United States Patent [19]

Higgins

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[54] **CRANE**

[75] Inventor: **Robert J. Higgins,** Baton Rouge, La.

[73] Assignee: **Joyce Burroughs Torregrossa,** Baton Rouge, La. ; a part interest

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[21] Appl. No.: **323,732**

Related U.S. Application Data

[63] Continuation of Ser. No. 76,485, Sept. 29, 1970.

[52] **U.S. Cl.** ..... **212/46 A,** 212/144

[51] **Int. Cl.** **B66c 23/62**

[58] **Field of Search** ..... 212/46 R, 46 A, 57, 58, 59, 212/144

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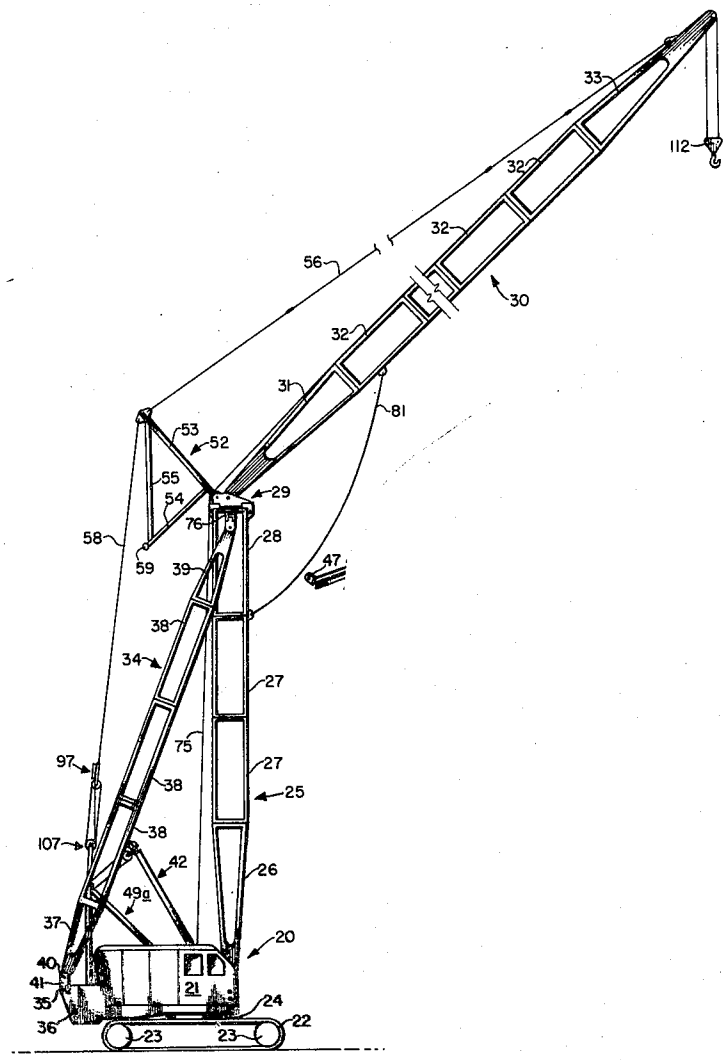
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Primary Examiner—Richard E. Aegerter
Assistant Examiner—James L. Rowland
Attorney, Agent, or Firm—E. Donald Mays

[57] **ABSTRACT**

A mobile crane for use in the construction industry. The crane includes a prime mover which may be a wheeled or endless track vehicle having the conventional superstructure with the power assembly mounted thereon. The crane has a main boom attached at its lower end in the conventional manner, which boom has attached at its upper ends two auxiliary support members, which members are removably attached to the rear of the crane to provide a tripod structure which includes the main boom. A secondary or elevated boom is attached to the topmost portion of the main boom by a novel connecting means which permits the secondary boom to be elevated into working position atop the main boom. The crane is characterized in that it permits the utilization of substantially the full capacity of the main boom, even though extending the crane height to approximately twice the height of the main boom by means of the secondary boom.

