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Hedeen et al.

[11] **3,804,264**

[45] **Apr. 16, 1974**

[54] **TOWER CRANE WITH ROCKABLE TOP SECTOR**

[75] Inventors: **Nils E. Hedeen; George S. Ailin, Jr.,** both of Mequon, Wis.

[73] Assignee: **Harnischfeger Corporation,** Milwaukee, Wis.

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[52] **U.S. Cl.** **212/144**

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

[58] **Field of Search** ..... 212/17, 46 R, 39, 58, 59, 212/144, 46 A, 46 B, 59 R, 59 A

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Primary Examiner—Evon C. Blunk
Assistant Examiner—Hadd Lane
Attorney, Agent, or Firm—James E. Nilles

[57] **ABSTRACT**

A tower crane is provided with a sector shaped rocker at the top of the tower boom and with a control cable which winds itself upon and unwinds itself from the arcuate periphery of the rocker during downward and upward swinging of the jib boom. A sharp change of angularity between the control cable and a connected hoist cable during raising and lowering of the jib boom is taken care of by a link joint which seats itself on the rear corner of the rocker when the jib boom is lowered and which swings away from it when the jib boom is raised. An articulated stop linkage at the top of the tower boom prevents back swing of the jib boom beyond a selected limit position.

7 Claims, 9 Drawing Figures

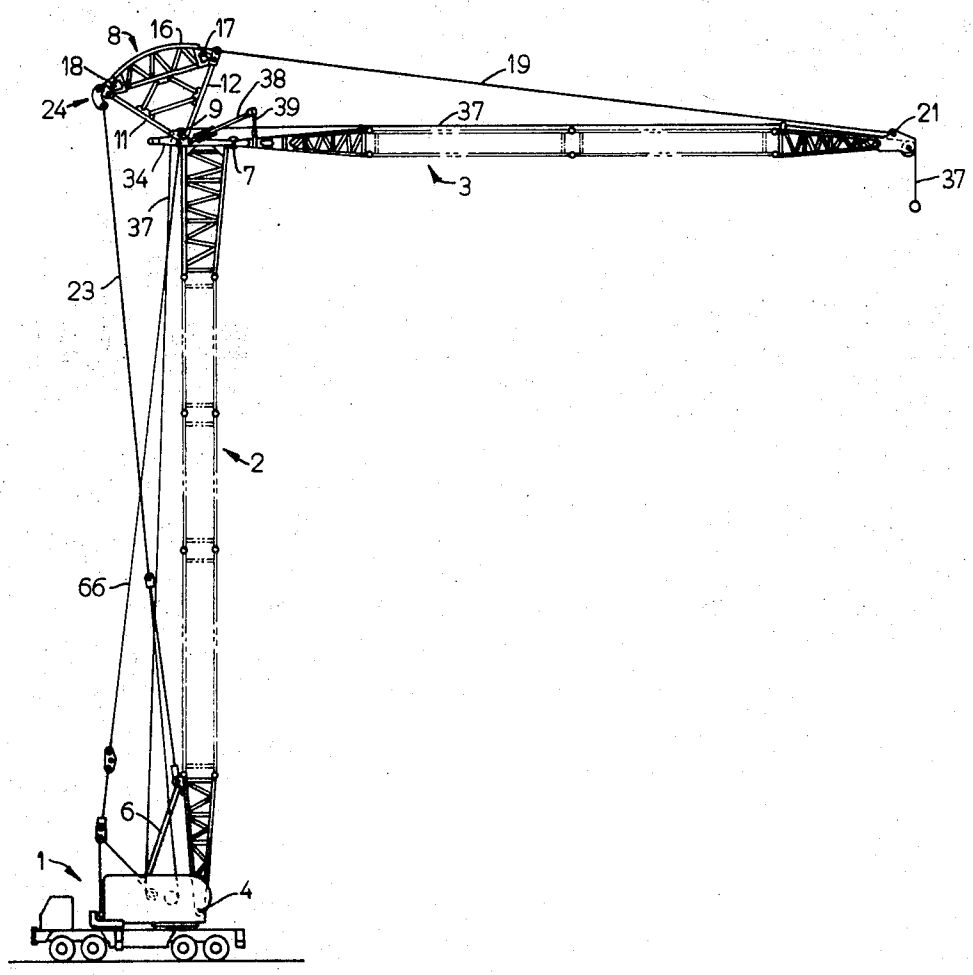


FIG. 2

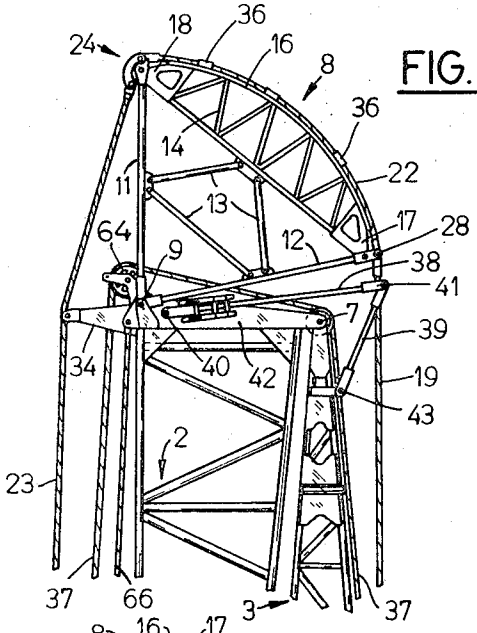
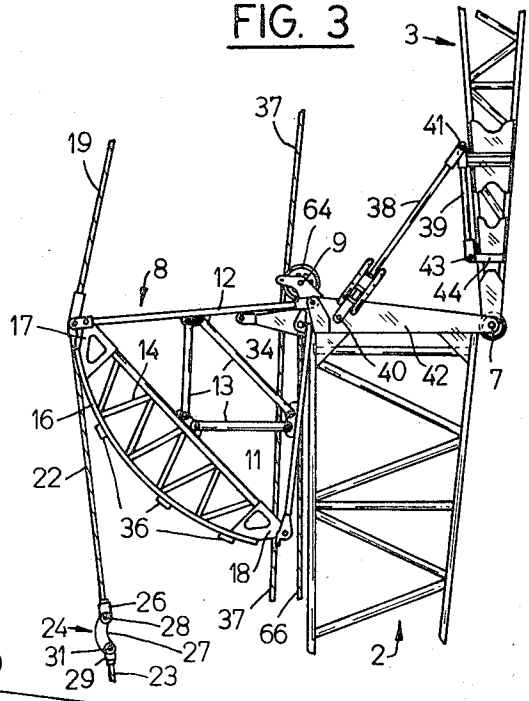


FIG. 3



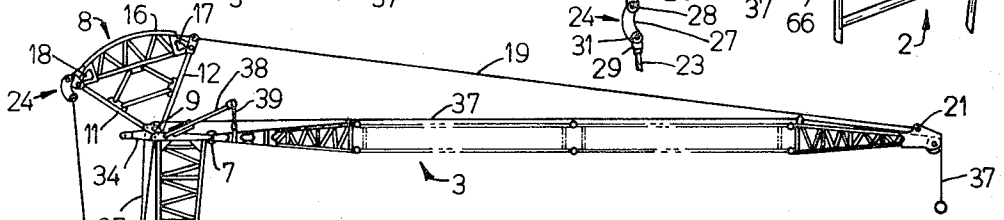
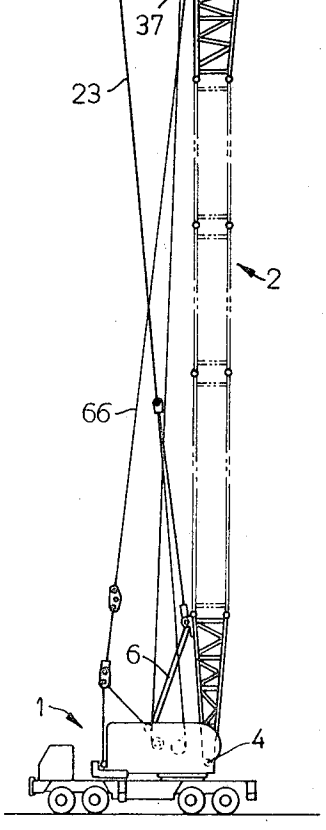


