Jan. 25, 1966 L. L. MYERS 3,231,044

ARTICULATED TOWER CONSTRUCTION

Filed Jan. 28, 1964 5 Sheets-Sheet 1

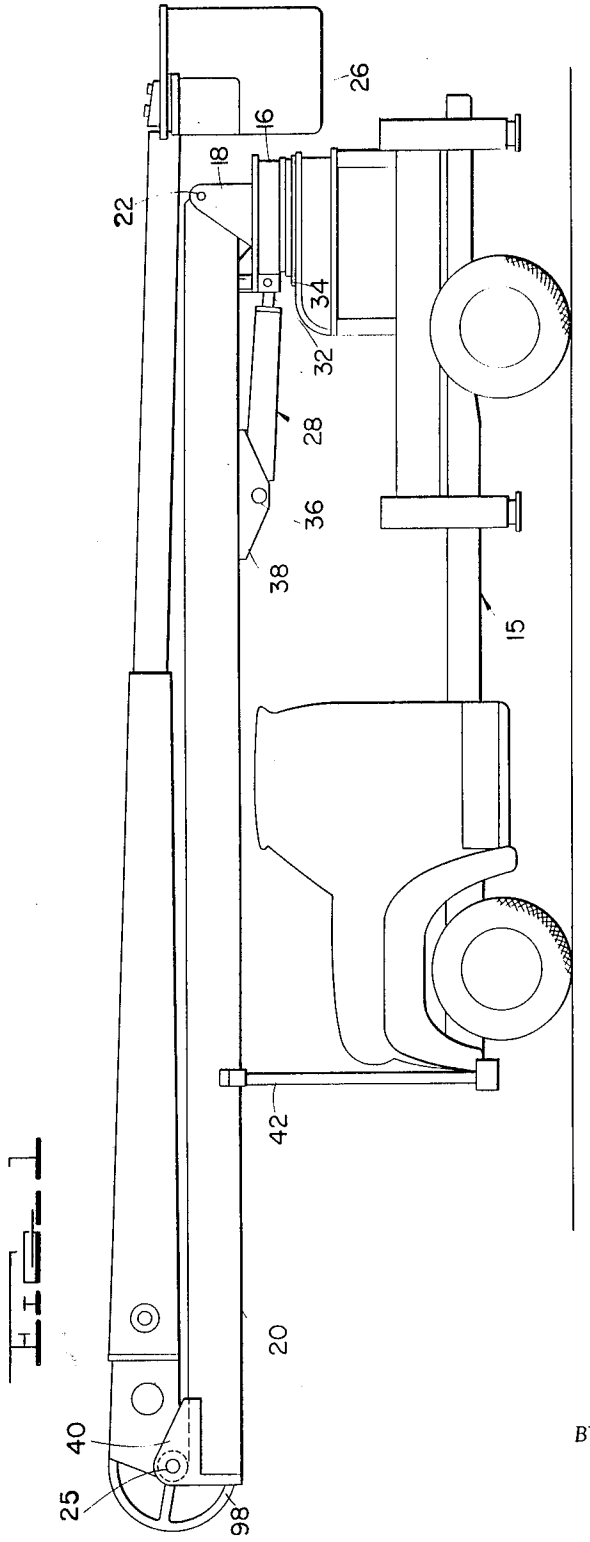


FIG. 1

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ARTICULATED TOWER CONSTRUCTION

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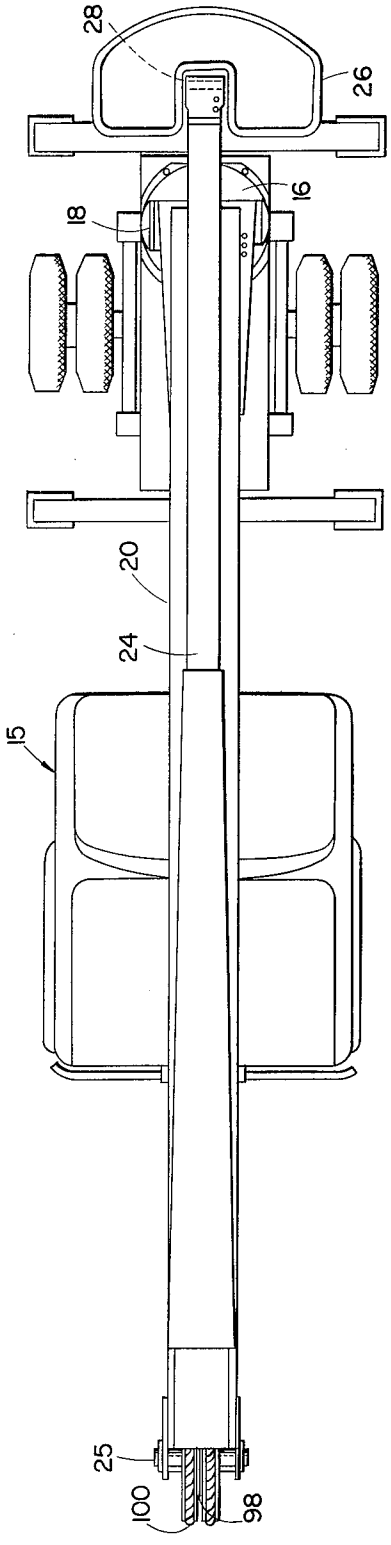


FIG. 2

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ARTICULATED TOWER CONSTRUCTION

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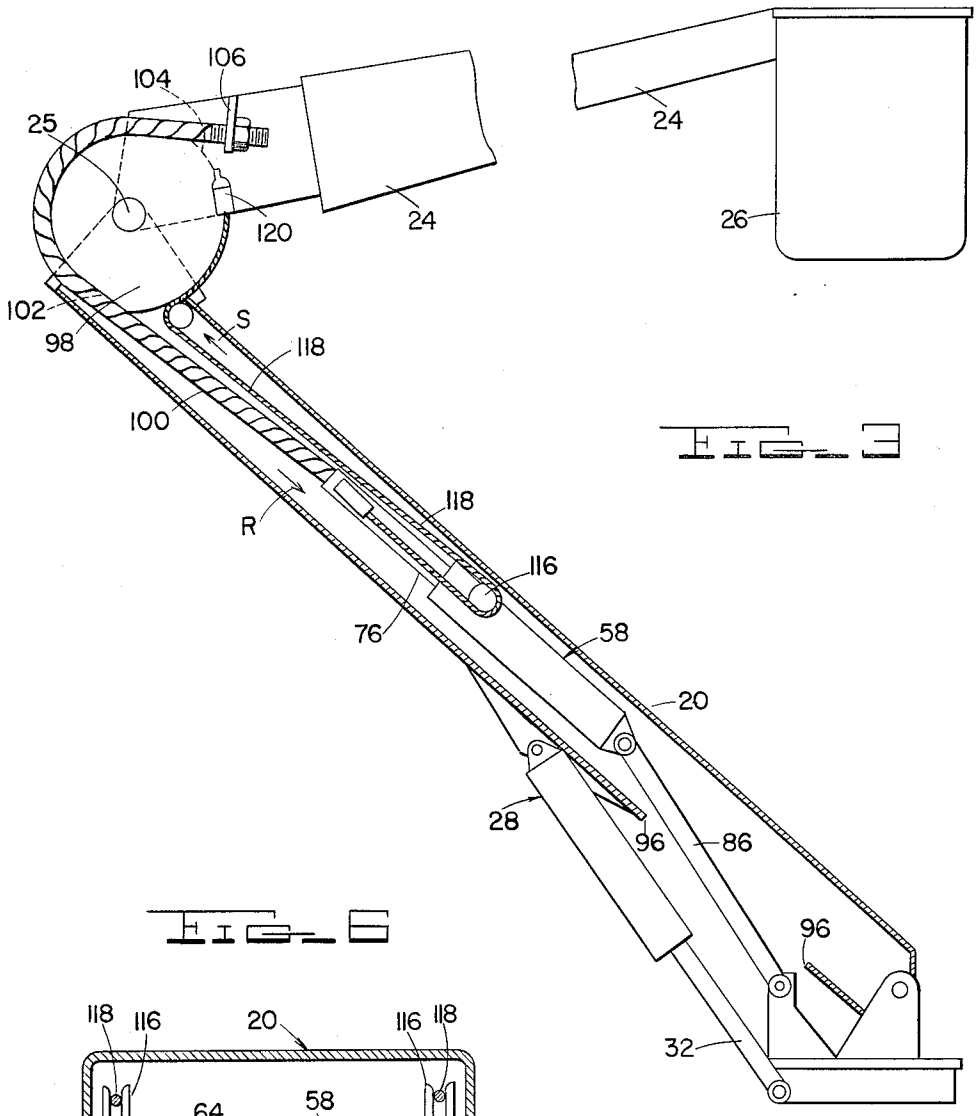
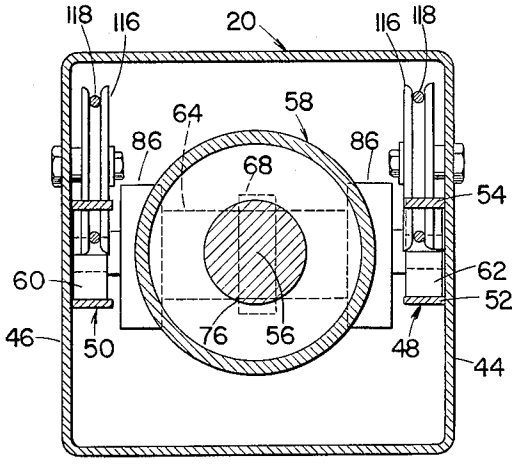


