Jan. 8, 1963 E. B. NICKLES 3,072,265

BOOM RIGGING

Filed Oct. 28, 1960 3 Sheets-Sheet 1

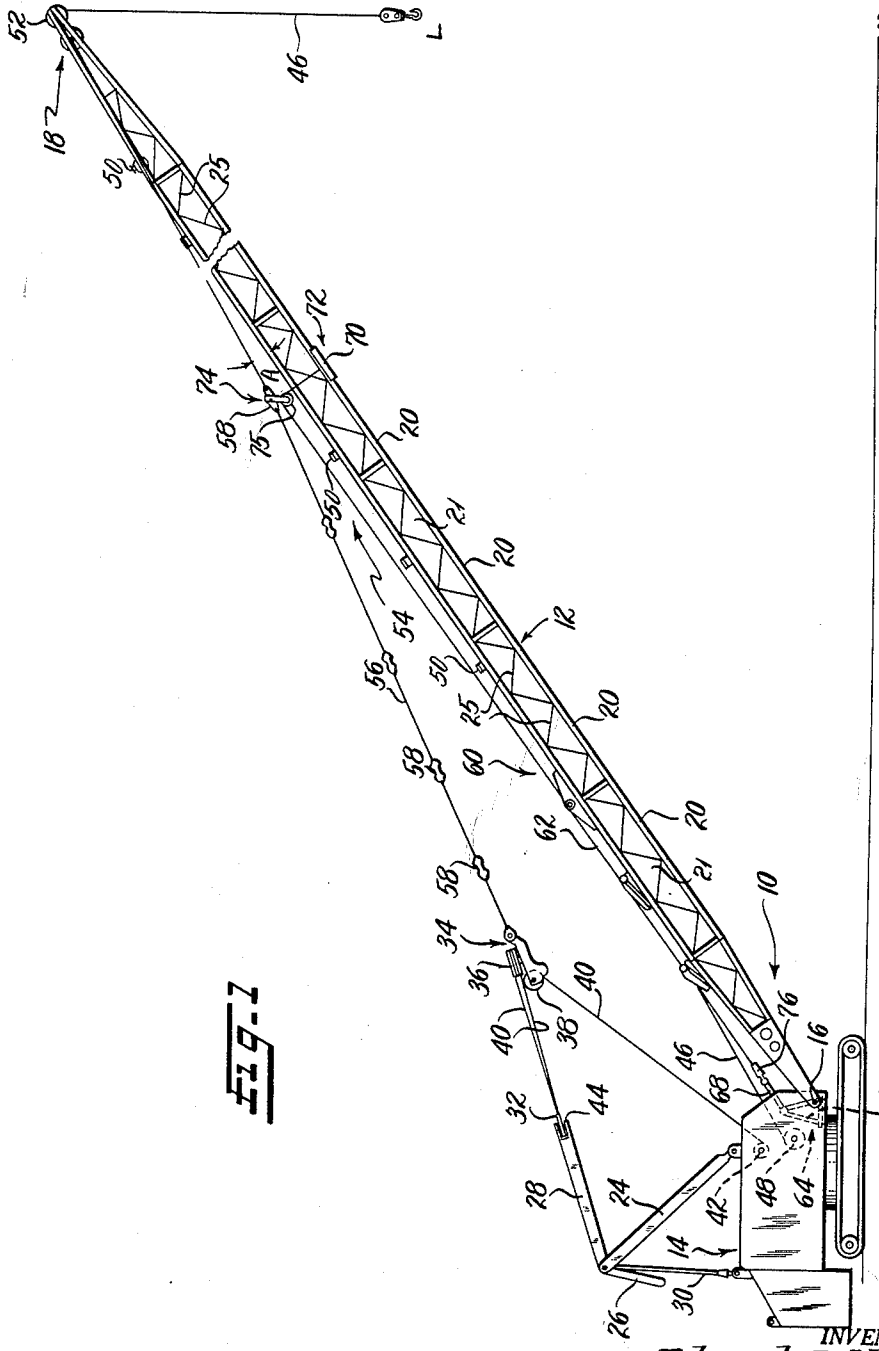


FIG. 1

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BOOM RIGGING

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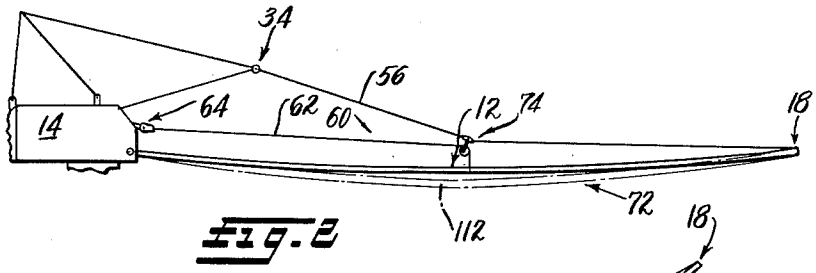


