April 2, 1963 J. I. JONES ETAL 3,083,837

CRANE

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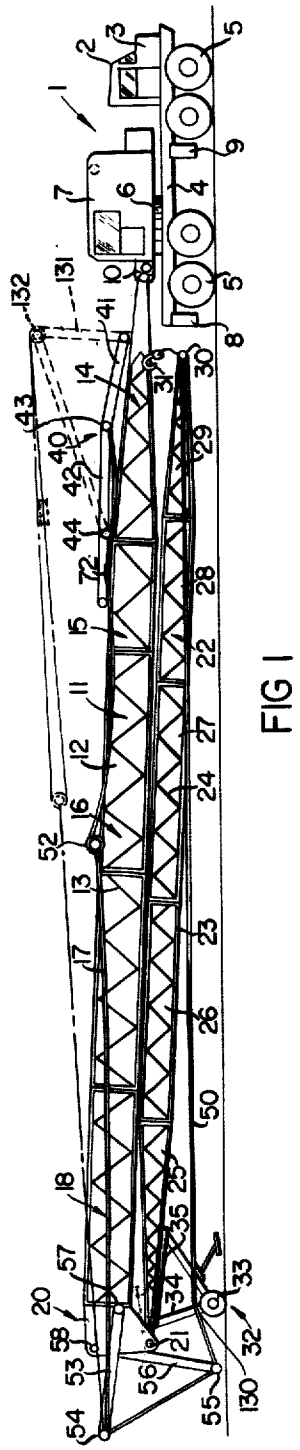

FIG 1

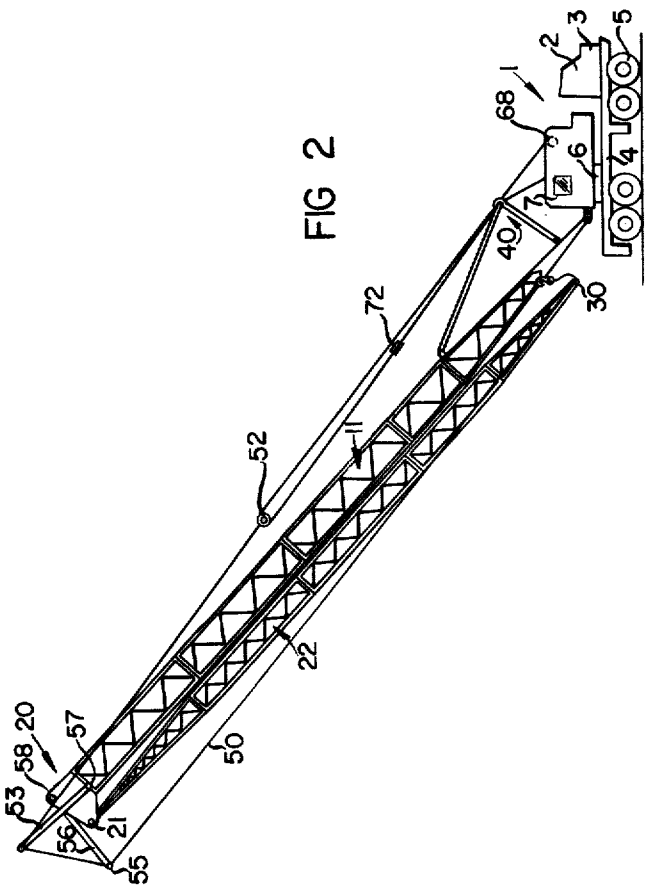

FIG 2

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CRANE

Filed Jan. 31, 1961 5 Sheets-Sheet 2

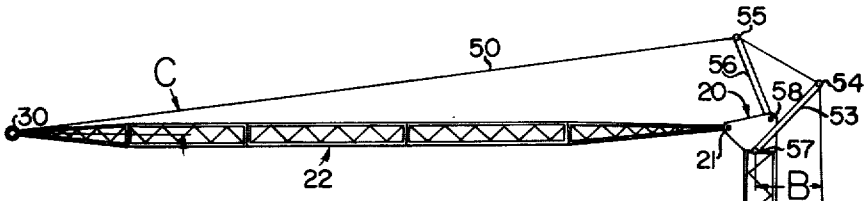


FIG 4

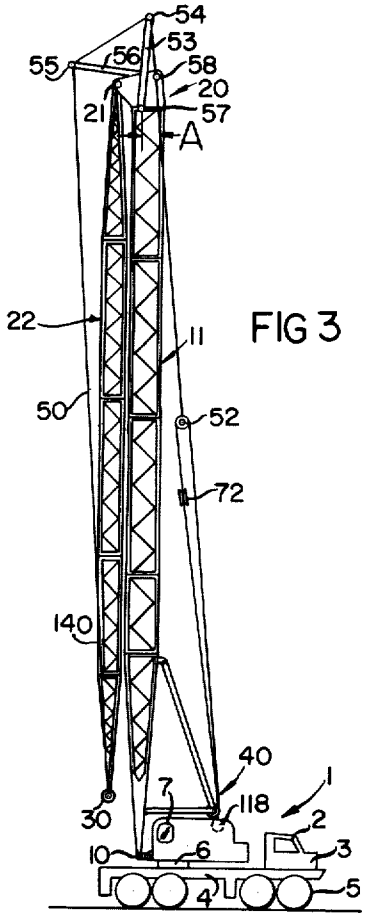
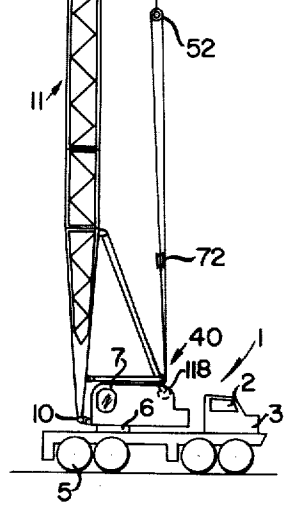


