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STRESS-COMPENSATED BOOM STRUCTURE

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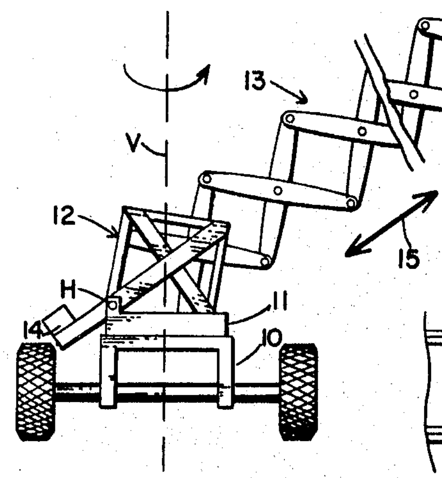

FIG. 1

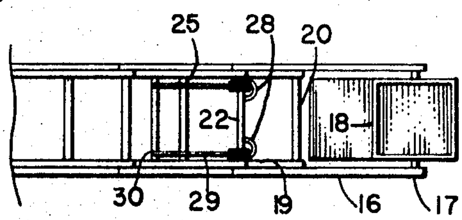

FIG. 2

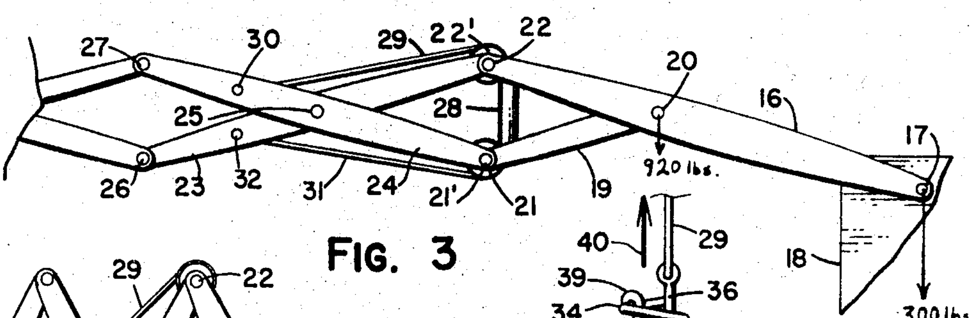

FIG. 3

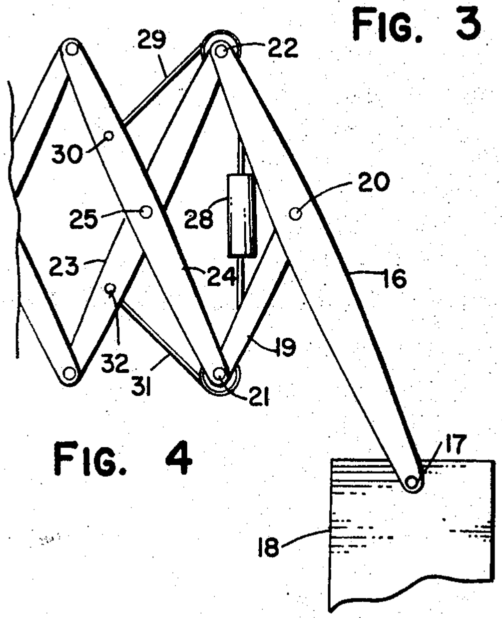

FIG. 4

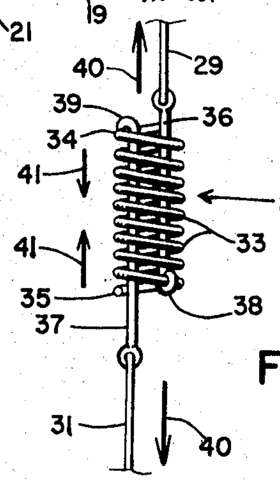

FIG. 5

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STRESS-COMPENSATED BOOM STRUCTURE

