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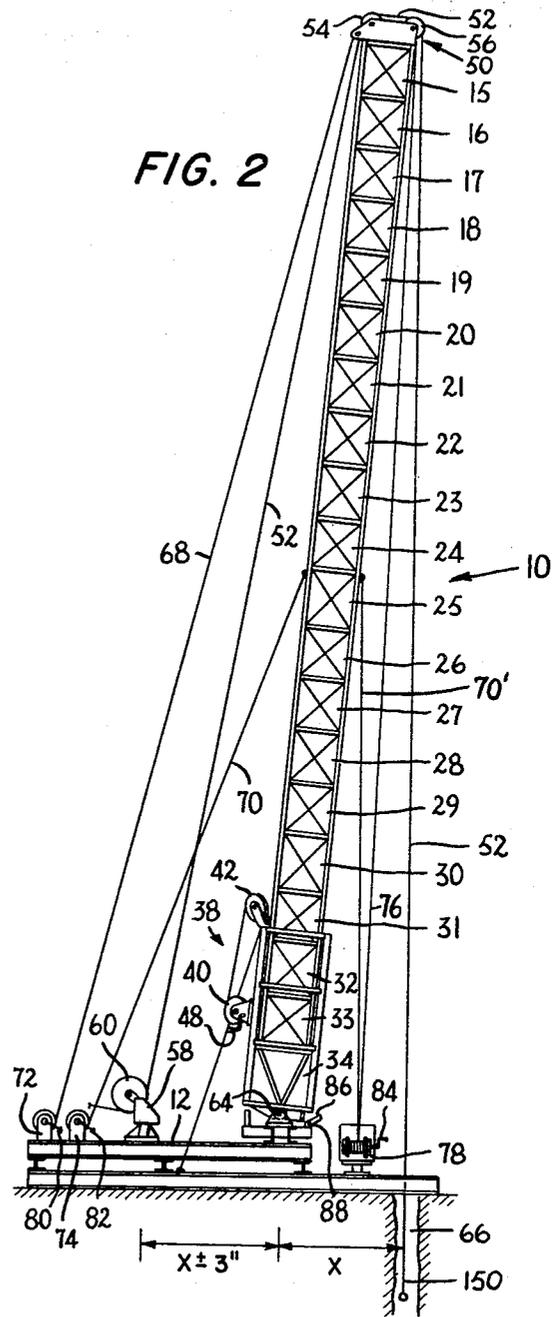
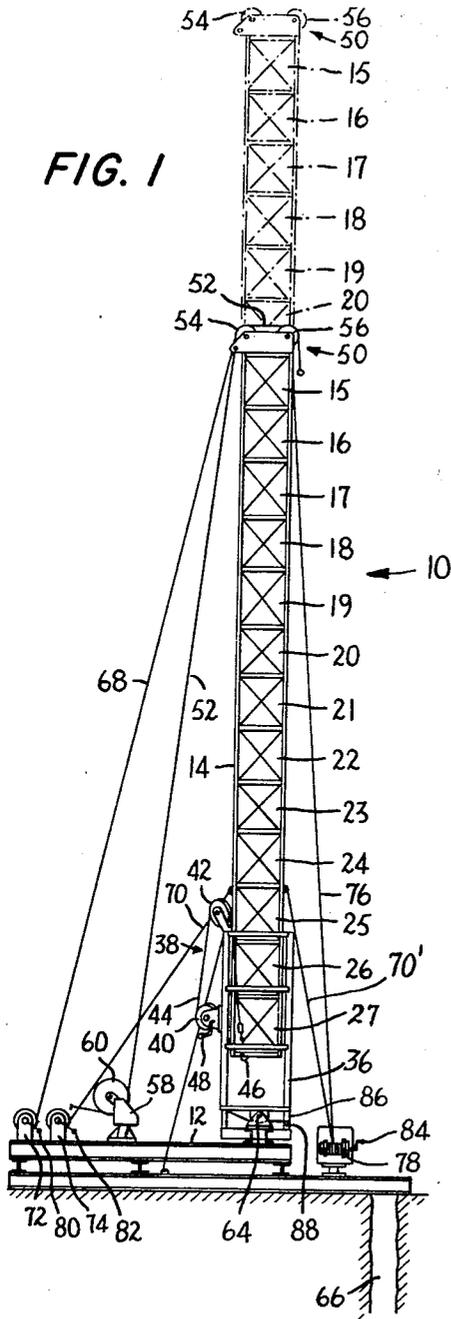
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3,494,593

