

**[54] COUNTER-BALANCED CRANE
STRUCTURE**

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[63] Continuation of Ser. No. 218,959, Jan. 19, 1972, abandoned.

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[51] **Int. Cl.**..... **B66c 23/74**

[58] **Field of Search** 212/48, 49, 59, 144, 145,
212/46 R

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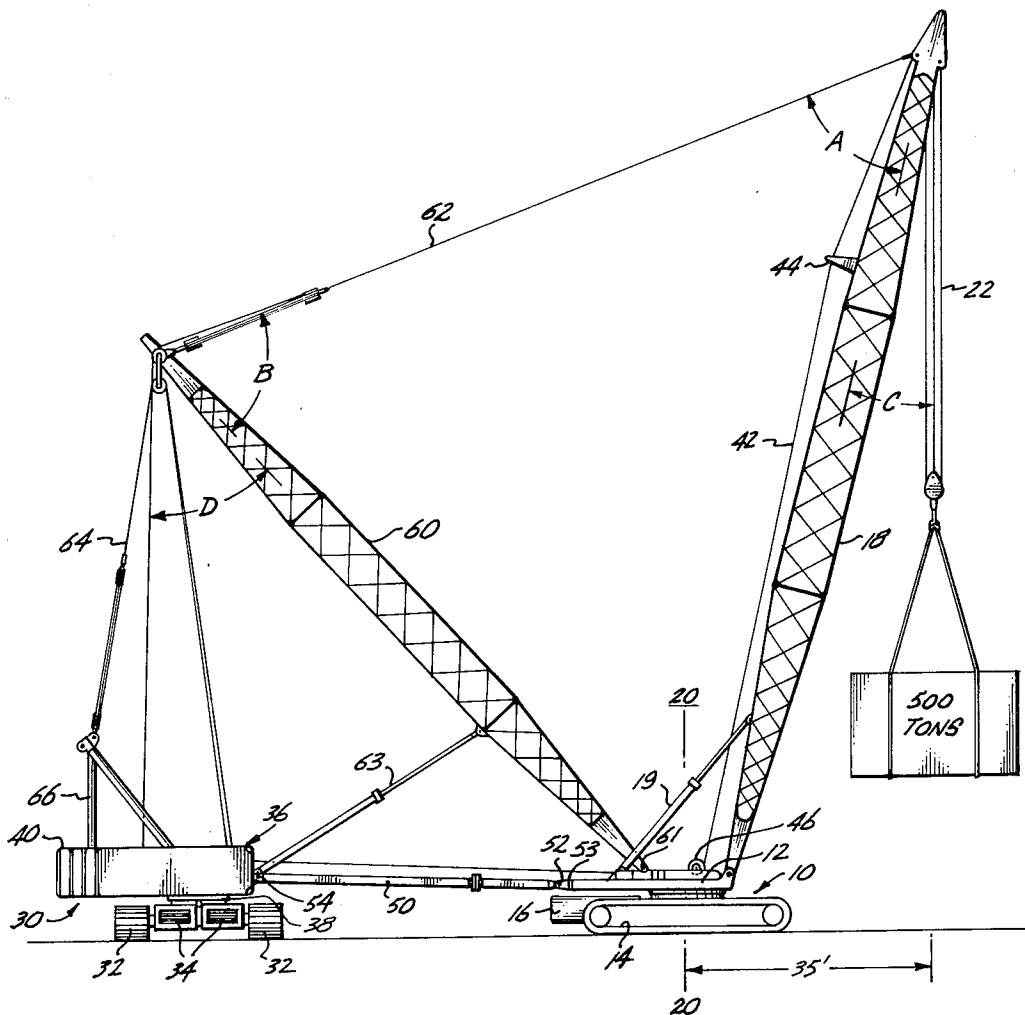
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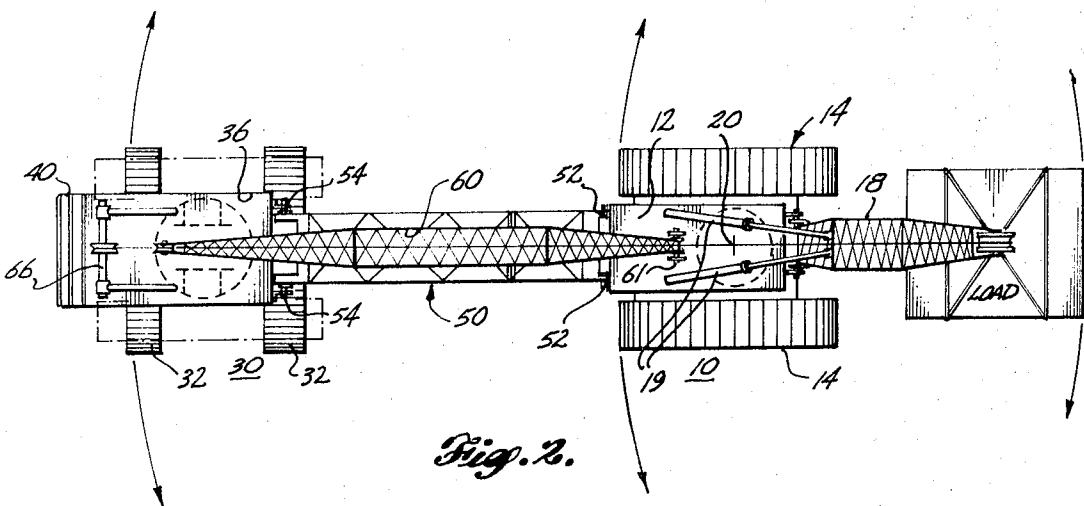
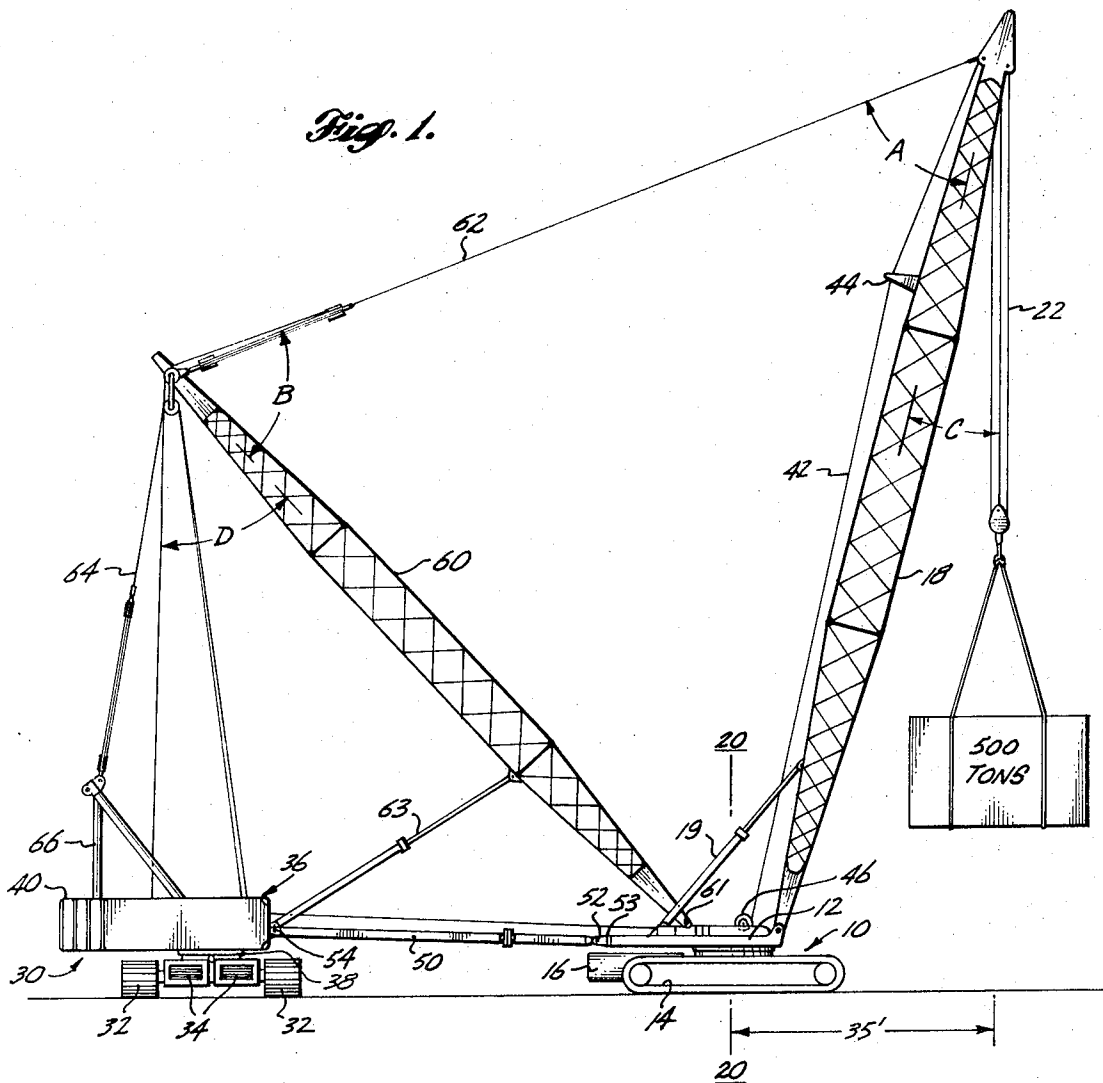
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[57] **ABSTRACT**