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ABSTRACT OF THE DISCLOSURE

A lazy tong type of boom structure has one end constituting a base which may be mounted on a moving vehicle and the other end supporting a load carrying means such as a platform or carriage for a worker, the free end being capable of extension or retraction or movement up and down or laterally to position the worker at various heights and distances from the base. The cantilevered load on the end of the boom results in uneven stresses in the various cross links defining the lazy tong structure. These unequal stresses are rendered more nearly equal by a force-providing means in the form of a spring positioned between the far ends of the last cross links making up the lazy tong structure. The force is such that it increases with increased extension of the lazy tongs and results in compensating stresses in the crossed links such that the overall stress distribution is equalized.

This invention relates generally to boom structures and more particularly to a novel stress-compensated boom structure of the lazy tong type.

Many different types of boom structures for positioning workers at various heights have been proposed and are presently in use. Examples of such use are in telephone line work, fruit picking operations in orchards, general maintenance work on buildings, and the like. One desirable boom design takes the form of a pair of lazy tongs each comprised of a plurality of outboard and inboard links crossing each other at their corresponding ends and centers to permit extension and retraction of the lazy tongs in unison and thus of a load-carrying structure at one end of the boom. An example of this type of boom is fully disclosed in U.S. Patent No. 2,927,705, issued Mar. 8, 1960.

With the foregoing basic structure, a large load at the free end of the boom will result in uneven stresses or loading forces in the inboard and outboard links of the lazy tongs. As a consequence, certain of the links would normally have to be made larger and stronger than other of the links to optimize the design. For example, four link sizes would be necessary to provide proper strength for the lazy tongs thus greatly increasing production costs. An alternative solution would be to design both the inboard and outboard links to carry the load imposed on the outboard link. However, this solution increases the total weight of the boom as well as increasing costs for necessary additional materials.

In addition to the foregoing, unequal loading and stressing of the inboard and outboard links in the lazy tong structures decreases the overall life of the boom particularly when aluminum is employed. In other words, the large differential in the stresses of the inboard and outboard links results in a fairly large maximum fiber stress which shortens the life of the particular link carrying this stress.

With the foregoing in mind, it is a primary object of the present invention to provide a boom structure of the lazy tongs type wherein the above problems are overcome.

More particularly, it is an object to provide a stress-compensating means which may be readily incorporated

in a lazy tong type of boom construction and which will function in a manner to render the strains and bending movements in inboard and outboard links defining the lazy tongs more equal than is the case in the absence of such compensating means. The result is that the various inboard and outboard links may be manufactured in an identical manner so that only two basic link designs are necessary for the entire boom structure with the attendant advantage of reduced production costs.

Still another object is to provide a compensating means for lazy tong type boom structures wherein more uniform loading results in each link resulting in a deflection of nearly equal amounts in each link thereby avoiding non-uniform deflection which would cause binding at the hinge points. The desirable end result is smoother operation of the overall boom during its extending and retracting movements.

Still another object is to provide a compensating means for a boom structure which results in an increased life of the boom by decreasing the maximum stress in any one link over that stress which would exist in the absence of such compensating means.

Briefly, these and many other objects and advantages of this invention are attained by providing a boom structure in the form of a pair of lazy tongs each of which is made up of a plurality of crossed inboard and outboard links together with suitable cross-rods pivotally mounting the links in the respective lazy tongs at their centers and outer ends to provide an overall structure capable of extension and retraction movement. First ends of the lazy tong structure are supported by a suitable base mounting and the other free ends terminate in a load-supporting means such as a suitable platform or basket for carrying a worker. A force-providing means is provided between the diverging ends of the last crossed links at the free end of the boom structure such that these crossed links are biased toward each other with a given force. The force-providing means preferably takes the form of a simple mechanical spring uniquely coupled to the end crossrods in such a manner that the force tending to urge the rods together actually increases with increased extension of the boom. As a consequence, stresses are rendered more nearly equal between inboard and outboard crossed link members over the entire range of operation of the boom structure.

