

March 10, 1970

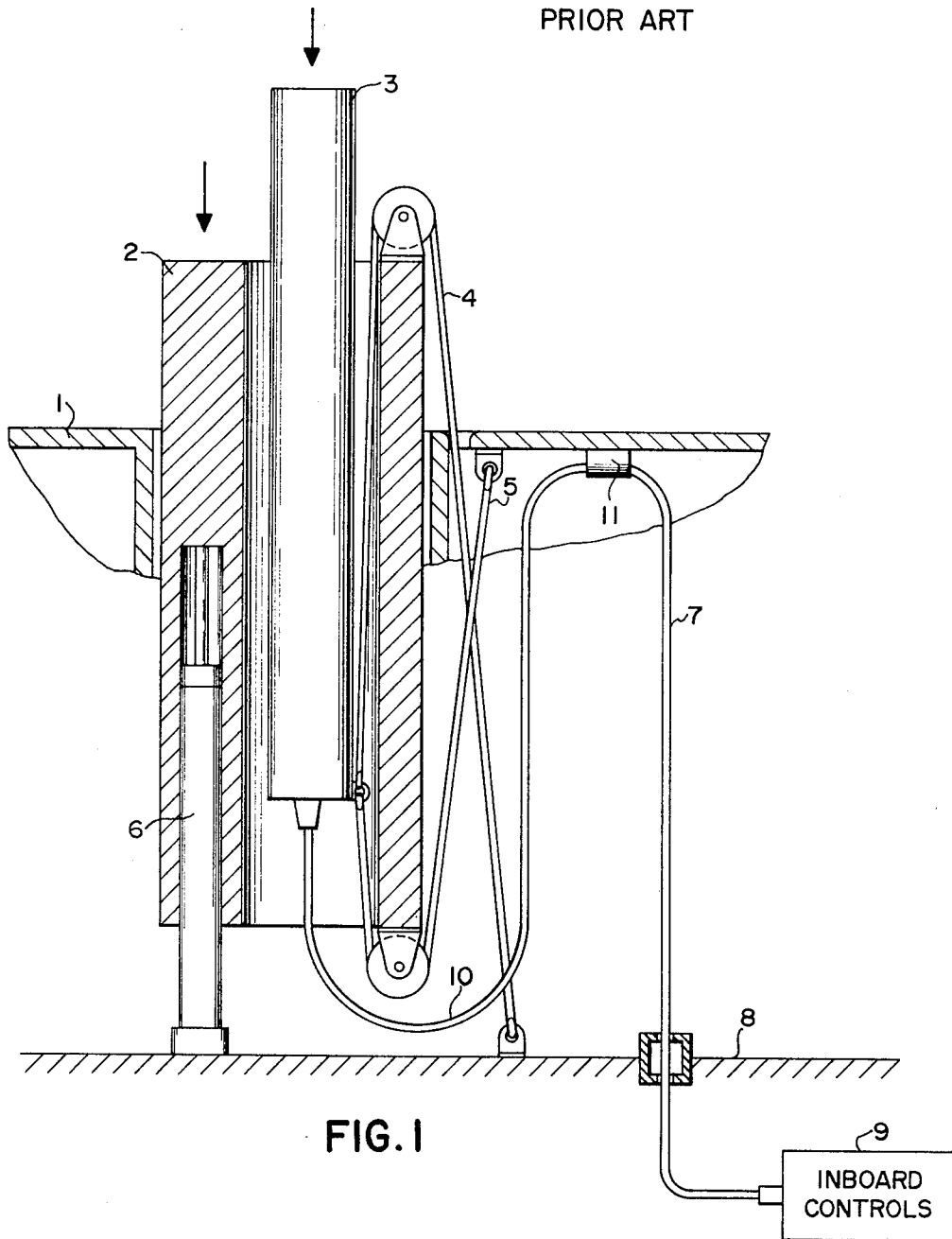
C. P. MAJKRZAK ETAL

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TELESCOPING ANTENNA SYSTEM WITH TRANSLATABLE PAYOUT REEL

Filed Sept. 8, 1966