FIG. 1



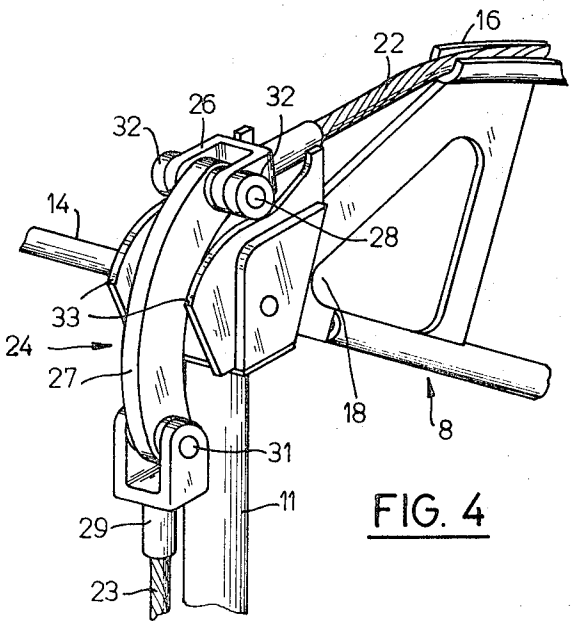


FIG. 4

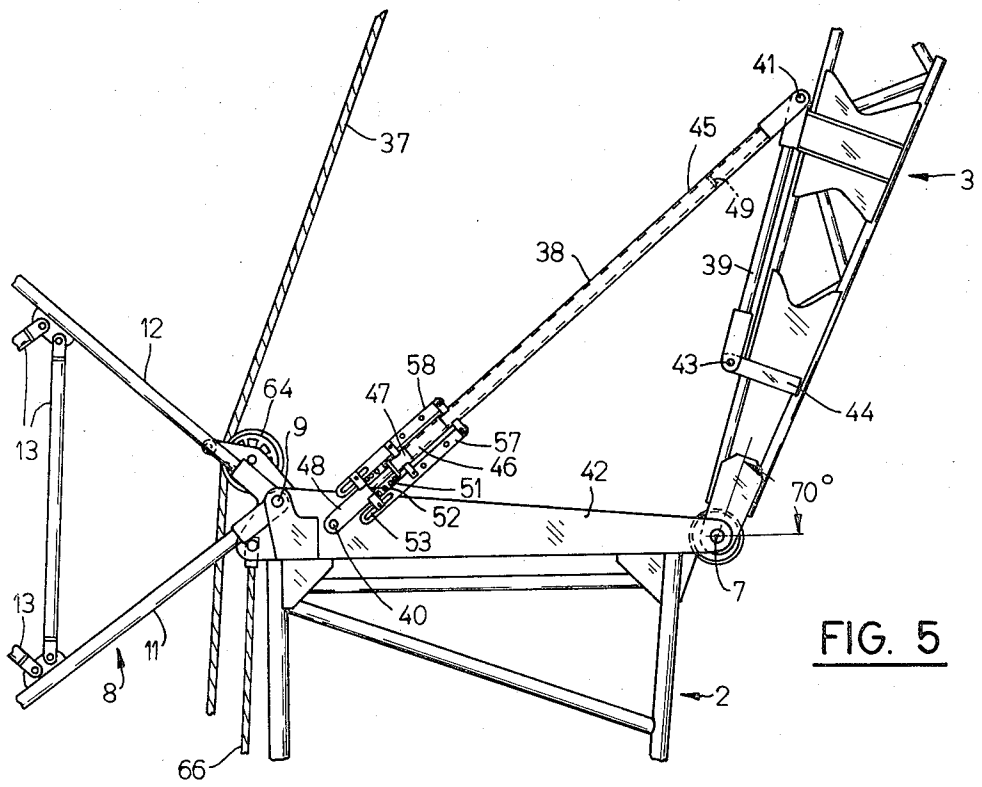

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FIG. 5

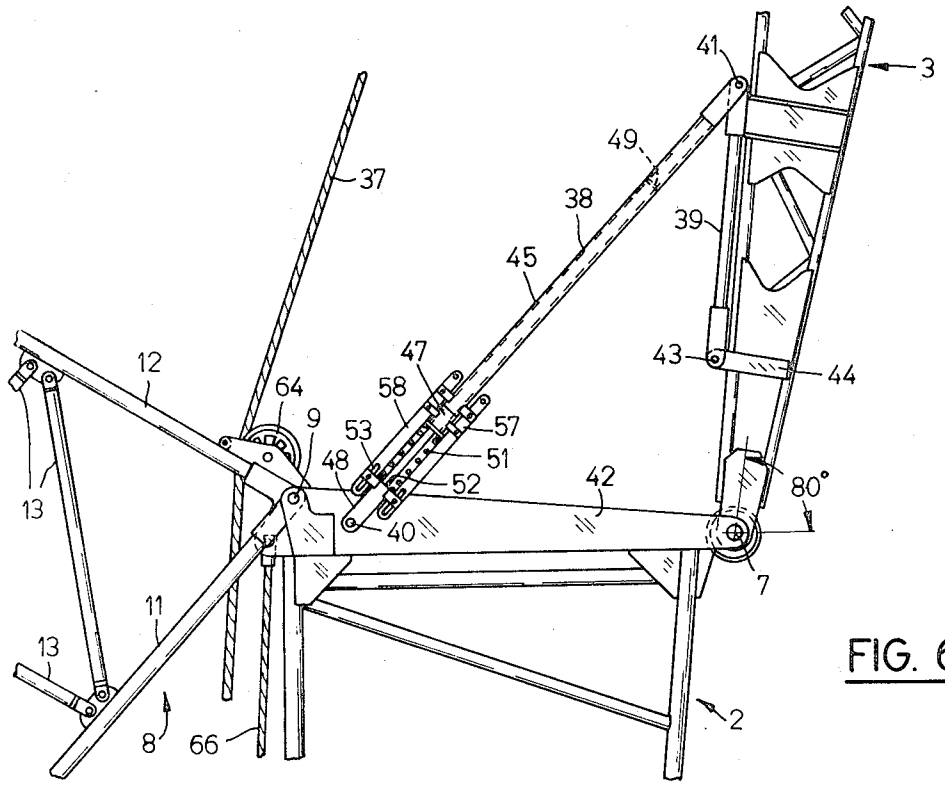

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FIG. 6

FIG. 9

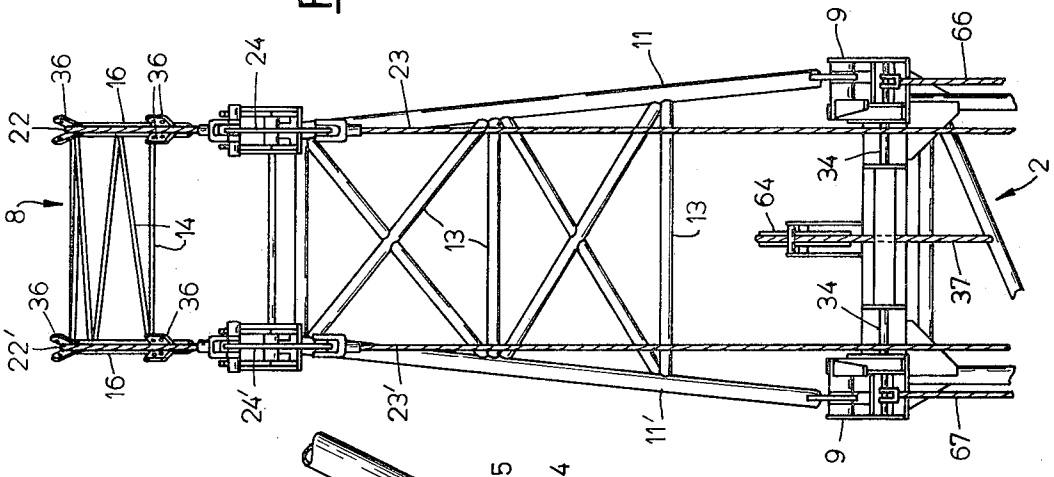


FIG. 8

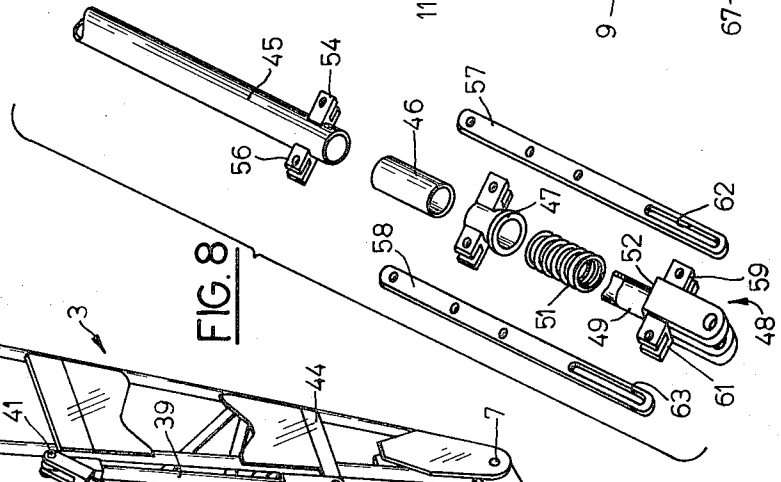
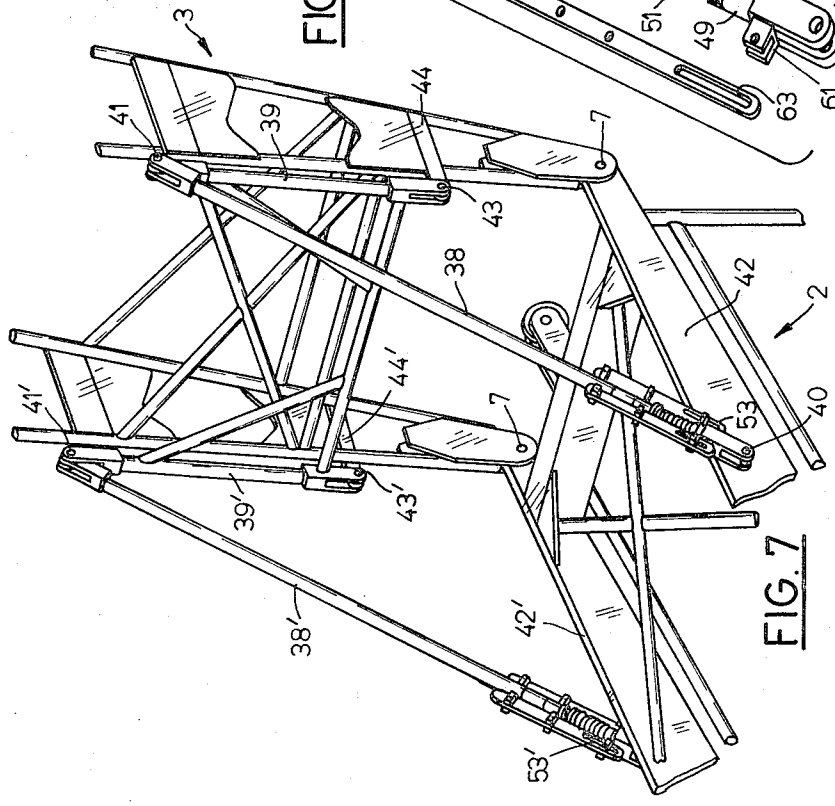


FIG. 7



TOWER CRANE WITH ROCKABLE TOP SECTOR

BACKGROUND OF THE INVENTION

The invention relates to tower cranes, that is to the type of crane which is commonly used at construction sites for the erection of tall buildings and which essentially consists of a mobile crane base, a tower boom connected with the base for swinging movement from a horizontal into a vertical position; and a jib boom connected with the tower boom for swinging from a folded position alongside the erected tower boom into a raised position of close to 90 degrees beyond horizontal.

