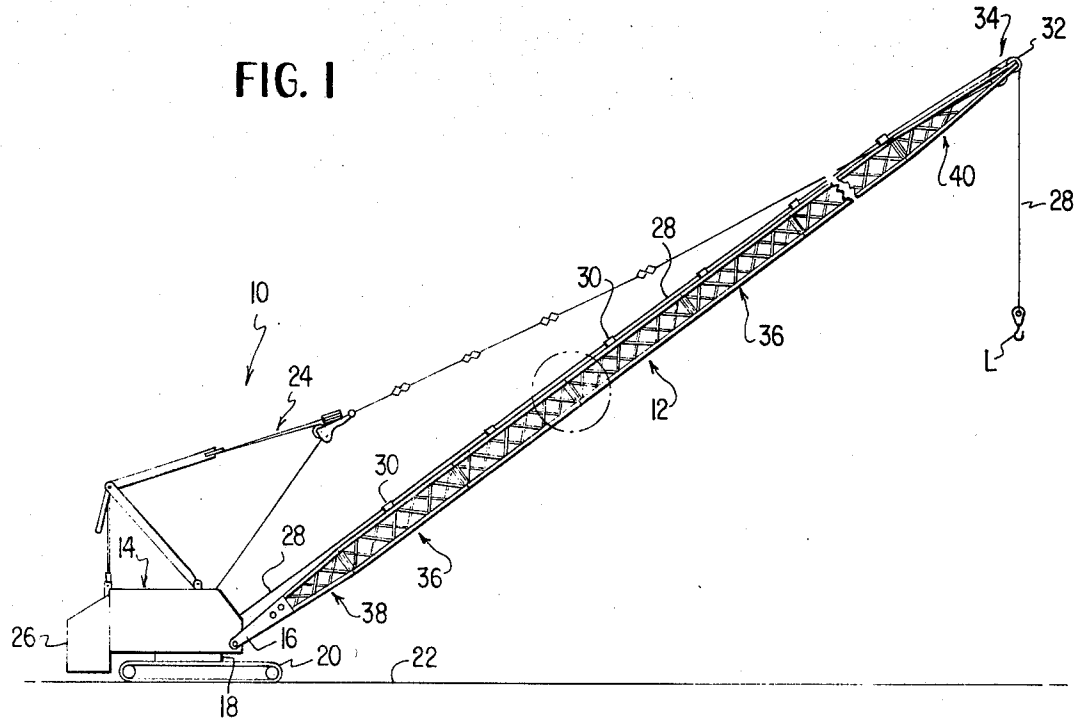
May 12, 1970 D. C. MARKWARDT 3,511,388

PIN CONNECTION FOR ELONGATE LOAD SUPPORTING BOOM STRUCTURE

Filed Sept. 18, 1967 2 Sheets-Sheet 1