FIG 3



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CRANE

Filed Jan. 31, 1961 5 Sheets-Sheet 3

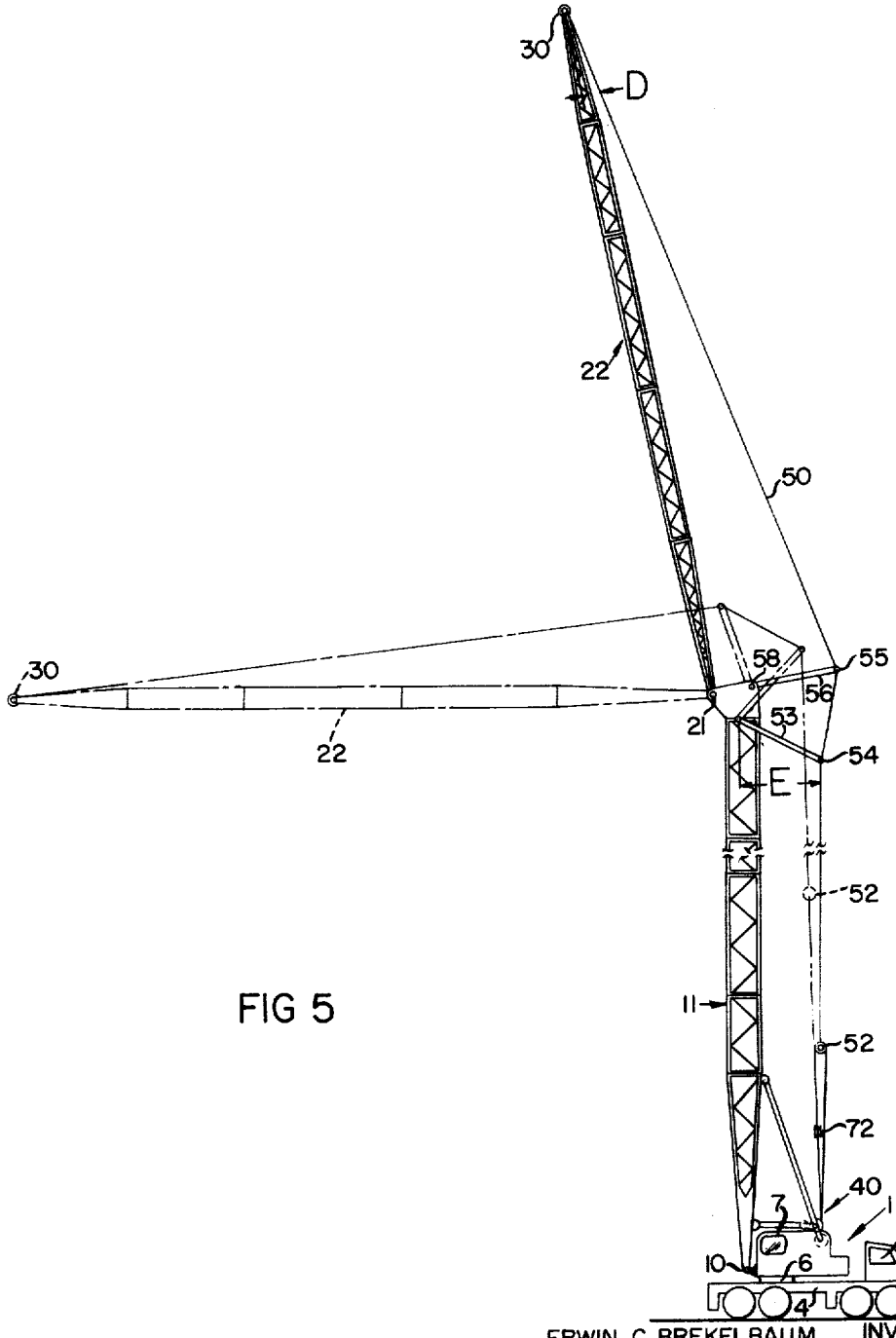

FIG 5

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CRANE

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FIG 6

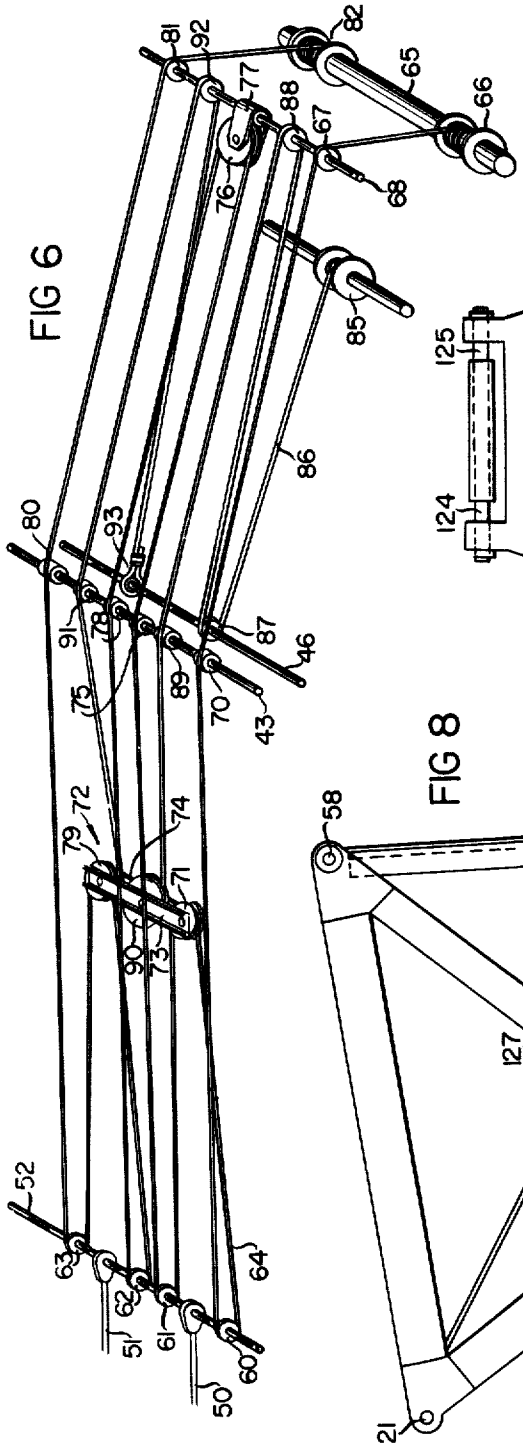


FIG 9

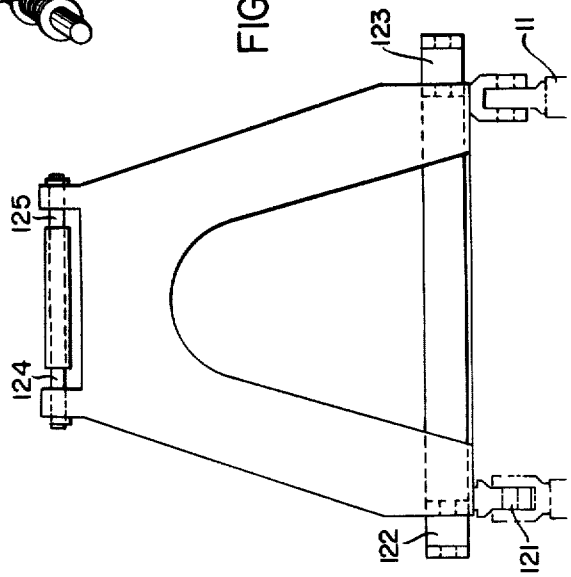
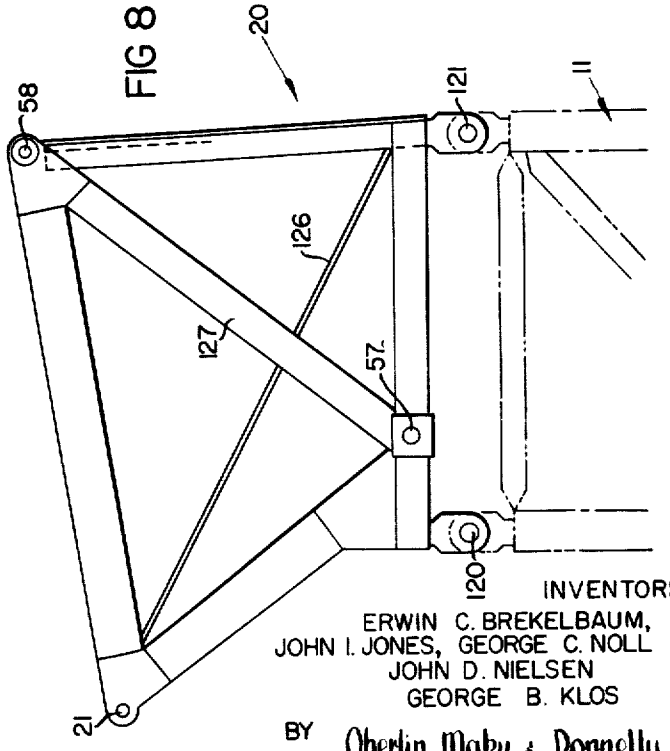


FIG 8



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CRANE