FIG. 3

FIG. 6

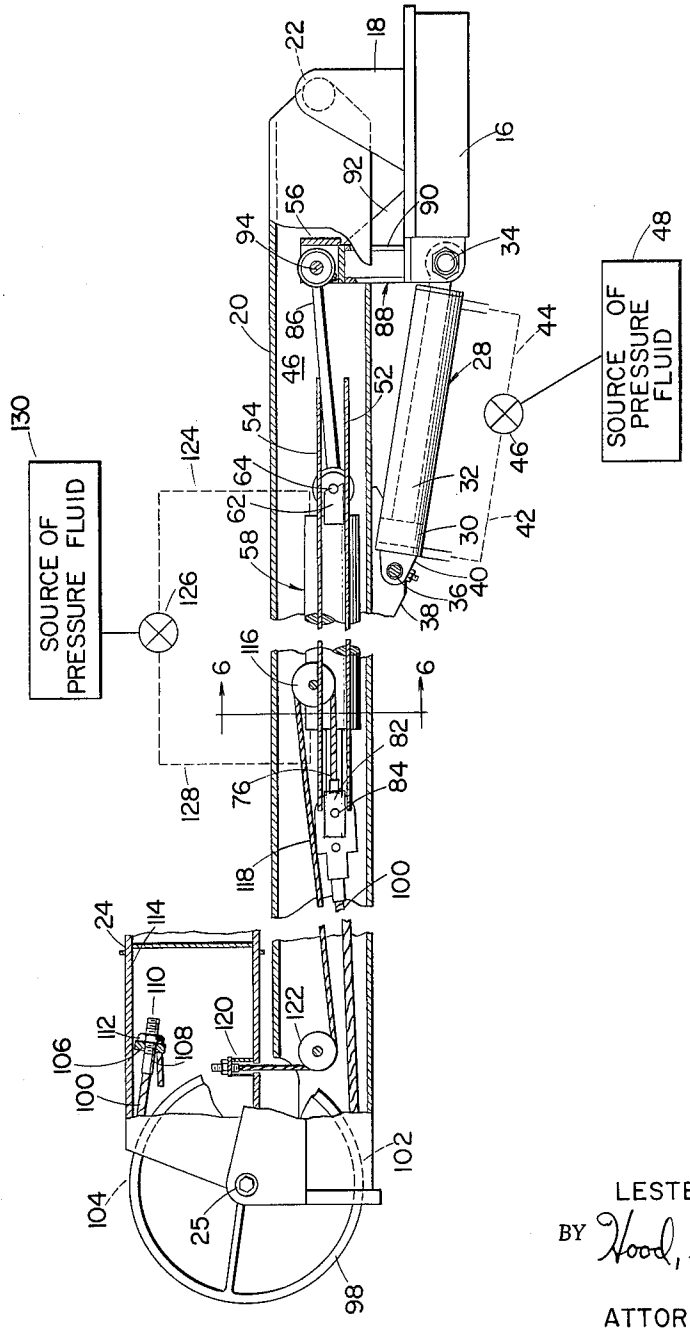


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ARTICULATED TOWER CONSTRUCTION

Filed Jan. 28, 1964 5 Sheets-Sheet 4

FIG. 4



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ARTICULATED TOWER CONSTRUCTION

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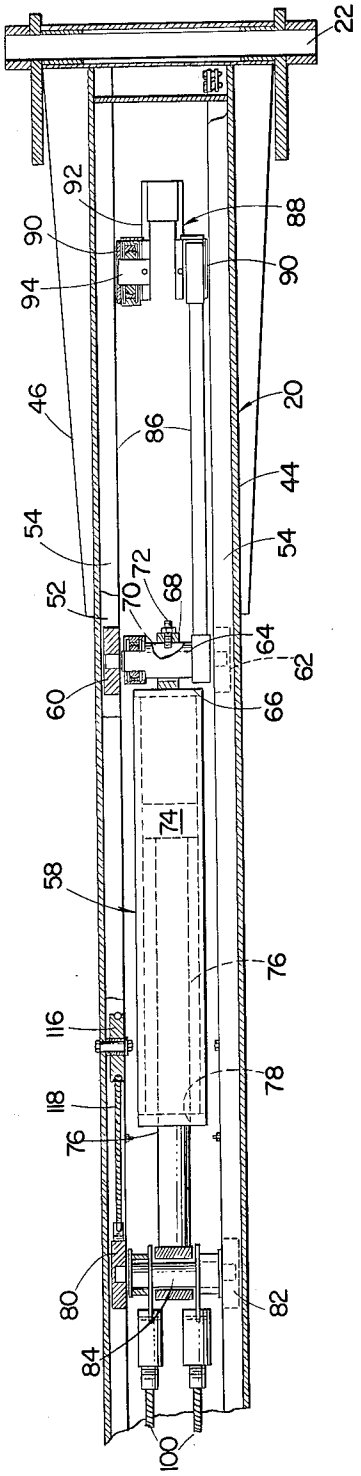


FIG. 5

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United States Patent Office 3,231,044 Patented Jan. 25, 1966

3,231,044

ARTICULATED TOWER CONSTRUCTION

Lester L. Myers, Fort Wayne, Ind., assignor to Mobile Aerial Towers, Inc., Fort Wayne, Ind., a corporation of Indiana

Filed Jan. 28, 1964, Ser. No. 340,629
15 Claims. (Cl. 182—141)

The present invention relates to an articulated tower construction, and more particularly to an arrangement for controlling the angular relationship between the upper and lower booms of an aerial tower mechanism.

Mobile aerial towers of the so-called "cherry picker" type conventionally comprise a mobile unit or truck upon which a tower structure is mounted for three-dimensional operation. The tower structure conventionally includes a turntable having an elongated lower boom pivotally mounted thereon. This pivotal mounting provides for swinging movement of the lower boom about a horizontal axis while the turntable provides for swinging movement about a vertical axis. To the outer end of the lower boom is pivotally connected an upper boom for swinging movement about another horizontal axis. To the remaining, outer end of the upper boom is pivotally connected a personnel platform or bucket which is at all times maintained in level position regardless of the position and elevation to which the two booms may be moved. Suitable motors provide rotary motion as well as relative vertical movement of the booms, such booms being swingable to a lower position in which the personnel bucket is positioned adjacent to the truck and to an elevated position of the desired height above the truck within the limits of the boom dimensions.