PORTABLE MAST

Filed Jan. 29, 1968

3 Sheets-Sheet 1



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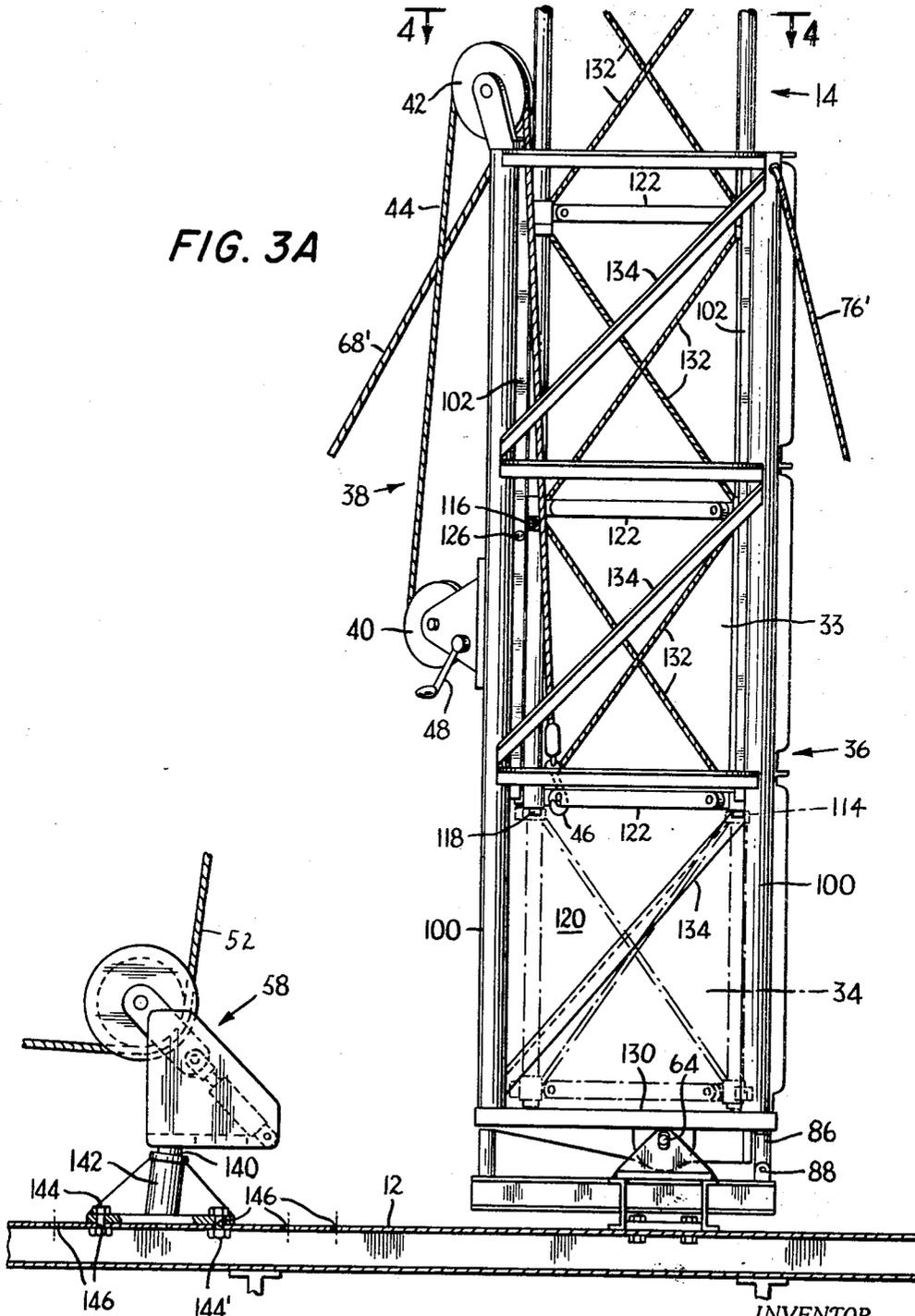
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PORTABLE MAST