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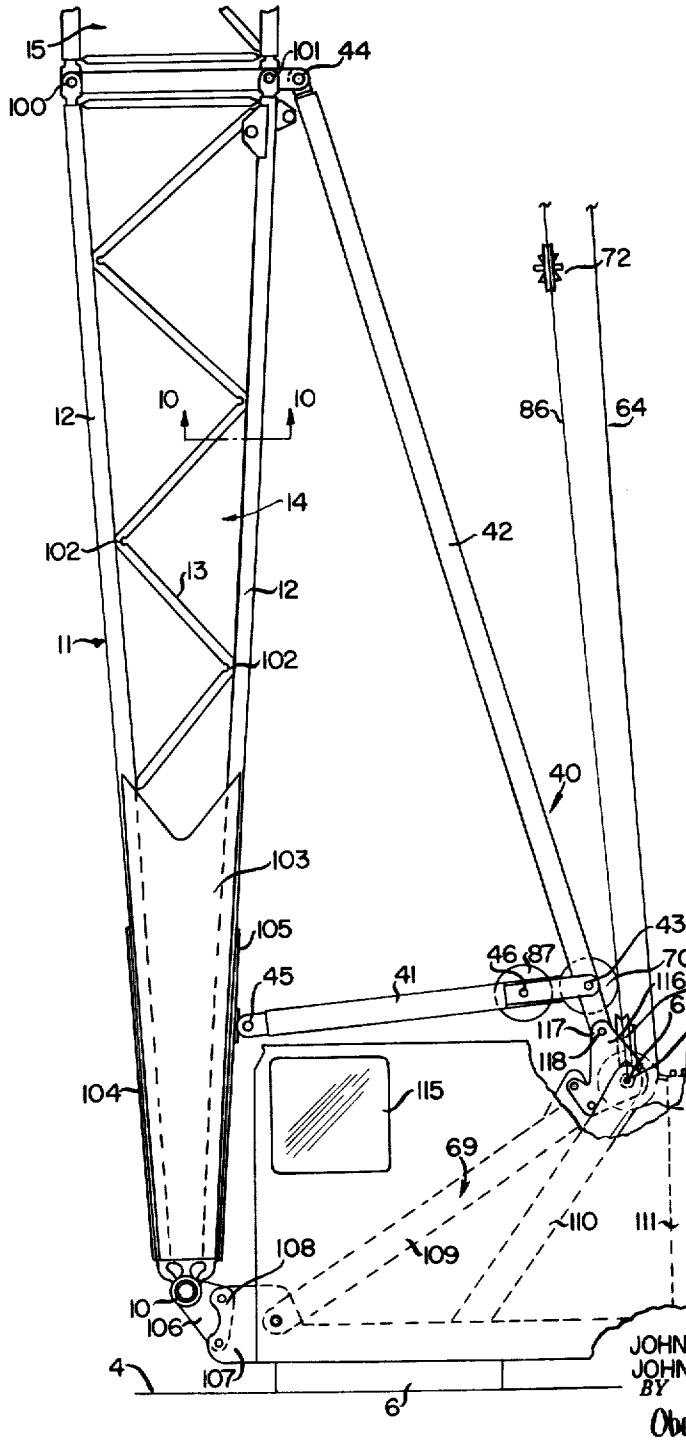

FIG 7

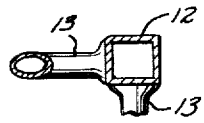

FIG. 10

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United States Patent Office 3,083,837 Patented Apr. 2, 1963

3,083,837

CRANE

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Filed Jan. 31, 1961, Ser. No. 86,166
19 Claims. (Cl. 212—46)

This invention relates, as indicated, to a crane and more particularly to a crane adapted for use in building construction.