Fig. 2

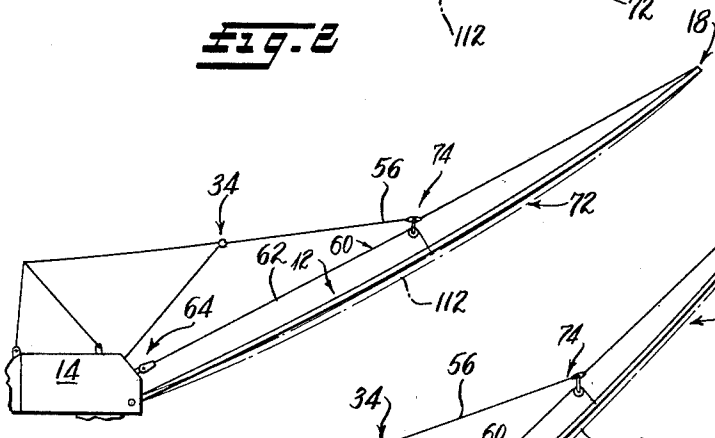


Fig. 3

Fig. 4

Fig. 5

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BOOM RIGGING

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Fig. 6

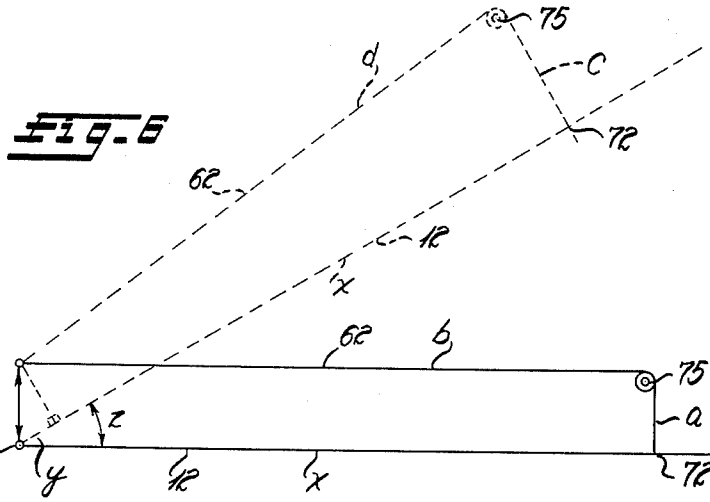


Fig. 7

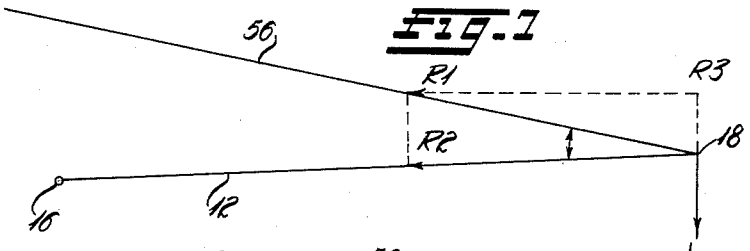


Fig. 9

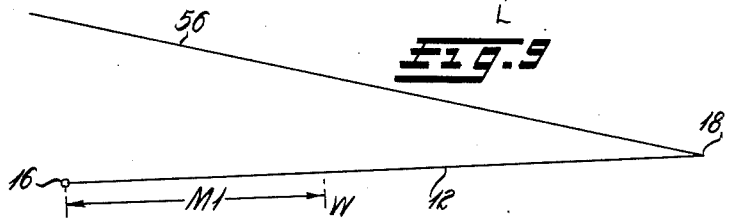


Fig. 8

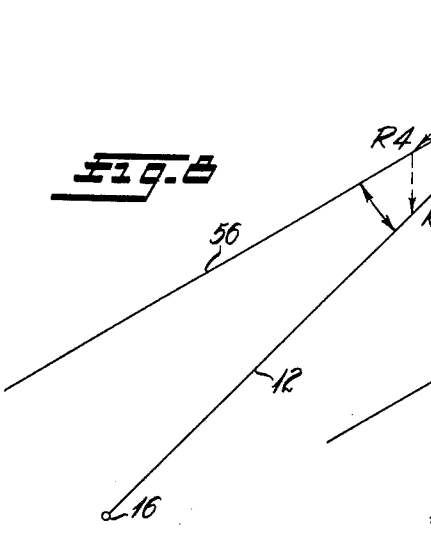
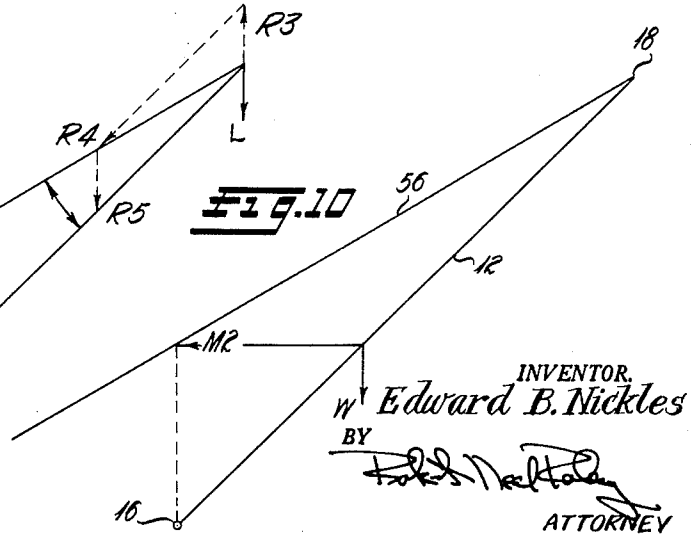


Fig. 10



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3,072,265
BOOM RIGGING

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16 Claims. (Cl. 212—59)

The invention relates to boom rigging and more particularly to an auxiliary suspending or supporting rigging assembly utilized in conjunction with a conventional boom structure and rigging in such manner as to limit the amount of downward bow in the boom structure thereby increasing the load-carrying capacity thereof.

The use of relatively long booms is becoming more and more commonplace and, as well, the actual lengths employed are being steadily increased. For example, it is not now unusual to encounter operations where booms having lengths exceeding 250 feet are desirable as well as practical. The utilization of such booms possess problems not realized with the much shorter booms which, in the past, were used almost exclusively. One such problem stems from the fact that the weight of a long boom becomes a material factor in the stresses which the boom must undergo during use. Consequently, the load-carrying capacity of the boom is reduced. The limiting factor is not the substantially pure compressive stresses induced when the boom is at or near a vertical position where its weight is acting axially therealong but the limiting factor is the stresses induced by bending when the boom is disposed near a horizontal position. When horizontal, the weight of the boom will be acting entirely as a bending moment, tending to produce a downward bowing or deflection of the boom. Of course, this deflection imposes a severe limitation upon the load-carrying capacity of the boom since further loading of the boom, conventionally rigged, by imposition of a load thereon will only increase the deflection.

In other words, the weight of a conventionally rigged boom having a length such as is common today will produce sufficient downward bow of the boom when horizontally disposed as to seriously impair or limit the additional loading which may be imposed on the boom. This occurs by reason of the fact that long booms especially are susceptible to failure by buckling initiated by bowing. That is to say, a boom such as is contemplated here is acting as a long, thin column and, as is well known, such members fail most easily due to excessive bowing or buckling.

It is therefore a primary object of the present invention to controllably limit the boom-weight induced bowing or deflection of a boom so as to thereby increase the load-carrying capacity of the boom.

