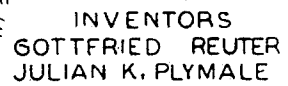


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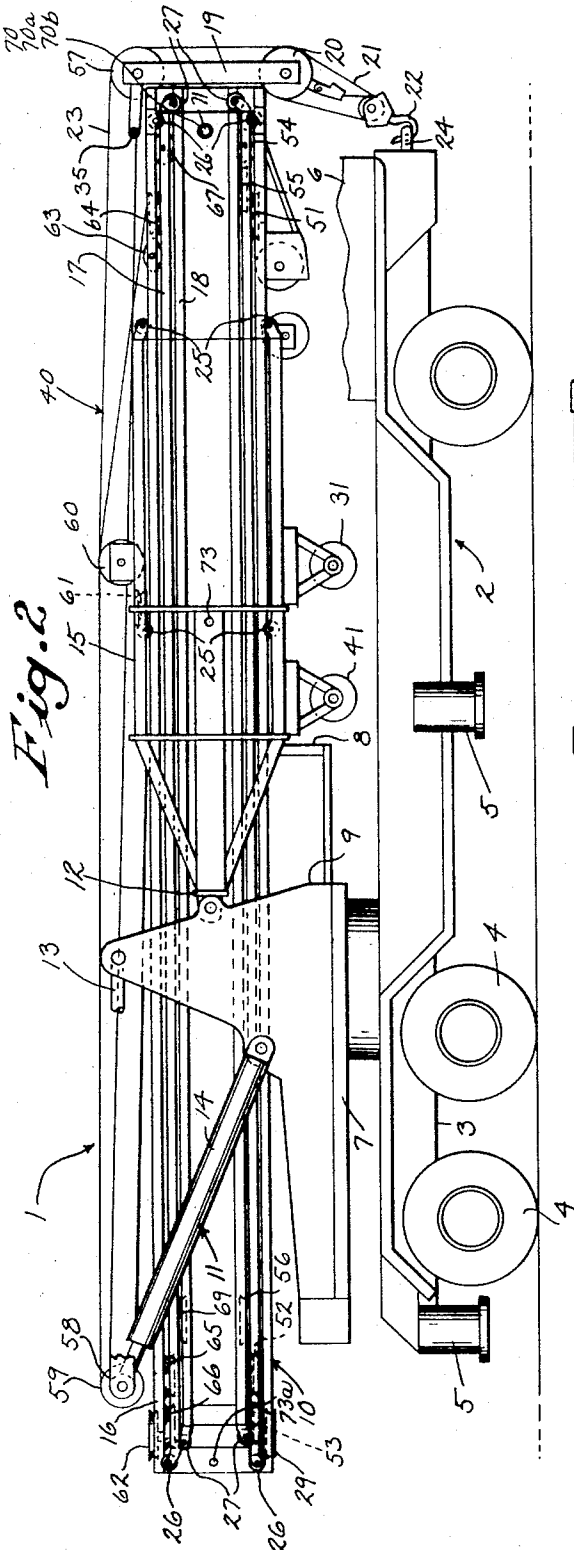
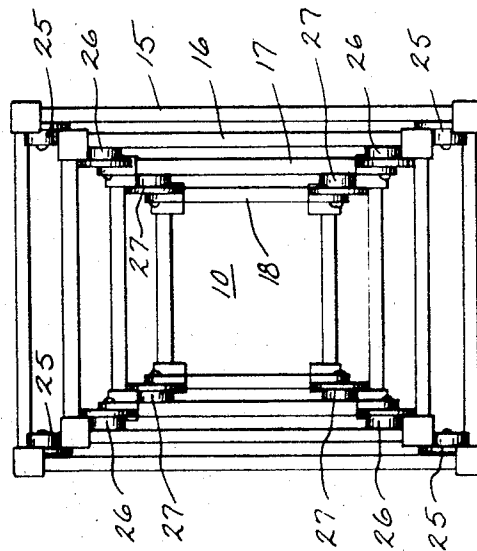
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TELESCOPING BOOM FOR HYDRAULIC CRANE