In the construction of buildings, especially buildings of considerable dimension, it has always been a problem to provide hoists or cranes having both sufficient height and reach to accomplish intricate steel erection and concrete pouring jobs. Cranes or elevators of sufficient capacity generally have to be erected at an on-site location and usually remain in one position during the period of construction. The erection of scaffold supported elevators and more or less permanent gantry cranes and the like for large scale building projects is quite a lengthy, expensive, and arduous task. Moreover, such cranes and elevators require lifting cables and pendants of great length and also expensive and intricate drum hoist mechanisms and controls.

It is accordingly a principal object of the present invention to provide a crane capable of very high and lengthy reaches which will yet be mobile.

It is another object to provide a crane especially adapted for use in building construction which can be quickly and simply erected.

It is yet another object to provide a crane having long and high reaches requiring relatively simple hoisting apparatus and considerably shorter than normally required lengths of hoisting cable.

It is also an object to provide a crane of the above type which can easily and quickly be transported to and from a construction site.

It is a further object to provide a building construction type crane which can utilize the mobility of the conventional motorized wheeled carriers enabling such cranes readily to be transported to such building site and moved thereabout when at such site and erected.

Other objects and advantages of the present invention will become apparent as the following description proceeds.

To the accomplishment of the foregoing and related ends, the invention, then, comprises the features hereinafter fully described and particularly pointed out in the claims, the following description and the annexed drawings setting forth in detail certain illustrative embodiments of the invention, these being indicative, however, of but a few of the various ways in which the principles of the invention may be employed.

In said annexed drawings:

FIG. 1 is a side elevational view of a crane in accordance with the present invention in position to be transported to a construction site or the like;

FIG. 2 is a similar side elevational view of such crane illustrating the manner in which the crane is erected;

FIG. 3 is a fragmentary somewhat schematic side elevational view of such crane illustrating a further stage of erection;

FIG. 4 is a somewhat schematic side elevational view of such crane illustrating a still further stage of erection;

FIG. 5 is a fragmentary somewhat schematic side elevational view illustrating the final stages of erection of such crane;

FIG. 6 is a diagrammatic illustration of the reeving employed for erection and operation of the present invention;

FIG. 7 is a fragmentary side elevational view of the crane illustrating the mounting of the main boom on a somewhat enlarged scale;

FIG. 8 is an enlarged fragmentary detailed view of the secondary boom foot;

FIG. 9 is a view of the secondary boom foot as seen from the right in FIG. 8; and

FIG. 10 is an enlarged fragmentary transverse section of one of the chords of the main boom taken substantially on the line 10—10 of FIG. 7.

Referring now to the annexed drawing and more particularly to FIG. 1, it will be seen that the illustrated crane is mounted on a conventional motorized crane carrier generally shown at 1. The carrier 1 may be a conventional 8 x 4 carrier which includes a driver's cab 2 and a prime mover 3 mounted on the chassis or frame 4. Large heavy-duty rubber tires 5 provide the requisite steerable mobility for the carrier 1. The chassis or frame 4 is provided with a turntable 6 upon which the crane cab 7 is mounted. The crane cab 7 includes the hoisting mechanism for the crane booms as well as the operator controls for operation of the booms in a manner hereinafter described. Outriggers 8 and 9 may be provided on the carrier frame 4, such outriggers preferably being of the type wherein curved outrigger beams are automatically extended and frictionally locked in place providing a firm and enlarged support for the turntable 6. Mounted at 10 on the turntable 6 is the foot of main boom 11. Such main boom is provided with four main chords 12 of square tubular cross-section which chords are hermetically sealed. Continuous sealed round tubular lacing members 13 are welded to the inner faces of the chords, such lacing members being crimped alternately on opposite sides and then welded to the inner faces of such chords. With a construction of this type, the greater torsional resistances usually obtained only by heavy banding results. The main boom 11 may be made up of several sections such as the base section 14 and sections 15, 16, 17 and 18 which may be pinned together in the conventional manner. Thus any number of sections may be employed to produce a main boom 11 of the desired length.

The top or outermost section 18 of the main boom 11 is provided with a boom foot structure 20 which may be pinned to such main boom section 18 as hereinafter described, such member 20 providing a foot 21 for secondary boom 22. This boom may be of a slightly smaller cross-sectional size than the main boom 11 but is constructed otherwise identically to such main boom. Thus, four square cross-sectional tubular chord members 23 are provided interconnected by circular section tubular lacing members 24 alternately crimped on opposite sides and welded to the inner faces of such square section tubular chords. Such secondary boom 22 may be provided with a base section 25 pivoted to the foot structure 20 at 21 and center sections 26, 27 and 28 and peak or tip section

29 providing boom peak 30. These sections also are connected in the conventional manner such that any desired boom length may be obtained. For a more detailed disclosure of the particular boom structure that may be utilized in the present invention, reference may be had to the copending application of Erwin Brekelbaum and Roy H. Zeilman entitled "Tubular Boom," filed November 22, 1955, Serial No. 548,512, assigned to The Thew Shovel Company of Lorain, Ohio.

In FIG. 1, the main and secondary booms 11 and 22 are in their folded or traveling position, with the boom peak 30 secured to the main boom base section 14 as shown at 31. A trailing dolly 32 provided with wheels 33 mounted on framing 34 and provided with a platform 35 may be clamped or otherwise suitably secured to the section 25 of the secondary boom 22 to provide a trailing support for the booms in their illustrated folded position.

As shown in full lines in its collapsed position is a floating gantry 40. The floating gantry consists of spaced link members 41 generally referred to as the mast and longer length link members 42 both of which may be pinned to the main boom base section 14. The members 41 and 42 are pivotally interconnected as shown at 43 with the mast peak and mast sub-peak providing shafts or axles for a series of rollers hereinafter described. The members 42 are removably connectable at 44 to the upper end of the main boom base section 14 such that the floating gantry will collapse to the position shown in full lines.