Filed Jan. 29, 1968

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FIG. 3A



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PORTABLE MAST

Filed Jan. 29, 1968

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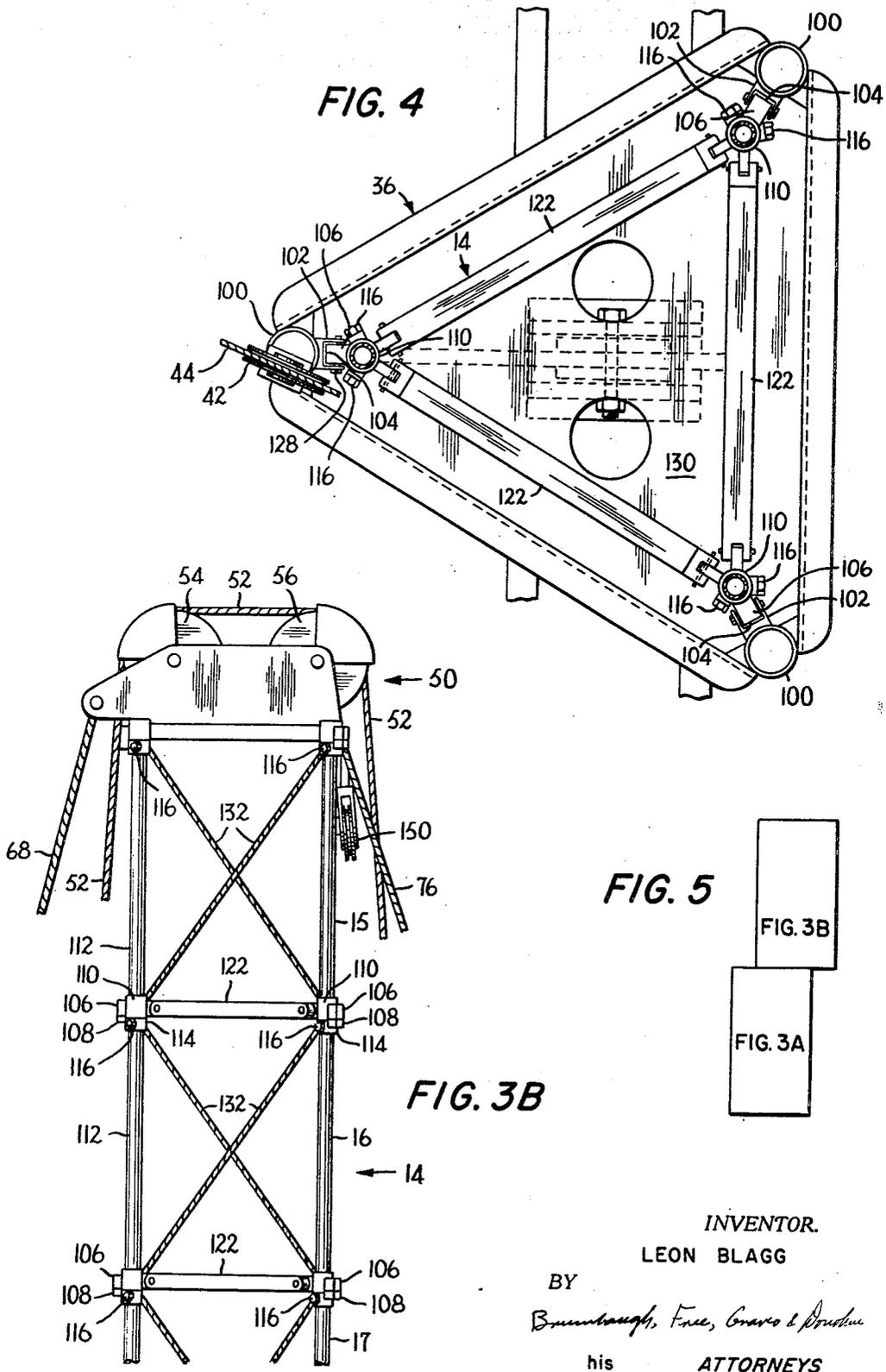


FIG. 5

FIG. 3B

FIG. 3A

FIG. 3B

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3,494,593

PORTABLE MAST

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Filed Jan. 29, 1968, Ser. No. 701,400