An earth-borne crane structure having a horizontally rotatable load platform for the superstructure is associated with a laterally displaced, weighty, self-propelled mobile unit by means of a stiff spreader link operable upon circumferential movement of said mobile unit relative to said crane structure to apply torque to the load platform and rotate the same and the load borne thereby from the superstructure.

8 Claims, 4 Drawing Figures





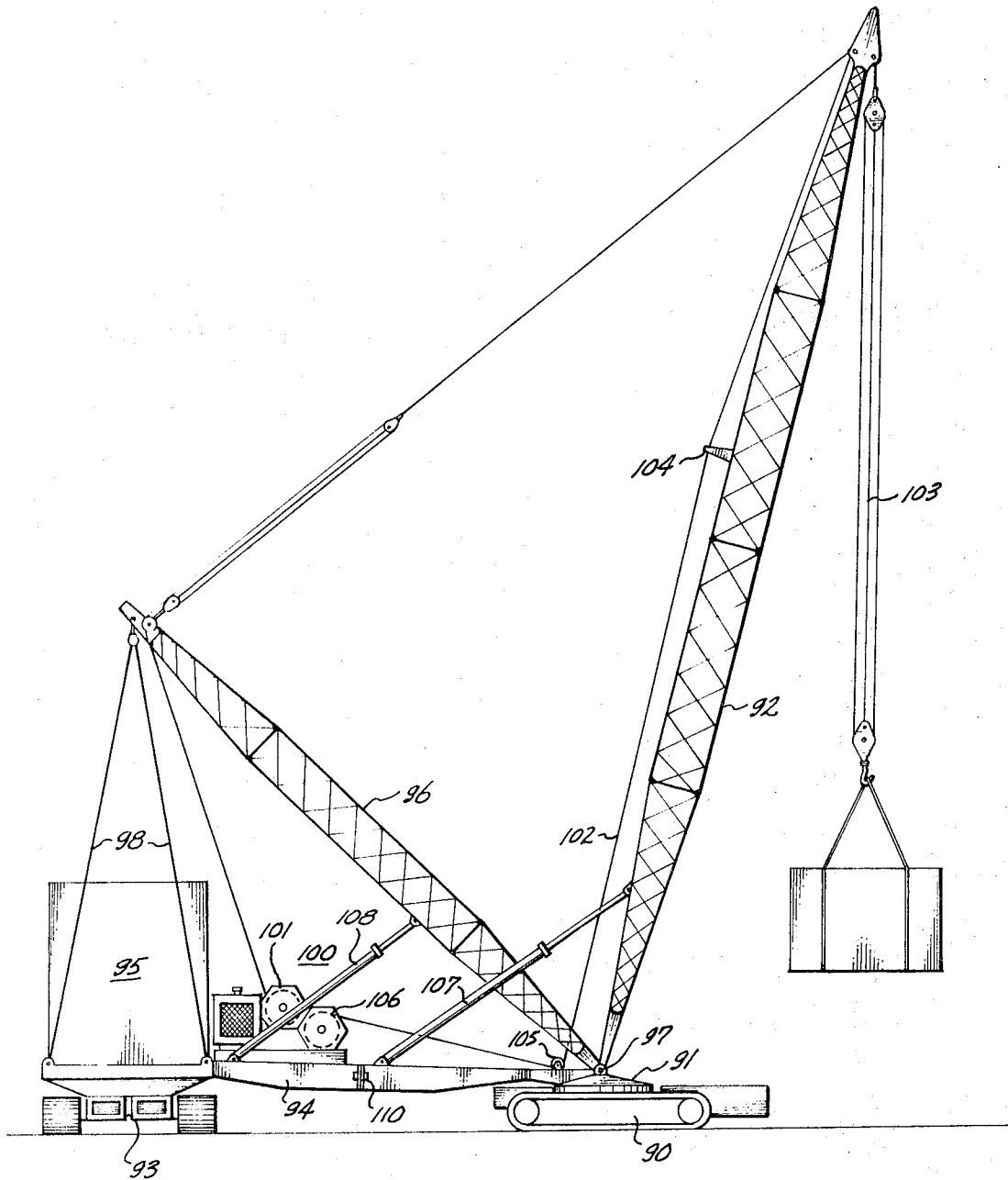


Fig. 4.

COUNTER-BALANCED CRANE STRUCTURE

This is a continuation of U.S. Pat. application Ser. No. 218,959, filed Jan. 19, 1972 now abandoned.

BACKGROUND OF THE INVENTION

Crane structures are rated by their lifting capacity at maximum extension under conditions of stability. While stability against tipping or toppling is relatively easy to obtain with fixed structures through the use of suitably anchored guys, the problem becomes very difficult of solution when extreme loads are to be lifted and swung about the lifting means in wide arcs up to and including, on occasion, 180° or more. When mobility of the crane structure under load is a requirement the problem of maintaining stability is greatly magnified.

It is known to apply an extended earth-borne counterweight arm to rotatable crane structures to provide stability and to overcome or counterbalance the tendency of its load to produce a tipping moment in the crane. In general it can be said that the length of the arm and, hence, the lateral displacement of the counterweight forces control or limits the lifting capacity of the crane. In a known crane structure, a self-rotatable crane is mounted on a vehicle provided with an immovable extended trailer which supports a traveling counterweight that may be variously displaced outward on the trailer as the lifted load becomes of such magnitude as to tend to overthrow the vehicular crane. In such structure the operator is limited to a small arc through which he may rotate and move a load, the length of the arc on each side of center decreasing as the load lifted is increased. Outriggers are sometimes employed to broaden the base of the vehicular crane but these tend to eliminate any possibility of mobility under load.

Another known crane system provides a vehicular crane capable of self-rotation and having a counterweighting trailer pivotally associated with the vehicle frame permitting its immovable disposition at right angles to the fixedly located vehicle in opposition to the crane when the latter is directed outward from the other side of the vehicle. This arrangement in effect provides a three-armed base for the revolving crane structure and permits a somewhat increased arc through which a load may be swung before a toppling moment is reached. However, once the loaded crane is swung to such an extent that the counterweight effect opposite the load has been surpassed, stability is lost. Here, too, as the load increases the swing arc decreases and lateral movements of the load become more restricted.