It is conventional to provide such towers with motors and controls whereby the movements of the upper and lower booms may be effected independently. When such booms are collapsed to the lowermost position, conventionally they lie in parallelism one on top of the other. When erecting the tower from such folded position, the lower boom may be raised to its uppermost position, following which the upper boom may then be raised to its uppermost position. Independently, such booms may be moved to any position intermediate these limits.

It frequently occurs that an operator wishing to reach a point in space must intermittently and independently operate both of the booms until the point is reached. However, this independent operation of the booms does require a period of time and further involves the requirement of a certain amount of operator skill in being able to reach the point. There are other requirements and disadvantages in the prior art arrangements which will be apparent to those skilled in the art.

The present invention constitutes an improvement over the prior art arrangements in the respect that upper boom movement may be obtained merely by effecting lower boom movement. Further than this, the spatial attitude of the upper boom can be made independent of lower boom movement, thereby simplifying the control system. It is possible for an operator by merely operating the lower boom to move horizontally without changing elevation in reaching a selected point in space.

In view of the foregoing, it is an object of this invention to provide an aerial tower arrangement wherein movement of the upper boom depends upon movement of the lower boom to the effect that as the lower boom is raised, the angular relationship between the two booms correspondingly increases.

It is another object of this invention to provide an aerial tower mechanism wherein the spatial attitude of the upper boom is independent or substantially independent of lower boom movement.

It is still another object of this invention to provide in an aerial tower mechanism a linkage arrangement operable to provide a varying angular relationship between the upper and lower booms in response to vertical angular movement of the lower boom with the maximum angle of the upper boom with respect to the ground being predetermined.

It is still another object of this invention to provide in an aerial tower mechanism a boom actuating arrangement wherein the maximum angle of the upper boom with respect to the ground is predetermined.

It is a further object to provide a boom actuating arrangement which is simple, economical and efficient.

Other objects will become apparent as the description proceeds.

The above-mentioned and other features and objects of this invention and the manner of attaining them will become more apparent and the invention itself will be best understood by reference to the following description of an embodiment of the invention taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a side elevation of one aerial tower embodiment of this invention;

FIG. 2 is a top plan view thereof;

FIG. 3 is a side elevation partly sectioned, partly broken away for clarity of illustration, and partly diagrammed of a part of the tower construction shown in the preceding figures;

FIG. 4 is a fragmentary, partly sectioned side elevation of the upper and lower boom construction, this figure being drawn substantially to scale;

FIG. 5 is a view substantially to scale, similar to FIG. 4 in top plan view and is partially sectioned and broken away for clarity of illustration; and

FIG. 6 is a cross-section taken substantially along section line 6—6 of FIG. 4.

Referring to the drawings, and more particularly to FIGS. 1 and 2, a truck **15** has mounted on the rear end thereof a conventional turntable **16** having an upstanding support or frame **18** thereon. A lower elongated boom **20** is pivotally connected to the support **18** by means of a horizontal shaft **22**. Pivotally connected to the left-hand end of the lower boom **20** is an elongated upper boom **24**, this pivotal connection being provided by another horizontal shaft **25**. Conventionally, the shafts **22** and **25** are parallel. On the outer end of the upper boom **24** is pivotally mounted a personnel platform or bucket **26**, this pivotal connection being provided by shaft **28**. As in the case of the two shafts **22** and **25**, this shaft **28** is parallel thereto.

When the tower is completely collapsed as shown in both FIGS. 1 and 2, the booms **20** and **24** are superposed adjacent to the truck and extend substantially horizontally. The bucket **26** is positioned adjacent to the truck bed such that personnel can easily enter and depart therefrom.

Suitable power mechanism is employed in the arrangement shown in FIGS. 1 and 2 for elevating the bucket **26** to any desired position by pivoting either or both of the booms **20**, **24** upwardly from the positions illustrated. This mechanism forms a substantial portion of the present invention and will be explained in detail in the following. As shown more clearly in FIGS. 1, 3 and 4, a double-acting power cylinder generally indicated by the numeral **28** reciprocally mounts a piston **30** having a piston rod **32** which projects beyond the right-hand end of the cylinder housing to be connected to a horizontally extending shaft or pin **34**. This pin **34** is mounted on the turntable **16** in such position that the axis of the cylinder **28** is included in the same vertical plane with the longitudinal axis of the boom **20**. The blind end of the cyl-

inder 28 is pivotally connected to another horizontally arranged pin 36 which is secured to two spaced apart supporting flanges 38 depending from the boom 20. A lug or ear 40 serves to connect the cylinder 28 to the pin 36.

This power cylinder 28 is of conventional design and preferably is connected into a suitable hydraulic system having a pair of lines 42 and 44 which terminate in a suitable reversing manually operable control valve 46. A suitable source 48 of hydraulic fluid is also connected to the valve 46 such that operation of the valve 46 in one direction will result in movement of the piston 30 toward the right (as viewed in FIG. 4) and reverse operation of the valve 46 will result in the piston 30 being moved toward the left. It is obvious that by reason of the pivot pin or fulcrum 34 being located below and toward the left of the shaft 22, extension of the power cylinder 28 will result in raising the boom 20 and retraction thereof lowering the boom 20. The proper selection of dimensions for the various pivots permits the boom 20 to be raised to a vertical or near vertical position.

The two booms 20 and 24 are of conventional design, being straight, elongated and hollow. The boom 20 may be of square or rectangular cross-section as shown more clearly in FIG. 6. The shaft 25 is mounted on a pair of spaced-apart parallel flanges 40 which extend upwardly beyond the upper surface of the boom 20, at the left-hand end thereof (FIG. 1), when the latter is lowered to the position of FIG. 1. By this means, the shaft 25 can be positioned slightly above the upper surface of the boom 20 (FIG. 1) thereby permitting the lower corner portion of the left-hand end of the boom 24 to be pivotally connected to the shaft 25. By so positioning the shaft 25, the two booms 20 and 24 may be collapsed and superposed in parallelism as shown in FIG. 1, a conventional cradle 42 mounted on the truck 15 supporting the two booms in this position in a conventional manner.

On the two side walls 44 and 46 of the lower boom 20, these side walls being parallel, are mounted a pair of channel-shaped tracks 48 and 50, respectively. A description of one of these tracks will suffice for both. Each track is composed of two rigid, flat strips of metal 52 and 54 which are spaced apart and parallel and extend for about one-third the length of the boom 20 nearer the lower end thereof. These strips 52 and 54 are edge-mounted by welding or the like to the boom side 44, 46, so as to provide a channel-shaped cross-section as shown more clearly in FIG. 6. The strips 52, 54 may also be characterized as extending parallel to the longitudinal axis 56 of the boom 20. The two tracks 48 and 50 have the open sides facing each other and otherwise are spaced apart and parallel.

A second double-acting, hydraulic power cylinder 58 is disposed inside the lower boom 20 in axial alignment therewith, the cylinder 58 being mounted for longitudinal movement in the boom. The mounting for the cylinder 58 includes four different sliding block-shaped shoes respectively mounted for sliding movement in the tracks 48 and 50, two of these shoes 60 and 62 (FIGS. 5 and 6) being slidably received by the two tracks 50 and 48, respectively. Also, these shoes 60 and 62 are positioned laterally opposite each other and pivotally mount the opposite ends, respectively, of a pivot pin or cross pin 64. The pin 64 with its axis normal to the longitudinal axis of the boom 20 may therefore be moved longitudinally of the boom.

The blind end 66 of the cylinder 58 has an ear 68 projecting therefrom which is provided with an opening 70 receiving the pin 64. A set screw 72 secures the ear 68 to the pin 64. By this means, the rear or blind end 66 of the cylinder 58 is mounted for longitudinal movement inside the boom 20.

