

**3,033,529**

# AUTOMATIC GUY TENSIONING DEVICE FOR ERECTION OF MASTS

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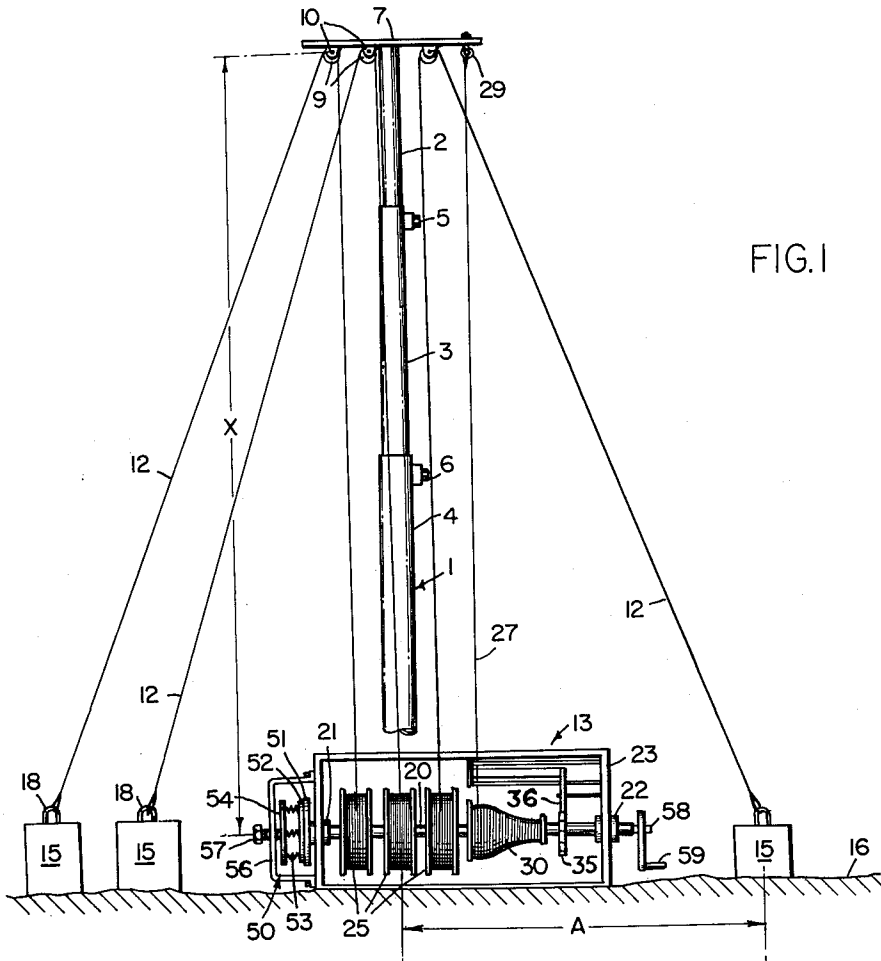


FIG. 1

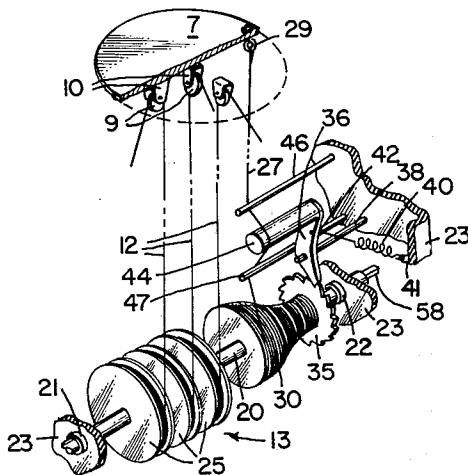


FIG.2

INVENTOR.

BY *Michel A. Pierrat*  
*Kenway, Jenney & Hildreth*  
ATTORNEYS

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## AUTOMATIC GUY TENSIONING DEVICE FOR ERECTION OF MASTS

Michel A. Pierrat, Andover, Mass., assignor to Craig Systems, Inc., Lawrence, Mass., a corporation of Massachusetts

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6 Claims. (Cl. 254-173)

This invention relates to an improved automatic guy tensioning device for use in the erection of guyed masts, and has as its primary object the provision of an improved device for paying out guy lines under tension in a manner to positively restrain the mast against tilting from a vertical position as it is raised or lowered. It is a further object of the invention to provide a device for automatically locking guy lines paid out to a mast to restrain any tendency of the mast to tilt. Further objects and advantages of the invention will become apparent as the following description proceeds.