Referring now to FIGS. 6 and 7 and more particularly to FIG. 7, it will be seen that the floating gantry 40 will be pin connected at 44 and 45 to the main boom base section 14 with the mast peak providing a pivot axle 43 for a series of rollers and the mast sub-peak providing an axle 46 for a further sheave and cable attachment. With special reference to diagrammatic FIG. 6, it will be seen that two boom pendants 50 and 51 are fixedly attached to transverse shaft 52, such pendants extending to the tip of pivotally mounted mast 53 as shown at 54 then to the tip 55 of pivotally mounted mast 56 and thence to the boom peak 30. (Note FIG. 1.) The mast members 53 and 56 are pivotally connected to the boom foot 20 as shown at 57 and 58. A series of four sheaves 60, 61, 62 and 63 is mounted on shaft 52 with, for example, a ¾ inch cable 64 entrained thereabout. Such cable 64 may, for example, be 280 feet long and is wound about the main dual hoisting drum 65. The drum 65 is provided with the more expensive ratchets as well as the power controls for both forward and reverse movement of the cable in addition to spring-loaded brakes. The cable 64 extends from the one drum 66 over sheave 67 mounted on shaft 68 positioned at the peak of A-frame 69 which is rigidly mounted on the turntable 6 for movement therewith. Such cable 64 then extends over roller 70 mounted on shaft 43 at the peak of mast 41. From there, the cable 64 extends about sheave 60 on shaft 52 and then about sheave 71 in harness 72. Such harness 72 comprises two spaced frame members 73 and 74 rotatably mounting sheaves therein. The cable 64 then extends about the sheave 61 on shaft 52 and back over roller 75 on shaft 43 and then back about sheave 76 held in clevis 77 which is horizontally pivotally mounted on shaft 68. From the sheave 76, the cable 64 extends over roller 78 and about sheave 62 on shaft 52. From there, it extends about sheave 79 in harness 72 and then about sheave 63 on shaft 52 and then over roller 80 on mast peak shaft 43 and finally over sheave 81 on A-frame peak shaft 68 and then about drum 82 of the dual drum 65.

A second hoisting drum 85 of a considerably less expensive variety may, for example, be provided with a manual brake, having no ratchet and no power down. Such drum 85 is employed with a heavier-duty cable 86. This cable may, for example, be 140 feet in length and ⅞ inch in diameter. This cable 86 extends from the drum 85 about sheave 87 on mast sub-peak shaft 46 and then about sheave 88 on shaft 68. From this sheave, the cable extends over roller 89 on the mast peak shaft 43 and about large sheave 90 in the center of harness 72. From the large sheave 90, the cable 86 extends over roller 91 on shaft 43, about sheave 92 on shaft 68 and is then fixedly secured as shown at 93 to the mast sub-peak shaft 46. It will be understood that the drums 65 and 85 will be mounted in the crane cab 7 to be controlled by the operator. Each of the drums 66 and 82 of the dual drum 65 may, for example, be only 10 inches wide and 14 inches in diameter and the single drum 85 may be, for example, only 12 inches wide and 16 inches in diameter.

It can now be seen that pulling on the upper harness shaft 52 and pendants 50 and 51 through cable 64 will raise the booms 11 and 22 about foot 10 as hereinafter described.

As seen more particularly in FIG. 7, the main boom base section 14 is pin connected as shown at 100 and 101 to the boom section 15 in the conventional manner with the lacing member 13 being welded as shown at 102 to the inner faces of the chord members 12. Reinforcing plates may be provided at the base of the boom section 14 as shown at 103 and 104 with the mast 41 being pinned to plate 105 as shown at 45. The foot of the boom 11 may be provided with special adaptor 106 to connect and support the foot of the boom clear of the cab 7, such adaptor being connected to the turntable as shown at 108. The A-frame 69 includes several brace members 109, 110 and 111 supporting the A-frame peak shaft 68 and the sheaves thereon. The member 111 may be provided with horizontal extensions 112 by which the removable counterweight 113 is held in place by turnbuckles 114. The operator may be positioned as shown by the window 115 to have a clear view of the operation being performed. Special adaptors 116 are provided secured to the peak of the A-frame having lugs 117 thereon to which the floating gantry is pinned as shown at 118 when the main boom 11 is in its raised or vertical position. Thus the pin connection 118 will provide a rigid firm support for the main boom 11 in its vertically extending position.

Referring now to FIGS. 8 and 9, it will be seen that the boom foot 20 at the top of the main boom 11 may be pinned at the four corners of its base to such main boom 11 as shown at 120 and 121. The mast structure 53 may be pivoted at the sides of the boom foot structure to the pivot 57 as shown at 122 and 123 whereas the mast structure 56 may be pivoted to the shaft 58 as shown at 124 and 125. Reinforcing plates 126 and 127 may be provided to take up the various tension and compression forces resulting from the raising and lowering of the secondary boom 22 and the loads thereon. It can now be seen that the boom foot structure 20 provides a foot 21 for the upper or secondary boom 22 which is laterally spaced from the main boom 11 such as to permit such secondary boom to be folded upon the main boom as seen in FIG. 1.

In its collapsed position, the folding gantry 40 will lie parallel to and on top of the main boom 11 when the pin connection 44 is removed. The harnesses 52 and 72, the pendants 50 and 51, and the cables 64 and 86 will rest on top of the main boom 11. If desired, a cable support 130 may be provided on the dolly 32 to keep the pendants 50 and 51 from dragging on the ground.

The Erection of the Crane

When the crane has been moved to the desired site, and the carrier is in the proper position with the outriggers 8 and 9 extended to support and to level the carrier frame 4, the floating gantry may be raised by actuation of hoist drum 85 with drum 65 braked, to the dotted line position shown in FIG. 1 at 131 and pinning the member 42 to the main boom base section 14 as shown at 44. This raises the mast peak to the position shown at 132. With the boom peak 30 connected to the main boom as shown

at 31 and the floating gantry raised and hoist drum 85 braked, the dual drum 65 is then utilized to raise the main and secondary booms in their folded position. Referring especially to FIG. 2, it will be seen that both booms will be lifted off the ground in their folded or collapsed condition. During the raising of the booms in their folded condition from the horizontal position in FIG. 1 through the inclined position of FIG. 2 to the vertical position of the boom as shown in FIG. 3, the upper harness shaft 52 will remain fixed with respect to point 54 while cable 64 is wound on the dual drums 66 and 82 thereby shortening the cable between shafts 43 and 68 and raising the booms to vertical position. During raising of the booms, the lower harness 72 is pulled outwardly taking up slack in the heavier cable 86 due to movement of shafts 43 and 46 closer to shaft 68. When the main boom 11 is in its vertical position as shown in FIGS. 3 and 7, the peak of the floating gantry 40 is pinned to the adaptor 116 at the tip of the A-frame as shown at 118 thus providing a firm rigid base for the main boom 11. In raising the main boom as aforesaid, the cable 64 will be wound about the drums 66 and 82 and the lower harness 72 will be moved outwardly. Now because of the limited cable capacities, it is necessary to release the boom hoist line 64 from the main dual drum 65 and spool the amount of cable used in raising the main boom off the drums 66 and 82. This is accomplished by winding the heavy cable 86 onto the less expensive hoisting drum 85 causing the harness 72 to move back down to its original position.