In another known crane structure of the vehicular type, a mobile earth-borne crane supports a turntable having a boom and stay mast mounted thereon together with a power package including a power source and the requisite winching means to provide the facility for load hoisting and relative adjustment of the boom and stabilizing mast. In this system a counterweight on a trailer is located behind and in opposition to the boom. The trailer is rigidly connected to the turntable. As the operator revolves the turntable the trailer is caused to travel in an arc about the axis of rotation. The power required to accomplish this trailer movement is derived from the same source as rotates the turntable. Bearing in mind that the counterweight is usually heavy and applies a substantial load per square inch via the ground-

engaging elements, it will be observed that substantial torque is required to be supplied by the turntable revolving means. Further, bearing in mind that the revolving of the crane turntable under substantial load can be a very critical operation the additional load of the counterweight may seriously interfere. Also note that in this arrangement the weight of the power package is borne by the crane base and tends to hamper its mobility.

SUMMARY OF THE INVENTION

It is among the primary objects of this invention to provide a crane base having a rotatable platform supporting a boom and a stay mast having great load lifting capacity and which is stabilized against toppling by a counter-balancing earth-borne, self-propelled, mobile vehicular means laterally displaced from the axis of rotation and stiffly coupled to the rotatable load platform to precisely and accurately revolve the same and its load as the mobile means travels thereabout.

While the crane base need not be mobile, in the preferred form of the invention it is provided with steerable ground engaging members such as endless tracks or multiple wheels. Thereby the entire crane assembly may be moved over the ground both unloaded and under load, thereby enhancing its usefulness and wherein such movement may be with either the crane base leading or following the mobile means, or the crane base and the mobile means simultaneously moving in parallel paths in all radial directions from a starting point.

Another object of the invention is to apply, in counter-balancing fashion opposite the main hoisting boom and its load, the weight of the usual power source and powered winching means required to provide boom and stay mast adjustments and to activate the load hoisting gear of the crane structure.

Other objects and advantages of the invention will become apparent during the course of the description of the invention in its preferred and alternative embodiments. Alterations and modifications of the invention will naturally occur to those skilled in the pertinent art. All such as fall within the spirit and scope of the invention, giving due regard to the doctrine of equivalents, as fall within the subjoined claims, is intended to be patented herein.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevation of the counter-balanced crane structure of this invention shown in operation;

FIG. 2 is a top plan view of the crane structure of FIG. 1;

FIG. 3 is a side elevation of a variant crane structure according to this invention; and

FIG. 4 is a side elevation of another crane structure with a variation in the mounting of the main hoist.

DESCRIPTION OF THE INVENTION

In the preferred embodiment of the invention shown in the accompanying drawings, the low-profile earth-borne crane base 10 supports the horizontal load platform 12, mounted thereon for rotation about the vertical axis 20—20. Desirably crane base 10 is mobile and it may be self-propelled, as shown, on endless tracks 14 driven from a power source 16.

Main boom 18 is pivotally mounted on load platform 12 to swing about a horizontal axis 20 permitting its dis-

position in various upright angular positions. Telescopic boom stops 19 cushion and make secure the boom and prevent the unloaded boom from moving over center. Load hoisting means 22 depend from the upper end of main boom 18. For extremely heavy loads means or system 22 may typically comprise as many as 24 line parts of 1 1/4 inches or greater sized cable.

Spaced laterally of crane base 10 is the self-propelled mobile unit 30 comprising endless tracks 32, its power source 34 and operating housing 36 mounted on swivel base 38 to rotate about a vertical axis. Housing 36 may contain counterbalancing ballast 40 and may include a power source and winching means (not shown) to which passes main line 42 of the hoisting means 22. Line 42 passes down the rear of boom 18 over guide 44 and around sheave 46 at the bottom rear of boom 18, thence to housing 36.

In most operations where heavy loads are to be lifted and rotatably moved about axis 20 of platform 12, the ground-engaging tracks 32 of mobile unit 30 will be disposed relative to crane base 10 so that unit 30 will be mobile in a path circumferential of axis 20. On other occasions the tracks of unit 30 may be aligned with unit 10 for straight line transport of the entire assembly with or without load.