12 Claims, 9 Drawing Figures



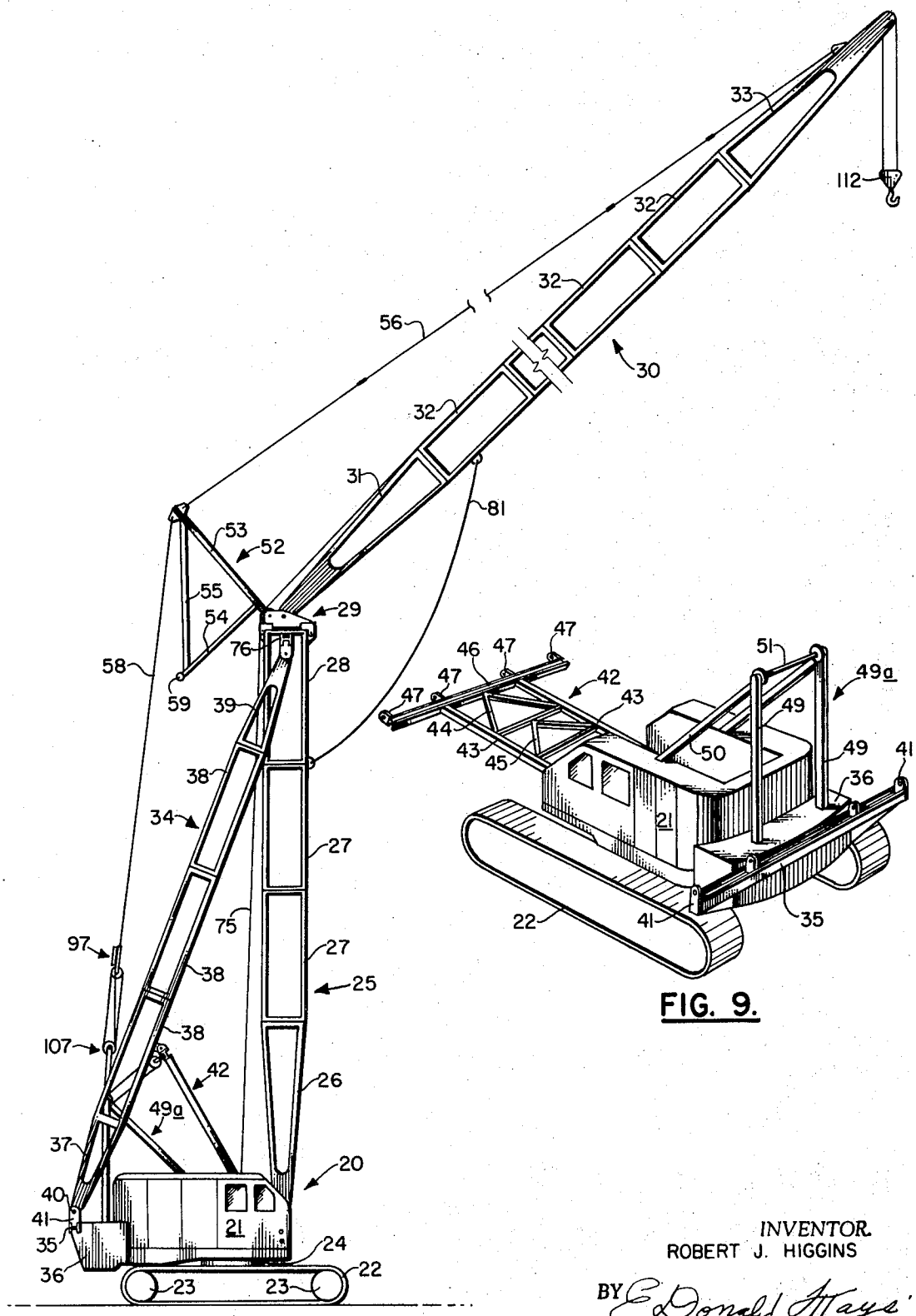


FIG. 9.

FIG. 1.

INVENTOR.
ROBERT J. HIGGINS

BY E. Donald Hays
ATTORNEY

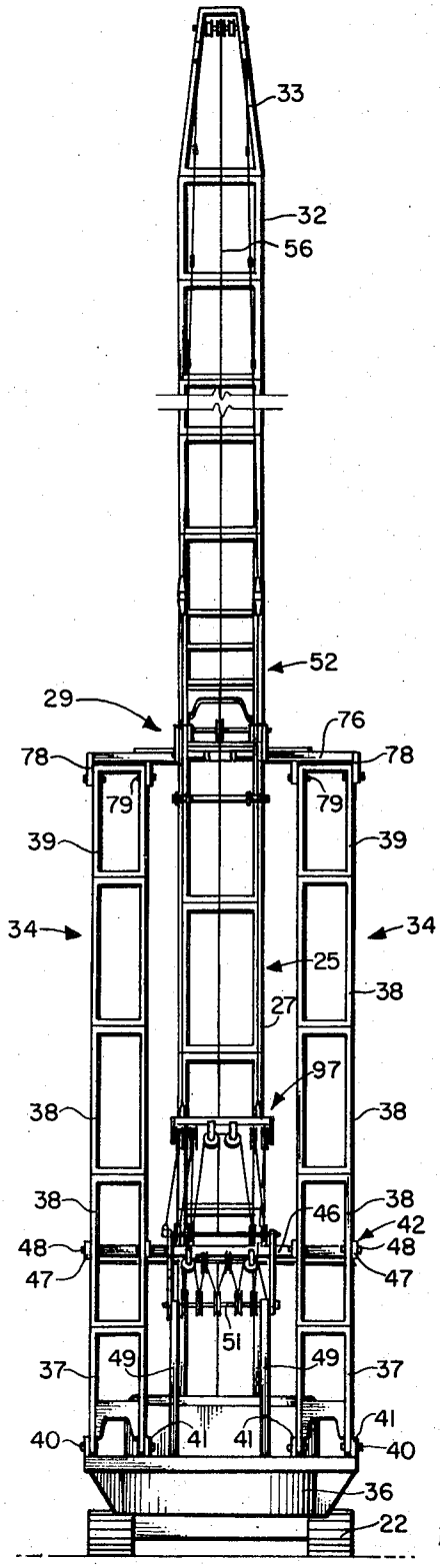


FIG. 2.

INVENTOR.
ROBERT J. HIGGINS
BY E. Donald Mays
ATTORNEY

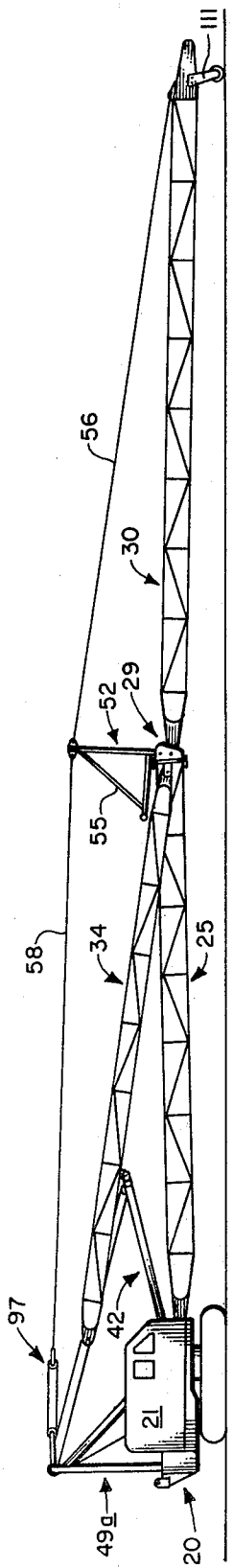


FIG. 3.