It is also an object of this invention to provide an auxiliary support assembly, cooperable with a conventional pendant bridle support as used for raising and lowering a boom, which will limit the downward bow of a boom.

A further object of this invention resides in the provision of an auxiliary rigging assembly for supporting a boom which cooperates with a conventional pendant bridle type support structure in such manner as to limit the downward bow of the boom to a predetermined maximum when the boom is disposed substantially horizontal, that is, in the most adverse position of loading, and which will automatically decrease its effect as the boom is moved toward the vertical, so that as the boom approaches the condition in which the forces acting thereon are substantially entirely axial compressive forces, the natural deflection or bow of the boom then being at a minimum, the effect of the auxiliary support will also be at a minimum.

A still further object of the present invention is to provide an auxiliary rigging assembly for supporting booms which is so arranged geometrically relative to the boom and the support therefor as to produce a maximum supporting force when the boom is disposed generally horizontal and which produces a progressively lessening supporting force as the boom is moved toward the vertical.

It is also a further object of this invention to provide improved boom support structure for supporting a hingeably mounted boom wherein the boom support structure includes a conventional bridle pendant rigging and an elongated bodily flexible element which is anchored at one end portion to a location which is adjacent the boom hinge and at the other end portion to the boom at a location thereon which is intermediate the end portions thereof with the elongated element being supported intermediate the end portions thereof from the pendant bridle support structure.

An additional object of this invention is to provide an improved boom support structure for supporting a boom which is hingeably mounted to the upper works of a crane, or the like, wherein the boom support structure includes pendant bridles which extend generally longitudinally along the boom from the upper works to the boom point and an auxiliary assembly in the form of an elongated bodily flexible cable which has one end portion anchored at a location on the upper works which is within the angle defined by the boom and the pendant bridles with the cable extending away from the location and passing over a sheave, pulley, or the like, which is carried by the pendant bridles with the other end portion of the cable being secured to the boom at a location thereon which is intermediate the end portions thereof.

In order to accomplish the desired objects as stated above, the improved boom support structure for supporting a boom which may be hingeably mounted to the upper works of a crane, or the like, comprises an auxiliary boom support assembly in the form of an elongated bodily flexible rope or cable which cooperates with the conventional type of pendant bridles which are employed for supporting the boom and for enabling the boom to be raised and lowered as desired. The bodily flexible elongated cable is anchored to the upper works of the crane at a location thereon which is within the confines of an angle that is defined by the boom and the pendant bridle support structure and the cable extends away from the stated location on the upper works and passes over a sheave or pulley which is secured to and carried by the pendant bridle support structure and the other end portion of the cable is anchored and secured to the boom at a location thereon which is intermediate the hinge and the boom point.

Other objects, advantages and important features of the invention will be apparent from a study of the specification following, taken with the drawing, which together describe, disclose and illustrate an embodiment of the invention and what is now considered and believed to be the best mode of practicing the principles thereof. Still other embodiments may be suggested to those having the benefit of the teachings herein, and such other embodiments are intended to be reserved especially as they fall within the scope and breadth of the subjoined claims.

In the drawing:

FIGURE 1 is a side elevational view of a crane apparatus having a conventional boom and rigging and illustrating an auxiliary support structure according to this invention incorporated therewith;

FIGURE 2 is a diagrammatic view of the crane apparatus of FIG. 1 showing the boom disposed substantially horizontal and illustrating in full lines the boom having the auxiliary support structure applied thereto

and in dotted lines the boom without the auxiliary support structure;

FIGURES 3, 4 and 5 are each diagrammatic views similar to FIG. 2 but illustrating, in each instance, the boom as being disposed in various different positions relative to the horizontal;

FIGURE 6 is a diagrammatic view showing the geometrical relationship of the auxiliary support structure with an associated boom;

FIGURES 7 and 8 are force diagrams illustrating a boom as being disposed horizontally and partially elevated, respectively, and showing the variations in the force components acting on a boom and a pendant bridle support structure therefor as the boom is raised while supporting a given load; and

FIGURES 9 and 10 are force diagrams showing the bending moment effect produced by the weight of the boom and illustrating the variations therein as the boom is raised.