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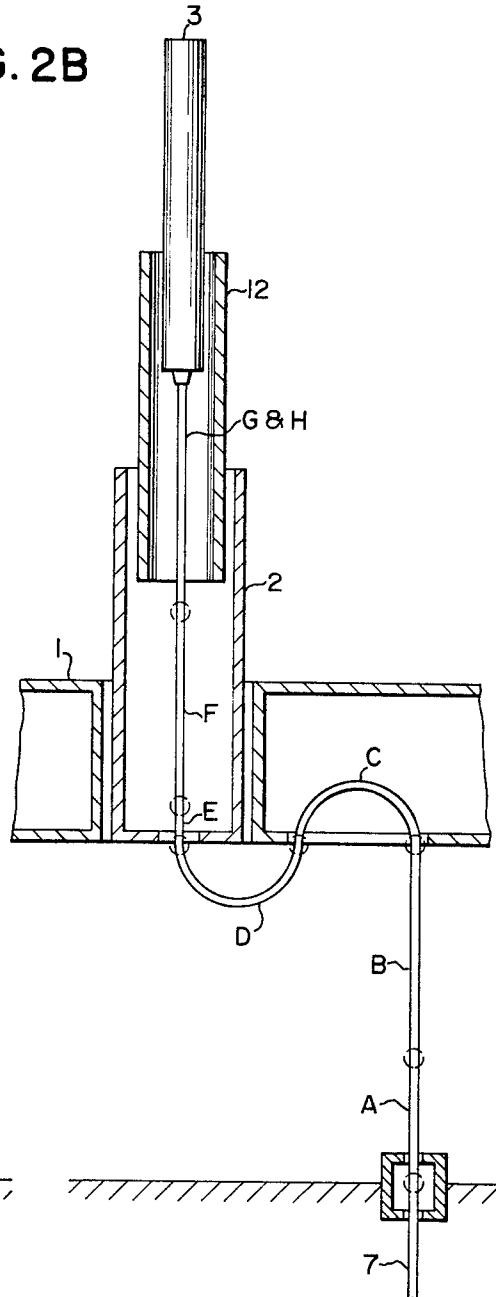
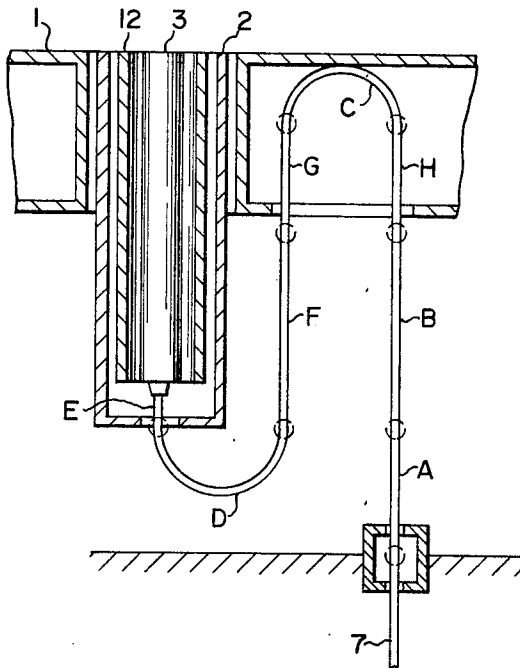
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FIG. 2A