Generally, according to a preferred embodiment of the invention, a number of reels of guy line are secured upon a common rotatable shaft, for running of the guy lines over pulleys secured to the top of the mast and thence to ground anchors secured circumferentially about the foot of the mast. A sensing cable is fastened to the top of the mast and is paid out by a drum which is also fixed upon the shaft. Additionally, braking means for the shaft are provided, generally comprising a ratchet wheel secured upon the shaft and a pawl pivotally supported for braking engagement with the ratchet wheel. The pawl carries a roll for engaging the sensing cable transversely, and is biased against the cable by suitable spring means which urge the pawl in a direction to engage the ratchet wheel for braking the shaft against rotation. Tension in the sensing cable biases the roller and pawl against the spring means in a direction to release the ratchet wheel and the shaft for paying out the guy lines and the sensing cable. A friction device applies a braking torque to the shaft as the mast is raised, normally maintaining sufficient tension in the sensing cable to hold the pawl out of engagement with the ratchet wheel. However, if the mast tends to tilt from the vertical position, at least one of the guy lines is drawn out to a greater extent than the remaining guy lines, causing the sensing cable to slacken sufficiently to permit the spring means to engage the pawl with the ratchet wheel. The guy line reels are then locked, while tension is maintained in each of the guy lines to positively support the mast against further tilting. The same result ensues when the movement of the mast is halted, relieving the shaft of braking torque; the shaft is immediately locked upon a slight slackening of the sensing cable, to maintain tension in the guy lines. The mast can be released only by raising it further into a vertical position to equalize the paid-out length of each of the guy lines and thus to tension the sensing cable; or by lowering the mast.

A crank attachable to the shaft is provided to reel in the guy lines and the sensing cable upon retraction of the mast. If the mast tends to tilt from a vertical position during its retraction, the consequent slacking of the sensing cable will cause the pawl to engage the ratchet, braking the shaft to maintain tension in the guy lines while preventing further tilting of the mast by any force insufficient to overcome the bias of the pawl against the ratchet wheel by the spring means.

While the specification concludes with claims clearly pointing out and distinctly claiming the subject matter which is regarded as the invention, it is believed that the invention may be more clearly understood from the

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following detailed description of a preferred embodiment thereof, referring to the accompanying drawings, in which:

FIG. 1 is a view in elevation of a preferred form of the automatic guy tensioning device shown in operative relationship with a telescoping mast; and

FIG. 2 is a pictorial view of the automatic tensioning device, with parts broken away to show more clearly the operative relationship of the elements thereof.

Referring to the drawings, a telescoping mast 1 is shown in conjunction with the automatic tensioning device for purposes of illustration, although it should be understood that the tensioning device may be utilized with various structures which are to be raised vertically and guyed to support them positively against tilting movement. The mast 1 includes a number of telescoping sections 2, 3, 4, etc. which are successively elevated by any suitable means, such as a crane (not shown) and locked together by means such as bolts 5 and lock-nuts 6. Upon the upper end of the topmost section 2, there is secured a disk 7 for supporting a plurality of rollers 9, which are rotatably mounted under the disk in brackets 10. A plurality of guy lines 12 pass from the improved tensioning device, generally designated at 13, vertically over the rollers 9 and thence to a plurality of anchors 15, which are circumferentially spaced about the foot of the mast at equal distances from the centerline thereof and firmly secured in the earth or other supporting surface 16. The guy lines are secured by means of eyes 18 affixed in the anchors, so that the mast may be positively guyed as it is erected, by paying out the guy lines under tension.

The automatic tensioning device includes a shaft 20 rotatably supported in bearings 21 and 22 mounted in a housing 23. A plurality of reels 25, each having one of the guy lines wound thereon, are fixed in axially-spaced relation upon the shaft, and a plurality of slots (not shown) are formed in the housing for the free passage of the guy lines to the top of the mast. According to the invention, a sensing cable 27 is secured to the disk 7 at a convenient point 29, and is wound upon a drum 30 which is also fixed upon the shaft 20. As the mast is raised vertically, a length of sensing cable is paid out which is equal to that portion of each guy line extending vertically between the corresponding reel 25 and the disk 7 at the top of the mast. Since the guy lines extend to the anchors 15, forming an angle with the ground which changes constantly as the mast is raised or lowered, the drum 30 is specially formed to pay out a length of sensing cable which remains equal to the aforementioned vertically-extending portions of the guy lines. This relationship is expressed by the formula:

$$D_1 = \frac{D}{\frac{X}{\sqrt{X^2 + A^2}} + 1}$$

where X represents the paid out length of sensing cable corresponding to a given diametral plane of the drum, equal to the corresponding height of the mast above the centerline of the shaft 20; A is the horizontal distance from the foot of the mast to any of the anchors 15; D is the diameter of any of the reels 25; and D<sub>1</sub> is the variable diameter of the sensing cable drum 30. The curvature of the drum 30 may be determined with regard to a specific diameter of sensing cable, assuming that the cable is to be wound smoothly and tightly on the drum, by substituting the expression

$$\frac{\pi D_1 e}{d}$$

for X in the aforementioned formula; e representing the

axial length of the drum 30 from an end thereof to any particular diametral plane, and  $d$  being the diameter of the sensing cable.

Tension applied to the sensing cable serves to render braking means inoperative while the mast is being raised or lowered in a vertical position. In the event that the mast becomes tilted, the length of at least one of the guy lines payed out from the corresponding drum becomes greater than the payed-out length of the remaining guy lines. The consequent slackening of the sensing cable results in actuation of the braking means to lock the shaft against further rotation. A similar result ensues if the movement of the mast is halted.

In the preferred embodiment shown, the braking means includes a ratchet wheel 35 fixed upon the shaft 20, and a cooperating pawl 36 which is rotatably mounted upon a stub shaft 38 supported in the housing 23. A tension spring 40 is secured at an end 41 thereof to the housing, and at an opposite end 42 to the pawl, in a manner to bias the pawl toward locking engagement with the ratchet wheel 35 for braking the shaft. At the outer end of the pawl there is mounted a roll 44 for cooperation with the sensing cable 27. The sensing cable is passed over a pair of guide rods 46 and 47, respectively spaced above and below the roll 44, in such a manner that a predetermined tension of the sensing cable is effective to pivot the pawl out of engagement with the ratchet wheel, against the bias of the tension spring 40.

A friction device 50 is secured upon the housing 23 for applying a restraining torque to the shaft 20 not only to tension the guy lines, but also to tension the sensing cable for holding the pawl 42 out of engagement with the ratchet wheel 35 while the mast is being raised or lowered and remains substantially vertical. In the embodiment illustrated, the friction device 50 includes a brake disk 51 secured to an end of the shaft 20 (FIG. 1), against which is biased a friction plate 52 by a plurality of compression springs 53. A mounting plate 54 supports the springs 53 and the plate 52 adjustably in a housing 56, for variation of the braking torque through rotation of an adjusting screw 57. The particular form of friction device utilized is not critical to the practice of the invention, and any well-known friction brake may be employed which is adapted to apply a restraining torque to the shaft to tension the guy lines and sensing cable during the raising of the mast.

At an end thereof opposite the friction device 50, the shaft 20 is formed with an irregular lug 58 for cooperation with a removable hand crank 59, by means of which the guy lines and sensing cable may be wound upon the reels 25 and the drum 30, respectively, for maintaining positive guying support during retraction of the mast.

In operation, the guy lines feed out freely under the restraining torque applied to the shaft by the friction device 50, so long as the mast is raised vertically. However, upon tilting of the mast, as by the application of a sudden bending moment by wind pressure, at least one of the guy lines is drawn out to a greater extent than are the remaining guy lines. The sensing cable consequently slackens and permits the pawl 36 to be biased into braking engagement with the ratchet wheel 35 by the tension spring 40. The reels 25 are then positively braked, and the mast is positively guyed against further tilting. Similarly, if the movement of the mast is halted for any reason, the shaft is relieved of frictional torque; a slight relaxation of the sensing cable ensuing thereon is sufficient to actuate the braking means and lock the shaft, for the maintenance of tension in the guy lines. The mast may be released by further raising it into a vertical position to tension the sensing cable and thus to withdraw the pawl from engagement with the ratchet wheel. In retracting the mast, the tensioning device acts in a similar manner to restrain the mast against tilting, although the ratchet wheel and the shaft are not then positively braked

by the pawl, and may override the pawl if sufficient torque is applied to overcome the bias of the tension spring 40.