Int. Cl. B66c 23/60

U.S. Cl. 254-139

3 Claims

ABSTRACT OF THE DISCLOSURE

A portable mast for use in raising and lowering instruments in a well bore is assembled from a plurality of sections by positioning a first section in an upright position; elevating the first section a distance approximately equal to the length thereof; positioning a second section underneath the first section in an upright position; connecting the adjacent ends of the first and second sections to each other; elevating the connected sections a distance approximately equal to the length of one of the sections; positioning a third section underneath the previously connected sections; connecting the adjacent ends of the second and third sections to each other; and repeating the foregoing elevating, positioning, and connecting steps for additional sections until the top end of the first section reaches the desired height. The mast is tilted by guy lines so that its upper end is over the well bore, and a cable is run from a lower sheave by the base of the mast on the opposite side thereof from the well bore to upper sheave means at the top of the mast and into the bore. The mast substantially bisects the angle formed by the cable in its run from the lower sheave to the upper sheave means to the well bore. The lower sheave is mounted for swivel movement for directing the cable to the mast structure from any one of a plurality of widely separated angular positions about the lower sheave.

BACKGROUND OF THE INVENTION

This invention relates to mast apparatus and, more particularly, to novel and highly-effective portable mast apparatus for use in well logging operations and the like.

In well logging operations and the like, it is necessary to raise and lower a variety of instruments and other objects. Conventional mast apparatus for accomplishing this purpose has a number of serious deficiencies. For example, erection of the apparatus at the site of a well bore is time-consuming and expensive. Further, the apparatus tends when positioned above a well bore to place undue strain on the guy lines holding it in position. Moreover, the angular position with respect to the mast apparatus of a winch or other means for paying out the cable used for suspending the instruments or other objects is severely limited.

SUMMARY OF THE INVENTION

An object of the invention is to remedy the shortcomings of conventional apparatus and methods noted above. In particular, an object of the invention is to provide a method of rapidly and economically erecting a composite mast structure. Another object of the invention is to provide a portable mast apparatus for use in well logging and the like wherein a load on the cable used for suspend-

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ing instruments or other objects in a well bore tends to compress the mast apparatus but not to cause undue tension in guy lines used for positioning the apparatus. A further object of the invention is to provide a portable mast apparatus for use in raising and lowering instruments in a well bore facilitating the selection of any one of a plurality of widely separated angular positions for a winch or other device for paying out a cable from which instruments or other objects are suspended.

The foregoing and other objects of the invention are attained by positioning a first section of a composite mast structure having a plurality of sections in an upright position; elevating the first section a distance approximately equal to the length thereof; positioning a second section underneath the first section in an upright position; connecting the adjacent ends of the first and second sections to each other; elevating the connected sections a distance approximately equal to the length of one of the sections; positioning a third section underneath the previously connected sections; connecting the adjacent ends of the second and third sections to each other; and repeating the foregoing elevating, positioning, and connecting steps for additional sections until the first section reaches the desired height.

The objects of the invention are further attained by the provision of a base structure positioned at least partly to one side of the well bore; mast means having a lower end pivotally mounted on the base structure and an upper end located over the well bore; means for guying the upper end in position over the well bore; upper sheave means around which cable can extend along a vertical line into the well bore; and lower sheave means around which the cable can pass and extend to a winch, the lower sheave means being located with respect to the lower end of the mast means so that the mast means substantially bisects the angle formed by the vertical line and a line between the upper and lower sheave means.

The objects of the invention are also attained by the provision of mast apparatus for use in raising and lowering instruments in a well bore comprising a base; a mast structure supportable by the base and having a plurality of removable sections disposed in end-to-end relationship; an erecting fixture mounted on the base for supporting the mast structure; elevating means coaxing between the mast structure and erecting fixture for elevating the mast structure over vertical distances equal to lengths of the sections; upper sheave means on the mast structure for supporting a cable; and lower sheave means mounted on the base for directing the cable to the mast structure from any one of a plurality of widely separated angular positions about the lower sheave means.