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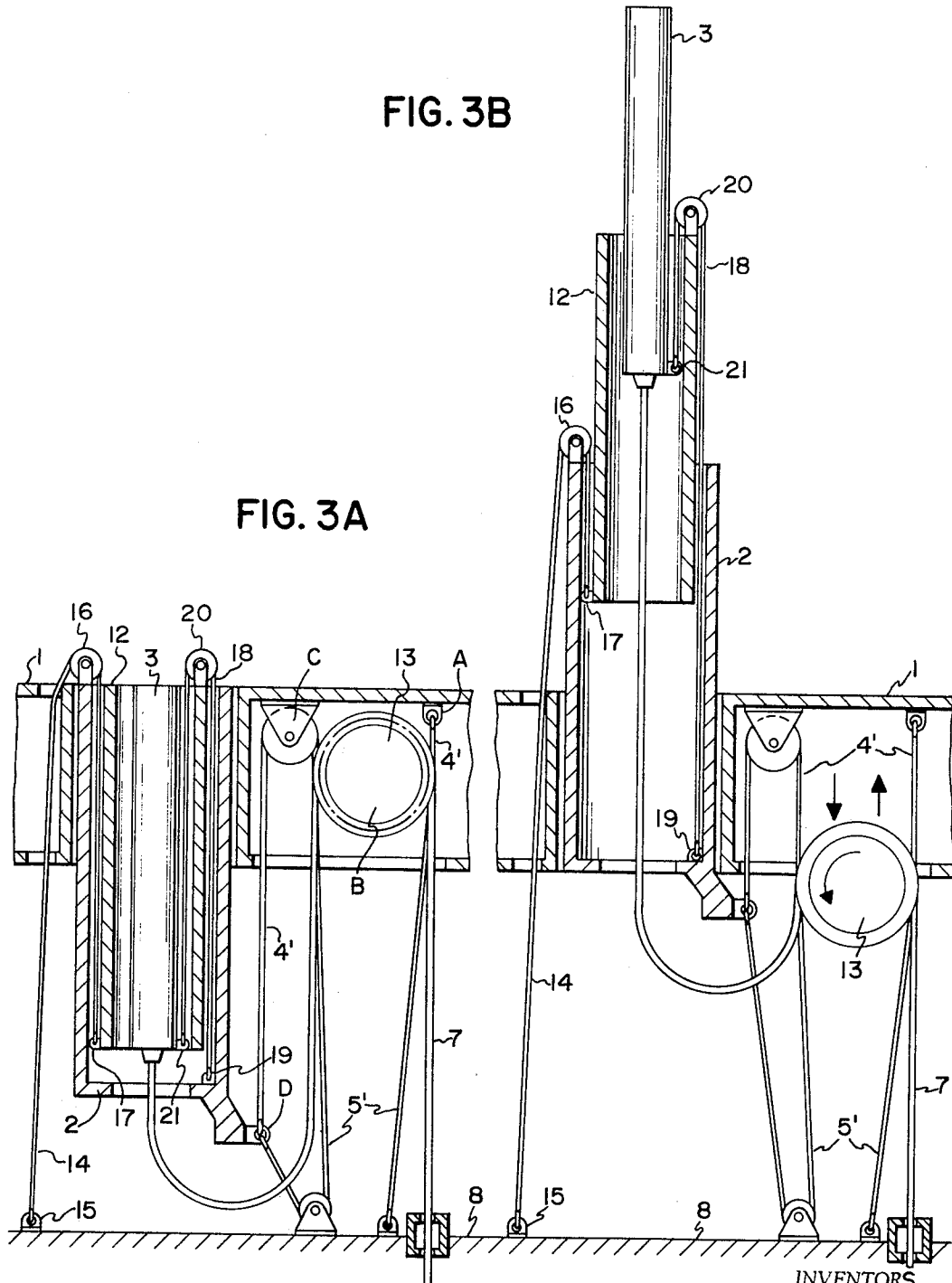
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FIG. 3B