Spreader link 50 connects between the load platform 12 and mobile unit 30. At its ends link 50 has a pair of spaced apart arms, as shown in FIG. 2, which are pivotally connected about the horizontal axes 52 and 54. The dual connections permit link 50 to pivot up and down, but must be such that when unit 30 is self-propelled on tracks 32 in its circumferential path about axis 20 torque will be applied to rotate load platform 12 and hence rotate the main boom 18 carried thereby.

In the preferred form shown in FIG. 1, wherein the crane is shown as rigged to handle extreme loads, it is desirable to employ stay mast 60 pivotally mounted at 61 on its lower end on platform 12 opposite boom 18. Mast 60 is disposed angularly upward behind boom 18 generally in overlying relation to link 50 and mobile unit 30. Boom stops 63 are employed to limit motion of mast 60. Adjustable guy line 62 connects between the upper ends of boom 18 and mast 60 and guy 64 extends from the upper end of mast 60 to the gantry frame 66 rising at the rear of housing 36. By means of guys 62 and 64 the weight of mobile unit 30 is applied to the upper end of main boom 18 in a counterbalancing and stabilizing relation to loads borne by the hoisting system 22.

When a load is raised as in FIG. 1 and it is desired to move to another position radially about axis 20 the propulsion mechanism of unit 30 is activated. As unit 30 travels in its arcuate path about axis 20 it exerts substantial torque through spreader link 50 on load platform 12 to rotate the same. By this arrangement the operator of unit 30 is able to swing the crane about axis 20 with great precision and safety. As unit 30 moves the stay mast 60 also swings or rotates and the guying effect and the counterweight of unit 30 on boom 18 is maintained in direct opposition to boom 18 and its load.

In the arrangement shown in FIG. 1,

Angle A (between boom 18 and guy 62) is 55°

Angle B (between mast 60 and guy 62) is 66.5°

Angle C (between boom 18 and lift means 22) is 14.5°

Angle D (between mast 60 and guy 64) is 44°.

The weight of unit 10 is assumed at 150 tons. Unit 30 is assumed to be 250 tons. With a 500 ton load the compressive force on boom 18 is calculated to be 597 tons and the compressive force on mast 60 is calculated to be 204 tons. Guy 62 will bear a tension force of 151 tons and guy 64 will bear a tension force of 200 tons. The total load carried by the earth beneath unit 10 is calculated to be 900 tons which, spread over the large area of the tracks 14 will be about 40 psi. Under the conditions shown the center of the load will be approximately 35 feet outward of axis 20.

Spreader link 50 is shown as sectional in FIGS. 1 and 2 in the same manner as are the boom 18 and mast 60. All of these elements may be lengthened by the addition of intermediate sections of like configuration. For example, link 50 may have a section introduced with the result that the counterbalance unit 30 is displaced outward of the crane base 10 a greater distance and, hence, a greater counterbalancing effect is produced.

It will be observed that the topping lift or guy 62 is adjustable as to length by means of the tackle 64 of variable length. Extending the length of guy 62 will decrease angle A and increase angle C thereby extending the reach of boom 18. If the load remains 500 tons as shown it may be necessary to increase the counterbalancing effect of unit 30. This can be accomplished by adding an additional ballast unit 40 or lengthening link 50, or both. Various other adjustments well within the purview of operators skilled in the use of such heavy equipment will naturally be employed to meet specific conditions encountered in the field. An increase in Angle D produces a beneficial result. By so doing there is an application of greater compressive forces on the spreader link 50 and a subtraction of proportional compressive forces on stay mast 60.

In the alternative arrangement of FIG. 3 unit 10 and its load platform 12 supports the elongated boom 78 stabilized by top guy 62 extending to the top of mast 80, also elongated. Mast 80 is likewise supported on platform 12. Guy 64 extends between the frame 66 on cab 36 of unit 30 and the upper end of mast 80. Boom stops 63 extend from unit 30 to the backside of mast 80.