FIG. 1



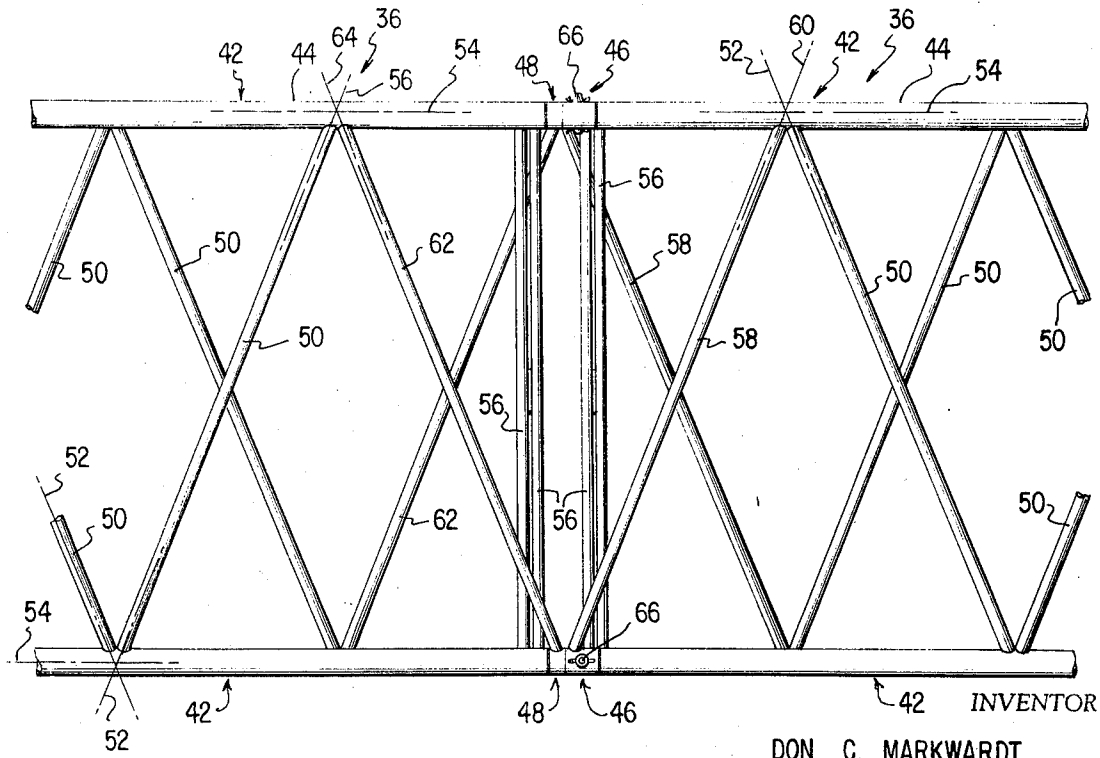


FIG. 2

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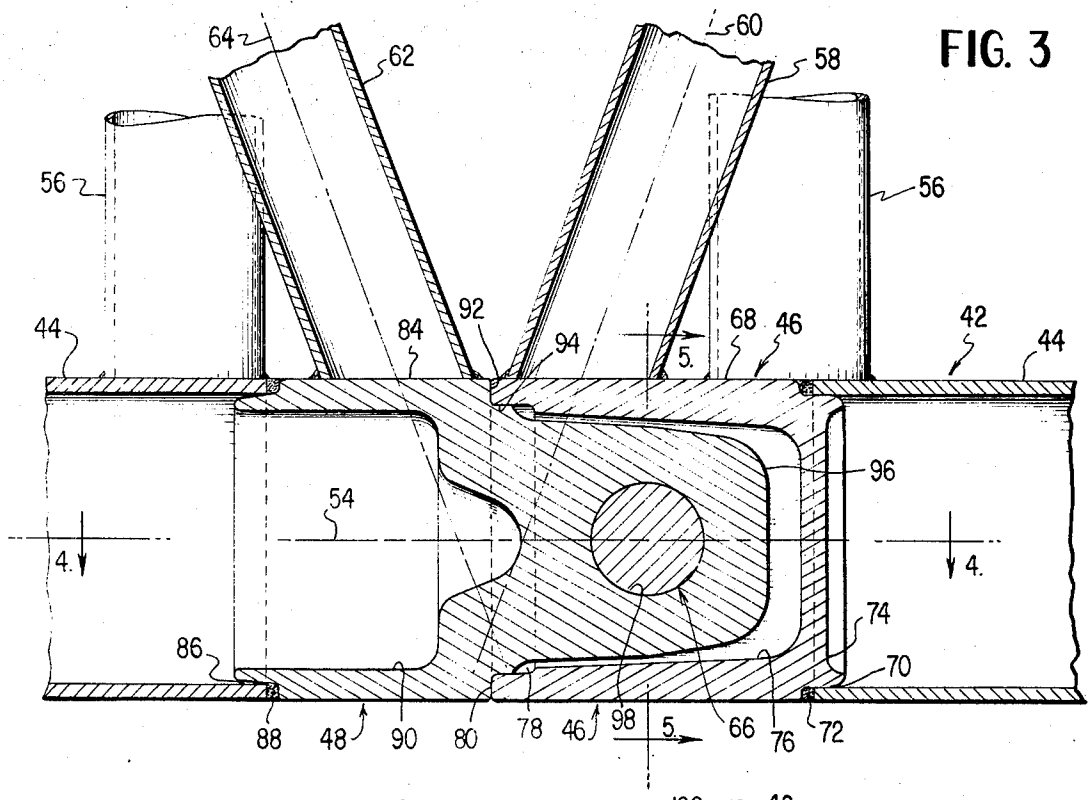