FIG. 3A



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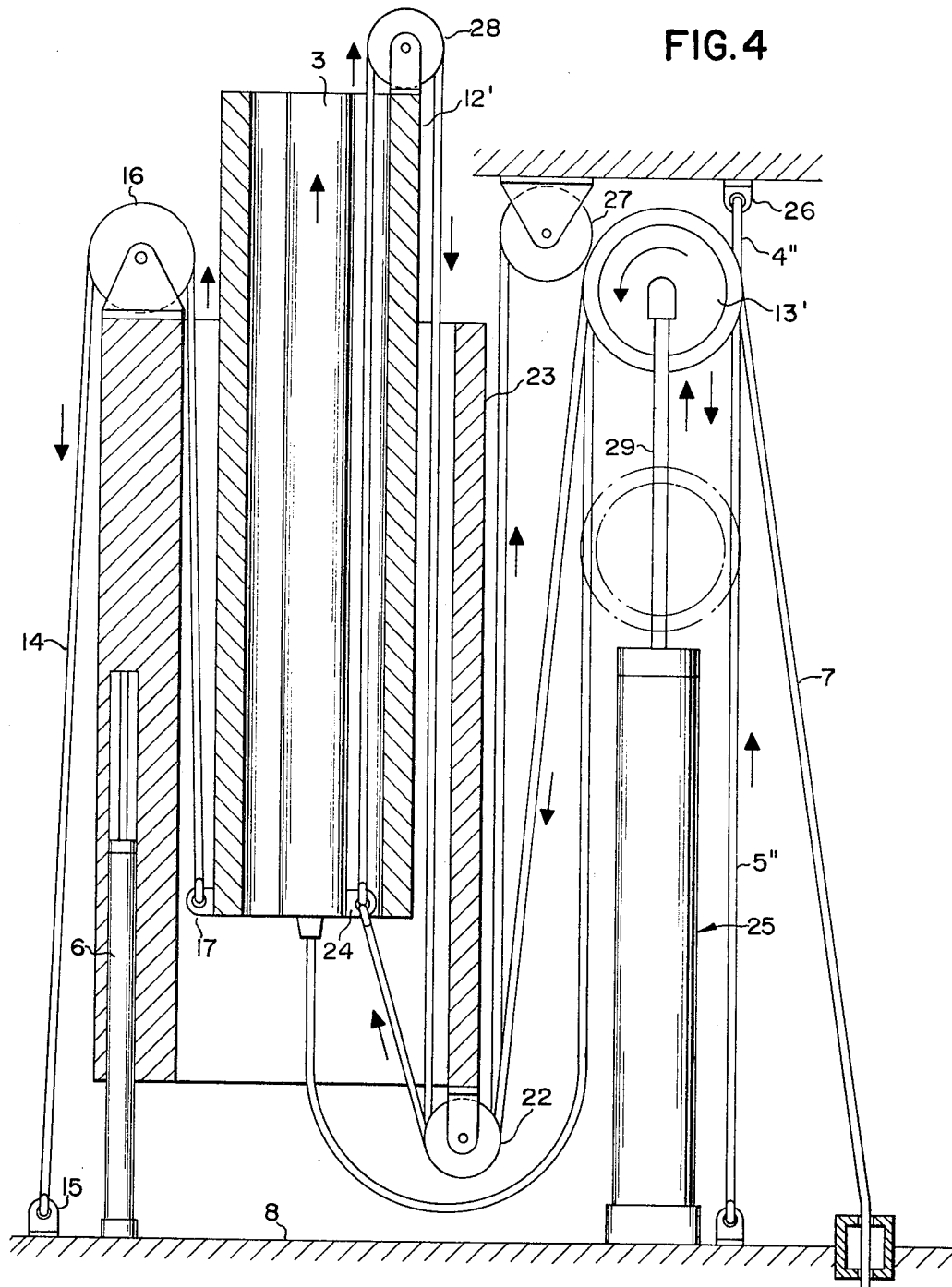
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**TELESCOPING ANTENNA SYSTEM WITH
TRANSLATABLE PAYOUT REEL**

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7 Claims

ABSTRACT OF THE DISCLOSURE

In a telescoping antenna system, a pulley is mechanically coupled to the antenna section which is lowered as the antenna is raised and raised as the antenna is lowered. An electrical cable which is connected to one end of the antenna section is placed over said pulley and is stowed or payed out to said antenna by the rotation and translation of said pulley.

This invention relates to extensible antenna systems and more particularly to telescoping antenna systems for use aboard submarines.

Presently-used antenna erection and electrical cable storage systems used aboard submarines employ a mast which is elevated from its retracted position within the sail by a hydraulic jack mounted on the hull. An antenna is suspended within the mast and rises with it but is also caused to be projected from the mast during the elevation. This is accomplished by a mechanical cable system that supports the antenna at all times within the mast. In this, one end of a mechanical cable is attached to the base of the antenna and passed over a pulley attached to the top of the mast and terminates at an attachment on the hull. When the mast is caused to be raised by the jack, the antenna also rises. Since the cable length is constant, and the cable end is fixed to the hull, the antenna rises out of and above the mast at velocities and displacements with respect to the hull twice that of the mast. Accordingly, with a second length of mechanical cable attached to the base of the antenna, and this cable passed over a pulley attached to the bottom of the mast with the other end fixed at the top of the sail, the antenna would be drawn into the mast when the mast is caused to be lowered by the jack. The velocities and displacements of the antenna and the mast will again be equal to that of system erection but in reverse. Since the movement of the antenna is at all times caused by the movement of the mast, the system described can be called a "dependent system."

Electrical cables connecting the antenna with inboard controls are coupled to and passed through the bottom end of the antenna structure. Since the antenna moves considerably relative to the hull in its erection and retraction, provision must be made for guiding the flexible electrical cables to prevent their entanglement.