While a preferred embodiment of the invention has been shown and described by way of illustration, it will be apparent to those skilled in the art that various changes and modifications may be made without departing from the true spirit and scope of the invention. It is therefore intended to cover all such changes and modifications in the appended claims.

What I claim is:

1. A device adapted for automatically tensioning guy lines secured in circumferentially-spaced relation about the foot of a vertically-erectable mast and running to the top of the mast and thence to the foot thereof, comprising, in combination; a plurality of rotatably-mounted reels for paying out guy lines, a rotatably-mounted drum for paying out a sensing cable adapted to be secured to the head of the mast, said reels and said drum being drivingly interconnected, means for applying a braking torque through said interconnection to said reels and said drum upon rotation thereof to tension said guy lines and said sensing cable, and braking means engageable to lock said reels and drum against rotation, said braking means constructed and arranged for cooperation with said sensing cable for disengagement thereby when the tension in said cable exceeds a predetermined value, and for self-induced engagement upon a reduction of the tension in said cable below said predetermined value.

2. A device as recited in claim 1, in which said drum is axially contoured to pay out a length of sensing cable equal to the length of that portion of each of the guy lines extending from said reels to the head of the mast when the latter is in a vertical position.

3. A device adapted for automatically tensioning guy lines secured in circumferentially-spaced relation about the foot of a vertically-erectable mast at equal distances therefrom and running to the top of the mast and thence to the foot thereof, comprising, in combination; a plurality of reels for paying out guy lines, a drum for paying out a sensing cable adapted to be secured to the head of the mast, a rotatably mounted shaft, said reels and said drum being fixed on said shaft, friction means for applying a braking torque to said shaft upon rotation thereof to tension the guy lines and the sensing cable, and braking means engageable to lock said shaft against rotation, said braking means constructed and arranged for cooperation with said sensing cable for disengagement thereby when the tension in said cable exceeds a predetermined value, and for self-induced engagement upon a reduction of the tension in said cable below said predetermined value.

4. A device as recited in claim 3, in which said drum is axially contoured to have a variable diameter equal to

$$\frac{D}{\frac{X}{\sqrt{X^2 + A^2}}} + 1$$

in which  $X$  represents the length of the sensing cable payed out from said drum at a given diametral plane thereof, and  $A$  represents the distance from the foot of the mast to the point at which any of said guy lines is secured; and in which each of said reels is of a uniform diameter  $D$ .

5. A device adapted for automatically tensioning guy lines secured in circumferentially-spaced relation about the foot of a vertically-erectable mast and running to the top of the mast and thence to the foot thereof, comprising, in combination: a plurality of reels for paying out the guy lines; a drum for paying out a sensing cable adapted to be secured to the head of the mast; a rotatably mounted shaft; said reels and said drum being fixed on said shaft; friction means for applying a braking torque to said shaft upon rotation thereof to tension said guy lines and said sensing cable; and braking means en-

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gageable to lock said shaft against rotation, said braking means comprising a ratchet wheel fixed on said shaft and a pivotally mounted pawl, and means biasing said pawl into engagement with said sensing cable and toward said ratchet wheel; said sensing cable being effective to pivot said pawl out of engagement with said ratchet wheel when the tension in said cable exceeds a predetermined value, and said biasing means being operative to engage said pawl with said ratchet wheel to lock said shaft against rotation when the tension in said cable is reduced below said predetermined value by tilting of said mast to draw out unequal lengths of guy line from the various ones of said reels.

6. A device adapted for automatically tensioning guy lines secured in circumferentially-spaced relation about the foot of a vertically-erectable mast and running to the top of the mast and thence to the foot thereof, comprising, in combination: a plurality of reels for paying out guy lines; a drum for paying out a sensing cable

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adapted to be secured to the head of the mast; a rotatably mounted shaft; said reels and said drum being fixed on said shaft; friction means for applying a braking torque to said shaft upon rotation thereof to tension said guy lines and said sensing cable; and braking means engageable to lock said shaft against rotation, said braking means comprising a ratchet wheel fixed on said shaft, a pivotally mounted pawl, and means biasing said pawl toward engagement with said ratchet wheel; said sensing cable being arranged to pivot said pawl out of engagement with said ratchet wheel when the tension in said cable exceeds a predetermined value, and said biasing means being operative to engage said pawl with said ratchet wheel to lock said shaft against rotation when the tension in said cable is reduced below said predetermined value by tilting of said mast to draw out unequal lengths of guy line from the various ones of said reels.

No references cited.