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3 Sheets-Sheet 2



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TELESCOPING BOOM FOR HYDRAULIC CRANE
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6 Claims

ABSTRACT OF THE DISCLOSURE

A crane with a four-section, telescopic boom uses cables to operate it. Stretch and suspension cables form block-and-tackles between the top of each section and the bottom of the next upper section. The suspension cable also supports the boom top from an adjustable A-frame. A shrink cable fastened to a second intermediate section passes around pulleys at the bottom of the first intermediate section and the top of a sleeve section. A control cable mounted about pulleys in the ends of the second intermediate section is fastened to the first intermediate and top sections.

Background of the invention

Heavy vehicle mounted cranes usually have fixed length booms that are pivotally mounted at the bottom to a revolving frame and suspended at the top from adjustable suspension cables to an A-frame mounted on the revolving frame behind the boom. The only way the length of such a boom can be changed either for highway travel or to suit work needs is to dismantle the boom and remove or add sections as required.

To avoid the cost of dismantling such booms, the prior art, represented in U.S. Patents Nos. 2,819,803 and 3,029,954, suggests the use of a telescoping boom. However, such telescoping booms also have problems. They tend to be extremely complex to build and to operate, and they are also very costly. The present invention provides a less expensive and complex telescoping boom for such a crane, and a telescoping boom embodying the present invention requires a minimum number of operator functions and is more stable than those of the prior art. These objects and advantages are achieved in part by employing an automatically adjustable suspension cable means that maintains a constant boom angle as the boom is extended or retracted. Also, the present invention incorporates a control cable in booms having three or more sections so that the boom sections will maintain the same relationships to each other, kinetic as well as static.

Summary of the invention

The present invention relates to a telescoping boom for a crane, and more specifically, it resides in a crane boom having at least two sections in telescoping relationship, an adjustable A-frame mounted behind said boom, a suspension cable which forms a block-and-tackle between said A-frame and a top of said boom and another block-and-tackle between a top end of a lower of said boom sections and a bottom end of an upper of said boom sections, a stretch cable which also forms a block-and-tackle between the bottom end of said upper boom section and the top end of said lower boom section and which is fastened to a power driven stretch drum, and a shrink cable which has one end fastened to a power driven shrink drum and another end fastened to said upper boom section.

Brief description of the drawings

FIG. 1 is a side elevation of a vehicle mounted crane embodying the present invention illustrating the boom in extended and retracted operating positions.

FIG. 2 is a side elevation of the embodiment shown in FIG. 1 with the boom nested in its traveling position.

FIG. 3 is a view in cross section of the retracted telescoping boom.

FIG. 4 is a diagrammatic representation illustrating the cable means for extending, retracting and suspending the boom of this embodiment of the invention.

Description of the preferred embodiment

In FIG. 1, a crane 1 embodying the present invention is shown mounted on a truck 2. The truck 2 is of the conventional sort used for vehicle mounted cranes and has a chassis 3 mounted on wheels 4 with hydraulic outriggers 5 that are lowered to support the chassis 3 when the crane 1 is operating. On the front end of the chassis 3 is a truck cab 6, and rotatably mounted over the back end of the chassis 3 is a revolving frame 7 of the crane 1. The revolving frame 7 supports a crane cab 8 and a boom pedestal 9, and although it does not appear from the side elevations of the drawings, the boom pedestal 9 is made up of two spaced apart vertical elements projecting upwardly side by side. Pivotally mounted on the front of the boom pedestal 9 is a telescoping boom 10, and behind the telescoping boom 10 on the boom pedestal 9 an A-frame 11 is mounted. The telescoping boom 10 has a bifurcated foot 12, the ends of which are attached to opposite elements of the pedestal 9. Similarly, the A-frame 11 is actually constructed of two parallel, side by side A-frame members attached to opposite elements of the boom pedestal 9, and each A-frame member is made up of a front leg 13 and a back leg 14, the latter 14 of which is an hydraulic cylinder. The most prominent characteristic of the A-frame 11 is its ability to swing in a limited arc aligned with the boom 10 and defined by the front legs 13 as radii, when the hydraulic cylinder back legs 14 are extended or contracted. By thus pivoting the A-frame 11 toward or away from the boom 10, the angle of the boom 10 is adjusted.