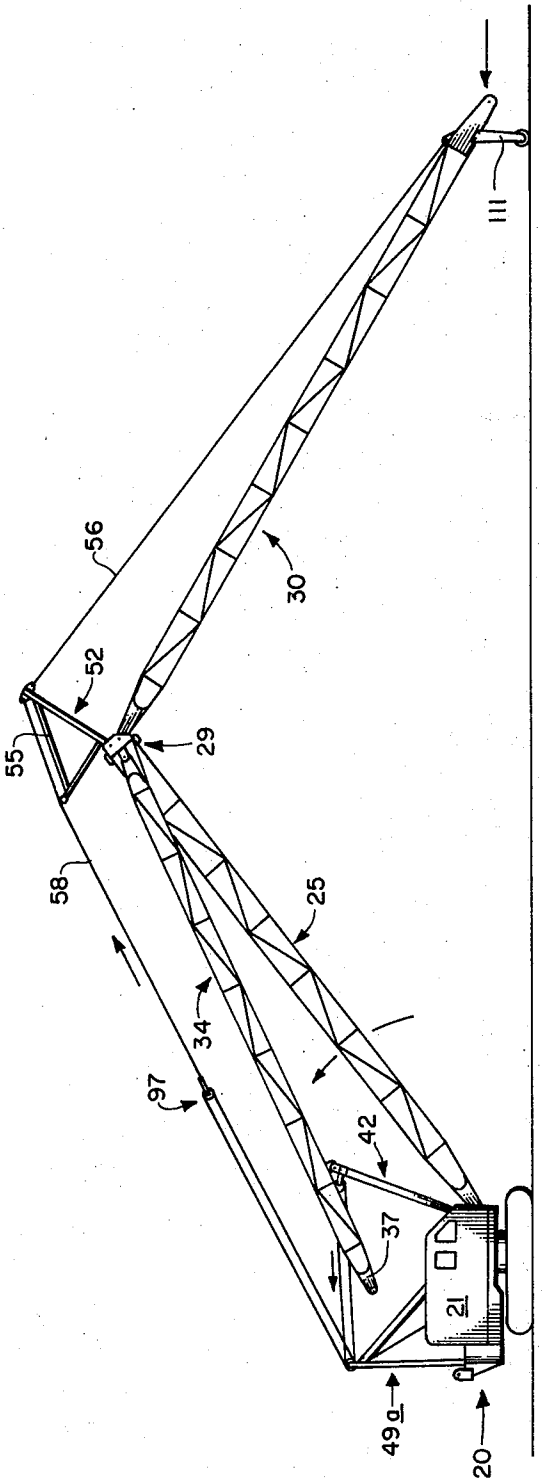


FIG. 4.

INVENTOR.
ROBERT J. HIGGINS
BY E. Donald Hays
ATTORNEY

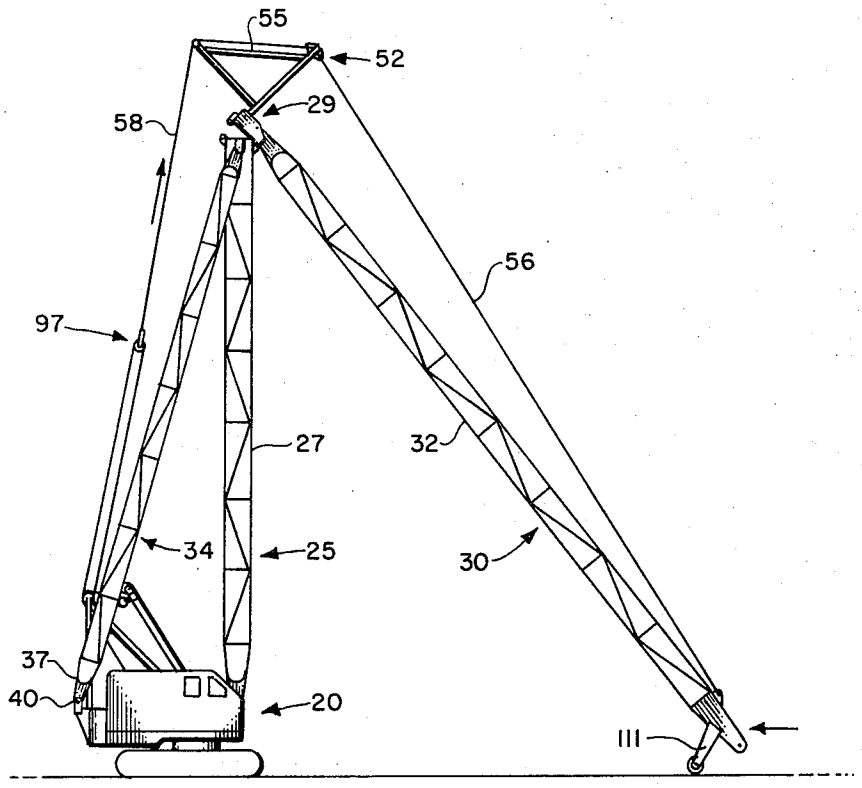


FIG. 5.

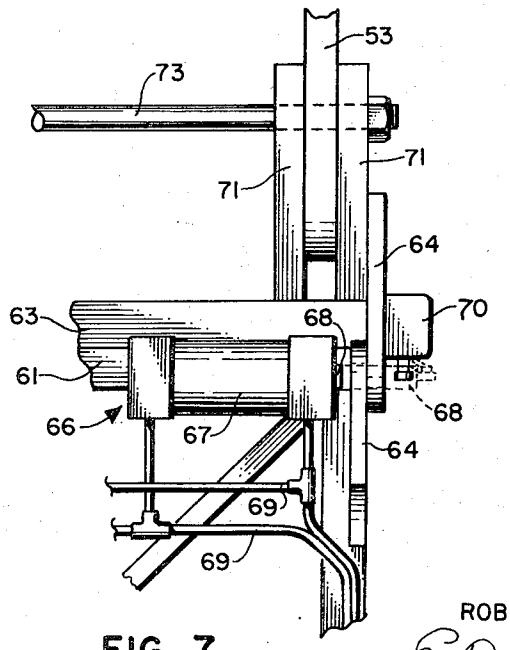


FIG. 7.

