting one of said boot-strap cables upon the upper end of the next inward element, the second end of each of said boot-strap cables being secured to the lower end of the second inward element; whereby hauling of said hauling cable is effective initially to extend said outer group of elements to tauten said guys, and subsequently to extend said inner and outer groups of elements fully.

8. A telescoping mast as recited in claim 7, together with brackets rotatably supporting said pulleys upon the upper ends of said elements, said first end of each of said boot-strap cables being secured to one of said brackets.

9. A telescoping mast as recited in claim 7, together with at least one further pulley rotatably mounted upon the lower end of said second outermost element, said first end of said hauling cable being trained over said further pulley and secured to said outermost element to afford a mechanical advantage for extending said mast.

10. A telescoping mast as recited in claim 7, together with a plurality of further guys each secured at one end to the upper end of said outermost element and adapted to be anchored upon a supporting surface in spaced relation to said mast when said mast is contracted.

11. A telescoping mast comprising a series of at least three tubular elements receiving one another in extensible telescoping relationship, a plurality of guy cables slidably supported upon the upper end of an intermediate one of said elements and having first ends thereof arranged to be anchored upon a supporting surface in spaced relation to said mast when said mast is supported on said surface, second ends of said guy cables being secured to a lower end of an inner one of said elements, a hauling cable slidably supported over the upper end of an outer one of said elements and having a first end thereof engaged with the lower end of said intermediate element and a second end thereof arranged to be hauled to initially extend said intermediate element and tauten said guy cables, and subsequently to extend said inner element while maintaining said guy cables taut.

12. A telescoping mast as recited in claim 11, together with a retractable base for said mast comprising a base plate for receiving the lower end of said outer one of said elements, and a series of legs pivotally secured upon said base plate for extension at an angle to said mast to engage said supporting surface, and a plurality of struts each arranged for attachment to one of said legs and to said outer element for securing said mast in a vertical position on said supporting surface.

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