FIG. 3

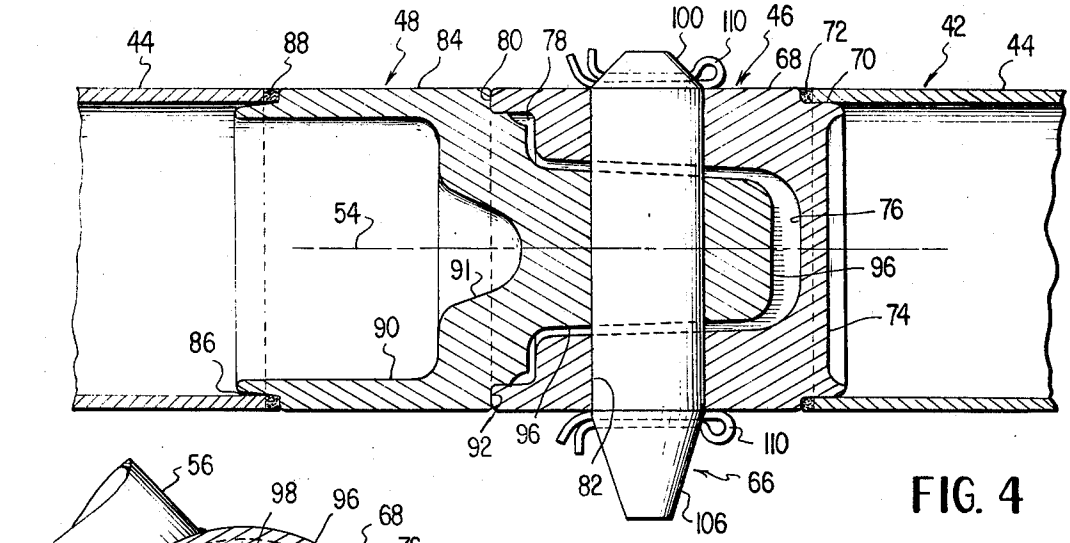

FIG. 4

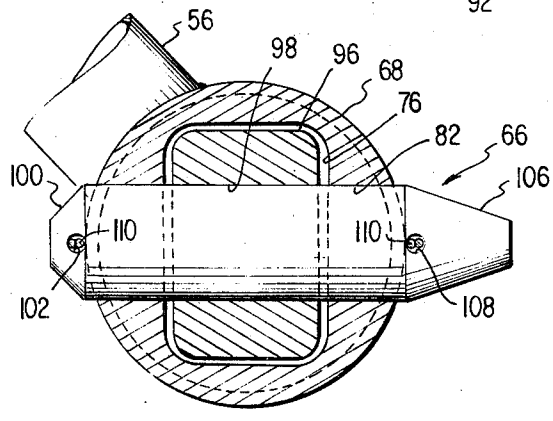

FIG. 5

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PIN CONNECTION FOR ELONGATE LOAD SUPPORTING BOOM STRUCTURE

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U.S. Cl. 212—144 12 Claims

ABSTRACT OF THE DISCLOSURE

The instant invention comprises a pin connection for boom segments in which the centerlines of the terminal lacing elements intersect within the confines of the chords thereby achieving the desiderata of easy assembly and disassembly of the boom segments, avoidance of localized eccentric loading of the chord, and general predictability of force diagrams drawn at the junction of the terminal lacing element and the chord. This is effected by recessing a female connector socket within the terminal end portion of the chord and securing the terminal lacing element as near as possible to the chord terminus. By constructing male and female connectors independently of the chord and fixedly securing them to the chord, it has been found that various economies in boom structure production may be made consistent with structural strength. Since the pinned male and female connectors of the instant invention peripherally abut, additional bearing area is provided to resist angular relative movement between adjacent boom segments and to transmit compressive loads on the chords.

This invention relates to a pin connection for elongate load supporting boom structures, and more particularly to a connection for crane boom structures, and the like, that is relatively easy to assemble and disassemble and at the same time produces an optimum distribution of forces along the boom structure.

Load supporting boom structures of the type used in equipment, such as cranes, draglines, and the like, are generally pivotally mounted adjacent one end portion thereof to a stationary or mobile base support and are equipped with suitable rigging to alter the inclination of the boom structure with respect to the ground in order to perform the various functions for which the equipment is made. The trend of recent years is to provide longer and longer boom structures in order to meet the requirements and demands of construction and excavation problems.

In order to allow dismantling of the boom structure for convenient transportation from place to place, boom structures may be constructed in a plurality of disconnectible segments. Boom segments are conventionally made of a plurality of generally axially disposed or extending parallel chords interconnected by diagonally disposed or extending lacing elements to provide the desired structural strength. The terminal end portions of each chord is generally provided with connections of one type or another in order to secure abutting boom segments together.

One desideratum of boom segment construction is that the centerlines of the lacing elements intersect generally at the centerline of the chords to avoid localized