A better understanding of the invention will be had by now referring to one embodiment thereof as illustrated in the accompanying drawings, in which:

FIGURE 1 is a highly diagrammatic side elevational view of the strain-compensated boom structure of this invention in a given extended position;

FIGURE 2 is a fragmentary plan view of the upper end portion of the boom structure of FIGURE 1;

FIGURE 3 is a fragmentary enlarged elevational view of the end portion of the boom structure in an extended position;

FIGURE 4 is a view similar to FIGURE 3 but showing the boom structure in a retracted position; and

FIGURE 5 is a schematic diagram of the force-providing means incorporated in the structures of FIGURES 1 to 4.

Referring first to FIGURE 1, there is shown a portion of a vehicle **10** supporting a rotary mount **11** for a base support structure **12**. The structure **12** is coupled to first ends of a boom of the lazy tong type designated generally by the numeral **13**. A counterweight **14** may be connected to the supporting structure **12** for the boom and the entire structure may be rotated about a vertical axis V as indicated. In addition, the boom structure may be rotated about an horizontal axis H to swing the same in a vertical plane. Finally, the lazy tong arrangement of the boom itself permits extension and retraction of the structure in the direction of the double-headed arrow **15.**

The foregoing described structure is not particularly pertinent to the present invention and is merely illustrated in schematic form. Any suitable type of supporting means constituting a base for a first end of the boom **13** may be provided and it may be stationarily or rotatably mounted or otherwise mounted in accord with the particular application for the boom structure.

Referring now to the boom structure, and also with reference to the fragmentary plan view in FIGURE 2, it will be evident that the boom comprises a pair of lazy tongs each of which is made up of inboard and outboard crossed links together with a plurality of cross-rods pivotally mounting the respective links of each of the lazy tongs at their center and outer end portions. First ends of the lazy tongs connect to the base **12.** The second or far ends of the lazy tongs terminate in a load-supporting means. This load-supporting means includes a coupling structure in the form of a lever **16** pivoted at its far end as at **17** to a basket or platform structure **18** which may support a worker. A similar lever as illustrated in FIGURE 2, is pivotally connected to the opposite side of the basket **18.**

The coupling also includes a short bar **19** pivotally connected to the lever **16** at the point **20** and to an end cross-rod **21** at the diverging far end of an outboard link **24.** The end of the lever **16** opposite its pivoted connection at **17** to the basket at **18** pivotally connects to an end cross bar **22** at the diverging far end of an inboard link **23.** With respect to the foregoing, the lever and bar **16** and **19** together with the basket **18** and the pivot points **17** and **20,** constitute the entire load-carrying means, the same being coupled to the end cross-rods **21** and **22** defining the second end of the boom.

As shown in FIGURE 1, the inboard and outboard links **23** and **24** cross each other and are pivoted by a center cross-rod **25** at their cross over points. These pivoted connections for the links **23** and **24** are identical for the other of the pair of lazy tongs behind the links visible in FIGURE 1 as shown in FIGURE 2.

The opposite ends of the inboard and outboard links **23** and **24** are pivoted respectively to cross-rods **26** and **27.** These cross-rods, in turn, pivotally connect to the ends of the next set of cross links. These latter cross links together with the rest of the cross links articulated in series to the base structure **12** are all pivoted in a similar manner and a detailed description thereof is not deemed necessary. It will be evident from the description given, however, that the cross links define lazy tong structures which may be extended or retracted in unison in the manner of conventional lazy tongs.

In accordance with the invention, there is incorporated in the boom structure a force-providing means, which, in the example chosen for illustrative purposes, takes the form of a spring structure **28** positioned between the end cross-rods **21** and **22** and including a first tension line **29** anchored to the link **24** as at **30** close to the cross-rod **27** and a second tension line **31** anchored to the link **23** at a point **32** close to the cross-rod **26.** As will become clearer as the description proceeds, the lines **29** and **31** pass over suitable bearing means on the cross-rods **22** and **21** respectively, to their anchor points.