In such cranes a variable leverage rigging is usually provided for pivoting the jib boom up and down on the erected tower boom, but difficulties have heretofore been encountered in providing a fully satisfactory rigging for that purpose. For instance, one of such difficulties has been to avoid undesirable stress conditions in the rigging, particularly when the jib boom is raised to its full height above horizontal. Another difficulty has been the tendency of the jib boom to overtravel its raised limit position due to inertia forces not only of the jib boom but also of the rigging itself. Further, the necessary cables for transmitting lifting force from a winch on the crane base to the jib boom on the erected tower must be suitably arranged so that they will not become subject to unduly sharp bending at any time during the up and down swinging of the jib boom.

SUMMARY OF THE INVENTION

Generally, it is an object of the invention to provide an improved tower crane wherein the hereinbefore mentioned difficulties are taken care of in a practical and fully satisfactory manner.

More specifically, it is an object of the invention to provide an improved back stop mechanism for the jib boom which will operate more safely than the cable type back stop mechanisms which have heretofore been used on tower cranes. Such earlier cable type back stop mechanisms had to be manufactured with great precision because the length of cables was critical, that is, only a slight excess length of the cables was apt to let the jib boom swing backward beyond its limit position, particularly when that limit position was close to 90 degrees beyond horizontal. Adjustment of the stop cables in the field was not practical because of the usually great height of the tower boom.

A further object of the invention is to provide an improved back stop mechanism which will safely absorb not only inertia forces of the jib boom but also inertia forces of a relatively heavy rocker structure which is mounted on top of the lower boom and which forms part of the variable leverage rigging for raising and lowering the jib boom.

A further object of the invention is to provide an improved back stop mechanism of the above mentioned character which will cushion the upward swing of the jib boom into its limit position.

A further object of the invention is to provide an improved back stop mechanism of the above mentioned character which may readily be adjusted so as to afford different limit positions of the jib boom, as for instance, one limit position of 70 degrees beyond horizontal, and an alternate limit position of 80 degrees beyond horizontal.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects and advantages of the invention will become apparent as this disclosure proceeds with reference to the drawings wherein:

FIG. 1 is an overall view of a tower crane embodying the invention;

FIG. 2 is an enlarged view of a variable leverage rigging for the jib boom of the crane shown in FIG. 1;

FIG. 3 is a view similar to FIG. 2 with the rigging in a different condition of adjustment;

FIG. 4 is an enlarged perspective view of a structural detail;

FIG. 5 and FIG. 6 are enlarged views of upper parts of the crane shown in FIG. 1, FIG. 5 showing a back stop mechanism for the jib boom in one condition of adjustment, and FIG. 6 showing the back stop mechanism in another condition of adjustment;

FIG. 7 is an enlarged perspective overall view of the back stop mechanism shown in FIG. 5;

FIG. 8 is an enlarged exploded view of parts of the back stop mechanism shown in FIG. 7; and

FIG. 9 is an enlarged rear view of the upper part of the crane shown in FIG. 1.

DETAILED DESCRIPTION

In FIG. 1, the mobile base of the tower crane is generally designated by the reference numeral 1, the tower boom by the reference numeral 2, and the jib boom by the reference numeral 3.

The mobile base 1 is a regular crane base with the usual winches and propelling gear and with a pivot connection 4 for the lower end of the tower boom 2. A brace 6 between the superstructure of the base and the tower boom prevents the same from going beyond a vertical position.

The upper end of the tower boom 2 is constructed to provide a forward pivot connection 7 with the jib boom 3 about which the latter is swingable downward into a depending position along the forward side of the tower boom as indicated in FIG. 2, and upward into a raised position beyond horizontal as indicated in FIG. 3. A variable leverage rigging for effecting the downward and upward swinging of the jib boom 3 about the forward pivot connection 7 includes a sector-shaped rocker structure 8 which is pivoted at its hub on top of the tower boom 2. The pivot connection 9 between the hub of the rocker 8 and the tower boom 2 is located near the rear side of the tower at a substantial horizontal spacing from the forward pivot connection 7 between the tower boom and the jib boom.