The following dimensions may be employed in the arrangement typically shown in FIG. 3:

Length of boom 78	340	feet
Length of mast 80	260	do.
Angle A	40°	
Angle B	62°	
Angle C	60°	
Angle D	16°	
Load	50	tons
Reach (center of unit 10 to load center)	300	feet
Compr. load on boom 78	96.3	tons
do. do. mast 80	24	do.
Tensile do. guy 62	73.5	do.
do. do. guy 64	250	do.

With this FIG. 3 rigging an operator is permitted to raise a very substantial load of 50 tons at a reach of 300 feet and to, with the greatest precision, manipulate and swing the load in a huge arcuate path.

In FIG. 4 crane base 90 has rotatable load platform 91 at the axis of which is mounted main boom 92. To one side is the self-propelled mobile unit 93 connected by spreader link 94 to platform 91. A ballast container

95 is carried by mobile unit 93 and may be loaded as counterbalance weight as required with water, metal billets, or sand ballast. Stay mast 96 is pivotally connected at 97 to load platform 91 and stands at an angle behind boom 92, overlying link 94. Slings 98 connect between the upper end of mast 96 and unit 93 whereby the load of the latter is applied downwardly in a stabilizing manner. The guying topping lift 98 extends between the upper ends of boom 92 and mast 96 and line 99 passes to winch drum 101 of the power package 100 shown mounted on link 94 at its outer end near unit 93. The main load line 102 from tackle 103 used in hoisting and supporting a load is led by guides 104 and 105 to drum 106 of power package 100. Boom stops 107 and 108 extend between link 94 and boom 92 and mast 98 respectively. Link 94 may be formed of two parts and connected pivotally at 110 to permit a degree of rotation of units 90 and 93 relative each other about the longitudinal axis of link 94. An appreciation of the size of the equipment shown in FIG. 4 may be had by understanding that as designed and shown the distance between the axis of the load platform 91 and the center of rotation of self-propelled unit 93 will be in the order of 60 feet.

A crane as disclosed in FIGS. 1, 2 and 4, can lift and rotatably transfer great loads, up to about 500 tons, because of the counterbalancing effect of the mobile unit and its capacity to apply torque to rotate the main boom under load with great precision and safety.

A crane as disclosed in FIG. 3 can lift very substantial loads, up to about 50 tons, at a great distance and transfer them laterally through a full circle because of the counterbalancing and stabilizing effect of the mobile unit and the absence of guying means in otherwise obstructing locations.

The general idea of the invention will be seen to be the combination with a crane base, rotatably supporting a main boom, of a stiff spreader link between the rotary means of the main base and a remotely located self-propelled mobile unit functioning to counterbalance a loaded main boom and operable to rotate it.

FIGS. 1 and 2 illustrate a preferred orientation with respect to the pivotal arrangements of the heels of the main boom and stay mast. An alternative arrangement involving pivoting of the heel of the main boom and the heel of the stay mast about a common axis is shown in FIG. 4.

Torsional freedom of the spreader link as shown at 110 in FIG. 4 is also indicated at 53 in FIG. 1 and 51 in FIG. 3. This permits the link to accommodate different relative horizontal dispositions that arise between the units 93 and 90 (FIG. 4) and units 10 and 30 (FIGS. 1 and 3) as the self-propelled units move over uneven ground and tend to tilt in such manner that torsional forces are applied tending to twist the spreader links about their longitudinal axes.

What is claimed is:

1. Counter-balanced crane structure, comprising: an earth-borne crane base supporting a horizontal load platform rotatable about a first vertical axis relative to ground-engaging members; an upstanding angularly disposed main boom pivotally mounted on said load platform about a horizontal boom axis and diverging upwardly from said vertical axis, said main boom being equipped with load hoisting means;

an earth-borne mobile counterweight unit spaced a substantial distance laterally from said crane base in diametric opposition to said main boom with respect to said first vertical axis, said mobile counterweight unit being arranged relative to said crane base for movement in a circumferential path about the vertical axis of said load platform;

said counterweight unit having a counterweight housing supported on a mobile base in which the mobile base is rotatable about a second vertical axis relative to the counterweight housing;

