Nov. 12, 1963 J. S. ROSS 3,110,368

SECTIONAL TORSIONALLY RIGID MAST

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Fig. 1.

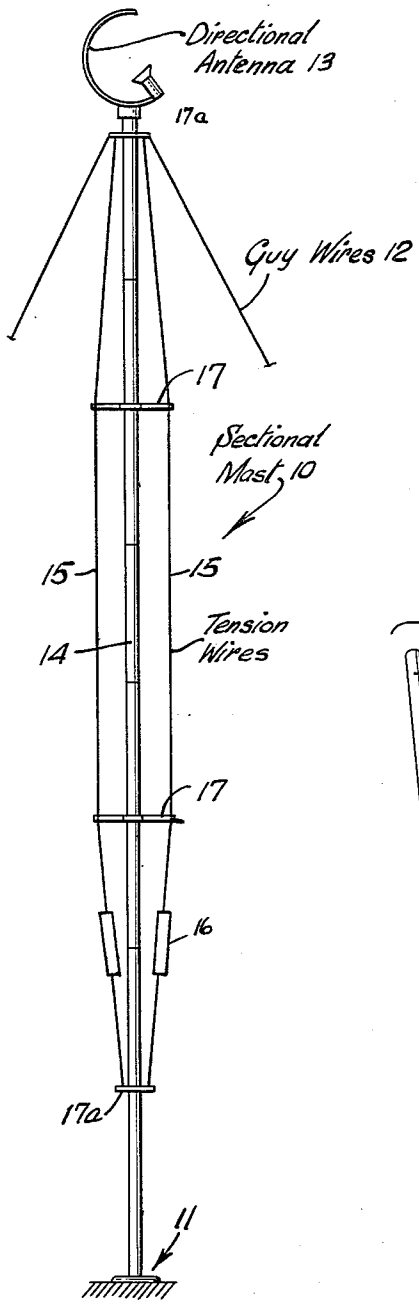


Fig. 2

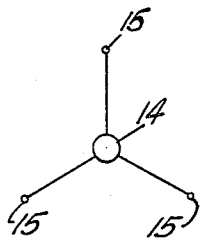
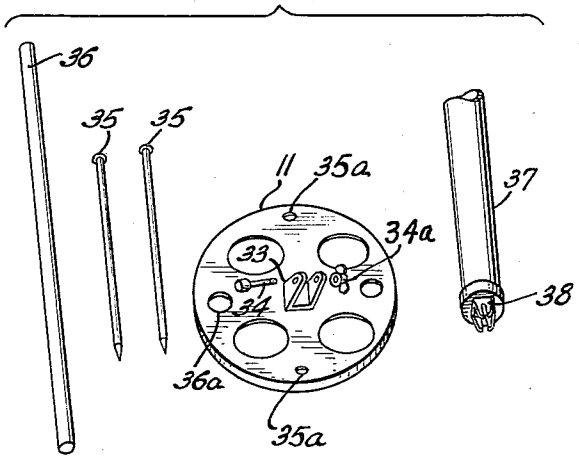


Fig. 3.



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Fig. 4.

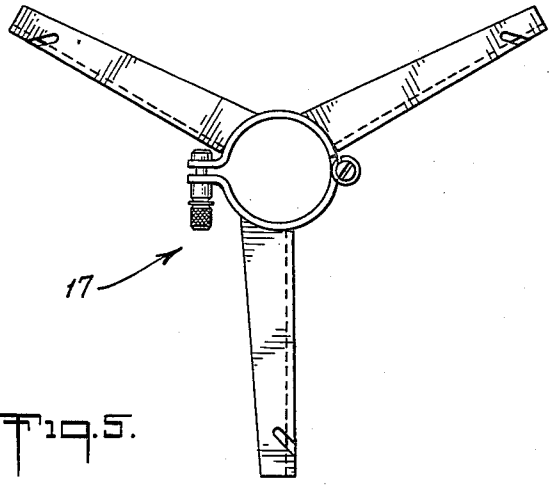


Fig. 5.

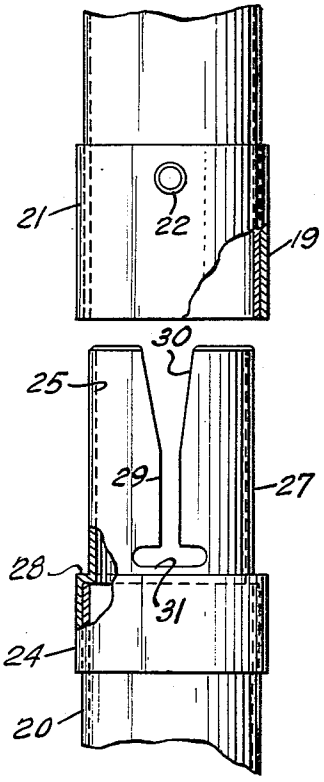
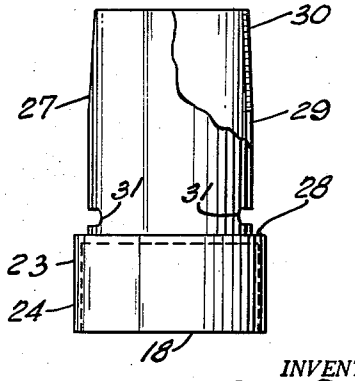


Fig. 6.