The rocker structure 8 is a rigid assembly of a pair of rear struts 11, (FIGS. 2 and 9), a corresponding pair of front struts 12, a cross bracing 13 between the pairs of front and rear struts, and a girder type bridge section 14 between the radially outer ends of the pairs of front and rear struts 11 and 12. The peripheral portion 16 of the bridge section 14 is circularly curved about the center of the pivot connection 9 and has a first corner 17 at its intersection with the front struts 12, and a second corner 18 at its intersection with the rear struts 11.

As shown in FIG. 9, the rocker structure 8 is spread out laterally, and in addition to the circularly curved peripheral portion 16 at one side of the rocker structure a corresponding circularly curved peripheral portion 16' is provided at its other side. Each of portions 16 and 16' has a channel shaped semicircular cross sec-

tion, the open sides of the channels facing radially outward as shown for the portion **16** in FIG. **4.** At the forward corner **17** (FIG. **1**) of the rocker structure **8** a pendant **19** is secured to it at its rear end and the forward end of the pendant is secured at **21** to the peak of the jib boom **3.** The forward corner **17** at the other side of the rocker structure is similarly connected with the peak of the jib boom by another pendant, not shown.

Also secured to the channel portion **16** at the forward corner **17** of the rocker structure is a control cable in the form of a wire rope **22** which forms a rearward continuation of the pendant **19,** and a duplicate **22'** of the wire rope **22** is secured to channel portion **16'** (FIG. **9**) at the forward corner **17** of the rocker structure. FIG. **2** shows the rocker structure **8** in a raised position on top of the tower boom into which it is swung by forward pivotal movement about its pivot center **9** and in which the first corner **17** overhangs the tower boom at its forward side and in which the second corner **18** is positioned substantially vertically above the pivot center **9.** While the rocker structure **8** is positioned as shown in FIG. **2,** the wire ropes **22, 22'** extend from the corner **17** along the arcuate periphery of the rocker structure in the grooves of the side portions **16, 16'** toward the corner **18** where they are supported on the rocker structure and connected to hoist cables in the form of wire ropes or pendants **23, 23'** by means of link joints generally designated by the reference characters **24, 24'** (FIG. **9**).

Referring to FIG. **4,** the wire rope **22** is solidly fastened in a forked end piece **26** which in turn straddles one end of an arcuate link **27.** The end piece **26** and the adjacent end of the link **27** are hingedly connected together by a cross pin **28.** The other end of the line **27** is straddled by a forked end piece **29** which is solidly secured to the wire rope **23** and hingedly connected to the adjacent end of the link by a cross pin **31.** The cross pin **28** which connects the end piece **26** with the link **27** extends laterally from both sides of the forked end piece **26** and carries two rollers **32,** one at each side. The rollers **32** are adapted to ride on curved upper edges of two track plates **33** which are rigidly secured to the rocker structure **8** at its rear corner **18.** The same explanations apply to the link joint **24'**.

The wire rope pendant **23** leads from the link joint **24** to a multiple part tackle arrangement connected to a hoist drum on the crane base **1,** and the jib boom **3** may be swung from the depending position in which it is shown in FIG. **2** through the horizontal position shown in FIG. **1** and into the raised position shown in FIG. **3** by rotation of the hoist drum in one direction. In order to provide initial leverage for the pendant **23,** a rearwardly extending pendant guide **34** is secured to the upper end of the tower boom. Continued pull on the pendant **23** will cause rearward swinging movement of the rocker structure **8** from the raised position in which it is shown in FIG. **2** into the lowered position in which it is shown in FIG. **3** and in which the corner **17** overhangs the tower boom at its rearward side while the corner **18** is positioned in close proximity to the latter. During rearward swinging of the rocker structure from the FIG. **2** into the FIG. **3** position, the wire ropes **22, 22'** unwind themselves from the periphery of the rocker structure and the rocker structure will not become subject to undesirable stress conditions due to heavy pull on the pendants **23.** On the other hand, during upward swinging of the rocker structure from the FIG. **3** position to the FIG. **2** position, the wire ropes **22, 22'** wind themselves upon the periphery of the rocker structure, and the link joints **24, 24'** prevent undesirably sharp bends of either the wire ropes or of the pendants when the rocker structure moves into its raised position. Cooperative engagement of the rollers **32** with the track plates **33** counteracts inherent twist forces in the wire ropes and insures proper seating of the wire ropes in the grooves of the side pieces **16, 16'**. Movement of the rollers on the track plates also accommodates stretching of the wire ropes to which they might become subjected under heavy load conditions. Guide lugs **36** are spaced along the arcuate side portions **16, 16'** to facilitate seating of the wire ropes in the grooves.

When the rocker structure **8** swings into its lowered position in the rear of the tower boom, as shown in FIG. **3,** its inertia and relatively heavy weight, and also the inertia of the upwardly swinging jib boom may develop a dangerous tendency of the jib boom to overtravel its upper limit position, particularly when no or only a relatively light load is carried by the load line **37** of the crane, and the upper limit position of the jib boom approaches 90° above horizontal. A stop mechanism for positively preventing such accidental overtravel of the jib boom is mounted on top of the tower boom **2** and constructed as follows.