In the presently-used antenna erection and electrical storage system described above, this guidance is easily obtained through the use of a simple pulley arrangement affixed to the bottom of the mast. Since the electrical cable can be appropriately affixed at some point along its length to the top of the sail, its suspension as a "hair-pin" loop will be parallel to and similar in action to the previously-described mechanical cable used for retraction. Thus it is evident that the electrical cable length is self-storing in its "hair-pin" loop during the entire process of erecting and retracting the mast-antenna system, since, according to the relative velocities and displacements of the antenna and mast, that cable which is given up as apparent excess on one side of the pulley must immediately be taken up on the other side to satisfy a lack.

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It occurs however that needs arise, because of the existence of a low sail, or because greater submerged depth is necessary for the submarine during periods of communication, for a more complex support mast system, one incorporating two or more masts plus an antenna. Plural mast systems require that "excess" electrical cable, i.e. a portion of the electrical cable required to follow the extended reach of a fully erected antenna, be stored, when the antenna-mast system is retracted, since a "hair-pin" loop is not self-storing as that described in the presently used antenna erecting systems because of the existence of a different ratio of velocities and displacements of the masts and antenna.

A common method for guiding and storing "excess" cable, to provide for the extra length required upon erection of the antenna in a multi-mast system, involves the use of a weighted pulley. The weighted pulley is disposed in the "hair-pin" loop of the electrical cable, the loop being formed in the spatial distance between the point of attachment at the top of the sail and the bottom antenna coupling. As electrical cable is required on erection of the antenna, it causes the loop to rise and to raise the weighted pulley. When the antenna is retracted the weighted pulley lowers and maintains the loop and thereby "stows" the extra length. However, during operation of the mast system, loading on the electrical cable is increased. The cable, necessarily in contact with a plurality of associated guide rollers and the weighted pulley, is always subjected to at least an axial tensile load as well as a radial compressive load caused by the weight and its inertia. Since electrical cables are necessarily made of materials that are not exceptionally strong, especially is this so of the RF transmission types, their lives become very limited in such cables storing systems. Another common system is to use mechanical springs instead of a weight to provide the force necessary for guiding and storing "excess" cable. This system has the same objections.

As noted previously, the known telescoping antenna systems are of the dependent type, wherein the movement of the antennas are caused by movement of the masts. Under certain conditions, however, it is advantageous for the antenna to move independently of the masts. Independent antenna motion is desirable when a fully-erected antenna obstructs a sector of the periscope's circular scanning range. Further, since the antenna is used above the surface of the sea, it would be desirable if it could, alone be retracted and erected independently, readily, quickly and quietly, especially if the submarine is moving at high speed subjecting the erected masts system to a heavy drag load. Finally, independent antenna motion is also desirable because it permits an easier access to the mounting of the antenna and to the attachment of electrical cables during installation and in periods of overhaul.

It is an object of the present invention, therefore, to provide a telescoping antenna system either "dependent" or "independent" of associated devices, as the case may be, with means for stowing and paying-out of electrical cable without subjecting the electrical cable to external loading.

Another object of this invention is to provide a support mast system for either a "dependent" or "independent" multiple-mast system.

A novel feature of the invention is provision of a displaceable and rotatable element which receives the mechanical cables for erection and retraction and the electrical cable for stowage and pay out.

Another novel feature of the invention is the provision of separate elevating and retracting means for the antenna which is independent of the principal elevating and retracting means for the mast sections.

The above mentioned and other features and objects

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of this invention will become more apparent by reference to the following description taken in conjunction with the accompanying drawings in which:

FIGURE 1 is a schematic representation of a simple dependent antenna system as is known in prior art,

FIGURES 2A and 2B are schematic representations of a multiple-mast, dependent, antenna system, useful in explaining the principle of this invention,

FIGURES 3A and 3B are schematic representations of a multiple-mast, dependent antenna system according to the invention, and

FIGURE 4 is a schematic representation of an independent, multiple-mast, antenna system with a support mast arrangement according to the invention.