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SECTIONAL TORSIONALLY RIGID MAST

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3 Claims. (Cl. 189—26)

This invention relates to a sectional mast that can be assembled in the field under difficult ambient conditions with no tools, and more particularly to a sectional mast that is rigid in torsion for supporting a directional antenna.

Lengthy rod or pole-like units, e.g., antenna masts for use by military or scientific expeditions are generally fabricated in sections so that they can be stored compactly and carried in man packs. Experience has demonstrated that sectional units for assembly in the field are progressively more reliable as the number of parts comprising the unit are reduced because the possibility of misplacing a part that could render the unit useless is correspondingly lessened and because the assembly time which is generally directly related to the number of parts in the unit is lessened. Also, while sectional units comprising small fastenings and requiring special tools for assembly may be satisfactory under circumstances where there is no need for haste in assembly, where there is plenty of light to work by, where the temperature is mild, and there is no mud, grit or the like, such units are not satisfactory for assembly in an Arctic blizzard, in a sandstorm, in a swamp, in the dark, or during a military operation. Bolt secured pipe joints are not satisfactory because of the number of fastening elements needed because grit or ice fouls bolts and nuts, because such pipe joints are not readily assemblable quickly by touch in the dark or under other adverse conditions, because screw threads are readily damaged in rough handling, and because bolt hole clearances that would be needed for quick assembly would permit relative displacement at the joints when subjected to torsion and such displacements at all the joints are cumulative. Screw thread pipe joints and tapered pipe joints readily damaged by rough handling and fouled by grit or ice are generally more troublesome to assemble and do not have satisfactory rigidity in torsion.

A sectional mast for supporting a directional antenna not only must include as few parts as possible, few or no small fastenings and be assemblable under difficult conditions in a short time, but also must have torsional rigidity.

An object of this invention is to provide a rugged, lightweight, compact, easily assemblable, easily transportable shaft or mast having excellent torsional rigidity after assembly requiring no tools for assembly and which can be quickly assembled under difficult ambient conditions.

A further object is to provide a shaft or mast according to the preceding object which can be fabricated at low cost, without troublesome tolerances.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

FIG. 1 illustrates schematically, an antenna mast in accordance with this invention,

FIG. 2 is an end view of FIG. 1 to show the truss or tension wires,

FIG. 3 illustrates base parts of the mast unassembled,

FIG. 4 illustrates one of the truss or tension wire spreaders,

FIG. 5 illustrates an embodiment of a section joint in accordance with this invention for the antenna mast shown in FIG. 1, and

FIG. 6 shows the male joint portion of FIG. 5 rotated

90 degrees and showing the longitudinal taper for providing better contact when wedged apart.

The mast 10 in FIG. 1 seats on a base 11 and is maintained in upright position by a plurality of guy wires 12 attached to staked ground anchors, not shown, and including length adjusting means, not shown, for tension adjustment. A disked directional antenna 13 and a feed horn is affixed to the upper end of mast 10. The microwave cable connection to the feed horn is omitted. The mast includes a plurality of elongated sections 14 assembled end to end. Three truss or tension wires 15, FIG. 2, are secured to the end sections in angularly spaced relationship (FIG. 2) and retain the sections assembled and under compression. A turnbuckle 16 is included in each of the tension wires to adjust their lengths at assembly. A pair of tension wire spreaders 17 are clamped to intermediate spaced parts of the sectional mast.

Sections 14 are tubular for stiffness and for lightness in weight. The cross-sectional dimensions of the tubular sections are based upon calculated polar moment of inertia for anticipated torque loads. One suitable material for sections 14 is aluminum of a tough commercial grade subsequently hardened. Each section joint comprises a plug ending 18 that telescopes into a socket ending 19. If each section 14 has a plug ending at one end and a socket ending at the other end and if all plug endings are identical and all socket endings are identical, assembly of the sections into a mast is substantially facilitated. The advantageous characteristics of the section joints described herein are obtained whether or not sections 14 are identical.