eccentric loading of the chord and to provide predictable force diagrams at the junction of the lacing element and the respective chord of the boom structure. This has not been difficult to achieve intermediate the ends of the chords. However, difficulty has arisen in constructing the boom segments such that the terminal lacing elements of abutting boom segments intersect within the confines of the respective chord as near as possible to the centerline of the chord.

One manner of achieving the desired result is by using flanged connections between abutting boom segments. This has proven undesirable because of the multiplicity of flange nuts that must be removed upon disassembly and reinstalled upon assembly of abutting boom segments thereby unnecessarily prolonging break down and set up time when a crane is moved from one construction site to another.

It is an object of the instant invention to provide a readily assemblable and disassemblable boom structure for cranes and the like wherein the connection between adjacent boom segments enables the centerlines of the terminal lacing elements to intersect within the confines of the chord.

Another object of the instant invention is to provide a pin connection for a disassemblable load supporting boom structure that allows the centerlines of terminal lacing elements of the several boom segments to intersect within the confines of the chords.

Still another object of the instant invention is to provide a pin connection for load supporting boom structures in which a female socket is disposed within the end portion of one of the chords to allow placement of the terminal lacing element in a most desirable position.

A further object of the instant invention is to provide a male-female connection for boom structures and the like in which peripheral abutting faces of the connection provide additional bearing surface to resist relative angular movement between boom segments.

A still further object of the instant invention is to provide a boom connection having the characteristics described wherein a single pin may be used to connect abutting chords.

Still another object of the instant invention is to provide a pinned boom connection which may be readily constructed to provide rapid assembly and disassembly consistent with optimum distribution of forces at the junction of adjacent boom segments.

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

In the drawing:

FIG. 1 is a side elevational view of a typical type of crane apparatus equipped with load supporting boom structure constructed in accordance with the principles of the instant invention;

FIG. 2 is an enlarged partial side elevational view of the load supporting boom structure of FIG. 1 and con-

stitutes an enlargement of the structure at the junction as shown within the dotted circle of FIG. 1;

FIG. 3 is a further enlarged side elevational view of the junction between abutting boom chords with certain parts thereof being cut away for purposes of illustration;

FIG. 4 is a longitudinal cross-sectional view of the pin connection of the instant invention taken substantially along line 4—4 of FIG. 3 as viewed in the direction indicated by the arrows, and

FIG. 5 is a transverse cross-sectional view of the pin connection of the instant invention taken substantially along line 5—5 of FIG. 3 as viewed in the direction of the arrows.