FIGURE 1, representing a simple dependent antenna system known in the prior submarine antenna art, shows the sail of the submarine 1, the elevating and retracting mast 2, the antenna 3, the elevating mechanical cable 4, the retracting mechanical cable 5, the elevating and retracting piston 6 for the mast, the electrical cable 7, and the hull of the submarine at 8. The inboard controls 9 to electrical cable 7 is attached as shown inside of the hull 8. It is seen that the electrical cable defines a "hairpin" loop 10 about the bottom of the mast 2. Also, the electrical cable is clamped inside the upper part of the sail at 11. It can be seen that as the mast and antenna erect, the mast retreats from the hairpin loop of the electrical cable, and correspondingly the loop gets shorter, following the mast upward. Here, there is no interference with the electrical cable, and there is an adequate supply of it. However, as can be seen in FIGURES 2A and 2B, in a complex system where there is an intermediate mast 12, there must be some adjustment in the disposition of the electrical cable as a greater length is required from the point of attachment to the bottom of the antenna 3 down through intermediate mast 12 and mast 2. As shown in FIGURES 2A and 2B, considering and comparing the electrical cable lengths in segments, those in the erected position FIGURE 2B with those in the retracted position FIGURE 2A, cable length A remains the same, cable length B remains the same, cable length equal to C remains the same, but is differently disposed, cable length D and E are the same, cable length equal to F can now be considered as being disposed outside the outer mast 2; finally, cable lengths equal to G and H are required to permit cable length C to be disposed to a higher level to store the required lengths G and H below it. As noted before, prior systems would dispose a weighted pulley in a loop formed of cable lengths E, D, F, G, C and H, as these are shown in the retracted-system deployment. Then, on erection of the antenna system, the electrical cable would be pulled against the weight of the pulley, and moved across roller guides disposed at the bottom of outer mast 2.

To avoid the deleterious effects of the weighted pulley or the spring-loaded arrangement, this invention teaches the use of a free or non-weighted pulley to accommodate the electrical cable and its so-called storage loop, and more, it teaches also the use of the same pulley to accommodate mechanical elevating and retracting cables. This novel concept is shown in FIGURES 3A and 3B where a complex mast system is shown with an intermediate mast 12 and the antenna 3 with elevating mechanical cable 4' and retracting mechanical cable 5'. Here the mechanical cables are disposed about the pulley 13 so that to elevate the telescoping system the pulley 13 is lowered. The effect here is to shorten the length of mechanical erecting cable between the sail 1 and the mast 2 and to lengthen the amount of retracting mechanical cable between the hull 8 and the mast 2. On retraction of the system the reverse becomes true. However, it will be noted that as the pulley lowers or rises it is caused to rotate in directions which correctly serve stowing or paying-out of electrical cable. It is a teaching of this invention then to use a pulley 13 having a pitch diameter for the me-

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chanical cables 4' and 5' appropriate to that required by the electrical cable 7 in order to prevent sliding of the electrical cable thereon. The electrical cable 7 thus disposed on pulley 13 is payed-out or stored at the proper rate without its having to be subjected to any axial tension or radial compression beyond the weight of the cable itself, and maintains a constant "hairpin loop" about the bottom of outer mast 2. A dependent antenna system is disclosed in FIGS. 3A and 3B. Wire rope 14, fixed to the hull 8 at 15, looped about an idler 16 secured to the top of mast 2, and secured to the intermediate mast 12 at 17 will cause the intermediate mast 12 to rise two feet for every one foot that mast 2 is elevated. Likewise, wire rope 18, fixed to mast 2 at 19, looped about an idler 20 atop the intermediate mast 12 and secured to the bottom of the antenna 3 at 21 will cause the antenna to rise two feet for every one foot that intermediate mast 12 is elevated. It will be evident, then, that with relation to hull 8, as the pulley 13 is lowered one-half foot, mast 2 is elevated one foot, the intermediate mast 12 rises 2 feet and the antenna 3 rises 3 feet. Should pulley 13 be raised instead of lowered, this relationship holds true but in reverse. It will be further evident that an even greater displacement of antenna 3 can be achieved by securing wire rope 18 to the hull 8 rather than to mast 2 at 19. In this instance a pulley-mast-intermediate mast and antenna velocity and displacement ratio of $\frac{1}{2}:1:2:4$ will be obtained.