The telescoping boom 10 in the embodiment shown is 90 feet long when fully extended and is made up of four sections, although such a boom could be shorter or much longer, and have fewer or more sections. At the foot 12 of the boom 10 is a sleeve section 15. Just above the sleeve section 15, and mounted to telescope in the sleeve section 15, is a first intermediate section 16, and above the first intermediate section 16 is a second intermediate section 17, which is constructed to telescope in the first intermediate section 16. A top section 18, above the second intermediate section 17, is mounted to telescope in the second intermediate section 17. Cheeks 19 are mounted on the top of the boom 10 to support a pair of working sheaves 20, and a working cable 21 passes upwardly from a drum (not shown) mounted on the revolving frame 7 and over the working sheaves 20 to support a hook 22, or any other of the usual tools used to perform the work of a crane such as the crane 1 shown here. A multipart suspension cable 23 connects the top of the boom 10 to the top of the A-frame 11 to support the boom 10, but the length of the suspension cable 23 need not be independently adjustable since the angle of the boom 10 is trolled by extending and contracting the hydraulic cylinders which make up the back leg 14 of the A-frame 11.

The crane 1 is operable with the telescoping boom 10 in its fully extended position as shown in solid lines in FIG. 1 as well as in the contracted position shown in broken lines in FIG. 1 and in any intermediate position desired. When the boom 10 is in its fully contracted working position, the top section 18 is all but completely telescoped inside of the second intermediate section 17, which is itself almost entirely telescoped inside of the first intermediate section 16, but the first intermediate section 16 is extended from the sleeve section 15.

When the boom 10 is in its traveling position, as is shown in FIG. 2, the first intermediate section 16, which has the second intermediate section 17 and the top section 18 telescoped inside of it, is telescoped through the sleeve section 15 so that its bottom end extends well beyond the boom foot 12 and the back of the revolving frame 7. The revolving frame is then rotated so that the top of the boom 10 is adjacent to the truck cab 6 with the hook 22 anchored in an eye 24 on the front of the truck chassis 3. In FIG. 3, a sectional view of the boom 10 in its nested traveling position is shown to illustrate the support of the various sections, one inside the other. As can be seen, the first intermediate section 16 is supported on rollers 25 mounted on the inside of the sleeve section 15, and the second intermediate section 17 is supported on rollers 26 mounted on the lower end of the second intermediate section 17 and the upper end of the first intermediate section 16, and finally, the top section 18 is supported on rollers 27 mounted on the lower end of the top section 18 and the upper end of the second intermediate section 17.

The means for suspending the boom and the means for contracting it and extending it are shown in the diagrammatic representation of FIG. 4. In addition to the suspension cable 23, the boom 10 also has a stretch cable 28 for extending it, a shrink cable 29 for retracting it, and a control cable 30 for ensuring uniform simultaneous movement of the intermediate and top sections 17 and 18, respectively, during extension and retraction. The stretch cable 28 has one end wound on a power driven stretch drum 31, which is mounted beneath the sleeve section 15, and its other end 32 dead ended on the top section 18 near its bottom end. Between the ends, the stretch cable 28 forms two successive block-and-tackle arrangements 33 and 34, which join the top end of one boom section with the bottom end of the next adjacent higher section. The intermediate stretch tackle 33 joins the top of the first intermediate section 16 with the bottom of the second intermediate section 17, and the top stretch tackle 34 joins the top of the second intermediate section 17 with the bottom of the top section 18.