Attention is now directed to FIG. 1 of the drawing wherein there is shown, for the purpose of illustration only, a crane **10** having elongate load supporting boom structure **12** hingeably connected to an upper works **14** by a hinge structure **16**. In accordance with conventional practice, the upper works **14** is mounted by a roller assembly **18** on a lower works **20** illustrated as being of the endless track variety to provide mobility along ground surface **22**.

The upper works **14** carries a boom rigging assembly **24** as well as a counterweight **26**. A suitable load line or hoist cable **28** is wound about a hoist drum (not shown) in the upper works **14** and passes through a plurality of guides **30** along the boom structure **12** to sheaves **32** secured adjacent a boom point **34**. The load hoist cable **28** then passes on to any load L being handled by the crane **10**.

The boom structure **12** is comprised of a plurality of generally similar intermediate segments **36**, a boom butt segment **38** hinged to the upper works **14**, and a boom top segment **40**, all of which are secured in axial relationship relative to each other by pin connecting means to be described and disclosed in more detail hereinafter.

Although the following description will be in terms of the intermediate boom segments **36**, it should be understood that the connection of the boom butt and boom top segments **38** and **40** at each end of the boom structure **12** may be effected in the same manner.

Each of the boom segments **36** comprises a plurality of chords **42** which are illustrated as being disposed at the corners of an imaginary rectangle although it should be understood that any configuration will suffice. For purposes of description only, each of the chords **42** may be divided into an intermediate chord section **44** of any desired cross-sectional configuration, a first terminal chord section **46** and a second terminal chord section **48**.

Interconnecting adjacent chords **42** of each of the boom segments **36** are a plurality of diagonal intermediate lacing elements **50** each of which converges with respect to the lacing element **50** immediately adjacent thereto so that a centerline **52** of each of the intermediate lacing elements **50** intersects with the centerline of the adjacent lacing element within the confines of the respective chord **42** and preferably intersect on a centerline **54** of the chords **42**. A pair of transverse lacing elements **56** may be disposed at each end portion of the boom segments to interconnect the diagonally opposed chords together to enhance torsional and bending stability. Similarly, additional transverse lacing elements may be disposed intermediate the end portions of each boom segment for similar purposes.

As shown in FIGS. 2 and 3 one terminal end portion of each boom segment **36** includes a first terminal lacing element **58** connected at one end portion thereof to the intermediate chord section **44** so that a centerline **60** intersects the centerline **52** of the adjacent intermediate lacing element **50** on the centerline **54** of the chord **42**. The other end portion of the first terminal lacing element **58** is fixedly secured, as by welding or the like, to the first terminal section **46** of the chord **42**. The other end portion of the boom segment **36** is provided with a second terminal lacing element **62** secured at one end portion

thereof to the intermediate chord section **44** so that a centerline **64** intersects the centerline **52** of the adjacent intermediate lacing element **50** on the centerline **54** of chord **42**. The other end portion of the second terminal lacing element **62** is connected to the second terminal section **48** of the chord **42** so that the centerline **64** intersects the centerline **60** of the first terminal lacing element **58** within the confines of the chord **42** and preferably as near as possible to the centerline **54** thereof. As may be clearly seen in FIG. 3, the centerlines **60**, **64** of the first and second terminal lacing elements **58**, **62** intersect in such a manner as to fulfill the desiderata of avoiding eccentric loading of chords **42** as well as providing generally predictable force distributions at the junction of the abutting boom segments **36**.