The cylinder 58 includes the usual piston 74 having a piston rod 76 extending through a bearing opening 78 in the rod end of the cylinder 58. Another pair of shoes

80 and 82, which may be identical to the shoes 60 and 62, are received by the two tracks 50 and 48, respectively, and pivotally mount the opposite ends of a cross pin 84 with the axis of the latter extending in a direction substantially normal to the longitudinal axis of the boom 20. The distal end of the piston rod 76 is pivotally connected to the central portion of the pin 84 thereby completing the mounting of a power cylinder 58 for longitudinal sliding movement inside the lower boom 20. The power cylinder 58 is held in parallelism with the lower boom by reason of the piston rod 76 being supported with respect to the cylinder proper by means of the rod bearing 78.

A pair of rigid compensating or connecting rods 86, which are straight and elongated, are pivotally connected at one end to the cross pin 64 and at the other end to a pivot support 88 which upstands from the turntable 16 as more clearly shown in FIG. 4. This pivot support 88 is constructed of suitably rigid material and as shown includes two upright, spaced-apart posts 90 which are secured and braced in position by a pair of rearwardly extending triangular plates 92. These plates 92 are welded or otherwise suitably rigidly secured to the upper surface of the turntable 16.

The upper ends of the two posts 90 individually mount two stub shafts 94 which are axially aligned and otherwise parallel to the shaft 22. The lower ends of the connecting rods 86 are pivotally connected to the two shafts 94, respectively, as shown. As is more clearly illustrated in FIG. 4, the axis of the shafts 94 lies in a common horizontal plane with the axis of the shaft 22, this plane also including the longitudinal axis 56 of the boom when the latter is positioned truly horizontal. It should be recognized at this point that the pins 94 may occupy other positions beneath this horizontal plane. Also as shown in the drawings, the pins 94 are positioned forwardly, or in other words toward the left, of the shaft 22 (as viewed in FIGS. 1, 3 and 4) and in alignment longitudinally of the boom 20. The shafts 94 may be moved closer to or farther away from the shaft 22 as well as to a position lower or higher than that illustrated without departing from the spirit and scope of this invention. The reasons for this will become apparent from the description which follows.

As shown more clearly in FIG. 3, the underside of the boom 20 is provided with a longitudinal opening 96 through which the connecting rods 86 may extend when the boom 20 is raised.

By reason of the pivoted connection between the two booms 20 and 24, a joint in the form of an elbow is provided. This elbow is equipped with a pair of pulleys 98 coaxially mounted for rotation on the shaft 25. These pulleys 98 are of a relatively large diameter such that the peripheries thereof lie within and adjacent to the opposite upper and lower walls of the two booms 20 and 24, respectively. The two pulleys 98 preferably are of the same diameter and are axially spaced apart inside the boom walls for purposes which will become apparent from the description that follows.

A pair of wire rope cables 100, hereinafter referred to as "lifting cables," are secured at one end to the cross pin 84 and pass around the outer peripheral portions of the two pulleys 98; more specifically around the arcuate portions of these pulleys lying clockwise between the two numerals 102 and 104 of FIG. 4. The upper ends of these cables 100 are secured to the upper boom 24 by means of two lugs 106 which are welded or otherwise suitably secured to the bottom 24. Each lug has an opening 108 through which the stud end 110 of one cable passes, a suitable nut 112 being threaded onto the stud 110 so as to engage the right-hand side of the respective lug 106. There are two such lugs 106, one for each of the cables 100, and these lugs are positioned adjacent to the upper wall 114 of the boom 24. This wall 114 is offset upwardly from the longitudinal axis of this boom. Also,

the lugs **106** are positioned on the right-hand side of a vertical plane including the axis of the shaft **25** and are also spaced rightwardly from the pulleys **98** to provide for a length of cable between the lugs **106** and the pulleys **98**. The reasons for this will become apparent from the following description.

Two smaller pulleys **116** are rotatably mounted on the side walls **44** and **46**, respectively, of the lower boom **20**, and are disposed axially opposite each other. These pulleys **116** form parts of identical pulley systems such that a description of one of these systems will suffice for both. Each pulley **116** receives thereover a hold-back cable **118** which is secured at one end to a shoe **80** and at the other end to a post **120** secured to the upper boom **24** after first passing around an idler pulley **122** and a circumferential groove in the elbow pulley **98** (see FIG. 3). This idler pulley **122** is mounted on the lower boom **20** in a position immediately adjacent to the periphery of the pulleys **98**.

The pulley **116** is positioned on the boom **20** between the cross pins **84** and **64** and further than this is situated or spaced toward the right (as viewed in FIGS. 4 and 5) from the cross pin **84** when the latter is moved to its lowest or most rightward position inside the boom **20**. This position will become obvious from the description that follows.

Both the cables **100** and **118** are taut and must be sufficiently strong to perform the functions which will be described later.

As previously described, the power cylinder **58** is double-acting such that the piston **74** may be controllably reciprocated inside the cylinder. A suitable system for accomplishing this is illustrated in FIG. 4 wherein the dashed line **124** indicates a pressure fluid line which connects at one end to a conventional hand control valve **126** and at its other end to the right-hand end of the cylinder **58**. A similar fluid line **128** connects to the left-hand end of the cylinder **58** and also leads to the valve **126**. A suitable source **130** of hydraulic fluid under pressure is connected to the valve **126**. By operating this valve **126** in one direction, fluid under pressure is admitted to the left-hand side of the piston **74**, causing the latter to move toward the left. By operating the valve **126** in the opposite direction, fluid under pressure is admitted to the left-hand end of the cylinder via the line **128**, thereby forcing the piston **74** to be moved toward the right. With the valve **126** in neutral position so as to cut off or close the two lines **124** and **128**, the piston **74** is locked in position inside cylinder **58**.

In operation, rotation of the boom assembly by means of the turntable **16** is conventional. In the conventional arrangement, the turntable **16** rotates about a vertical axis and is carried by a stationary supporting frame such as the truck or truck chassis shown in FIGS. 1 and 2.

As explained previously, when it is desired to elevate the boom **20**, the power cylinder **28** is actuated. Extension of this cylinder, or in other words protraction of the piston **30**, results in the boom **20** being swung upwardly about its horizontal pivot shaft **22**.

Assuming that the two booms **20** and **24** are collapsed to horizontal positions as shown in FIGS. 1, 2 and 4, it will be seen that as the lower boom **20** is raised, the tension linkage composed of the rods **86**, locked cylinder **58**, cables **100** and pulleys **98** cause the upper boom **24** to swing upwardly away from the lower boom **20**. This occurs for the reason that the pivot shaft **94** for this linkage is located forwardly and horizontally of the shaft **22**, such that as the lower boom raises, the locked cylinder **58** slides downwardly in the boom **24**, thereby pulling the cable **100** toward the right as viewed in FIGS. 3 and 4. This in effect shortens the length of the cable **100** between the lugs **106** and point **104** on the pulleys **98**, thereby lifting the upper boom **24** about the elbow shaft **25**. Obviously, in order to produce this lifting action, it is necessary that a moment arm be provided between the lugs **106** and the elbow shaft **25**. By connecting the terminal end of the cables **100** to the upper boom **24** as previously described, this moment arm is provided. It will now be obvious that as the raising process of the lower boom **20** is continued, the upper boom **24** will be correspondingly raised relative to the boom **20**. During this movement of the lower boom, the piston **74** in the cylinder **58** is locked in position such that the distance between the cross pins **64** and **84** remains a constant.

If it is assumed that the lower boom **20** has been raised to an almost upright position, and in this position the upper boom **24** has been raised to a substantially horizontal position, lowering of the lower boom to the horizontal position of FIG. 1 will automatically result in corresponding lowering of the upper boom **24**. During this lowering action, the cylinder **58** (with piston **74** locked in position therein) moves relative to the boom **20** toward the pulley **98**. This results in increasing the length of the cable **100** between the lugs **106** and point **104** on the pulleys **98**, allowing the upper boom **24** to collapse onto the lower boom. Again, the piston **74** is locked in position inside the cylinder **58**.