The relative positions of the lower harness 72 may be seen in FIGS. 3 and 4 in relation to the upper harness 52. All of this may be accomplished, of course, without any manual cable handling. Once the drums 66 and 82 have been unwound to the proper extent by the spooling of the cable 86 onto the drum 85, the boom peak 30 anchor is weighed or released, drum 85 is braked, and operation now of the dual drum hoist 65 will operate the secondary boom 22 to raise the same.

It will now be seen that the less expensive drum 85 is employed only to reposition the harness 72 to unwind the working cable 64 from the dual drum 65 thus to permit its operation again now to raise the secondary boom 22 from its folded position shown in FIG. 3. The winding of the cable 64 onto the dual drum 65 now raises the secondary boom 22 from the position shown in FIG. 3 to the position shown in FIG. 4. Since the pendants 50 and 51 are fixed to the tips of pivotally mounted masts 53 and 56, only a very slight movement of the harness 52 is required thus to raise such secondary boom 22.

Moving now to FIG. 5, it will be seen that continued reeling of the cable 64 onto the dual drum 65 will further lower the harness shaft 52 raising the boom 22 to its maximum position, the masts 53 and 56 pivoting from the dotted line position to the full line positions shown in FIG. 5. For clarity of illustration, the hoist line for the hook 31 or other such lifting device as well as the Kelly stops have not been illustrated.

Referring to FIGS. 3, 4 and 5, it will be seen that the angle at the pivot 57 between mast 53 and the boom pendants 50 and 51 increases according to the effort required to raise the boom 22. Thus in FIG. 3, the angle or corresponding moment arm A is quite small since little effort would be required for initial clockwise swinging of boom 22 about pivot 21 in such position. In the horizontal position of the boom 22 as shown in FIG. 4, the moment arm B is considerably greater as is the angle C between the pandants 50 and 51 and the boom 22, and in the maximum up position of the boom 22 as shown in FIG. 5, the angle D between the boom 22 and the pendants 50 and 51 reaches its maximum while the moment arm E is yet substantial. Thus not only does the angle between the pendants and mast 53 increase as does the angle between the booms 11 and 22 increase, but also the angle C between the pendants and boom 22. The resultant increase in the angle C is, of course, due to the spacing of the boom foot pivot 21 and the pivot 58 for the mast 56. In the collapsed position of the boom 22, the mast 56 is substantially horizontal overlying the pivot 21. In the FIG. 5 position, the mast 56 extends approximately in the opposite direction away from the boom foot pivot 21. Particular attention is directed to the point 140 where the boom pendants 50 and 51 cross the boom chords. Thus a portion of the mass of the boom is actually on the opposite side of the boom pendants contributing to the ability of the pendants to lift such boom. The effective moment arm provided by the pivotally mounted mast 56 increases as the boom 22 moves from its collapsed position to its maximum up position where the effort required will be greatest.

The construction illustrated also tends to relieve any bending moments on the top of the main boom 11 caused by direct pulling on the boom 11 by the pendants since the masts 56 and 53 will be in compression with the exception that a slight tension will be provided on mast 53 during the uppermost elevation range of the secondary boom 22 as shown in FIG. 5.

It can readily be seen that in the position shown in full lines in FIG. 4 and in dotted lines in FIG. 5, the boom peak 30 will extend well into the center of a building being erected, such boom 22 being, for example, a standard 90 foot boom. In the particular crane structure illustrated, the boom peak 30 will be 104 feet from the ground in the horizontal position, and thus the boom foot pivot 21 will be 104 feet above the ground, the main boom raising the foot of the secondary boom approximately 100 feet. In such position, the illustrated crane will have a lifting capacity of approximately 5550 pounds. The following is a chart of the various recommended lifting capacities, reaches and pendant tensions in various angular positions of the secondary boom 22 with respect to the main boom 11:

Angle	Pendant Tension 54 to 52	Pendant Tension 30 to 55	Height, Feet	Reach, Feet	Recommended Load Limit, Pounds
0°	94,000	44,000	104	97	5,550
12°	74,000	42,000	122.6	95	5,750
36°	54,000	39,000	166.7	80	7,550
62°	57,000	41,000	183.2	50	15,000
79°	54,000	45,000	192.2	25	40,550

It can accordingly be seen that the height to which the foot of the secondary boom may be raised is limited only by the weight of the booms and it has been found that a boom of the tubular chord and lacing construction herein shown is extremely light-weight while yet providing the adequate compressive and torsional strength necessary to provide a boom of this size with the indicated capacities. Since the weight of the boom must be taken into account in determining the load which may be lifted, it is obvious that in a boom and crane structure of the type illustrated, the weight of the boom is extremely significant.

In many conventional cranes of extreme height or size, it is not unusual to employ one or more extremely expensive drums 4 to 5 feet in width having all of the expensive ratchets, speed and power controls and brakes. However, with the present reeving system, it will be seen that only a small single inexpensive drum and control is required, such being the dual drum 65.

The replacement of extremely long length cables can be a very expensive proposition and needless to say the capital investment in the controls and drums for such cable can often be prohibitive. With the present crane structure, it will be realized that a completely mobile crane is obtained by which steel, concrete buckets or material may be positioned in the center of or beyond a building being erected. Since the positionnig of the carrier is in no way limited, and since the turntable has

complete freedom of revolution on the carrier, a mobile crane is provided that can be positioned at any desired location on the building site. Whereas the crane illustrated has particular use in the building construction industry, it will be understood it may be used for raising any object. By way of example, the working cable 64 need only be 280 feet in length and the cable 86 need only be 140 feet in length. Accordingly, only 280 feet of cable 64 needs to be periodically replaced and a relatively small dual drum 65 will handle that length of cable. Otherwise, the working cable would have to be 560 feet in length with consequent much increased expense for replacement and much larger drums would have to be employed to handle that amount of working cable.