INVENTOR.
ROBERT J. HIGGINS
BY E. Donald Hayn
ATTORNEY

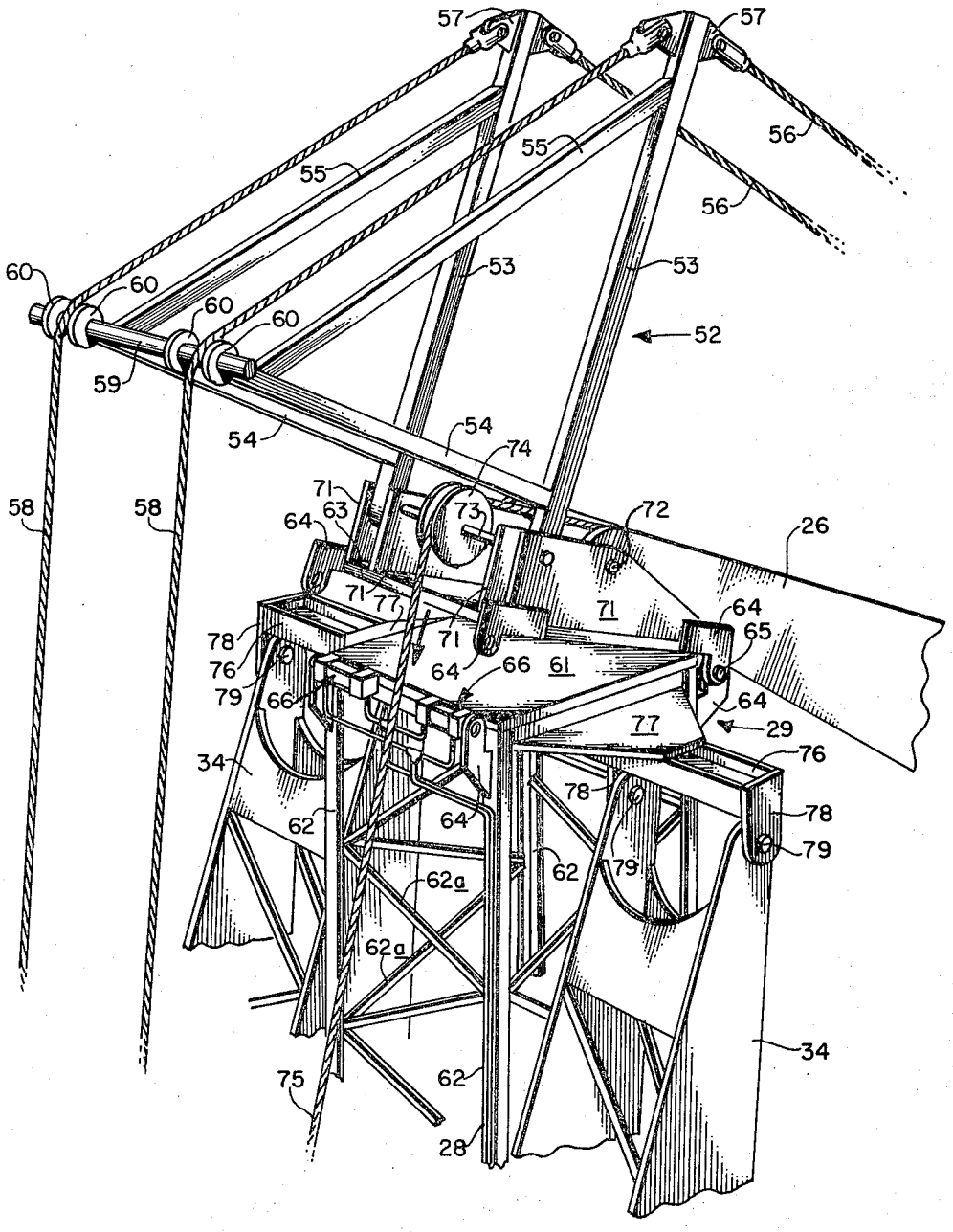


FIG. 6.