The suspension cable 23 has one end 35 dead ended at the top of the boom 10 and its other end 36 dead ended near the bottom end of the top section 18. Corresponding to the stretch tackles 33 and 34, the suspension cable 23 also forms a succession of suspension block-and-tackle arrangements 37, 38 and 39, as well as a boom suspension block-and-tackle arrangement 40. The top suspension tackle 37 is connected between the bottom of the top section 18 and the top of the second intermediate section 17. The intermediate suspension tackle 38 is connected between the bottom of the second intermediate section 17 and the top of the first intermediate section 16, and the suspension cable take-up tackle 39 is connected between the top of the sleeve section 15 and the bottom of the first intermediate section 16. As distinguished from the other two suspension block-and-tackles 37 and 38, the function of the suspension cable take-up tackle 39 is to take up excess suspension cable 23 when the boom 10 is retracted to its traveling position to prevent fouling and festooning of cable 23 that would otherwise render a boom of the present invention practically unfeasible. Finally, the suspension cable 23 forms a boom suspension tackle 40 which supports the top of the boom 10 from the top of the A-frame 11.

The shrink cable 29 has one end wound on a power driven shrink drum 41, which is mounted beneath the sleeve section 15, and its other end 42 dead ended on the bottom of the second intermediate section 17. A simple one part shrink block-and-tackle 43 is effected between the top of the sleeve section 15 and the bottom of the first intermediate section 16 by passing the shrink cable 29 from the shrink drum 41 over a sheave 44 at the top of the sleeve section 15, back around a sheave 45 at the bottom of the first intermediate section 16, and up to

the dead end 42 on the bottom of the second intermediate section 17. The control cable 30 is an endless cable mounted about sheaves 46 and 47 at the top and bottom, respectively, of the second intermediate section, and it has a fastening 48 securing it to the top of the first intermediate section 16 and another fastening 49 securing it to the bottom of the top section 18. Of course, a strictly endless cable need not be used for the control cable 30, and, in truth, two separate cables each terminating at the fastenings 48 and 49 would probably be used on a crane of any substantial size. Hence the reference to an endless cable is more functional than strictly structural and should be so understood.

Examining the stretch cable block-and-tackle arrangements 33 and 34 in greater detail, it will be seen that the intermediate stretch tackle 33 is made up of a pair of pulleys 50 and 51 mounted in the top of the first intermediate section 16 and a pair of pulleys 52 and 53 mounted on the bottom of the second intermediate section 17. The stretch cable 28 passes from the stretch drum 31 to the pulley 50 in the top of the first intermediate section 16, and then down to the pulley 52 on the bottom of the second intermediate section 17, and then back up to the pulley 51 in the top of the first intermediate section 16 and down around the pulley 53 on the bottom of the second intermediate section 17 and up to the top block-and-tackle 34. Thus, when the stretch cable 28 is wound on to the stretch drum, the pulleys 52 and 53 in the bottom of the second intermediate section 17 are drawn up to the pulleys 50 and 51 in the top of the first intermediate section 16, extending the second intermediate section 17 out of the first intermediate section 16. From the intermediate stretch tackle 33, the stretch cable 28 passes up to one pulley 54 of two pulleys 54 and 55 mounted in the top of the second intermediate section 17 and forming a part of the top stretch tackle 34. The other pulley 56 in the top stretch tackle 34 is mounted in the bottom end of the top section 18 along with the dead end 32 of the stretch cable 28. The stretch cable 28 is alternately strung about the upper pulleys 54 and 55 and the lower pulley 56 to the dead end 32 so that, when the stretch cable 28 is wound on to the drum 31, the bottom end of the top section 18 is drawn toward the top of the second intermediate section 17 to extend the boom 10.

The stretch drum 31 and the shrink drum 41 are powered by hydraulic motors (not shown) which are linked together in a single hydraulic system (not shown) so that, when one of the drums 31 or 41 winds in its cable 28 or 29, the other drum 41 or 31 lets out its cable 29 or 28. Hydraulic motors, pumps, circuitry and other components capable of so driving the drums 31 and 41 are well known to the art; and since these are not a part of the present invention, no further description of them here is necessary.