Referring now to FIGS. 3–5, the pin connecting means of the instant invention is illustrated as including a female connector socket formed within the first terminal chord section **46**, a male connector formed by the second terminal chord section **48** and a pin **66** securing the male and the female connectors together. The female socket formed by the first terminal chord section **46** comprises a body portion **68** of generally identical external cross-sectional configuration to the intermediate chord section **44**. The body portion **68** has one end portion **70** of reduced external dimension received in the open end portion of the intermediate chord section **44** with suitable weld material **72** securing the body portion **68** to the intermediate section **44**. A recess **74** may be formed in the terminus of the end portion **70** to reduce the weight of the body portion **68** consistent with desired strength.

Centrally of the body portion **68** and coaxial with the centerline **54** is a blind cavity **76** having an enlarged outer end portion forming a shoulder **78** and a face **80**. A transverse pin receiving opening **82** communicates with the cavity **76** to receive the pin **66** thereby providing means for retaining the male connector in the female socket formed with the end portion of the chord **42**.

The second terminal section **48** of the chord **42** comprises a body portion **84** having one end portion **86** of reduced external dimension received in the open end portion of the intermediate chord section **44** and retained therein by suitable weld material **88** or other connecting means. An enlarged recess **90** and a smaller dimple **91** formed in the end portion of the body portion **84** are provided to minimize weight consistent with needed strength and to allow uniform cooling of the material after casting. Immediately beyond the area where the second terminal lacing **62** is secured to the body portion **84** the external dimension of the body portion **84** is reduced to form a face **92** in abutting relation to the face **80** of the female connector socket to carry compressive loads from one chord to the other and to provide additional bearing area to withstand any tendency toward relative angular movement between adjacent boom segments.

Similarly a radially facing shoulder **94** is preferably closely received by the open end portion of the blind cavity **76**. A tongue **96** of the body portion **84** extends into the cavity **76** and provides a pin receiving aperture **98** aligned with the aperture **82** of the female socket.

The pin **66** is of conventional construction and comprises a first tapered end portion **100** having a transverse opening **102** therethrough to receive a cotter key **104** or other temporary retaining means. The other end portion **106** of pin **66** is tapered throughout a greater length and at a lesser angle than end portion **102** and also provides a transverse opening **108** receiving a cotter key **110** or the like.

It will be noted from FIG. 2 that the end portion of pin **66** is visible in the chord nearest the bottom of the figure but is not visible in the chord illustrated thereabove. The disposition of the pins **66** at 90° relative to each other is to provide for movement of the pin **66** out of the apertures **86**, **98** without interference from the terminal lacing ele-

ments 58. For example, if the pin 66 in FIG. 3 were disposed at 90° with respect to the actually illustrated pin, interference between the pin 66 and the terminal lacing element 58 would result.

As a matter of convenience of manufacture, the terminal chord sections 46, 48 are cast of material having the desired structural characteristics. Because the casting operation does not produce articles having close tolerances, the faces 80, 92 are machined to provide the close abutting relation needed.

It will be readily apparent that the adjacent boom segments 36 are disassembled by removing the pins 66 as by the use of a punch and hammer thereby tending to make assembly and disassembly a relatively easy and rapid operation. It will also be noted that the compressive loads transmitted to the junction of adjacent boom segments 36 is carried by the abutting faces 80, 92 while tensile loads are transmitted by the pin 66.

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.

I claim as my invention:

1. An elongate load supporting structure comprising:
a plurality of abutting generally coaxial segments having at least three chords; intermediate diagonal converging lacing elements disposed intermediate the end portions of the chords interconnecting adjacent chords together with the centerlines of adjacent intermediate lacing elements intersecting within the confines of the chords; and at least one terminal diagonal lacing element for each chord disposed on one end portion of each segment interconnecting adjacent chords together and having a centerline intersecting the centerline of the adjacent intermediate lacing element within the confines of one of the adjacent chords and intersecting the other of the adjacent chords at the terminal end portion thereof; and means connecting abutting segments together and disposing the intersection of the centerlines of the adjacent terminal lacing elements of abutting chords within the confines of the chord, the connecting means comprising a male connector disposed on selected end portions of the chords and having an apertured tongue extending beyond the terminal end portion of the chord; means forming a female connector socket within the adjacent terminal end portion of an abutting chord for receiving the tongue and having an aperture aligned with the tongue aperture; and a removable pin received in the aligned apertures of the male and female connectors for securing the abutting segments together.