INVENTOR.
ROBERT J. HIGGINS
BY C. Donald Hays
ATTORNEY

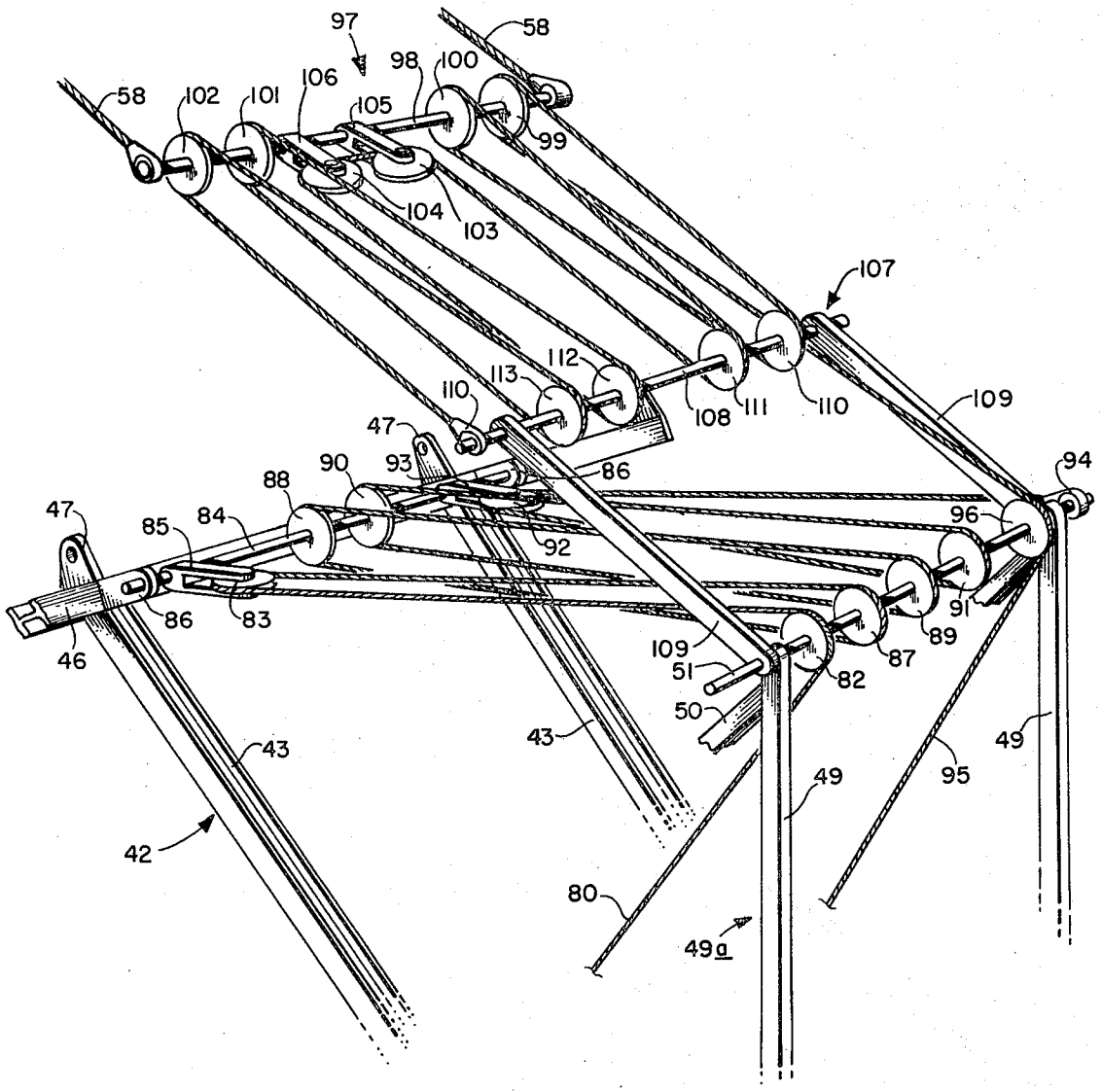


FIG. 8.

INVENTOR.
ROBERT J. HIGGINS
BY C. Donald Hayes
ATTORNEY

CRANE

This is a continuation, of application Ser. No. 76,485, filed Sept. 29, 1970.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a mobile crane and more particularly to a mobile crane having an elevated boom which has high capacity.

2. Description of the Prior Art

In the construction industry cranes have been used for many years. The cranes in present use generally fall into two types - the fixed, heavy-duty crane which is permanently mounted and requires construction from components to take place at the site of use and which is immovable as far as being transported from one site to the other in the assembled condition; and conventional mobile cranes wherein both endless track propelled type vehicles are used or either the conventional heavy-duty, wheeled over the road carrier type crane is used. One of the paramount problems always facing the construction industry in connection with the use of cranes is the difficulty in raising extraordinarily heavy weights to extreme heights with cranes. Use of mobile cranes has been limited by the foregoing limitation, and, in buildings above a certain number of stories, it has been required that permanent or semi-permanent in-place cranes be constructed as the building construction proceeds. While there are commercially available mobile cranes having a primary boom and a secondary boom which permit lifting loads to heights of as much as 200 feet, the amount of load capable of being lifted by these cranes is quite limited because of the difficulty of providing a sound support base and also the difficulty of overcoming the bending forces naturally occurring when making the lift. Also, another disadvantageous feature found in two-section mobile cranes is the inability to make lifts at a very great distance from the base of the crane without the danger of tipping the crane over.

Thus, it is seen that there is a real need for a mobile crane which can both provide capacity for lifting to great heights and also a crane capable of operating with an increased lifting radius for greater loads than is possible with cranes of present construction.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a crane having increased reach and lifting capabilities.

It is another object of the present invention to provide a crane having increased load carrying capabilities at higher elevations.

It is also an object of the present invention to provide a crane having the capability of lifting loads positioned very close to its own base.

It is a further object of the present invention to provide a crane having a majority of components which can be readily assembled from standard, commercially available materials.

It is still another object of the present invention to provide a mobile crane having increased rigidity and load bearing capability.

It is a still further object of the present invention to provide a crane which may be readily moved from site to site without extensive dismanteling and reconstruction procedures being required.

The foregoing and other objects are realized in the crane of the present invention which includes a mobile carrier having a power unit superstructure revolvably mounted on the carrier. A main boom having its lower end pivotably attached to the superstructure is provided. A pair of diagonal brace members have their upper ends pivotably attached to the main boom adjacent the upper end thereof and their lower ends attached to said superstructure rearwardly of said main boom. A secondary boom has its lower end pivotably coupled to the upper end of the main boom and elevating means are provided to raise the main boom, diagonal brace members, and secondary boom from a substantially horizontal position into the operating position. Means are provided to raise and lower the secondary boom when the crane is in the operating position.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevation of a crane in accordance with the present invention showing the crane in the fully assembled and operative condition;

FIG. 2 is a rear elevational view of the crane of FIG. 1;

FIG. 3 is a side elevational view of the crane of the present invention showing the position of the members prior to elevation into the operative position;

FIG. 4 is a side elevational view of the crane of the present invention similar to that of FIG. 3 showing the support members in the position assumed as the crane is being erected;

FIG. 5 is a side elevational view of the crane of the present invention showing the position of the crane after erection of the main boom and diagonal brace members, but prior to elevation of the secondary boom;

FIG. 6 is an enlarged elevational perspective view of the upper end of the main boom showing the diagonal brace member ends and the auxiliary boom attachment;

FIG. 7 is an enlarged elevational view of the pinning mechanism for attaching the secondary boom to the main boom;

FIG. 8 is a diagrammatic illustration of one of the reeving systems that may be employed in the erection and operation of the crane of the present invention; and