Now, if it is desired to operate the upper boom independently of the lower boom, the power cylinder **28** is not actuated, but, instead, the power cylinder **58** is operated. If it is assumed that the upper and lower booms are in the positions illustrated in FIG. 3, retraction of the piston **74** will result in pulling the cable **100** around the corresponding pulley **98**, thereby raising the boom **24**. Conversely, protraction of the piston **24** will result in leftward movement of the piston rod **76** (FIG. 3) and will permit the boom to lower. During this movement of the upper boom **24**, the cylinder **58** retains its position with respect to the boom **20**.

The dimensions are so arranged that the two cables **100** and **118** are retained taut at all times for any given movement of the two booms. For example, when the upper boom **24** is moved independently of the lower boom **20** by actuation of the power cylinder **58**, the cable **118** moves oppositely to that of the cable **100**. If the upper boom **24** is raised, this would require movement of the cable **100** in the direction of the arrow R and of the cable **118** in the direction of the arrow S. Since the cable **100** passes around the outside of the pulleys **98** (elbow), and the cable **118** is positioned on the inside of the pulleys **98** (elbow), the two cables **118** are always moving in opposite directions, thereby holding the upper boom **24** locked in position with respect to the lower boom **20**. In order to obtain this cooperative action between the two cables, it is, of course, necessary for the locations of the pulleys, the diameters of the pulleys, the points of attachment on the two booms and the like to be selected properly, and for different sizes of towers and booms, these dimensions and locations obviously differ.

The linkage (consisting of the rods **86**, cylinder **58**, cables **100**, **118**, pulleys **98** and the like) in one embodiment of this invention, is so dimensioned and proportioned that in operation the upper boom **24** retains a nearly fixed angular relationship with a horizontal plane when the lower boom only is moved between an angle of about 45° above the horizontal to a fully extended vertical position. Additionally, in a preferred embodiment of this invention, this linkage is so dimensioned and proportioned that if the lower boom is fully raised from the folded position shown in FIG. 1, without actuating the upper boom cylinder **58**, the upper boom **24** is positioned approximately horizontal. Still further, preferably full travel of the upper boom **24** with the lower boom approximately vertical is made to be about 70° above the horizontal to about 80° below the horizontal, thereby providing a total swing of the upper boom of about 150°.

In this preferred design, the upper boom never rises to or beyond a vertical position. Overturning from this near vertical position is prevented by the hold-back cables

118. Such overturning can result from an external force such as the wind working against the upper boom and personnel bucket 26. Also, these hold-back cables 118 serve to prevent slack from developing in the lift cables 100 if the cylinder 58 is extended while the upper boom is resting on a fixed object or is folded against the lower boom.

In order to prevent overloading of the smaller cables 118, a conventional built-in relief valve inside the cylinder 58 limits the force developed on the push stroke to much less than that developed in the pull or lifting stroke. Since such relief valves are conventional, they need not be further elaborated here.

With the linkage dimensioned and proportioned as preferred, erection of the lower boom 20 from folded to vertical position automatically places the upper boom in a horizontal position. This results in reducing by a considerable amount the time required to lift the personnel platform to the selected working area. Since the spatial attitude of the upper boom 24 is appreciably independent of lower boom movement, the hydraulic control operation is considerably simplified. For example, in order to move horizontally forward, the operator need only operate the control handle for raising the lower boom 20. The personnel bucket moves forwardly while retaining substantially its elevation.

When the lower boom 20 is fully erected, the upper boom 24 can be raised to an angle of about 70° above horizontal by fully retracting the upper boom cylinder 58. Since this angle of 70° does not increase when the lower boom 20 is lowered, no limit device of any type is required to prevent the upper boom from traveling over dead-center backwardly beyond the limits of the suspension of the bucket 26. Also, since the upper boom 24 cannot raise beyond the vertical, annoying over-center backlash found on certain prior art units is eliminated.

As will now be apparent from the preceding explanations, almost any movement relationship between the two booms may be obtained by proper selection of the various dimensions, proportions and locations of the parts which make up the boom-actuating linkage.

Among other items which may be varied in order to obtain a given movement relationship between the two booms are the diameter of the pulleys 98 and the location of the fixed pivot shafts 94 with respect to the shaft 22.

While there have been described above the principles of this invention in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of the invention.

What is claimed is:

1. An articulated tower construction comprising a supporting frame means, a turntable mounted on said frame means for rotation about an upright axis, a lower elongated boom having opposite ends, one end of said boom being connected to said turntable for pivotal movement about a horizontal axis, an upper elongated boom having opposite first and second ends, a horizontally extending shaft pivotally connecting the other end of said lower boom to the first end of said upper boom, the axis of said shaft being substantially parallel to the first-mentioned horizontal axis whereby said upper boom is foldable onto said lower boom in parallelism therewith, a personnel platform connected to the second end of said upper boom for swinging movement about a horizontal axis parallel to said first-mentioned axis, a first power cylinder having opposite ends, a piston reciprocably mounted in said cylinder, a piston rod connected at one end to said piston and extending substantially coaxially of said cylinder through one end thereof, said piston rod being connected to said turntable for pivotal movement about an axis parallel to said first-mentioned axis, the last-mentioned pivotal connection being disposed in a horizontal plane below said first-mentioned axis, the other end of said cylinder being connected to said lower boom for pivotal movement about an axis parallel to said first-mentioned axis, means including said cylinder and piston for selectively controllably raising and lowering said lower boom about said first-mentioned axis, both said upper and lower booms being hollow, said lower boom having two opposite spaced-apart side walls, two elongated parallel and spaced-apart channel-shaped tracks mounted on said two side walls, respectively, and extending substantially parallel to the longitudinal axis of said lower boom, said tracks having open sides, respectively, which face each other, a second power cylinder having opposite ends and disposed between said side walls and extending parallel to said longitudinal axis, a second piston reciprocably mounted in said second cylinder, a second piston rod connected to said second piston and extending parallel to said second cylinder axis, said second cylinder having a bearing opening in one end thereof which reciprocably receives said second piston rod therethrough, means including said second power cylinder for selectively controllably reciprocating said second piston in said second cylinder, a first pair of spaced-apart supporting shoes slidably mounted in said two tracks, respectively, for movement longitudinally of the latter, a first cross pin having opposite ends mounted on said supporting shoes, respectively, said cross pin extending substantially normal to the longitudinal axis of said lower boom, means connecting the other end of said second cylinder to said cross pin for movement therewith, at least one connecting rod pivotally connected at one end to said cross pin and extending toward said one end of said lower boom, a pivot support fixedly secured to said turntable and being disposed in substantial longitudinal alignment with said lower boom between said first-mentioned axis and the other end of said lower boom, the other end of said connecting rod being connected to said pivot support for pivotal movement about an axis parallel to said first-mentioned axis, a second pair of spaced-apart supporting shoes slidably mounted in said two tracks, respectively, for movement longitudinally of said tracks, a second cross pin having opposite ends mounted on said second supporting shoes, said second cross pin extending substantially parallel to said first cross pin, a first pulley rotatably coaxially mounted on said shaft, a first cable passing around said pulley and being secured at one end to said second cross pin and at the other end to a point on said upper boom which is spaced from said pulley whereby movement of said second cross pin toward said first-mentioned axis results in swinging said upper boom upwardly away from said lower boom, a second pulley rotatably mounted on said lower boom at a location between a first position of said second cross pin and said first-mentioned axis, said first position being the location of the closest approach of said second cross pin to said first-mentioned axis, a third pulley mounted on said lower boom adjacent to said first pulley and between the latter and said second pulley, a second cable passing around said second pulley and being operatively secured at one end to said second cross pin, said second cable extending from said second pulley to and around said third pulley and being secured at the other end to said upper boom at a location adjacent to said first pulley and between the latter and the second end of said upper boom, and means including said first and second cables, said first pulley, and the location of the connection of said connecting rod for maintaining said upper boom at a substantially fixed angle with the horizontal for a predetermined arc of movement of said lower boom.