BRIEF DESCRIPTION OF THE DRAWING

An understanding of additional aspects of the invention may be gained from a consideration of the following detailed description of representative embodiments thereof, taken in conjunction with the accompanying figures of the drawing, in which:

FIG. 1 is a diagrammatic view in elevation of a portable mast apparatus constructed in accordance with the invention, the apparatus being shown at an intermediate stage of its erection at the site of a well bore and also being shown in phantom outline at a later stage of the erection;

FIG. 2 is a view similar to FIG. 1 showing the com-

pleted mast apparatus in a tilted position facilitating raising and lowering of instruments in the well bore;

FIGS. 3A and 3B are a fragmentary view in elevation of the apparatus of the invention on a scale larger than that of FIGS. 1 and 2;

FIG. 4 is a sectional plan view taken along the line 4—4 of FIG. 3A of the apparatus of the invention, on a scale larger than that of FIGS. 3A and 3B; and

FIG. 5 is a schematic view showing the manner in which the sheets of drawings containing FIGS. 3A and 3B must be juxtaposed in order to position FIGS. 3A and 3B properly with respect to each other.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIGS. 1 and 2 show apparatus 10 constructed in accordance with the invention at successive stages of its erection at the site of a well bore. The apparatus includes a base 12 and a mast structure 14 supportable by the base and having a plurality of removable sections 15—34 disposed in end-to-end relationship.

An erecting fixture 36 is mounted on the base 12 for supporting the mast structure. Elevating means 38 comprising winch 40 and pulley 42, a cable 44, a hook 46 or the like adapted to engage the lower end of the mast structure 14, and a crank 48 or electric motor (not shown) coacts between the mast structure 14 and the erecting fixture 36 for elevating the mast structure 14 over vertical distances equal to lengths of the various sections 15—34.

Upper sheave means 50 is provided on the mast structure 14 at the upper end thereof for supporting working a cable 52. The upper sheave means 50 comprises a pair of pulleys 54 and 56 about which the cable 52 is trained successively. Lower sheave means 58 is also provided and comprises a pulley 60 about which the cable 52 is trained. The lower sheave means 58 is mounted on the base 12 for directing the cable 52 to the mast structure 14 from any one of a plurality of widely separated angular positions about the lower sheave means 58. To this end, the lower sheave means 58 is mounted for a swivel movement on the base 12.

The erecting fixture 36 is mounted for pivotal movement about a pin 64 so that, when the mast structure 14 has reached the desired height, the mast structure 14 and erecting fixture 36 can be pivoted from the position illustrated in FIG. 1 to that illustrated in FIG. 2. In the position of FIG. 1, the mast structure 14 and erecting fixture 36 are vertical to facilitate the addition of mast sections; in the position of FIG. 2, they are inclined so that the cable 52 descends in a vertical line from the upper sheave means 52 into the well bore 66.

To facilitate the tilting operation, guy lines 68 and 70 on the side of the mast structure 14 opposite the well bore 66 are gradually paid out from winches 72 and 74 respectively, while guy lines 76 and 70' are gradually reeled in by winches 78 located to either side of the well bore. Hand cranks 80, 82, and 84 are shown for operating the winches 72, 74, and 78 but any other suitable motive means may of course be employed.

In the tilted position of the mast 14 shown in FIG. 2, the mast 14 substantially bisects the angle formed by the vertical line traversed by the cable 52 between the upper sheave means 52 and the well bore 66 and the line traversed by the cable 52 between the upper sheave means 52 and lower sheave means 58. Accordingly, a load on the cable 52 due to the suspension of tools and the like herefrom, the end of the cable 52 shown at the left of FIGS. 1 and 2 being held fast, tends to compress the mast structure 14 but not to cause rotation thereof about the pivot pin 64.

The pivoting movement described above is further facilitated by the removal of a support member 86 shown in a vertical position in FIG. 1 and in an inclined position in FIG. 2. The member 86 can be pivotable about a

pin 88 and, in the vertical position, prevents pivoting of the mast structure 14 and erecting fixture 36. Of course other similar arrangements could be used. In the position of FIG. 2, however, the member 86 is clear of the erecting fixture 36 so that the erecting fixture 36 and mast structure 14 can be pivoted in response to the guidance of the guy lines 68, 70, 70', and 76.

FIGS. 3A, 3B, and 4 show the mast structure 14 and erecting fixture 36 in greater detail. Both the mast structure 14 and the erecting fixture 36 are generally triangular in cross section, as FIG. 4 clearly shows. The erecting fixture 36 includes a vertical stanchion 100 at each corner. Each vertical stanchion 100 is formed with a vertical guide 102 forming a vertical channel 104 within which lugs 106 and 108 are adapted to slide vertically.

The lugs 106 are integral with cylindrical portions 110 which are in turn integral with vertical support members 112 at the lower ends thereof. The lugs 108 are integral with cylindrical portions 114 which are in turn integral with the upper ends of vertical support members 112.