2. The elongate load supporting structure of claim 1 wherein
the centerlines of adjacent intermediate lacing elements intersect at the centerline of the chord.

3. The elongate load supporting structure of claim 1 wherein
the centerlines of adjacent terminal lacing elements intersect within the confines of the male connector.

4. The elongate load supporting structure of claim 1 wherein
the male and female connectors provide abutting substantially peripheral faces for transmitting compressive loads.

5. The elongate load supporting structure of claim 1 wherein
the pin resides at a point spaced from a plane drawn through the intersection of the male and female connectors in a direction axially along the chord which carries the female connector.

6. The elongate load supporting structure of claim 1 wherein the included angle between the terminal lacing elements and the chords is substantially the same as the included angle between the intermediate lacing elements and the chords.

7. The elongate load supporting structure of claim 1 wherein each segment includes four chords; and further comprising a pair of transverse lacing elements on each segment interconnecting diagonally opposed chords, the transverse lacing elements being disposed immediately adjacent the terminal end portions of the chords and perpendicular to the plane of the terminal lacing elements.

8. An elongate load supporting structure comprising
a plurality of abutting generally coaxial segments having at least three chords each of which has an intermediate section and two terminal sections;
intermediate diagonal converging lacing elements for interconnecting intermediate sections of adjacent chords of each segment together with the centerlines of adjacent intermediate lacing elements intersecting within the confines of the chords of the segment;
a first terminal diagonal lacing element interconnecting a first terminal section of one of the adjacent chords of a first boom segment and the intermediate section of another of the adjacent chords of the first segment with the first terminal lacing element centerline intersecting the centerline of the adjacent intermediate lacing element within the confines of the other adjacent chord and the first terminal lacing element intersecting the first terminal section adjacent the end portion thereof;
a second terminal diagonal lacing element interconnecting a second terminal section of one of the adjacent chords of a second boom segment and the intermediate section of another of the adjacent chords of the second segment with the second terminal lacing element centerline intersecting the centerline of the adjacent intermediate lacing element within the confine of the other adjacent chord and the second terminal lacing element intersecting the second terminal section at the end thereof with the centerlines of the first and the second terminal lacing elements intersecting within the confines of the one adjacent chords of the first and the second boom segments;
the first terminal section forming an apertured female connector socket within the confines of the one adjacent chord of the first boom segment;
an apertured tongue secured to the second terminal section and extending beyond the end portion of the one adjacent chord of the second boom segment into registry with the female connector socket; and
removable means extending through the apertures of the tongue and the socket for retaining the first and the second boom segments together.

9. The elongate load supporting structure of claim 8 wherein
the centerlines of adjacent intermediate lacing elements intersect at the centerline of the chord.

10. The elongate load supporting structure of claim 8 wherein
the centerlines of the first and the second terminal lacing elements intersect within the confines of the male connector.

11. The elongate load supporting structure of claim 8 wherein
the first terminal section forms a peripheral face about the female connector socket; and
the second terminal section forms a peripheral face at the junction of the tongue in abutting relation to the peripheral face of the first terminal section.

12. The elongate load supporting structure of claim 8 further comprising
a boom butt segment secured to one of the boom segments;
a boom top segment secured to another of the boom segments;
an upper works; and

means hingedly mounting the boom butt segment on the upper works for pivotal movement in a generally vertical plane.

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HARVEY C. HORNSBY, Primary Examiner

U.S. Cl. X.R.

52—117; 212—59; 287—103