FIG. 9 is a perspective elevational view of the prime mover and gantry assembly of the crane before attachment of the main boom, diagonal support members and secondary boom.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. 1, the crane of the present invention, designated generally by the reference numeral 20, includes a power unit superstructure with the conventional cab 21 containing the power source, draw works and operating controls, which unit is in turn mounted on endless tracks 22 carried by powered wheels 23 which are utilized to propel the crane across the ground. If desired, the superstructure may be mounted on a wheeled carrier for movement over the highways. Cab 21 is fully rotatable through 360 degrees by means of turntable 24 which connects the superstructure to the track section. The crane is equipped with a main boom, designated generally by the numeral

25, which, as depicted, is made up of a number of sections including a foot section 26, two intermediate sections 27 and an upper section 28. While in the illustration in FIG. 1 only two intermediate sections are shown, it is understood that any number of intermediate sections may be used to achieve the height desired up to the maximum permitted for the main boom. While these boom sections are shown diagramatically, it is understood that they will correspond to the conventional construction used for crane boom elements wherein they are generally rectangular in shape and have cross bracing 62A connecting the four main cords 62 of each section to provide rigidity and strength, as can be seen in FIG 6. The top or upper section of the main boom is provided at its uppermost part with a special connecting structure, designated generally by the numeral 29, for attachment of the secondary boom, designated generally by the numeral 30. The construction of the connecting structure 29 is more clearly shown in FIG. 6 and will be described in more detail in conjunction with that figure hereinafter. The secondary boom includes a lower foot section 31 pivotably attached to the connecting structure 29, a multiplicity of intermediate sections 32 and a top or upper section 33 having the conventional load block 112 attached thereto.

As seen more clearly in FIGS. 1 and 2, the crane of the present invention, which is shown in the operating position, is provided with two diagonal brace structure members 34—34 which are pivotably connected at their top ends to the connecting structure 29 at the uppermost end of the main boom and attached at their lower ends to the strut member 35 which is horizontally mounted and attached fixedly to the counterweight 36 carried by the rear end of the cab 21. This diagonal brace member includes a foot section 37, intermediate sections 38, and an upper or top section 39. As seen in FIGS. 1, 2 and 9, drift pins 40 are received in aligned openings to removably attach the foot section 37 of each of the diagonal members to the upstanding lugs 41 provided on and fixedly attached to strut member 35.

As seen more clearly in FIGS. 1, 2 and 9, the crane of the present invention has attached pivotably to the cab an erecting gantry, designated generally by the numeral 42. This gantry may be pivotably mounted (not shown) at the base of the foot section 26 of the main boom, or it may be pivotably mounted otherwise to the rear thereof if desired. The gantry includes a pair of vertical support members 43—43 interconnected by diagonal cross braces 44 and horizontal cross braces 45. Fixedly attached to the top of the two vertical support members 43—43 is a transverse connector member 46. The connector member is provided with two sets of spaced apart lugs 47—47. As seen in FIGS. 1 and 2, these lugs are received in matching abutment with similar lugs provided on the lowermost intermediate diagonal member 38 on each of the brace members 34 and is attached thereto by means of pins 48 received in openings in the lugs whereby the gantry 42 may be utilized to elevate each of the diagonal members 34 into position for attachment to the strut member 35 as described hereinbefore.

As seen in FIGS. 1 and 9, a rear gantry 49A includes a pair of vertical, spaced apart, sheave support members 49—49 fixedly attached at their lower end to the counterweight 36; however, they can be attached to the rear end of the frame of the superstructure (not shown) if desired. A pair of diagonal brace members 50—50 have their lower ends attached to the cab 21 and their upper ends attached to the top of the vertical support members 49—49. As seen more clearly in FIG. 8, these rigid support members carry a shaft 51 on which are mounted a plurality of sheaves as will be described hereinafter.

A top gantry structure, designated generally by the numeral 52, is pivotably attached at its lower end to the top portion of the connecting structure 29 as can be seen in FIGS. 1 and 6. The top gantry includes interconnected pairs of spaced apart, vertical legs 53—53, base legs 54—54 and diagonal legs 55—55. An upper pair of pendant lines 56—56 are attached at their lower ends to lugs 57—57 provided at the upper end of vertical legs 53—53 of the top gantry. A lower pair of pendant lines 58—58 is also attached to a like set of lugs 57—57 on the opposite side of legs 53—53 and pass over a fixed shaft 59 fixedly attached at the outer ends of the base leg members 54—54 of the top gantry. As seen in FIG. 6, two pairs of guides 60—60 are provided on shaft 59 to prevent the pendants from slipping out of their proper position on shaft 59 when in contact therewith. A pair of stop cables 81—81 are connected to the front side of the main boom and the secondary boom to prevent the secondary boom from pivoting over the rear of the crane.

Referring now to FIG. 6, the connecting structure 29 for coupling the main and secondary booms together includes a flat, rectangular lower plate 61 which can be welded to the top of each one of the four main cords 62 in the upper section 28 of the main boom, or can be removably attached thereto by lugs and pins if desired. An upper plate 63 is pivotably connected to the forward edge of the main boom by means of lugs 64 carried by the top plate which engage lugs 64 carried by the forward portion of the top section 28 of the boom. Pins 65 connect these lugs together. Similarly located pairs of engaging back lugs 64—64 are provided at the rearward edge of each of the plate sections. The back lugs are pinned with hydraulically actuated pinning devices, designated generally by the numeral 66, as seen more clearly in FIG. 7. A double-acting hydraulic cylinder 67 contains a piston (not shown) having one end of a piston rod 68 attached thereto and the other end projecting through one end wall of the cylinder. A pair of hydraulic fluid supply lines 69—69 supply fluid to each end of the cylinder 67 from a hydraulic power source in the cab of the crane. Upon the application of fluid pressure to the rear of the piston, the pin 68 moves into the openings provided in the overlapped lugs 64—64 and locks the top plate 63 and bottom plate 61 firmly together to couple the main boom 25 and secondary boom 30 together. An electrical switch 70 is actuated by the end of the piston rod 68 when it projects through the openings in lugs 64—64 to provide the crane operator with a positive indication that the connecting assembly 29 has been properly coupled together before he begins elevating the secondary boom from the horizontal position. Preferably the ends of the piston rods 68—68 are tapered and are received in matching tapered openings in the lugs 64—64 to insure that the rods are securely received in and make a tight fit in the openings in the lugs.