Each section 14 includes an elongated circular cylindrical tube 20. Each socket ending includes a reinforcing sleeve 21 dip brazed over and coterminous with an end of a tube 20, the sleeve and tube end being squared relative to the tube axis. A pin 22 is affixed to the socket end of the tube to extend diametrically through both the sleeve 21 and the tube end. Pin 22 is tubular-shaped for stiffness and is secured in place by staking each end. Each plug ending 18 is formed from a length of tubing stock 23 of outside diameter 24 and inside diameter 25. At one end the inside diameter of the tubing 23 forming the plug ending is enlarged to telescope over an end of a tube 20 and to seat that end of the tube 20 and is secured thereto as by dip brazing. Most of the length of the tube 23 forming socket ending 18 is reduced in outside diameter as at 27 so that it is somewhat smaller than the inside diameter of tube 20. The step 28 formed in the socket ending is squared relative to the axis to serve as a bearing surface and stop when it seats against the squared termination of a socket ending 19 telescopically joined therewith, to ensure axial alignment of the joined sections. The plug ending 18 is diametrically slotted longitudinally. The plug ending 18 is formed with diametrically opposed longitudinal slots 29, 30, whereby it can be forceably wedged apart; for stress relief when wedged apart, the inner end 31 of the longitudinal slots are transversely enlarged. Each slot is convergently tapered inwardly from the free end as at 30 so that a plug ending 18 telescoping into a socket ending 19 and properly oriented to straddle the pin 22 encounters no resistance while telescoping into the socket ending until the step surface 28 is proximate (on the order of ⅛ inch) to the free end of the mating socket. At that time, the pin 22 abuts the sloping sides of the two longitudinal slots and then upon application of compressive force to the telescoping plug and socket endings, the plug is forced inwardly, its slotted portion is wedged apart, and its outer peripheral surface firmly engages the inside peripheral surface of the socket when the step surface 28 abuts the socket ending. To increase the frictional contact surface between plug and socket when the plug is wedged apart into abutting engage-

ment with the inner surface of the socket, the plug portion 27 may be slightly tapered as in FIG. 6 so that when wedged apart at assembly, a larger portion of its surface area is forced into engagement with the inside surface of the socket. All clearances between mating surfaces are taken up without precision machining operation by the flexing action of the plug endings when engaged and wedged apart by the pins in the respective socket endings. Nicks and scratches on the plug and socket endings arising from rough handling in the field are not troublesome because of the available clearance before wedging action begins. Satisfactory results were obtained even when the slots were punched out.

When assembling the sectional mast in the field, the plurality of tubular sections 14 are telescopically assembled loosely end to end on the ground. This can be accomplished without any difficulty, at night, in bad weather, and even in the presence of ice, grit, mud or the like. A ring 17*a* having angularly spaced eyes or hooks for the tension wires is clamped on each of the two end sections 14. Spreaders 17 for the tension wires are clamped on intermediate sections 14. The rings include clamping wing screws, or equivalent, which may be tightened without tools. Tension wires 15 having fittings at the ends are hooked to the two clamping rings 17*a*. The tension wires include some simplified takeup means such as intermediate hooks and eyes for fast hand takeup and also include turnbuckles 16 or equivalent to apply compressive force to the assembled sections 14 for compacting the sections. First, the wires are hooked onto the rings 17*a*. Then the rings 17 and 17*a* are adjusted angularly till they are in line. The tension wires are hooked onto the wire spreaders 17, are taken up till hand tight and then the turnbuckles 16 are tightened till the tubular sections 14 pull together snugly.

The assembled mast has excellent torsional rigidity. There is substantially no angular displacement at any of the joints because any force tending to twist the mast causes the pins 22 to exert additional spreading force on the plug endings thereby increasing the resistance of the sockets to torsion. The tension wires contribute to the rigidity of the mast because any force tending to bend or twist the mast must also stretch at least one of the tension wires.

At one end, the assembled mast is provided with a terminating section 37 having a bifurcated ending 38 for seating on the base 11. The section 37 may be separably secured to one of the sections 14 or may be integral with one of the sections 14.

The assembled mast seats on a base 11 that is anchored in the ground. A suitable base is shown in FIG. 3. It includes a welded on U-shaped element 33, a bolt 34 welded to one of the legs of element 33 and extending through the other leg, and a wing nut 34*a* for clamping. The legs of element 33 yield somewhat when the wing nut is tightened. The distance between the legs of element 33 is substantially the same as the width of bifurcated ending 38 of the mast. Spikes 35 and rod 36 are illustrative of anchoring elements for the base 11 registering with the holes 35*a* and 36*a* at assembly. The rod 36 serves as a locating pin. The antenna 13 and the feed horn are secured to the end of the mast remote from section 37. Then the guy wires 12 are attached to the ring 17 at the mast head and the bifurcated ending of the mast is located against the bolt 34 between the legs of the member 33. Two men as a team raise the mast to vertical position, one tugging on the guy wires and the other pivotally lifting the mast progressively around the bolt 34. When in vertical position, the wing nut 34*a* is tightened and the orientation of the antenna is checked. If adjustment is necessary, the mast is lowered to the ground. When the orientation is correct and the mast is vertical the guy wires are attached to staked ground anchors. A five section mast made in accordance with this invention about twenty feet high has been assembled and set up in five minutes by two men with one day's training.