Attention is now directed to FIG. 1 of the drawing wherein there is illustrated a crane 10 having an elongated boom 12 hingeably connected to an upper works 14 by a hinge structure 16 with the boom 12 extending therefrom and terminating in a boom point 18.

According to conventional practice, the boom 12 may comprise a plurality of insert sections 20 each of which includes a plurality of chords 21 and interconnecting reinforcing lacing members 25, all preferably formed from tubular steel stock, although it will be appreciated that other materials may be used and that insofar as the present invention is concerned the specific construction of the boom 12 may be in any desired fashion or manner and further that it is the relationship of the boom 12 and the support structure therefor, as will be hereinafter set forth, which is significant and important in connection with this invention.

A gantry 24 is pivotally mounted to the upper works 14 and carries an anchor strap 26 and a back hitch strap 28. A back hitch pendant 30 extends between the gantry 24 and the upper works 14 for maintaining the gantry 24 in a position, as illustrated, which enables the boom 12 to be operated as desired and the anchor strap 26 enables the gantry 24 to be tied to the upper works 14 to position the gantry 24 in a lowered position. The back hitch strap 28 carries sheaves 32 which cooperate with a spreader or equalizer assembly 34 having sheaves 36—38 thereon by reason of a boom hoist rope 40 which is wound upon a boom hoist 42 and issues therefrom to pass first over the sheave 38 of the spreader assembly 34 then over the gantry sheave 32, back to the spreader sheave 36 and finally back to an anchor 44 on the back hitch strap 28.

A load hoist cable 46 is provided which is wound about a hoist drum 48 and passes through guides 50 to sheaves 52 secured adjacent the boom point 18 and the load hoist cable 46 then passes on to any load L being handled by the crane 10.

Boom rigging or boom support structure 54 is provided for supporting the boom 12 during the operation thereof on movement between a substantially horizontal position to a substantially vertical position as illustrated in FIGS. 3–5. The support structure 54 includes primary support structure 56 defined by a plurality of elongated bodily flexible pendant bridles, such as cables, ropes, or the like, which are interconnected in end-to-end fashion by connectors 58 with the interconnected pendant bridles 56 extending between the spreader or equalizer assembly 34 and the boom point 18 with the adjacent end portions of the pendant bridle support structure 56 being anchored respectively thereto. The pendant bridles 56 are each preferably made in sections of suitable lengths which substantially correspond to the length of the insert sections 20 of the boom 12 which enables the overall effective length of the boom 12 and the pendant bridle support structure 56 to be adjusted and varied for different conditions by merely adding or removing the insert sections 20 together with the corresponding associated pendant bridles 56.

The boom rigging 54 further includes auxiliary support structure 60 in the form of an assembly including a bodily flexible elongated member 62 which may also be preferably a cable or a rope having a fixed unstressed length.

An anchor device 64 secures one end portion of the member 62 to the upper works 14 at a location thereon which is within the confines of an angle A defined by the boom 12 and the pendant bridle support structure 56 with the location being intermediate the boom 12 and the back hitch strap 28. As illustrated in FIG. 1 of the drawing the anchor device 64 comprises an upstanding stand 66 having a pivotally mounted arm 68 which extends generally in the direction toward the apex of the angle A.

Another anchor device 70 secures the other end portion of the member 62 at a suitable location 72 along the boom 12 with the location 72 being intermediate and spaced from the hinge structure 16 and the boom point 18 of the boom 12. In actual practice, it has been found preferable to position the location 72 as near as possible to the center of the boom 12, i.e., somewhere adjacent to the mid point between the hinge structure 16 and the boom point 18.

The member 62 is secured to the arm 68 and extends therefrom above the adjacent portion of the boom 12 between the boom 12 and the pendant bridle support structure 56 toward the boom point 18 or the apex of the angle A and passes over or through a support 74 in the form of an antifriction device 75, such as a sheave, pulley, or the like, carried by the connector 58 of the pendant bridle support structure 56 which is disposed adjacent to the location 72 on the boom 12 so that the intermediate portion of the member 62 is flexibly supported by the sheave device 75 through the pendant bridle support structure 56.