Referring again to FIG. 6, the upper plate 63 is provided with two pairs of vertically extending, spaced

apart brackets 71—71 welded to the top surface adjacent opposite edges. The two lower ends of the foot section 26 of the secondary boom are received between the brackets 71—71 and are pivotably attached thereto by means of pins 72. The lower ends of the legs 53—53 of the gantry are also received between the brackets 71—71 and are pivotably attached thereto by shaft 73. This shaft also carries sheave 74 which guides the load line 75 running from the cab through the conventional sheave block 112 at the upper end of the secondary boom as seen in FIG. 1.

The upper ends of the diagonal brace members 34 are attached to a strut member 76 attached to the underside of lower plate 61. The strut is reinforced by gusset plates 77—77 which are welded to boom section 28 and extend outwardly therefrom. A pair of spaced apart lugs 78—78 extend downwardly from each end of strut member 76 and are engaged by the upper ends of brace member 34 and pinned thereto by pins 79 received in matched, opposed openings provided in the lugs and the brace members.

While the connecting assembly 29 can be welded to the ends of the cords of the top section 28 of the main boom, another preferred construction (not shown) utilizes removable locking pins received in aligned openings in lugs depending from the top plate 61 and similar lugs attached to the cords of section 28. With this construction a standard boom section may be used for the top section 28 of the main boom and no special construction is required.

Referring now to FIG. 8, the reeving system for the erection of the main and secondary booms operates from the lower erecting gantry 42 and the rear gantry 49A. The lower end of line 80 is wound on one of the two standard hoist drums (not shown) provided in the crane draw works in the cab 21. The line passes around sheave 82 on shaft 51, then over sheave 83 connected to shaft 84 by clevis 85. Shaft 84 is received in openings in spaced apart lugs 86—86 carried by transverse member 46 of the erecting gantry. The line then passes over sheave 87 on shaft 51 and back over sheave 88 on shaft 84, then to sheave 89 on shaft 51 and back to sheave 90 on shaft 84. The line then passes to sheave 91 on shaft 51, back to sheave 92 carried by clevis 93 carried by shaft 84 and finally dead ends on shaft 51 at point 94.

The reeving system for the secondary boom 30 as seen in FIG. 8 including line 95 which has its lower end wound on the boom hoist drum (not shown) in the crane cab. This line passes first over sheave 96 carried by shaft 51 supported by the rear gantry 49A. The line 95 then passes to a floating link, designated generally by the numeral 97. The link includes a shaft 98, sheaves 99, 100, 101 and 102 carried on shaft 98. Sheaves 103 and 104 are connected to shaft 98 by means of clevises 105 and 106. The ends of the pendants 58—58 are connected to the ends of the shaft 98. Line 95 also passes through a harness, designated generally by the numeral 107. The harness includes a shaft 108 carried by a pair of arms 109—109 which are pivotably attached to shaft 51 on gantry 49A. Sheaves 110, 111, 112 and 113 are mounted on shaft 108. Line 95 passes from sheave 96 through the floating link 97 and the harness 107 in the following sequence: sheave 99, 110, 100, 111, 103, 104, 112, 101, 113, 102 and then dead ends at point 110 on the end of shaft 108.

In assembling the crane, the components, i.e., the tracked power unit and the disassembled boom and gantry sections, are transported to the construction site by truck or other suitable means. The rear and erecting gantrys may remain attached to the power unit if desired when moving from one site to another. The vertical support members 49—49 on the rear gantry may be made from very heavy cable (e.g., 2 or 3 inches), and the ends of diagonal members 50 may be pivotably attached to the frame of the crane to permit the fixed gantry to be folded down when transporting the power unit. As seen in FIG. 3, the various sections of the main boom 25 are bolted together and the boom is attached to the power unit. The two diagonal brace members 34—34 are then assembled and attached to the main boom and to the erecting gantry 42 by pins. The secondary boom 30 is then assembled and attached to the top of the main boom by connecting structure 29. The top gantry 52 is attached to connecting structure 29 and then pendants 56—56 and 58—58 are rigged. The reeving systems for the boom elevation and operation are then rigged and the hoist line is threaded up. A wheeled cradle 111 is placed under the end section 33 of the secondary boom to carry the weight of the boom as it moves into the erected position. As seen in FIG. 4, the operator erects the crane by applying power to the hoisting drum carrying line 80 to elevate erecting gantry 42 to the vertical position. The gantry is connected to the two diagonal brace members 34—34, as described hereinbefore, which in turn elevate the main boom and the lower end of the secondary boom. The upper end of the secondary boom remains in contact with the ground through cradle 111 to prevent tipping of the crane during elevation of the main boom to the vertical position.

As seen in FIGS. 1 and 5, when the main boom has been raised to the vertical position, the pins 40 are placed in the aligned openings in lugs 41—41 in the lower ends of the foot section 37 of each of the brace members 34—34 to lock the brace members and the main boom into a rigid tripod structure. In this position the connecting structure 29 is in the open position, i.e., piston rods 68—68 are in the retracted position and plates 61 and 63 are pivoted apart so that the weight of the secondary boom is carried by the wheeled cradle 111.

After the main boom and brace legs are securely locked in position, line 95 is taken up on the boom hoist drum thereby elevating the secondary boom to the operating position shown in FIG. 1 by means of the reeving system described hereinbefore and depicted in FIG. 8. When the secondary boom passes the horizontal position, the connecting structure 29 is closed and the crane operator energizes the hydraulic pinning devices 66—66 to securely lock the plates 61 and 63 of the connecting structure together. A positive lockup will be indicated on an indicator light (not shown) actuated by toggle switch 70. Any change of position of the secondary boom is made by taking in or paying out cable 95 to alter the elevation of boom 30 through the secondary boom reeving system and the lower pendants 58—58, the top gantry 53 and upper pendants 56—56.