It may also be noted that obliquely mounted pulleys are employed to transfer the various cables to the interiors of successive sections 15, 16 and 17 of the boom 10. The shrink cable 29 coming off the shrink drum 41 on the outside of the sleeve section 15 is carried to the inside of the sleeve section by the oblique mounting of the pulley 44 on the sleeve section 15, and then it is guided to the inside of the first intermediate section 16 by the oblique mounting of the pulley 45 on the bottom of that section 17. Similarly, the stretch cable 28 coming off the stretch drum outside of the boom 10 is successively guided into the first and second intermediate sections 16 and 17 by the pulleys 50 and 54, respectively, obliquely mounted on the tops of those sections 16 and 17.

To examine the block-and-tackle arrangements 37, 38, 39 and 40 of the suspension cable 23 in detail, it is convenient to start at the dead end 35 at the very top of the boom 10, which is a part of the boom suspension tackle 40. In addition to the dead end 35 fastening, there is also a pulley 57 mounted on top of the boom 10 and two pulleys 58 and 59 mounted on top of the

A-frame 11. The suspension cable 23 is strung back and forth between the dead end 35 fastening and these pulleys 57, 58 and 59 to come out of the boom suspension tackle 40 at the top of the A-frame 11, and from there it reaches to the sleeve section tackle 39. The suspension cable 23 passes under a pulley 60 mounted on the outside of the sleeve section 15, around a pulley 61 obliquely mounted at the top of the sleeve section 15, and back inside the sleeve section 15 to a pulley 62 mounted on the bottom of the first intermediate section 16. From the pulley 62, the suspension cable 23 extends to an obliquely mounted pulley 63, which is one of the two pulleys 63 and 64 of the intermediate suspension tackle 38 mounted in the top of the first intermediate section 16 of the boom 10. The other two pulleys 65 and 66 of the intermediate suspension tackle 38 are mounted on the bottom end of the second intermediate section 17, and the suspension cable 23 is strung back and forth around these pulleys 63, 64, 65 and 66 to come out of the intermediate tackle 38 off the pulley 66 at the bottom of the second intermediate section 17. From the intermediate suspension tackle 38 the suspension cable extends to an obliquely mounted pulley 67, which is one of the two pulleys 67 and 68 in the top suspension tackle 37 mounted in the top of the first intermediate section 17. One other pulley 69 and the dead end 36 of the suspension cable 23 are fastened on the bottom end of top section 18 to complete the top suspension tackle 37, and the suspension cable 23 is alternately strung back and forth between the pulleys 67 and 68 at the top of the second intermediate section 17 and the pulley 69 and dead end 36 at the bottom of the top section 18.

It is noteworthy that with the stretch cable 28 and suspension cable 23 arrangements described, there is no telescoping force acting on the top of the top section 18. Since the top section 18 is often of the lightest possible construction, it is very desirable to avoid exerting such forces on it.

When the stretch drum 31 winds in stretch cable 28 and the shrink drum 41 lets out shrink cable 29, the pulleys described above at opposite ends of the intermediate and top stretch tackles 33 and 34, respectively, are drawn together, shortening the stretch tackles 33 and 34 and thus extending the boom 10. When the boom 10 extends, the dead end 42 of the shrink tackle 43 extends also, taking the shrink cable 29 from the shrink drum 41. At the same time, the pulleys described above at the opposite ends of the intermediate and top suspension tackles 38 and 37 are also moved toward each other, with the result that the suspension cable 23, which is released from the shortened tackles 37 and 38, may be taken up to lengthen the boom suspension tackle 40. Since the boom 10 is being extended, the distance between the top of the boom 10 and the top of the A-frame 11 is being enlarged. Thus, the suspension cable 23 released to the suspension tackle 40 permits the boom suspension tackle 40 to lengthen so that the angle of the boom 10 remains substantially the same as the boom 10 is extended.