An antenna mast constructed in accordance with this invention and tested successfully under various conditions was constructed of two inch aluminum tubing (61S–T6 round drawn) with 0.083 inch wall thickness, clearance between wall plug and socket respectively before wedging on the order of 1/32 inch, clearance between start of wedging action and end of travel about 1/8 inch, slot length on the order of 2¼ inches, tapered portion of the slots being about half the slot length, slot convergence angle on the order of twenty degrees, wall thickness of the plug ending on the order of 0.15 inch, and wedging pin diameter on the order of 0.3 inch. No tolerance need be any better than several thousandths of an inch. A twenty foot aluminum directional antenna mast constructed with the above dimensions and mounting a 30 inch diameter paraboloidal reflector can operate successfully in a wind as high as 60 miles per hour and can withstand wind velocities up to ninety miles per hour.

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 otherwise than as specifically described.

I claim:

1. A sectional torsionally rigid mast for supporting a directional antenna which can be stored compactly and carried in a manpack and which can be easily and quickly assembled without tools under difficult conditions which comprises a plurality of elongated sections that can be assembled end-to-end to form the mast with abutting ends of the assembled sections telescoping with one another, each inner telescoping end being slotted from its terminus in a lengthwise direction, each slot being gradually tapered toward its inner end for a substantial distance, means within each outer telescoping end of a size to enter the slot in the cooperating telescoping end and to spread the inner end as the telescoping proceeds into firm contact with the inner peripheral wall of the outer telescoping end, the outer surface of each inner telescoping end being tapered for at least part of its length to a reduced diameter at its free end to render telescoping assembly easier even when said inner telescoping end is slightly deformed in field use and for increased surface contact between telescopically assembled ends, means for connecting the end sections of the assembled mast and applying compressive force to the assembled mast, and effective to increase compressive force on the mast when torsional force is applied to the mast, a base for supporting said mast, said base and one end of the assembled mast having pivotal joinder means for permitting approximately 180° relative pivotal movement therebetween, and guy wires for attachment to the other end of the assembled mast whereby when said base is anchored to the ground and said last-mentioned end of said assembled mast is pivotally joined to said base, said mast may be hauled into vertical position by pulling on the guy wires and then anchored in that position by the guy wires.

2. A mast as defined in claim 1 wherein said means includes a plurality of tension wires arranged peripherally around the mast and means spacing the tension wires intermediate of their ends from the intermediate portions of the mast, said tension wires including length adjusting means to apply selected compressive force lengthwise of the mast, said tension wire being effective to add to the torsional rigidity of said mast.

3. An improved torsionally rigid sectional mast comprising a plurality of elongated tubular interchangeable sections telescopically joined together end-to-end, each section having a plug termination at one end and a socket termination at the other end, the corresponding terminations of all said sections being substantially identical, the socket termination of each section having a circular cylindrical inside surface, the plug termination of each section

being tubular with its outer surface tapered for at least part of its length to a reduced diameter at its free end and its nontapered portion being of somewhat smaller diameter than the inside diameter of the socket for facile insertion into a mating socket termination, said plug termination being formed with a plurality of substantially identical longitudinal slots separated by predetermined angular spacing and extending inward from the free end of the plug and for substantiatly its entire length, a wedge means for each slot in the plug termination affixed within the socket termination for registration with the respective longitudinal slots of a mating plug termination, the width of each slot at the open end being larger than the width of said wedge means and at the inner end being smaller than the width of said wedge means and having a tapered portion therebetween, said plug being of a material such that the slot separated portions thereof may be wedged apart in the direction of increasing diameter to at least an extent where the minimum outside diameter of the plug exceeds the inside diameter of said socket whereby when said plug is inserted into a mating socket with slots

and wedge means in registration said plug may be expanded until its tapered surface area firmly engages the inside surface of the socket, tension wires attached to the end sections of said mast and applying compressive force between the end sections of said mast whereby each plug nesting in a socket is expanded by the wedge means in that socket so that the outer surface of said plug firmly abuts the inner surface of the mating socket to resist torsional displacement between mating plug and socket.

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