In order to provide the member 62 with a desired amount of tension, an adjustment 76, in the form of a turnbuckle, or the like, may be provided and, as illustrated, such adjustment is shown as being disposed adjacent to the arm 68 of the anchor device 64.

For the sake of brevity, in the above description and disclosure, only one element of the respective support structures and associated accessories has been mentioned, but it is to be noted and understood that corresponding elements and accessories are provided in laterally spaced relationship relative to each other on each side of the crane 10 and the boom 12.

It is also to be understood that other apparatus than the crane 10 may be provided with the improved boom rigging support structure of this invention and in such instances the auxiliary rigging assembly 60 will be anchored to a base from which the boom 12 may be pivoted in the manner as described and disclosed above with reference to the upper works 14 of the crane 10.

The effect of the auxiliary support assembly 60 on the boom 12 may be noted from an inspection of FIGS. 2–5 wherein there is illustrated, in solid lines, the boom 12 having the auxiliary support assembly 60 provided therewith while in dotted lines a boom 112 is illustrated, for the purpose of comparison, which is not provided with the auxiliary support assembly 60. It is to be noted that the boom 112 has an appreciable amount of normal downward bow or natural deflection due to the weight of the boom while the boom 12, which is provided with the auxiliary support assembly 60, has a controlled bow or downward deflection which is materially reduced. In actual practice, it has been found that the resulting effect of employing the auxiliary support assembly 60 with the boom 12 will decrease the normal downward bow or natural deflection therein by a value equal to at least one half the extent of the normal downward bow or natural deflection.

As can be seen sequentially in FIGS. 2–5, as the boom is raised toward the vertical, less and less deflection or bow results. The reason for this is twofold. First, the bending moment exerted on the boom by virtue of its weight W decreases progressively as the boom is moved from horizontal toward the vertical since the moment arm is progressively decreased. Second, the axial compressive force component in the boom as transmitted thereto by the pendant bridle support structure 56 decreases from the horizontal toward the vertical position of the boom.

This latter effect can be seen more clearly in FIGS. 7 and 8 of the drawing. In FIG. 7, the boom is substantially horizontal and the load L is equal to the boom weight component at the free end of the boom plus whatever actual load is being supported. In order to support the boom under this condition, the pendant bridle support structure must exert a force R–1 which produces a vertical component R–3 equal to the load L. An axial compression force R–2 is imposed upon the boom which is of course opposed at the hinged connection for the boom. Consider now FIG. 8 wherein the same load L is supported by the boom which is now at about 45° elevation. In FIG. 8, due to the changed geometry of the force system, the pendant bridle support structure must exert a much smaller force R–4 to produce the vertical component R–3 which is equal to the load L. Likewise, the axial compression component R–5 on the boom is much smaller than the compression component R–2. Thus, it will be appreciated that as the boom is raised, with the load L remaining constant, both the tension in the pedant bridle support structure and the axial compression component in the boom decrease progressively. Theoretically, the tension in the pendant bridle support structure would be zero when the boom is prefectly vertical and the axial compression component in the boom would be equal to the load L.

To consider the effect produced by the weight W of the boom, reference is now had to FIGS. 9 and 10 of the drawing. In FIG. 9, the boom is substantially horizontal and the weight W thereof acts through the center of gravity at a moment arm M–1 effecting forces at the hinge structure 16 to produce a bowing effect. When, on the other hand, the boom is raised from the horizontal, as in FIG. 10, the moment arm M–2 is much smaller thus producing considerably less bowing or deflection in the boom.

It will be appreciated, however, that the bowing effect is not produced solely by the weight of the boom but is also effected by the axial compression force on the boom. Therefore, when the boom is horizontal and the bending moment due to the weight of the boom and the axial compression force is greatest, the maximum deflection will occur. Conversely, since both the bending moment and the axial compression lessen as the boom is raised, the deflection is correspondingly decreased. Therefore, to utilize the principle of the present invention, some provision should be made to decrease the auxiliary supporting effect as the boom is raised, for if such is not done, the relatively large auxiliary support effect necessary when the boom is horizontal may well produce a reversal of the deflection at some point during the raising of the boom.