2. An articulated tower construction comprising a supporting frame means, a turntable mounted on said frame means for rotation about an upright axis, a lower elongated boom having opposite ends, one end of said boom being connected to said turntable for pivotal movement about a horizontal axis, an upper elongated boom

having opposite first and second ends, a horizontally extending shaft pivotally connecting the other end of said lower boom to the first end of said upper boom, the axis of said shaft being substantially parallel to the first-mentioned horizontal axis whereby said upper boom is foldable onto said lower boom in parallelism therewith, a personnel platform connected to the second end of said upper boom for swinging movement about a horizontal axis parallel to said first-mentioned axis, a first power cylinder having opposite ends, a piston reciprocably mounted in said cylinder, a piston rod connected at one end to said piston and extending substantially coaxially of said cylinder through one end thereof, said piston rod being connected to said turntable for pivotal movement about an axis parallel to said first-mentioned axis, the last-mentioned pivotal connections being disposed in a horizontal plane below said first-mentioned axis, the other end of said cylinder being connected to said lower boom for pivotal movement about an axis parallel to said first-mentioned axis, means including said cylinder and piston for selectively controllably raising and lowering said lower boom about said first-mentioned axis, both said upper and lower booms being hollow, said lower boom having two opposite spaced-apart side walls, two elongated parallel and spaced-apart channel-shaped tracks mounted on said two side walls, respectively, and extending substantially parallel to the longitudinal axis of said lower boom, said tracks having open sides, respectively, which face each other, a second power cylinder having opposite ends and disposed between said side walls and extending parallel to said longitudinal axis, a second piston reciprocably mounted in said second cylinder, a second piston rod connected to said second piston and extending parallel to said second cylinder axis, said second cylinder having a bearing opening in one end thereof which reciprocably receives said second piston rod therethrough, means including said second power cylinder for selectively controllably reciprocating said second piston in said second cylinder, a first pair of spaced-apart supporting shoes slidably mounted in said two tracks, respectively, for movement longitudinally of the latter, a first cross pin having opposite ends mounted on said supporting shoes, respectively, said crosspin extending substantially normal to the longitudinal axis of said lower boom, means connecting the other end of said second cylinder to said cross pin for mevement therewith, at least one connecting rod pivotaliy connected at one end to said cross pin and extending toward said one end of said lower boom, a pivot support fixedly secured to said turntable and being disposed in substantial longitudinal alignment with said lower boom between said first-mentioned axis and the other end of said lower boom, the other end of said connecting rod being connected to said pivot support for pivotal movement about an axis parallel to said first-mentioned axis, a second pair of spaced-apart supporting shoes slidably mounted in said two tracks, respectively, for movement longitudinally of the latter, a second cross pin having opposite ends mounted on said second supporting shoes, said second cross pin extending substantially parallel to said first cross pin, a first pulley rotatably coaxially mounted on said shaft, a first cable pasing around said pulley and being secured at one end to said second cross pin and the the other end to a point on said upper boom which is spaced from said shaft whereby movement of said second cross pin toward said first-mentioned axis results in swinging said upper boom upwardly away from said lower boom, and means including said first cables, said first pulley, and the location of the connection of said connecting rod to said pivot support maintaining said upper boom at a substantially fixed angle with the horizontal for a predetermined arc of movement of said lower boom.

3. An articulated tower construction comprising a supporting frame means, a turntable mounted on said frame means for rotation about an upright axis, a lower elongated boom having opposite ends, one end of said boom being connected to said turntable for pivotal movement about a horizontal axis, an upper elongated boom having opposite first and second ends, a horizontally extending shaft pivotally connecting the other end of said lower boom to the first end of said upper boom, the axis of said shaft being substantially parallel to the first-mentioned horizontal axis whereby said upper boom is foldable onto said lower boom in parallelism therewith, a personnel platform connected to the second end of said upper boom for swinging movement about a horizontal axis parallel to said first-mentioned axis, means for selectively controllably raising and lowering said lower boom about said first-mentioned axis, both said upper and lower booms being hollow, said lower boom having two opposite spaced-apart side walls, two elongated parallel and spaced-apart channel-shaped tracks mounted on said two side walls, respectively, and extending substantially parallel to the longitudinal axis of said lower boom, said tracks having open sides, respectively, which face each other, a power cylinder having opposite ends and disposed between said side walls and extending parallel to said longitudinal axis, a piston reciprocably mounted in said cylinder, a piston rod connected to said second piston and extending parallel to said cylinder axis, said cylinder having a bearing opening in one end thereof which reciprocably receives said piston rod therethrough, means including said power cylinder for selectively controllably reciprocating said piston in said cylinder, a first pair of spaced-apart supporting shoes slidably mounted in said two tracks, respectively, for movement longitudinally of the latter, a first cross pin having opposite ends mounted on said supporting shoes, respectively, means connecting the other end of said second cylinder to said cross pin for movement therewith, at least one connecting rod pivotally connected at one end to said cross pin and extending toward said one end of said lower boom, a pivot support fixedly secured to said turntable and being disposed in substantial longitudinal alignment with said lower boom between said first-mentioned axis and the other end of said lower boom, the other end of said connecting rod being connected to said pivot support for pivotal movement about an axis parallel to said first-mentioned axis, a second pair of spaced-apart supporting shoes slidably mounted in said two tracks, respectively, for movement longitudinally of the latter, a second cross pin having opposite ends mounted on said second supporting shoes, a first pulley rotatably coaxially mounted on said shaft, a first cable passing around said pulley and being secured at one end to said second cross pin and at the other end to a point on said upper boom which is spaced from said shaft whereby movement of said second cross pin toward said first-mentioned axis results in swinging said upper boom upwardly away from said lower boom, and means including said first cable, said first pulley, and the location of the connection of said connecting rod to said pivot support for maintaining said upper boom at a substantially fixed angle with the horizontal for a predetermined arc of movement of said lower boom.

4. An articulated tower construction comprising a supporting frame means, a lower elongated boom having opposite ends, one end of said boom being connected to said frame means for pivotal movement about a horizontal axis, an upper elongated boom having opposite first and second ends, a horizontally extending shaft pivotally connecting the other end of said lower boom to the first end of said upper boom, the axis of said shaft being substantially parallel to the first-mentioned horizontal axis whereby said upper boom is foldable onto said lower boom in parallelism therewith, means for selectively controllably raising and lowering said lower boom about said first-mentioned axis, both said upper and lower booms being hollow, said lower boom having two opposite spaced-apart side walls, two

elongated parallel and spaced-apart channel-shaped tracks mounted on said two side walls, respectively, and extending substantially parallel to the longitudinal axis of said lower boom, said tracks having open sides, respectively, which face each other, a power cylinder having opposite ends and disposed between said side walls and extending parallel to said longitudinal axis, a piston reciprocably mounted in said cylinder, a piston rod connected to said piston and extending parallel to said cylinder axis, said cylinder having a bearing opening in one end thereof which reciprocably receives said piston rod therethrough, means including said power cylinder for selectively controllably reciprocating said piston in said cylinder, a first pair of spaced-apart supporting shoes slidably mounted in said two tracks, respectively, for movement longitudinally of the latter, a first cross pin having opposite ends mounted on said supporting shoes, respectively, means connecting the other end of said second cylinder to said cross pin for movement therewith, at least one connecting rod pivotally connected at one end to said cross pin and extending toward said one end of said lower boom, a pivot support fixedly secured to said frame means and being disposed in substantial longitudinal alignment with said lower boom between said first-mentioned axis and the other end of said lower boom, the other end of said connecting rod being connected to said pivot support for pivotal movement about an axis parallel to said first-mentioned axis, a second pair of spaced-apart supporting shoes slidably mounted in said two tracks, respectively, for movement longitudinally of the latter, a second cross pin having opposite ends mounted on said second supporting shoes, a first pulley rotatably coaxially mounted on said shaft, a first cable passing around said pulley and being secured at one end to said second cross pin and at the other end to a point on said upper boom which is spaced from said shaft whereby movement of said second cross pin toward said first-mentioned axis results in swinging said upper boom upwardly away from said lower boom, and means including said first cable, said first pulley, and the location of the connection of said connecting rod to said pivot support for maintaining said upper boom at a substantially fixed angle with the horizontal for a predetermined arc of movement of said lower boom.