As seen in the drawings, particularly FIG. 6, the ends of the foot section 26 of the secondary boom are pivotably attached midway of the width of the connecting structure 29, i.e., spaced an equal distance between the

front and back pairs of cord members **62—62.** By this unique construction compression forces transmitted by the secondary boom to the main boom are distributed equally among the four main cord members. In contrast, other commercial tower cranes have their secondary booms pivoted over the two forward cords and thus apply an uneven load to the main boom resulting in a much lower net lifting capacity than that of the crane of the present invention. Because of the vertical positioning of the main boom and the diagonal brace members, the crane of the present invention has been found to have the ability to lift heavier loads spaced a greater distance from the base point of the main boom than do conventional double boom tower cranes, i.e., the secondary boom may be operated at a lower angle to obtain a greater reach without danger of tipping the crane. Since prior art mobile tower cranes can never operate with their main boom in the vertical position, the moments of force transmitted by the secondary boom do not pass through the base point of the main boom as does the present crane, but centers some distance in front of the base point of the main boom, thus limiting the angle at which the secondary boom can be operated to lift a given load without tipping the crane. Another feature of the present crane is that the top gantry **52** need only be strong enough to carry a part of the tipping load since the greater part of the rearwardly and downwardly acting moments of force are not transmitted through the top gantry as they are in the conventional crane, but are transmitted to the power unit from through diagonal braces **34—34.** Another feature of the present crane is its ability to make lifts spaced only a few feet forward of the axis of the main boom. The tripod construction and the centering of the secondary boom foot over the vertical main boom permit the secondary boom to be operated in an almost vertical position thereby allowing the distal end of the hoisting line **75** carrying the load blocks **112** to work very close to the base point of the main boom **25.**

From the foregoing it is seen that the crane of the present invention provides a number of unique advantages not found in prior art cranes. While there has been depicted and described a preferred embodiment of the invention, it is understood that various improvements, modifications and refinements may be made by those skilled in the art and it is intended that such improvements, modifications and refinements shall be included in the spirit of the present invention and that the invention is limited only by the scope of the following claims.

What is claimed is:

1. In a mobile tower crane the combination comprising: a mobile carrier; a power unit superstructure revolvably mounted on said carrier; a main boom having its lower end pivotably attached to the forward end of said superstructure; a pair of rigid, spaced apart, fixed length, diagonal brace members, each possessing a large moment of inertia and having its upper end pivotably attached to opposite sides of said main boom adjacent the upper end thereof and its lower end detached from said superstructure when said main boom is in a substantially horizontal position and attached to said superstructure adjacent the rear end thereof when said main boom is in a substantially vertical operating position to form a tripod shaped, rigidly braced structure; a secondary boom having its lower end pivotably coupled to the upper end of said main boom; elevating means to raise said main boom, diagonal brace members, and secondary boom from a substantially horizontal position into the operating position; and means to raise and lower said secondary boom when in the operating position.

2. The combination set forth in claim **1** wherein said main boom is constructed from a plurality of generally rectangular sections each having four longitudinally extending main cord members.

3. The combination set forth in claim **1** wherein said diagonal brace members are connected to said main boom through a transverse strut carried by said main boom.

4. The combination set forth in claim **1** wherein said secondary and main booms are coupled by means of a connecting structure having an upper flat plate pivotably connected to said secondary boom and a lower flat plate fixedly attached transversely to the top of said main boom, said plates being in abutting relationship when said crane is in the operating position, and said plates being pivotably connected adjacent one edge thereof.

5. The combination set forth in claim **1** wherein said elevating means includes a rigid erecting gantry having its lower end pivotably attached to said superstructure adjacent the base of said main boom and its upper end attached to each of said diagonal brace members.

6. The combination set forth in claim **1** wherein said lower ends of said diagonal braces are attached to said superstructure by means of a transverse strut member carried by said superstructure.

7. The combination set forth in claim **4** wherein said secondary boom is attached to said main boom through a bifuricated foot section pivotably attached to the top of said upper flat plate.

8. The combination set forth in claim **4** wherein said secondary boom is attached to said upper flat plate at approximately the middle of said upper flat plate.

9. The combination set forth in claim **4** wherein said upper and lower plates are pivotably connected at their forward edges.

10. The combination set forth in claim **4** wherein said main boom terminates in a section having four main spaced apart cord members; said lower plate being attached to the ends of said cords and pivotably connected at its forward edge to the forward edge of said upper plate; said secondary boom being pivotably attached to the top of said upper plate at points on a line through the middle of said upper plate through upstanding brackets fixed to the top surface of said upper plate.

11. The combination set forth in claim **4** wherein an upper gantry is pivotably attached at its lower end to the upper plate of said connecting structure, said gantry having pendant lines attached to its upper end, said pendant lines being connected to the outer end of said secondary boom, said upper end of said gantry being connected through a reeving system to power means whereby said secondary boom can be raised and lowered when the crane is in the substantially vertical operating position.

12. In a mobile tower crane the combination comprising: a mobile carrier; a power unit superstructure revolvably mounted on said carrier; a main boom made up of individual sections coupled together and having its lower section pivotably attached to the forward end

of said superstructure and its upper end attached to a connecting structure; a rigid, fixed length, first diagonal brace member pivotably attached at its upper end to one side of the upper end of said main boom; a rigid, fixed length, second diagonal brace member pivotably attached at its upper end to the other side of the upper end of said main boom and spaced apart from said first diagonal member, each of said diagonal members having their spaced apart lower ends attached to the rear of said superstructure; said braces possessing a large moment of inertia; a secondary boom made up of individual sections coupled together, said boom having its lower end pivotably coupled to said connecting structure; a reeving system coupled to said power unit and having a floating link at its upper end; a first pair of pendant lines coupling said floating link to an upper gantry pivotably mounted on said connecting structure, a second pair of pendant lines connecting said upper gantry to the upper end of said secondary boom; and load hoisting means including a load line running from said power unit over a sheave carried by said connecting structure and through a sheave carried by the end of said secondary boom.

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