Other modes of applying the principles of the invention may be employed, change being made as regards the details described, provided the features stated in any of the following claims or the equivalent of such be employed.

We, therefore, particularly point out and distinctly claim as our invention:

1. In combination, a crane carrier comprising a mobile chassis frame having steerable ground-engaging wheels supporting the same, a turntable mounted on said frame, boom hoisting mechanism on said turntable, a main boom pivoted to said turntable, means to hold said main boom in a vertical position on said turntable, a boom foot structure mounted on the top of said main boom providing a boom pivot laterally offset from said main boom and fixed with respect thereto, a secondary boom pivoted to said offset boom foot pivot, a first mast structure pivoted to said boom foot structure rearwardly of said secondary boom pivot, pendants interconnecting the peak of said first mast structure and the peak of said secondary boom, a second mast structure pivoted to said boom foot structure, pendants interconnecting said first and second mast structures, and boom derricking cable means interconnecting the peak of said second mast structure and said boom hoisting means operative to pivot said secondary boom about said offset boom pivot on the boom foot structure at the top of said main boom, the angle of incidence between said secondary boom and the boom pendants interconnecting the peak of said secondary boom and the first mast structure increasing as the angle between said main and secondary booms increases, the moment acting on said secondary boom at the maximum position of elevation being substantially equal to the length of said first mast structure and the distance between said offset boom pivot and the pivotal connection of said first mast structure with said boom foot structure.

2. In combination, a crane carrier comprising a mobile chassis frame having steerable ground-engaging rubber tired wheels supporting the same, a turntable mounted on said frame, outriggers on said chassis frame operative to provide a firm and enlarged support for said turntable, boom hoisting mechanism on said turntable, a main boom pivoted to said turntable, means to hold said main boom in a vertical position on said turntable, a boom foot structure mounted on the top of said main boom providing a boom pivot laterally offset from said main boom and fixed with respect thereto, a secondary boom pivoted to said offset boom foot pivot, said secondary boom being adapted to be folded to lie parallel to said main boom, a first mast structure pivoted to said main boom foot structure rearwardly of said secondary boom pivot, pendants interconnecting the peak of said first mast structure and the peak of said secondary boom, a second mast structure pivoted to said boom foot structure between the secondary boom pivot and the pivotal connection of said first mast structure and said boom foot structure, pendants interconnectnig said first and second mast structures, and boom derricking cable means interconnecting the peak of said second mast structure and said boom hoisting means operative to raise and lower said secondary boom about the offset boom pivot at the top of said main boom.

3. In combination, a crane carrier comprising a mobile chassis frame having steerable ground-engaging means supporting the same, a turntable mounted on said frame, outriggers on said chassis frame operative to provide a firm and enlarged support for said turntable, boom hoisting mechanism on said turntable, a main boom pivoted to said turntable, means to hold said main boom in a vertical position on said turntable, a boom foot structure mounted on the top of said main boom providing a boom pivot laterally offset from said main boom and fixed with respect thereto, a secondary boom pivoted to said offset boom foot pivot, said secondary boom being adapted to be folded to lie parallel to said main boom, a first mast structure pivoted to said boom foot structure at the top of said main boom rearwardly of said secondary boom pivot, pendants interconnecting the peak of said first mast structure and the peak of said secondary boom, a second mast structure pivoted to said boom foot structure, pendants interconnecting said first and second mast structures, and boom derricking cable means interconnecting the peak of said second mast structure and said boom hoisting means operative to raise and lower said secondary boom about the offset boom pivot at the top of said main boom.

4. In combination, a crane carrier comprising a mobile chassis frame having steerable ground-engaging means supporting the same, a turntable mounted on said frame, a main boom pivoted to said turntable, a boom foot rigidly secured on the top of said main boom laterally offset therefrom and fixed with respect thereto, a secondary boom pivoted to said boom foot, said secondary boom being adapted to be folded to lie parallel to said main boom, means to raise said booms in such folded condition from a horizontal position to a vertical position, means to lock said main boom in such vertical position, boom pendants secured to the peak of said secondary boom, a pair of pivotally mounted masts at the top of said main boom, means fixedly securing the peaks of said masts to said boom pendants, means to exert a lifting force on said boom pendants thus to raise said booms in such folded condition including a drum hoist, a harness secured to the lower end of said boom pendants, means to actuate said drum hoist to move said harness, a second lifting drum, a second harness, and means to actuate said second drum to unwind cable from said first mentioned drum when said main boom is locked in vertical position.

5. In combination, a crane carrier comprising a mobile chassis frame having steerable ground engaging means supporting the same, a turntable mounted on said frame, a main boom pivoted to said turntable, a boom foot on the top of said main boom laterally offset therefrom, a secondary boom pivoted to said boom foot, said secondary boom being adapted to be folded to lie parallel to said main boom, means to raise said booms in such folded condition from a horizontal to a vertical position, and means to lock said main boom in such vertical position, said booms comprising boom sections having square section tubular chord members and circular section tubular lacing members flattened transversely of said chord members and welded to the inside faces of said square section tubular chord members.

6. In combination, a crane carrier comprising a mobile chassis frame having steerable ground engaging means supporting the same, a turntable mounted on said frame, a main boom pivoted to said turntable, a boom foot on the top of said main boom laterally offset therefrom, a secondary boom pivoted to said boom foot, said secondary boom being adapted to be folded to lie parallel to said main boom, means to raise said booms in such folded condition from a horizontal to a vertical position, means to lock said main boom in such vertical position, boom pendants secured to the peak of said secondary boom, a

pair of pivotally mounted masts at the top of said main boom, means fixedly securing the peaks of said masts to said boom pendants, and means to exert a lifting force on said boom pendants thus to raise said booms in such folded condition, said booms comprising boom sections having square section tubular chord members and circular section tubular lacing members flattened transversely of said chord members and welded to the inside faces of said square tubular chord members.