The manner in which the auxiliary support force is decreased as the boom is raised is illustrated in FIG. 6. In this FIGURE, the boom 12 is illustrated in full lines in the horizontal position and in dotted lines in a partially raised position. In the horizontal position, the auxiliary support cable member 62 is illustrated by *a*—*b* and in the raised position by *c*—*d*. For the sake of simplicity, the auxiliary support portion *b* is illustrated as of the same length and parallel to the partial length X of the boom 12 when the boom is horizontal. Although this condition need not prevail for proper operation of this invention, the principle involved is the same in any case. As stated, in FIG. 6, a plus *x* and of course a plus *b* equal the fixed length of the auxiliary support cable member 62. Now, when the boom 12 is raised through angle Z, as shown, it can be seen by inspection that *d* is approximately equal to *x* minus *y* although due to the fact that *d* is not parallel to the boom 12, it will be slightly greater than *x* minus *y*, but not significantly so. In any event, it is easily seen that *d* is less than both *x* and *b*. Consequently, *c* must be greater than *a*. Therefore, the force exterted by the auxiliary support member 62 decreases as the boom 12 is raised since the distance *a* and *c* in FIG. 6 reflect the amount of deflection imparted to the pendant bridle support structure 56 by the auxiliary support assembly 60, see also FIGS. 2–5. In other words, the force exerted by the auxiliary support assembly 60 is caused by the degree to which the pendant bridle support structure 56 is deflected from its otherwise substantially straight line condition, coupled with the amount of tension in the pendant bridle support structure 56. Since the tension in the pendant bridle support structure 56 steadily decreases as the boom 12 is raised it is not necessary that the deviation from the straight line of the pendant bridle support structure 56 be decreased as the boom 12 is raised in order to decrease the auxiliary support assembly 60 force. In fact, in FIGS. 2–5, the deflection of the pendant bridle support structure remains substantially constant and in this case, it is substantially solely the decrease in the pendant bridle support structure 56 tension which decreases the auxiliary support assembly 60 force as the boom is raised. However, this deflection of the pendant bridle support structure 56 is of course dependent upon the geometry involved and may be altered as desired.

While the invention has been described and disclosed in terms of an embodiment which it has assumed in practice, the scope of the invention should not be deemed to be limited by the precise embodiment herein shown, illustrated, described and disclosed and it is to be understood that other such embodiments are intended to be reserved, especially as they fall within the scope of the claims herein subjoined.

I claim as my invention:

1. In a crane having an upper works, an elongated boom hingeably mounted to the upper works and bodily flexible pendant bridle support structure for supporting the boom, the improvement comprising, in combination with the boom, the upper works and the pendant bridle support structure, an auxiliary support assembly including an elongated bodily flexible member, a device for anchoring one end portion of said member to the upper works of the crane at a location thereon which is within the confines of an angle defined by the boom and the bodily flexible pendant bridle support structure, another device for anchoring the other end portion of the member to the boom at a location thereon which is intermediate the end portions thereof, and still another device for supporting the intermediate portion of the member from the bodily flexible pendant bridle support structure.

2. In a crane having an upper works, an elongated boom hingedly mounted to the upper works and bodily flexible pendant bridle support structure for supporting the boom, the improvement comprising, in combination with the boom, the upper works and the pendant bridle support structure, an auxiliary support assembly including an elongated bodily flexible member, a device for securing one end portion of said member to the upper works of the crane, another device for securing the other end portion of the member to the boom at a location thereon which is intermediate the end portions thereof, and still another device for supporting the intermediate portion of the member from the bodily flexible pendant bridle support structure.

3. A crane having an upper works, an elongated boom hingeably mounted to the upper works, bodily flexible

pendant bridle support structure for supporting the boom, and an auxiliary support assembly including an elongated bodily flexible cable-like member, a device for securing one end portion of said member to the upper works of the crane at a location thereon which is within the confines of an angle defined by the boom and the bodily flexible pendant bridle support structure, another device for securing the other end portion of the member to the boom at a location thereon which is intermediate the end portions thereof, and an anti-friction device for supporting the intermediate portion of the member from the bodily flexible pendant bridle support structure.