FIGURE 4 illustrates another embodiment of the invention which is an independent complex mast system. In this embodiment the erection of the antenna 3 beyond the masts is independent of the movement of the masts themselves. Here we have a pulley 13' about which is arranged a retracting mechanical cable 5'' fixed to the hull 8 at 14 arranged about an idler 22 on outer mast 23 and secured to the bottom of the antenna 3 at 24. In this embodiment pulley 13' is rotatably mounted to the reciprocating, extended end 29 of a piston actuator 25. The elevating mechanical cable 4'' is secured at one end to the sail at 26, arranged about the pulley 13', deployed around another idler 27, brought down to idler 22, up to another idler 28 which is mounted on the intermediate mast 12' and secured to the bottom of the antenna 3 at 24. The electrical cable is shown at 7. At 6 is represented the same elevating and retracting piston as shown in FIGURE 1 which elevates and retracts the outer mast 23 and elevates the intermediate mast 12' through the interaction of wire rope 14 and retracts intermediate mast 12' through the combined interaction of wire ropes 4'' and 5''. Upon examination it will be seen that the outer mast 23 and intermediate mast 12' are elevated and retracted simultaneously, and antenna 3 is carried by the latter without displacement relative thereto. In this embodiment is disclosed the separate elevating and retracting means for the antenna 3 comprising the pulley 13', a piston actuator 25, and the mechanical cables 4'' and 5'', the latter being the antenna elevating and retracting cables, respectively. When the piston actuator 25 retracts the pulley 13' down toward the hull 8, the antenna 3 is elevated and ejected from the intermediate mast 12'. Also as the pulley 13' is lowered toward the hull 8, it is caused to rotate in the direction shown by the arrow. The electrical cable 7, being deployed on pulley 13', is payed out toward the antenna supplying thereby the extra length of electrical cable required by the antenna in the fully erected position. Conversely, when the piston actuator 25 raises pulley 13', the arrangement of mechanical cable 4'' and 5'' causes a retraction of the antenna 3 into the intermediate mast 12'. Pulley 13' on rising revolves in the direction opposite to that shown on by the arrow; that is, it revolves clockwise and withdraws excess electrical cable length. It is to be noted that the mast erection-retraction system and the antenna erection-retraction system operate independent of each other and may be operated either separately or simultaneously with the desired results.

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In FIGURES 1, 3A, 3B, and 4 the mechanical elevating and retracting cables are shown in various angular displacements from true vertical. These illustrative displacements are given to enhance the pictorial clarity of cable attachments and deployments. As a matter of practical engineering the cable runs, at either sides of given pulleys or idlers, would have to be parallel with each other—and thus, with the masts and antenna—and truly vertical, with respect to the hull. Otherwise, on erection and retraction, undue slackening or tautness will occur in particular cable lengths. It is to be understood, then, that the illustrations are only diagrammatic presentations of our invention.

While we have described above the principles of our invention in connection with specific apparatus it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of our invention as set forth in the objects thereof and in the accompanying claims.

We claim:

1. A telescoping antenna system, comprising a plurality of telescoping sections one of which is an antenna; an electrical cable coupled to one end of said antenna; a mechanical cable coupled to one end of one of said telescoping sections; and a translatable pulley engaging both cables for paying out or reeling in said electrical cable and simultaneously guiding said mechanical cable.
2. A telescoping antenna system, according to claim 1 wherein said mechanical cable is connected to one end of said antenna, further including means for translating said translatable pulley for elevating and retracting said antenna independently of any other of said sections.
3. A telescoping antenna system, according to claim 1, wherein: said plurality of telescoping sections comprises three sections further including first means for elevating and retracting one of said sections a given distance, and elevating and retracting each of the other sections different multiples of said distance.

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4. A telescoping system, according to claim 3, wherein: said plurality of telescoping sections comprises a first mast, a second mast, and an antenna; and said first means elevates and retracts said first mast a given distance, said second mast twice said given distance, and said antenna at least three times said given distance.

5. A telescoping antenna system, according to claim 2, wherein: said sections comprise a first mast, a second mast, and an antenna; further including means for elevating and retracting said first mast a given distance, said second mast and said antenna twice said given distance; and said means for translating said translatable pulley elevates and retracts said antenna three times said given distance.

6. A telescoping antenna system, according to claim 2, wherein: said means for translating said translatable pulley comprises and reciprocable extended member connected to said pulley; and means for reciprocating said extended member.

7. A telescoping antenna system, according to claim 6, wherein: said pulley has an open loop of said electrical cable partially encircling it.

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U.S. Cl. X.R.

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