7. A reeving system for a crane and the like comprising an upper harness, boom pendants secured to said upper harness, a lower harness, a cable entrained about said upper harness and said lower harness and wound upon a lifting drum, a second drum, a cable wound on said second drum and about said lower harness, one end of said second cable being secured in a fixed position relative to said lower harness, the other end of said second cable being entrained about said second drum, said second drum being thus adapted to move said lower harness with respect to said upper harness thereby to unwind said first mentioned cable from said first mentioned drum.

8. A crane comprising a main boom and a secondary boom pivoted to the end of said main boom, cable means to pivot said secondary boom with respect to said main boom, and means directly to vary the angle of said cable means with respect to said secondary boom to pivot said secondary boom with respect to said main boom as the force required to pivot said secondary boom increases.

9. A crane comprising a first boom and a second boom, means pivotally interconnecting said booms, cable means connected to the tip of said second boom, and means to increase the moment arm of said cable with respect to said second boom as the angle between said booms increases.

10. A crane as set forth in claim 9 wherein said means pivotally interconnecting said booms includes a pivot providing a foot for said second boom laterally offset from said first boom whereby said second boom can be folded to lie parallel to said first boom.

11. A crane as set forth in claim 9 wherein said last mentioned means includes a mast connected at one end to said cable means and pivoted at the other end to the top of said main boom rearwardly of said first mentioned means.

12. In combination, a crane carrier comprising a chassis frame with steerable ground engaging wheels thereon, a turntable mounted on such frame, a main boom pivoted to said turntable, a boom foot mounted on said main boom providing an offset boom foot for a secondary boom, a secondary boom pivoted to said boom foot, said secondary boom being adapted to be folded to lie parallel to said main boom, means to lock said main boom in vertical position; a reeving system for raising said booms including an upper harness, boom pendants secured to said upper harness, a lower harness, a cable entrained about said upper harness and said lower harness and wound upon a lifting drum, a second drum, a cable wound on said second drum and about said lower harness, said second drum and cable being adapted to move said lower harness with respect to said upper harness thereby to unwind said first mentioned cable from said first mentioned drum.

13. The combination set forth in claim 12 wherein said boom pendants are connected to the peak of said secondary boom and pass over the top of said main boom.

14. In combination, a crane carrier comprising a mobile chassis frame having steerable ground engaging means supporting the same, a turntable mounted on said frame, a main boom pivoted to said turntable, a boom foot rigidly secured on the top of said main boom laterally offset therefrom and fixed with respect thereto, a secondary boom pivoted to said boom foot, said secondary boom being adapted to be folded to lie parallel to said main boom, boom pendants connected to the peak of said secondary boom, means connected to said pendants operative to raise said booms in such folded condition from a horizontal position to a vertical position, means to lock said main boom in such vertical position, and said first mentioned means being again operative to pivot said secondary boom about said boom foot thus to raise the same to operating position.

15. In combination, a crane having a crane carrier comprising a mobile chassis frame having steerable ground engaging means supporting the same, a crane turntable mounted on said frame, a standard boom adapted to be pivotally connected to said crane turntable for use as a standard operating crane boom; and a tower boom attachment for said crane having a boom foot rigidly secured on the top thereof laterally offset and fixed with respect thereto whereby said standard boom may be elevated by the height of said attachment and operated from the top thereof.

16. In combination, a crane carrier comprising a mobile chassis frame having steerable ground-engaging rubber tired wheels supporting the same, a turntable mounted on said frame, outriggers on said chassis frame operative to provide a firm and enlarged support for said turntable, boom hoisting mechanism on said turntable, a main boom pivoted to said turntable, means to hold said main boom in a vertical position on said turntable, a boom foot structure mounted on the top of said main boom, a forwardly offset boom foot pivot on said boom foot structure fixed with respect thereto, a secondary boom pivoted to said forwardly offset pivot, said secondary boom being adapted to be folded to lie parallel to said main boom, a mast structure pivoted to said boom foot structure on the top of said main boom substantially rearwardly of said secondary boom pivot, pendants interconnecting the peak of said mast structure and the peak of said secondary boom, and boom derricking means connecting the peak of said mast structure and said boom hoisting means operative to raise and lower said secondary boom about the offset boom pivot at the top of said main boom, the angle of incidence between said boom pendants and said secondary boom increasing as the angle between said main and secondary boom increases.

17. In combination, a crane carrier comprising a mobile chassis frame having steerable ground-engaging means supporting the same, a turntable mounted on said frame, boom hoisting mechanism on said turntable, a main boom pivoted to said turntable, means to hold said main boom in a vertical position on said turntable, a boom foot structure mounted on the top of said main boom, a forwardly offset boom foot pivot on said boom foot structure fixed with respect thereto, a secondary boom pivoted to said forwardly offset pivot, said secondary boom being adapted to be folded to lie parallel to said main boom, a first mast structure pivoted to said boom foot structure on the top of said main boom, pendants interconnecting the peak of said first mast structure and the peak of said secondary boom, a second mast structure also pivoted to said boom foot structure on the top of said main boom, tension means of fixed length interconnecting the peaks of said first and second mast structures, said boom hoisting means being connected to the peak of said second mast structure, said first mast structure spacing said pendants from said secondary boom, and said second mast structure spacing said boom hoisting means from said main boom.

18. A crane comprising a first boom and a second boom, means pivotally interconnecting said booms, cable means connected to the tip of said second boom, and mast means mounted on said first boom connected to said cable means operative to increase the moment arm of said cable means with respect to said second boom as the angle between said booms increases.

19. A crane comprising a mobile chassis frame having steerable ground engaging means supporting the same, a turntable mounted on said frame, boom hoisting mechanism on said turntable, a main boom pivoted to said turn-

able, means to hold said main boom in a vertical position on said turntable, a boom foot on the top of said main boom providing a boom foot pivot, a secondary boom pivoted to said boom foot pivot, a first mast structure pivoted on the top of said main boom, pendants interconnecting the peak of said first mast structure and the peak of said secondary boom, a second mast structure also pivoted on the top of said main boom, and tension means of fixed length interconnecting the peaks of said first and second mast structures, said boom hoisting mechanism being connected to the peak of said second mast structure, said second mast structure changing from a compression strut to a tension strut as said hoisting mechanism elevates said secondary boom about its boom foot pivot on the top of said main boom.

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