Referring to FIGS. **5, 6** and **7,** a pair of links **38** and **39** are hingedly interconnected at relatively adjacent ends thereof by a hinge pin **41.** The link **38** is connected by a link pivot pin **40** to a horizontal side beam **42** which forms part of the top structure of the tower boom. The side beam **42** carries the pivot which connects the unitary jib boom to the tower boom and it also carries the pivot **9** for the rocker structure **8,** the link pivot pin **41** being spaced a substantial rearward distance from the front pivot **7.** The link **39** is connected by a link pivot pin **43** to a brace **44** of the jib boom **3** at a fixed radial spacing from the jib boom pivot pin **7.** The distances of the link pivot pins **40** and **43** from the pivot connection **7** of the jib boom, and the effective lengths of the links **38** and **39** are relatively proportioned so that when the jib boom **3** is in its depending position as shown in FIG. **2,** the pivot connection **7** is straddled by the links **38, 39;** and so that when the jib boom is in its raised position, the end of the link **39** which is connected to the link **38** bears against the jib boom **3** above the pivot connection **7,** as best shown in FIG. **7.**

The links **38** and **39** together with their associated pivots **40, 41** and **43** provide freely articulated link means which are operatively interposed between the tower and jib booms **2** and **3** so as to permit downward movement of the jib boom into its depending position along the tower boom, and so as to prevent upward movement of the jib boom beyond a raised limit position.

Referring to FIGS. **5, 7** and **8,** the link **38** comprises a tubular section **45;** a tubular spacer **46** having one end in axial abutting engagement with the free end of the tubular section **45;** a collar **47** in axial abutting engagement with the other end of the spacer **46;** an extension element **48** having a rod portion **49** telescopically extending through the collar **47** and spacer **46** into the tubular section **45;** a coil spring **51** surrounding the rod portion **49** and bearing at its opposite ends against the

collar 47 and against a shoulder 52 on the extension element, and a separable lost motion connection 53 between the tubular link section 45 and the extension element 48, the latter having a bifurcated end receiving the pivot pin 40.

The lost motion connection 53 comprises a pair of side lugs 54, 56 on the tubular section; a pair of side bars 57, 58 bolted respectively to the side lugs 54, 56 and extending therefrom in the longitudinal direction of the tubular section 45 past the spacer 46, collar 47, spring 51 and forked head of the extension element 48. The side bars 57, 58 are straddled by side lugs 59, 61 of the extension member 48, and coupling pins extend through the side lugs 59, 61 and through elongated openings in the side bars 62, 63, respectively, to keep the link section 45 and the extension element in assembled, axially shiftable relation to each other.

In the assembled condition of the link 38 as shown in FIG. 5, upward swing of the jib boom about the pivot connection 7 is limited to about 70° above horizontal. Inertia forces tending to swing the jib boom beyond the 70° limit position have been absorbed by compression of the coil spring 51.

FIG. 6 shows the link 38 in an assembled condition in which it limits the upswing of the jib boom 3 to about 80° above horizontal. Comparing FIG. 6 with FIG. 5, it will be noted that in FIG. 6 the link 38 has been assembled without the spacer 46, and that the collar 47 has been secured to the side bars 57, 58 in a position close to the open end of the tubular link section 45. Here again, inertia forces tending to swing the jib boom 3 beyond the 80° limit position have been absorbed by compression of the coil spring 51. Insertion and removal of the spacer 46 thus provides for varying the effective length of the link 38 and thereby for varying the raised limit position of the jib boom.

From FIG. 7 it will be noted that the stop mechanism comprising the links 38, 39 is duplicated between a horizontal side beam 42' at the top of the tower boom and adjacent portions of the jib boom 3. The explanations hereinbefore with reference to the stop links 38, 39 obviously also apply to the duplicate stop links 38', 39'.

Referring again to FIG. 1, the load line 37 is trained over a pulley 64 at the top of the tower boom and connected to a hoist drum on the crane base, and the usual tower erecting tackle includes a pair of cables 66, 67 (FIG. 9) which are secured to the top of the tower boom and are led from there to another winch on the crane base 1.

We claim:

1. In a tower crane the combination of a vertically positioned tower boom, a unitary jib boom, forward pivot means at the top of said tower boom mounting said jib boom for downward movement into a depending position alongside said tower boom and for upward movement into a raised limit position beyond horizontal; and freely articulated link means operatively interposed between said tower and jib booms so as to permit said downward movement of said jib boom into said depending position and prevent said upward movement thereof beyond said limit position, said link means comprising a pair of links hingedly interconnected at relatively adjacent ends thereof; link pivot means at the top of said tower boom and link pivot means on said jib boom spaced predetermined distances, respectively, from said forward pivot means and operatively connected, respectively, with one and the other of said links; the distances of said first and second mentioned link pivot means from said forward pivot means, and the effective lengths of said links being relatively proportioned so that when said jib boom is in said depending position said forward pivot means are straddled by said hingedly interconnected links, and when said jib boom is in said raised limit position one said hingedly interconnected link ends bears against said jib boom above said forward pivot means.