power means independent of said crane base and operably connected to said mobile base for selectively moving the mobile counterweight unit in said circumferential path;

rigid spreader link means operably connected between said load platform and said counterweight housing for maintaining said counterweight housing diametrically opposite to said boom and for applying rotational torque to said load platform about said first vertical axis in response to movement of said mobile counterweight unit along said circumferential path;

a power source and winching means operably connected with said load hoisting means;

an upright stay mast mounted on said load platform; and

guying means between the upper portion of said main boom, the stay mast and said mobile counterweight unit whereby the weight of the latter is applied to the upper ends of said main boom and said stay mast in counterbalancing relation to loads borne by said main boom.

2. The crane structure according to claim 1 in which the power source and winching means is mounted on said mobile counterweight unit.

3. The crane structure according to claim 1 in which the crane base is mobile and self-propelled by a second power means independent of the power means connected to the counterweight mobile base.

4. The crane structure according to claim 1 in which the mobile counterweight unit is adapted to be steered and to have mobility in all directions.

5. Counter-balanced crane construction, comprising:

an earth-borne crane base unit having a pivotal load platform mounted thereon to rotate about a first vertical axis relative to ground-engaging members;

an upstanding main boom pivotally mounted to said load platform about a horizontal boom axis radially displaced from said first vertical axis;

a self-propelled earth-borne mobile unit spaced radially from said crane base unit in the direction from the mounting of said main boom through said first vertical axis;

said self-propelled earth-borne mobile unit having a counterweight housing supported on a powered mobile base in which the powered mobile base is rotatable about a second vertical axis relative to the counterweight housing;

a rigid spreader link connected between said load platform of said crane base unit and said counterweight housing and operable upon movement of said mobile unit to apply torque upon said load platform about said vertical axis while maintaining

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said counterweight housing diametrically opposed to said main boom with respect to said first axis;
a stay mast pivotally mounted about a horizontal axis on said load platform positioned opposite said main boom with respect to said vertical axis and diverging upward relative to said main boom, the upper end of said stay mast being in overlying relation to said mobile unit;
means between the upper end of said stay mast and said mobile unit whereby the weight of said mobile unit is applied in a downward direction to the upper end of said stay mast;
boom suspension means between the upper end of said main boom and the upper end of said stay mast;
load raising and lowering means on said main boom depending from the upper end of said main boom opposite to said boom suspension means; and
powered winching means operably connected to said load raising and lowering means on said main boom and located so that the weight thereof is essentially applied downward to the upper end of said stay mast.
6. The crane structure of claim 5 in which the winching means is mounted on said mobile counterweight unit.
7. The crane structure of claim 5 in which the winching means is mounted on the rigid spreader link adjacent its connection to said mobile counterweight unit.
8. Counterbalanced crane structure, comprising:
an earth-borne crane base supporting a horizontal load platform rotatable about a first vertical axis relative to ground engaging members;
an upstanding angularly disposed main boom

mounted on said load platform and extending outwardly from said vertical axis, said main boom being equipped with load hoisting means;
an earth-borne mobile counterweight unit spaced a substantial distance laterally from said crane base in diametric opposition to said main boom with respect to said first vertical axis, said unit being arranged relative to said crane base for movement in a circumferential path about the first axis;
said counterweight unit having a counterweight housing supported on a mobile base in which the mobile base is rotatable about a second vertical axis relative to the counterweight housing;
power means independent of said crane base and operably connected to said mobile base for selectively moving the counterweight about said circumferential path;
rigid spreader link means operably connected between said load platform and said counterweight housing for maintaining said counterweight housing diametrically opposite to said boom while the counterweight unit is moved in said circumferential path and for applying rotational torque to said load platform about said vertical axis in response to movement imparted to said mobile counterweight unit along said circumferential path by said power means;
a power source and winching means operably connected with said load hoisting means; and
guying means between the upper portion of said main boom and said mobile counterweight unit whereby the weight of the latter is applied to the upper end of said boom in counterbalancing relation to loads borne by said main boom.

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