5. For use in an aerial tower, a lower elongated boom having opposite ends, means supporting one end of said boom for pivotal movement about a horizontal axis, an upper elongated boom having opposite first and second ends, a horizontally extending shaft pivotally connecting the other end of said lower boom to the first end of said upper boom, the axis of said shaft being substantially parallel to the first-mentioned horizontal axis whereby said upper boom is foldable onto said lower boom in parallelism therewith, means for selectively controllably raising and lowering said lower boom about said first-mentioned axis, both said upper and lower booms being hollow, said lower boom having two opposite spaced-apart side walls, two elongated parallel and spaced-apart channel-shaped tracks mounted on said two side walls, respectively, and extending substantially parallel to the longitudinal axis of said lower boom, said tracks having open sides, respectively, which face each other, a power cylinder having opposite ends and disposed between said side walls and extending parallel to said longitudinal axis, a piston reciprocably mounted in said cylinder, a piston rod connected to said piston and extending parallel to said cylinder axis, said cylinder having a bearing opening in one end thereof which reciprocably receives said piston rod therethrough, means including said power cylinder for selectively controllably reciprocating said piston in said cylinder, a first pair of spaced-apart supporting shoes slidably mounted in said two tracks, respectively, for movement longitudinally of the latter, a first cross pin having opposite ends mounted on said supporting shoes, respectively, means connecting the other end of said second cylinder to said cross pin for movement therewith, at least one connecting rod pivotally connected at one end to said cross pin and extending toward said one end of said lower boom, means securing the other end of said connecting rod for pivotal movement about a third axis which is parallel to and fixed with respect to said first-mentioned axis, said third axis being located in a vertical plane adjacent to said first-mentioned axis and between the latter and the other end of said lower boom when the latter is in a horizontal position, said third axis further being situated either in or beneath a horizontal plane including said first-mentioned axis, a second pair of spaced-apart supporting shoes slidably mounted in said two tracks, respectively, for movement longitudinaly of the latter, a second cross pin having opposite ends mounted on said second supporting shoes, a first pulley rotatably coaxially mounted on said shaft, a first cable passing around said pulley and being operatively secured at one end to said second cross pin and at the other end to a point on said upper boom which is spaced from said shaft whereby movement of said second cross pin toward said first-mentioned axis results in swinging said upper boom upwardly away from said lower boom.

6. For use in an aerial tower, a lower elongated boom having opposite ends, means supporting one end of said boom for pivotal movement about a horizontal axis, an upper elongated boom having first and second ends, the other end of said lower boom and the first end of said upper boom being connected together for pivotal movement about an elbow axis which is substantially parallel to the first-mentioned axis thereby providing an elbow, means for raising and lowering said lower boom about said first-mentioned axis, said lower boom having two opposite spaced-apart side walls, two elongated parallel and spaced-apart channel-shaped tracks mounted on said two side walls, respectively, and extending substantially parallel to the longitudinal axis of said lower boom, said tracks having open sides, respectively, which face each other, a power cylinder having opposite ends and disposed between said side walls and extending parallel to said longitudinal axis, a piston reciprocably mounted in said cylinder, a piston rod connected to said piston and extending parallel to said cylinder axis, said cylinder having a bearing opening in one end thereof which reciprocably receives said piston rod therethrough, a first pair of spaced-apart supporting shoes slidably mounted in said two tracks, respectively, for movement longitudinally of the latter, a first cross pin having opposite ends mounted on said supporting shoes, respectively, said cross pin extending transversely to said longitudinal axis, means connecting the other end of said cylinder to said cross pin for movement therewith, at least one connecting rod pivotally connected at one end to said cross pin and extending toward said one end of said lower boom, means securing the other end of said connecting rod for pivotal movement about a fixed axis which is parallel to and fixed with respect to said first-mentioned axis, said fixed axis being located in a vertical plane adjacent to said first-mentioned axis and between the latter and the other end of said lower boom when the latter is in a horizontal position, said fixed axis further being situated either adjacent to or beneath a horizontal plane including said first-mentioned axis, a second pair of spaced apart supporting shoes slidably mounted in said two tracks, respectively, for movement longitudinally of the latter, a second cross pin having opposite ends mounted on said second supporting shoes, said second cross pin extendnig transversely normal to said longitudinal axis, a first pulley mounted on said first end of said upper boom and said other end of said lower boom coaxially with respect to the second-mentioned axis, a first cable passing around said pulley and being oper-

atively secured at one end to said second cross pin and at the other end to a point on said upper boom which is spaced from said pulley whereby movement of said second cross pin toward said first-mentioned axis results in swinging said upper boom upwardly away from said lower boom, a second pulley rotatably mounted on said lower boom at a location between a first position of said second cross pin and said first-mentioned axis, said first position being the location of the closest approach of said second cross pin to said first-mentioned axis, a third pulley mounted on said lower boom adjacent to said first pulley and between the latter and said second pulley, a second cable passing around said second pulley and being operatively secured at one end to said second cross pin, said second cable extending from said second pulley to and around said third pulley and being secured at the other end to said upper boom at a location adjacent to said first pulley and between the latter and the second end of said upper boom, and means including said cables, said pulleys, and the location of said fixed axis for maintaining said upper boom at a substantially fixed angle with the horizontal for a predetermined arc of movement of said lower boom.

7. The arrangement of claim 6 wherein said pulleys, said cables and the locations of attachment of said cables to said booms are such that both said cables are taut for different predetermined angular relationships between said upper and lower booms.

8. For use in an aerial tower, a lower elongated boom having opposite ends, means supporting one end of said boom for pivotal movement about a horizontal axis, an upper elongated boom having first and second ends, the other end of said lower boom and the first end of said upper boom being connected together for pivotal movement about an elbow axis which is substantially parallel to the first-mentioned axis thereby providing an elbow, means for raising and lowering said lower boom about said first-mentioned axis, two elongated parallel and spaced apart tracks mounted on said lower boom and extending substantially parallel to the longitudinal axis of the latter, a double-acting power cylinder having first and second ends, a piston rod projecting from the first end, means mounting the distal end of said piston rod on said tracks for movement longitudinally of said lower boom, means mounting said second end of said cylinder on said tracks for movement longitudinally of said lower boom, means pivotally connecting said second end of said cylinder to a support which is fixed with respect to said first-mentioned axis, a first pulley mounted on said first end of said upper boom and said other end of said lower boom coaxially with respect to the second-mentioned axis, a first cable passing around said pulley and being operatively connected at one end to said piston rod and at the other end to a point on said upper boom which is spaced from said pulley whereby movement of said piston rod toward said first-mentioned axis results in swinging said upper boom upwardly away from said lower boom, a second pulley rotatably mounted on said lower boom at a location between the connection of said cable to said piston rod and said first-mentioned axis, a third pulley mounted on said lower boom adjacent to said first pulley and between the latter and said second pulley, a second cable passing around said second pulley and being operatively connected at one end to said piston rod, said second cable extending from said second pulley to and around said third pulley and being secured at the other end to said upper boom at a location adjacent to said first pulley and between the latter and the second end of said upper boom, and means including said cables, said pulleys, and the location of said fixed support for maintaining said upper boom at a substantially fixed angle with the horizontal for a predetermined arc of movement of said lower boom.