The first section 15 shown in FIG. 3B is joined to the second section 16 by suitable fastening means such as swing bolts 116 or the like hinged from the cylindrical portions 114 and coupled to the cylindrical ends 118 (see FIG. 3A) of the vertical support members 112. The cylindrical ends 118 are housed within the cylindrical portions 114, the latter being hollow.

In a similar manner, the second section 16 is joined to the third section 17, and additional sections are joined to the mast structure in number sufficient to erect a mast of the desired height.

Additional sections are inserted at the bottom of the mast structure 14 and erecting structure 36 through an open bay 120 formed at the bottom of the erecting fixture 36. In order to add an additional section of the sections assembled previously, the sections assembled previously are elevated by the elevating means 38. To this end, the hook 46 at the end of the cable 44 is made to engage a cross member 122 of the bottom section, say the section 33, of the sections previously assembled. The cross members 122 can be hinged at their central portions by suitable means (not shown) so that the sections 33 can be collapsed when not in use into very compact units. Of course, when the members 122 are straightened, the hinged joints can be latched so that the members 122 are rigid.

By means of the crank 48 or any other suitable motive means, the cable 44 is reeled in by the winch 40 over the pulley 42 so that the previously assembled sections are raised a distance approximately equal to the height of one of the sections.

An aperture 126 (FIGS. 3A and 4) is formed in the guide 102, and a temporary retaining pin 128 is inserted through the aperture 126. By virtue of the elevation of the previously assembled sections, the lugs 108 (FIG. 3B) are elevated above the elevation of the aperture 126, and insertion of the pin 128 is therefore adapted to retain the previously assembled section in the position to which they are elevated by the elevating means 38.

An additional section, say the final section 34, is then positioned below the previously-assembled sections (a slight additional elevation may be given the previously-assembled sections to permit the positioning of the section 34, shown in phantom outline in FIG. 3A, and the previously-assembled sections may then be lowered to feed the cylindrical portions 118 of the vertical support members 112 into the cylindrical portion 114 formed at the upper end of the vertical support members 112 of the final section 34).

The lower section 34 rests on a floor support 130. Thus, the vertical stanchions 100 do not support the weight of the completed mast structure 14. The erecting fixture 36 does, however, serve to position the lower end of the mast structure 14, the positioning function being facilitated by the guides 102, which extend from an

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elevation slightly higher than the top of a section resting on the floor 130 upwardly a distance approximately equal to the height of two of the sections of the mast 14. When the final section 34 is bolted into place in the same manner in which the previously-assembled sections are bolted into place, the mast structure 14 is an integral unit having the requisite strength to suspend instruments and other objects in the well bore. The mast structure 14 and erecting fixture 36 may be triangulated by diagonally-extending cables 132 and braces 134, respectively, in order to provide additional strength. The brace 134 shown at the bottom of the erecting fixture 36 extends between first and second of the vertical stanchions 100 and between second and third of the vertical stanchions 100 but not between the first and third of the vertical stanchions. In this way, the bay 120 is left open for the insertion of the sections of the mast structure 14.

The lower sheave means 58 is mounted for a pivoting or swivel movement as indicated at 140 and pivots as a whole about the axis of a cylindrical mounting member 142. The cylindrical mounting member 142 is secured by suitable fastening means such as bolt-and-nut combinations 144 passed through apertures 146 formed in the base 12. The apertures 146 are at intervals of approximately 6 inches. Accordingly, the position of the cylindrical mounting member 142 and of the lower sheave means 58 is adjustable in increments of approximately 6 inches, and, if the distance between the center line 150 of the well bore 66 and the pivot 64 (FIG. 2) is X, the distance between the pivot 64 and the line about which the lower sheave means 58 swivels can be adjusted to be equal to X plus or minus 3 inches. In general, the distance between the lower sheave means 58 and the pivot 64 can be made equal to the distance between the pivot 64 and the center line 150 of the well bore, within a tolerance equal to half the spacing between the apertures 146.

Such adjustment assures that the mast means 14 substantially bisects the angle formed by the vertical line between the upper sheave means 52 and the well bore 66 and the line between the upper sheave means 52 and the lower sheave means 60. As noted above, this arrangement assures that a load on the cable 52 tends merely to compress the mast apparatus 14 and not to cause it to tend to pivot about the pivot 64.