2. The combination set forth in claim 1 and further comprising means for varying the effective length of said one of said hingedly interconnected links and thereby varying said raised limit position of said jib boom.

3. The combination set forth in claim 1, wherein said one of said hingedly interconnected links comprises an assembly of telescopically extensible and contractable thrust transmitting elements, and resilient means operatively interposed between said thrust transmitting elements so as to yieldingly resist relative contraction of the latter.

4. The combination set forth in claim 3, and further comprising an auxiliary thrust transmitting element adapted for selective insertion into and removal from said assembly so as to increase and decrease the effective length of said one of said hingedly interconnected links.

5. In a tower crane the combination of a vertically positioned tower boom, a unitary jib boom, forward pivot means at the top of said tower boom mounting said jib boom for downward movement into a depending position alongside said tower boom and for upward movement into a raised limit position beyond horizontal; and freely articulated link means operatively interposed between said tower and jib booms so as to permit said downward movement of said jib boom into said depending position and prevent said upward movement thereof beyond said limit position, said link means comprising a tubular first link member and second link member hingedly interconnected at relatively adjacent ends thereof; a bracket structure secured to said tubular link member and extending lengthwise beyond the free end of the latter, a collar selectively connectable to said bracket structure at different axial spacings from said free end of said tubular link member; an extension element having a rod portion extending telescopically through said collar and into said tubular link member; a coil spring surrounding said rod portion and bearing at its opposite ends against said collar and a shoulder of said extension element; a lost motion connection between said bracket structure and said extension element; link pivot means at the top of said tower boom and link pivot means on said jib boom spaced predetermined distances, respectively, from said forward pivot means and operatively connected, respectively, with said extension element and with the free end of said second link member; the distances of said first and second mentioned link pivot means from said forward pivot means, and said link members and extension element being relatively proportioned so that when jib boom is in said depending position said first pivot means are straddled by said hingedly interconnected link members and when said jib boom is in said raised limit position one of said hingedly interconnected link ends bears against said jib boom above said forward pivot means.

6. In a tower crane the combination of a vertically positioned tower boom, a unitary jib boom, forward pivot means at the top of said tower boom mounting said jib boom for downward movement into a depending position alongside said tower boom and for upward movement into a raised limit position beyond horizontal, and freely articulated link means operatively interposed between said tower and jib booms so as to permit said downward movement of said jib boom into said depending position and prevent said upward movement thereof beyond said limit position, said link means comprising a tubular first link member and a second link member hingedly interconnected at relatively adjacent ends thereof; a tubular spacing element having one end in axial abutting engagement with the free end of said tubular link member, a collar in axial abutting engagement with the other end of said spacing element; an extension element having a rod portion extending telescopically through said collar and spacing element into said tubular link member, a coil spring surrounding said rod portion and bearing at its opposite ends against said collar and a shoulder on said extension element; separable lost motion connecting means between said tubular link member and said extension element; link pivot means at the top of said tower boom and link pivot means on said jib boom spaced predetermined distances, respectively, from said forward pivot means and operatively connected, respectively, with said extension element and with the free end of said second link member; the distances of said first and second mentioned link pivot means from said forward pivot means, and said link members and extension element being relatively proportioned so that when said jib boom is in said depending position said forward pivot means are straddled by said hingedly interconnected members, and when said jib boom is in said raised limit position one of said hingedly interconnected link ends bears against said jib boom above said first pivot means.

7. In a tower crane, the combination of a vertically positioned tower boom; a jib boom, forward pivot means at the top of said tower boom mounting said jib boom for downward movement into a depending position along the forward side of said tower boom and for upward movement into a raised position beyond horizontal; a sector shaped rocker structure having a hub portion and an arcuate peripheral portion presenting first and second corners at its opposite ends; rearward pivot means at the top of said tower boom mounting said rocker structure at said hub portion thereof for forward swinging movement into a raised position in which said first corner thereof overhangs said tower boom at its forward side and said second corner is positioned above said rearward pivot means, and for rearward swinging movement into a lowered position in which said first corner of said rocker structure overhangs said tower boom at its rearward side and said second corner is positioned in proximity to the latter; a pendant connected at its opposite ends to said first corner of said rocker structure and to the peak of said jib boom; a control cable anchored at one end thereof to said first corner of said rocker structure and movable upon and from said arcuate peripheral portion of said rocker structure; a link member pivotally connected with the other end of said control cable and adapted to bear upon said second corner of said rocker structure while the latter is in said raised position; a hoist cable pivotally connected with said link member; and roller means on said link member and track means connected with said rocker structure at said second corner thereof for cooperative engagement with said roller means during swinging movement of said rocker structure into said raised position, and for separation of said track means from said roller means during swinging movement of said rocker structure into said lowered position.

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