9. For use in an aerial tower, a lower elongated boom having opposite ends, means supporting one end of said boom for pivotal movement about a horizontal axis, an upper elongated boom having first and second ends, the other end of said lower boom and the first end of said upper boom being connected together for pivotal movement about an elbow axis which is substantially parallel to the first-mentioned axis thereby providing an elbow, means for raising and lowering said lower boom about said first-mentioned axis, two elongated parallel and spaced apart tracks mounted on said lower boom and extending substantially parallel to the longitudinal axis of the latter, a double-acting power cylinder having first and second ends, a piston rod projecting from the first end, means mounting the distal end of said piston rod on said tracks for movement longitudinally of said lower boom, means mounting said second end of said cylinder on said tracks for movement longitudinally of said lower boom, means pivotally connecting said second end of said cylinder to a support which is fixed with respect to said first-mentioned axis, a first pulley mounted on said first end of said upper boom and said other end of said lower boom coaxially with respect to the second-mentioned axis, a first cable passing around said pulley and being operatively connected at one end to said piston rod and at the other end to a point on said upper boom which is spaced from said pulley whereby movement of said piston rod toward said first-mentioned axis results in swinging said upper boom upwardly away from said lower boom, and means including said cable, said pulley, and the location of said fixed support for maintaining said upper boom at a substantially fixed angle with the horizontal for a predetermined arc of movement of said lower boom.

10. For use in an aerial tower, a lower elongated boom having opposite ends, means supporting one end of said boom for pivotal movement about a horizontal axis, an upper elongated boom having first and second ends, the other end of said lower boom and the first end of said upper boom being connected together for pivotal movement about an elbow axis which is substantially parallel to the first-mentioned axis thereby providing an elbow, means for raising and lowering said lower boom about said first-mentioned axis, a double acting power cylinder having first and second opposite end portions which are movable toward and away from each other, means mounting said cylinder on said lower boom for movement longitudinally of the latter, means pivotally connecting said first end portion of said cylinder to a support which is fixed relative to said first-mentioned axis, a first pulley operatively mounted on the elbow of said upper and lower booms, a first cable passing around said pulley and being operatively connected at one end to the second end portion of said cylinder and at the other end to a point on said upper boom which is spaced from said pulley whereby movement of said second end portion toward said first-mentioned axis results in swinging said upper boom upwardly away from said lower boom, a second pulley rotatably mounted on said lower boom at a location between the connection of said cable to said second end portion and said first-mentioned axis, a third pulley mounted on said lower boom adjacent to said first pulley and between the latter and said second pulley, a second cable passing around said second pulley and being operatively connected at one end to said second end portion, said second cable extending from said second pulley to and around said third pulley and being secured at the other end to said upper boom at a location adjacent to said first pulley and between the latter and the second end of said upper boom, and means including said cables, said pulleys, and the location of said fixed support for maintaining said upper boom at a substantially fixed angle with the horizontal for a predetermined arc of movement of said lower boom.

11. For use in an aerial tower, a lower elongated boom having opposite ends, means supporting one end of said boom for pivotal movement about a horizontal axis, an upper elongated boom having first and second ends, the other end of said lower boom and the first end of said upper boom being connected together for pivotal movement about an elbow axis which is substantially parallel to the first-mentioned axis thereby providing an elbow, means for raising and lowering said lower boom about said first-mentioned axis, a double acting power cylinder having first and second opposite end portions which are movable toward and away from each other, means mounting said cylinder on said lower boom for movement longitudinally of the latter, means pivotally connecting said first end portion of said cylinder to a support which is fixed relative to said first-mentioned axis, a first pulley operatively mounted on the elbow of said upper and lower booms, a first cable passing around said pulley and being operatively connected at one end to the second end portion of said cylinder and at the other end to a point on said upper boom which is spaced from said pulley whereby movement of said second end portion toward said first-mentioned axis results in swinging said upper boom upwardly away from said lower boom, and means including said cable, said pulley and the location of said fixed support for maintaining said upper boom at a substantially fixed angle with the horizontal for a predetermined arc of movement of said lower boom.

12. For use in an aerial tower, a lower elongated boom having opposite ends, means supporting one end of said boom for pivotal movement about a horizontal axis, an upper elongated boom having first and second ends, the other end of said lower boom and the first end of said upper boom being connected together for pivotal movement about an elbow axis which is substantially parallel to the first-mentioned axis thereby providing an elbow, means for raising and lowering said lower boom about said first-mentioned axis, a double acting power cylinder having first and second opposite end portions which are movable toward and away from each other, means mounting said cylinder on said lower boom for movement longitudinally of the latter, means pivotally connecting said first end portion of said cylinder to a support which is fixed relative to said first-mentioned axis, said elbow having guiding means radially spaced outwardly from said elbow axis, a first cable passing around and engaging said guiding means and being operatively connected at one end to the second end portion of said cylinder and at the other end to a point on said upper boom which is spaced from said guiding means whereby movement of said second end portion toward said first-mentioned axis results in swinging said upper boom upwardly away from said lower boom, and means responsive to movement of said lower boom for limiting the maximum angle of the upper boom above the horizontal.

13. For use in an aerial tower, a lower elongated boom having opposite ends, means supporting one end of said boom for pivotal movement about a horizontal axis, an upper elongated boom having first and second ends, the other end of said lower boom and the first end of said upper boom being connected together for pivotal movement about an elbow axis which is substantially parallel to the first-mentioned axis thereby providing an elbow, means for raising and lowering said lower boom about said first-mentioned axis, a double acting power cylinder having first and second opposite end portions which are movable toward and away from each other, means mounting said cylinder on said lower boom for movement longitudinally of the latter, means pivotally connecting said first end portion of said cylinder to a support which is fixed relative to said first-mentioned axis, said elbow having guiding means radially spaced outwardly from said elbow axis, a first cable passing around and engaging said guiding means and being operatively connected at one end to the second end portion of said cylinder and at the other end to a point on said upper boom which is spaced from said guiding means whereby movement of said second end portion toward said first-mentioned axis results in swinging said upper boom upwardly away from said lower boom.

14. For use in an aerial tower, a lower elongated boom having opposite ends, means supporting one end of said boom for pivotal movement about a horizontal axis, an upper elongated boom having first and second ends, the other end of said lower boom and the first end of said upper boom being connected together for pivotal movement about an elbow axis which is substantially parallel to the first-mentioned axis thereby providing an elbow, means for raising and lowering said lower boom about said first-mentioned axis, a first elongated flexible linkage having first and second opposite ends, the first end of said linkage being connected to a support which is fixed relative to said first-mentioned axis, said elbow having guiding means radially spaced outwardly from said elbow axis, said first linkage passing around and engaging said guiding means and being connected at said second end to a point on said upper boom, said point being spaced from said guiding means whereby movement of said lower boom results in relative movement of said upper boom, said first linkage having a portion which is movable with respect to said lower boom, means for controlling the length of said first linkage whereby said upper boom may be moved independently of said lower boom, and a second elongated flexible linkage connected at one end to a point on said upper boom and at the other end to said movable portion of said first linkage, second guiding means spaced inwardly from said elbow axis, said second linkage having guiding engagement with said second guiding means, and means including said second linkage and said second guiding means for accommodating relative swinging movement of both booms but selectively applying a holding force against separation movement of said booms.

15. For use in an aerial tower, a lower elongated boom having opposite ends, means supporting one end of said boom for pivotal movement about a horizontal axis, an upper elongated boom having first and second ends, the other end of said lower boom and the first end of said upper boom being connected together for pivotal movement about an elbow axis which is substantially parallel to the first-mentioned axis thereby providing an elbow, means for raising and lowering said lower boom about said first-mentioned axis, power means having first and second opposite end portions which are movable toward and away from each other, means mounting said power means on said lower boom for movement longitudinally of the latter, means pivotally connecting said first end portion of said power means to a support which is fixed relative to said first-mentioned axis, said elbow having guiding means radially spaced outwardly from said elbow axis, a first cable passing around and engaging said guiding means and being operatively connected at one end to the second end portion of said power means and at the other end to a point on said upper boom which is spaced from said guiding means whereby movement of said second end portion toward said first-mentioned axis results in swinging said upper boom upwardly away from said lower boom.

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