4. Support structure for supporting an elongated hingeably mounted boom from a base, said support structure including a plurality of pairs of elongated cable devices attached to and extending between the base and the boom, one of said cable devices of each pair having the intermediate portion thereof supported from the other cable device of the respective pair.

5. The support structure as set forth in claim 4 wherein each of said one cable devices has one end portion thereof anchored to the base and the other end portion thereof anchored to the boom at a location thereon which is intermediate the end portions thereof.

6. Support structure for supporting an elongated hingeably mounted boom from a base, said support structure including a pair of elongated members attached to and extending between the base and the boom, one of said members having the intermediate portion thereof supported from the other member.

7. The support structure as set forth in claim 6 wherein said one member has one end portion anchored to the base and the other end portion thereof anchored to the boom at a location thereon which is intermediate the end portions thereof.

8. In combination with a boom hingeably mounted to a base and primary support structure for supporting the boom during movement thereof between generally horizontally disposed and generally vertically disposed positions, auxiliary support structure for supporting the boom, said auxiliary support structure including an elongated bodily flexible member, a device for securing one end portion of the member to the base, another device for securing the other end portion of the member to an intermediate portion of the boom, and still another device for supporting an intermediate portion of the member from the primary support structure.

9. In combination with a boom hingeably mounted to a base and primary support structure for supporting the boom during movement thereof, auxiliary support structure for supporting said boom, said auxiliary support structure including an elongated bodily flexible member having one end portion anchored to the base and the other end portion anchored to an intermediate portion of the boom, and an anti-friction device for flexibly supporting an intermediate portion of the member from the primary support structure.

10. In combination with a boom hingeably mounted to a base and primary support structure for supporting the boom during movement thereof, auxiliary support structure for supporting the boom, said auxiliary support structure including an elongated bodily flexible member having one end portion anchored to the base and the other end portion anchored to an intermediate portion of the boom, and a device for supporting an intermediate portion of the member from the primary support structure.

11. An elongated boom hingeably mounted to an upper works of a crane, said boom extending away from said upper works and terminating in a boom point, support structure extending between the upper works and the boom point, said support structure defining with said boom an angle, auxiliary support structure extending between the upper works and the boom, said auxiliary support structure including a bodily flexible elongated cable-like member, a device securing one end portion of the member to the upper works at a location thereon which is within the confines of the angle defined by the support structure and the boom, another device securing the other end portion of the member to the boom at a location thereon which is intermediate the end portions thereof, and still another device supporting an intermediate portion of the member from the support structure.

12. An elongated boom hingeably mounted to a base, said boom extending from said base and terminating in a boom point, primary support structure extending between the base and the boom point, said primary support structure defining with said boom point an angle, auxiliary support structure extending between the base and the boom, said auxiliary support structure being supported by the primary support structure and secured to the base at a location thereon which is within the confines of the angle defined by the support structure and the boom and secured to the boom at a location thereon which is intermediate the end portions thereof.

13. An elongated boom hingeably mounted to a base, elongated primary and auxiliary support structure extending between the base and the boom for supporting the boom from the base, said auxiliary support structure being supported intermediate the end portions thereof by the primary support structure and secured adjacent one end portion to the base and also secured adjacent the other end portion to the boom at a location thereon which is intermediate the end portions thereof.

14. A support assembly for supporting a boom having one end portion hingeably mounted to a base, said assembly including a device for anchoring one end portion of a member to the base adjacent the hinged end portion of the boom, another device for anchoring the other end portion of the member to an intermediate portion of the boom, and flexible support structure for supporting an intermediate portion of the member from the base.

15. A support assembly for supporting a boom having one end portion hingeably mounted to a base, said assembly including an elongated bodily flexible member having one end portion secured to the base adjacent the hinged end portion of the boom and the other end portion thereof secured to an intermediate portion of the boom, and apparatus for flexibly supporting an intermediate portion of the member from the base.

16. A support assembly for supporting a boom having one end portion hingeably mounted to a base, said assembly including a device for anchoring one end portion of a member to the base, another device for anchoring the other end portion of the member to an intermediate portion of the boom, and anti-friction support structure for flexibly supporting an intermediate portion of the member from the base.

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