A swivel movement of the lower sheave means 58 about the axis of the cylindrical mounting member 142 results in virtually no displacement of the portion of the cable 52 between the upper sheave means 52 and the lower sheave means 58 but permits angular movement of the portion of the cable 52 extending to the left of the sheave means 58 (FIGS. 1, 2, and 3A), so that there is freedom of choice of the location of a winch or other means for paying out and reeling in the cable 52.

Dismantling of the apparatus of the invention is the reverse of the method described above. Specifically, the mast apparatus 14 is brought to a vertical position and raised slightly by the elevating means 38, the pin 128 is inserted to hold the upper portion of the mast apparatus 14, and the lower section 34 is unbolted and removed. The pin 128 is removed, and the elevating apparatus 38 lowers the remaining sections of the mast apparatus 14 until the section 33 is in the open bay 120. The pin 128 is inserted again to hold the upper portion of the mast apparatus 14 in position, and the section 33 is unbolted and removed through the open bay 120. Dismantling proceeds in a similar fashion until all of the sections 15-34 have been uncoupled from each other and removed.

Thus, there is provided in accordance with the invention novel and highly-effective apparatus and methods facilitating raising and lowering of instruments in a well bore. The mast sections employed in the novel manner of the invention are conventional per se and available commercially. The sections are typically three feet in height and light enough to be carried easily by two men. In accordance with the invention, portable mast apparatus can be assembled at the site of a well bore rapidly

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and economically without conventional reliance upon mast trucks. It should also be noted that all guy lines, cat lines, and cables can be put in position on the section 15 before the sections are elevated as previously described, thereby obviating the need for anyone climbing the mast.

Many modifications of the representative embodiments described herein will occur to those skilled in the art. For example, while the invention is illustrated as applied to well logging operations conducted on dry land, it is particularly adaptable to such operations conducted from marine platforms. Also, while a pin 128 is shown in FIG. 3A for supporting the upper portion of the mast apparatus 14 during periods when it is elevated above the floor support 130, a ratchet type mechanism can be substituted therefor or used in conjunction therewith. Again, the first three sections 15, 16, and 17 can be mounted in the erecting fixture 36 horizontally while the fixture 36 is in a horizontal position. Again, guy lines 68' and 76' may be employed for guying the erecting fixture 36 and may be paid out and reeled in analogously to the paying out and reeling in of the guy lines 68 and 76 during the tilting of the mast apparatus 14 and erecting fixture 36. Also, a snatch block 150 (FIG. 3B) may be mounted near the upper end of the mast apparatus 14 for supporting a cat line. Many other modifications of the apparatus of the invention will readily occur to those skilled in the art. Accordingly, the invention is to be construed as including all of the modifications thereof within the scope of the appended claims.

I claim:

1. A portable mast apparatus for use in raising and lowering instruments in a well bore comprising: a base; a mast structure supportable by said base and having a plurality of removable sections disposed in end-to-end relationship; an erecting fixture mounted on said base for supporting said mast structure; elevating means coaxial between said mast structure and erecting fixture for elevating said mast structure over vertical distances equal to lengths of said sections; upper sheave means on said mast structure for supporting a working cable; lower sheave means and swivel means mounting said lower sheave means on said base, said lower sheave means directing said working cable to said mast structure from any one of a plurality of widely separated angular positions about said lower sheave means, said swivel means having a swivel axis generally aligned with the portion of said working cable extending between said lower and upper sheave means, said base including a plurality of spaced anchoring positions whereby said lower sheave means may be selectively positioned thereon.

2. Apparatus according to claim 1 in which said erecting fixture is pivotally mounted on said base.

3. A portable mast apparatus for use in well logging operations or the like wherein instruments are suspended in a well bore on a working cable, comprising: a base structure positioned at least partly to one side of the well bore; mast means having a lower end pivotally mounted on said base structure to one side of the well bore and an upper end located over the well bore; means guying said upper end in position over the well bore; upper sheave means around which said working cable extends along a vertical line into the well bore; and a swivel-mounted lower sheave means around which said working cable passes and extends to a winch, the lower sheave means being spaced apart from the lower end of the mast means a distance substantially equal to the spacing between the lower end of the mast means and the well bore and on the opposite side of the mast means from the well bore so that said mast means substantially bisects the angle formed by said vertical line and a line between said upper and lower sheave means, whereby a load on the cable tends to compress said mast means but not to cause rotation thereof about said pivotally mounted lower end.

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