When the stretch and shrink drums 31 and 41 are reversed, the opposite occurs, and the stretch drum 31 lets out the stretch cable 28 while the shrink drum 41 draws in shrink cable 29. The shrink cable 29 draws the second intermediate section 17 into the first intermediate section 16. The fastening 48 of the control cable 30 to the first intermediate section 16 causes the control cable 30 to move with the relative movement of the first and second intermediate sections 16 and 17, and since the control cable 30 is connected to the top section 18 by the fastening 49 on the bottom end of the top section 18, the movement of the control cable 30 during extension and retraction of the boom 10 will synchronize the telescoping of the top section 18 and the second intermediate section 17. The top and intermediate suspension tackles 37 and 38 will be lengthened by the retracting telescoping movement of the boom sections 17 and 18; and those

suspension tackles 37 and 38 will draw suspension cable 23 from the boom suspension tackle 40, which is shortened by the retraction of the boom 10. Thus, the angle of the boom 10 is held substantially constant during retraction of the boom 10.

The operation described above permits the boom 10 to be extended or retracted at the operator's command, even under load, as a part of the crane's normal operation. Moreover, the angle of the boom 10 is maintained automatically without attention by the operator during extension and contraction. If the operator wishes to change the angle of the boom 10, he must swing the top of the A-frame 11 in the desired direction by extending or retracting the back legs 14 of the A-frame 11.

The control cable 30 performs several functions. It ensures uniform telescoping movement of the boom sections 17 and 18 during extension and contraction of the boom 10. Depending upon the load on the boom and the relative weights of the boom sections 17 and 18, the sections 17 and 18 will move at varying speeds with respect to one another and some may actually move in opposite directions unless there is some means for controlling them. The control cable 30 provides such means. Also, the control cable 30 will hold the boom sections 17 and 18 in proper relationship to each other when the boom 10 is stationary, regardless of the loading of the boom 10. However, the control cable 30 is necessary only when the boom 10 is made up of more than three sections.

To stow the boom 10 into its non-operational, traveling position, the boom 10 is first telescoped into its fully retracted operating position in the manner described above. Then the intermediate sections 16 and 17 and the top section 18 are latched to each other in that retracted position by some suitable latching means. In the preferred embodiment, the latching means consists of a pin 71 of the sort commonly used in boom structures of cranes which is fitted through aligned holes 70b, 70a and 70 in the telescoped sections 16, 17 and 18. Next the first intermediate section 16 is unlatched from the sleeve section 15 by removal of the pin 72 from the aligned holes 73 and 73a in the two sections 15 and 16. Then the stretch drum 31 is driven to wind in stretch cable 28 just as if it were extending the boom 10; but since the boom sections 16, 17 and 18 are latched together and the pin 72 has been removed, the stretch cable 28 can only draw the top of the first intermediate section 16 towards the stretch drum 31. At the end of its travel toward the stretch drum 31, the first intermediate section 16 will be drawn through the sleeve section 15 so that its bottom end projects all the way through the spaced apart elements of the boom pedestal 9 and over the back end of the revolving frame 3, as is shown in FIG. 2.

Returning the boom 10 from its traveling position to its retracted operating position is the reverse of the operation described in the immediately preceding paragraph. The shrink drum 41 is driven to wind in shrink cable 29. Since the boom 10 is already fully retracted, the effect of winding in the shrink cable 29 is to draw the obliquely mounted pulley 45 on the bottom of the first intermediate section 16 toward the obliquely mounted pulley 44 on the top of the sleeve section 15. Thus, the winding in of the shrink cable 29 serves to drive the first intermediate section 16 out of the sleeve section 15 until it is fully extended. After the first intermediate section 16 is thus extended, the pin 72 may be placed through the aligned holes 73 and 73a in the sleeve and first intermediate sections 15 and 16 to latch the first intermediate section 16 in place. The latching pin 71 restraining the first and second intermediate sections 16 and 17 and the top section 18 in relation to each other can be withdrawn to release them and render the boom 10 fully operational.

The above described means for stowing the boom 10 into a traveling position may not be necessary or desirable in many embodiments of the present invention.

For example, the present invention will find valuable embodiments in yard cranes, which do not travel and therefore need no additional stowage means. Also, a short boom on a traveling crane can be more economically made without provision for a special traveling position. Finally, it may be preferable to use a telescoping boom 10 of the present invention with a boom handling apparatus such as is shown in the co-pending application Ser. No. 600,541 filed on Dec. 9, 1966. Also, the fact that the present invention may be used with booms of any length of having any number of boom sections merits special note. In yard cranes, for example, a two-section telescoping boom in many instances will be preferable. It is also worth noting that in the preferred embodiment shown in the drawings and described above, the dead end 42 of the shrink cable 29 could as well be fastened to the top section 18 as to the first intermediate section 16.

Thus, a crane boom embodying the present invention will manifest the objects and advantages set forth in providing a cable operated telescoping boom that can be operated easily by one operator. The boom will maintain its angle automatically during extension and contraction, which can be accomplished under load as a part of normal operation. Moreover, there is never excess or loose cable to become fouled. All of these operations require only a minimum number of operator controls. A great many other variations can be made in the preferred embodiment shown to provide other embodiments of this invention, so the embodiment described and illustrated here cannot be deemed to be the limit of the subject matter that is the invention. However, the subject matter that is regarded as the invention is particularly pointed out and distinctly claimed as follows.

We claim:

1. A telescoping boom for a crane comprising the combination of
 - a frame;
 - a boom having at least two sections in telescoping relationship with each other, a top end, and a foot end, said foot end being pivotally mounted on said frame;
 - an A-frame mounted behind said boom;
 - a stretch cable having one end fastened to a stretch drum and forming a block and tackle between said telescoping sections for extending said boom;
 - a shrink cable having one end fastened to a shrink drum and having another end fastened to said boom sections for retracting said boom;
 - and a self-adjusting boom suspension cable connected between said top of said boom and said A-frame and forming a block and tackle between said telescoping sections such that said block and tackle extends during retracting of the boom to shorten the cable between the top of said boom and said A-frame and said block and tackle retracts during extension of said boom to lengthen the cable between the top of said boom and said A-frame, so as to

maintain a substantially constant boom angle when said boom is extended or retracted.

2. A telescoping boom as set forth in claim 1 wherein said boom includes a sleeve section at said foot end of said boom, a top section at said top end of said boom, and an intermediate section.
3. A telescoping boom as set forth in claim 1 wherein said A-frame is adjustable to raise and lower the angle of said boom.
4. A telescoping boom as set forth in claim 3 wherein said boom includes a sleeve section at said foot end, a first intermediate section telescoping in said sleeve section, a second intermediate section telescoping in said first intermediate section, and a top section at said top end of said boom and telescoping in said second intermediate section.
5. A telescoping boom as set forth in claim 4 wherein an endless control cable is mounted about sheaves at opposite ends of said second intermediate section; said top section is fastened to said control cable near a bottom end of said top section; and first intermediate section is fastened to said control cable near its top end.
6. A telescoping boom as set forth in claim 4 wherein said suspension cable has one end fastened to the top end of said top section and forms a block and tackle with pulleys mounted at the top of said boom and pulleys mounted at the top of said A-frame; said suspension cable forms a suspension cable take-up block and tackle with a pulley mounted on the top of said sleeve section and a pulley mounted at the bottom of said first intermediate section; said suspension cable forms a third block and tackle with pulleys mounted at the top end of said first intermediate section and pulleys mounted at the bottom end of said second intermediate section; and said suspension cable forms a fourth block and tackle with pulleys mounted at the top of said second intermediate section and a pulley mounted at the bottom of said top section, and another end of said suspension cable is fastened to said bottom end of said top section.

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