With particular reference now to FIGURE 3, the boom is illustrated in its maximum extended position. As shown in FIGURE 3, the bearing means over which the lines **29** and **31** pass may take the form of pulleys or sheaths on the cross-rods **21** and **22** such as indicated at **21'** and **22',** respectively. Actually there would be provided pairs of pulleys as illustrated in FIGURE 2 and there would be provided pairs of force-providing means in the form of the spring structure **28** although it should be understood that a single force-providing means may be provided centrally located between the pairs of lazy tongs and suitably coupled by means of lines to the cross-rods **30** and **32** as described.

With the boom in its maximum extended position as illustrated in FIGURE 3, the lines **29** and **31** are pulled or stretched in view of the increased distance between the securement points on the cross-rods **30** and **32** and the end cross-rods **22** and **21.** The connection with the spring means **28** is such that the force exerted tending to move the end cross-rods **21** and **22** towards each other increases with increased extension of the lazy tong arrangement, this increased force resulting from the stretching of the lines **29** and **31** when in this extended position.

For example, referring to FIGURE 4, the structure of FIGURE 3 is shown in a retracted position wherein it will be evident that the cross-rods **30** and **32** are considerably closer to the end cross-rods **22** and **21** respectively. In this condition, the tension force in the lines **29** and **31** has been relaxed somewhat so that the force exerted by the spring structure **28** between the rods **21** and **22** is less than in the case in FIGURE 3. On the other hand, the stresses developed in the various links is less when the lazy tong structure is retracted to the position shown in FIGURE 4 because of the decreased length of the overall cantilevered portion of the boom.

FIGURE 5 illustrates one type of force-providing spring which is preferably employed in the structure of FIGURES 1 to 4. In FIGURE 5, it will be noted that the structure **28** comprises an helical compression spring **33** having its opposite ends **34** and **35** respectively coupled to the ends of suitable connecting rods **36** and **37,** respectively. These rods pass through the coil spring as at **38** and **29** to connect to the tension lines **29** and **31** respectively.

With the foregoing arrangement, it will be evident that when a tension force is provided on the tension lines **29** and **31** in the direction of the arrows **40,** the spring coils **33** will be compressed as indicated by the arrows **41.** The same result could be achieved by a simple tension spring connected directly between the lines **29** and **31.** However, in this case the stretching of the spring would result in an overall increase in its length with the disadvantage that it could not readily be accommodated between the end cross-rods **21** and **22** when in their closest position as illustrated in FIGURE 3. The particular construction of FIGURE 5 is thus advantageous.

With the foregoing brief description of the various elements making up this invention in mind, the overall operation will now be described. With the spring structure coupled to the lazy tong arrangement as described, when the boom is extended from the position shown in FIGURE 4 to the position shown in FIGURE 3, the resulting pulling on the lines **29** and **31** will compress the spring **28.** The force exerted on the cross-rods **21** and **22** tending to move them closer together will thus increase. As the boom retracts to separate the cross-rods **21** and **22,** they will be positioned closer to the anchor points **30** and **32** of FIGURE 3 as illustrated in FIGURE 4 and thus the pulling forces exerted by the tension lines **29** and **31** will be gradually relaxed so that the overall force exerted between the cross-rods **21** and **22** will become less.

Actually, the pulling force could be adjusted to be substantially constant for any particular position of the lazy tong structure. This provision of a substantially constant force between the cross-rods can be achieved by selecting the proper anchor points **30** and **32** for the ends of the lines **29** and **31.** It will be evident that the decrease in pulling force on the lines **29** and **31** as a consequence of the change in spacing between the anchor points and the end cross-rods, is compensated for somewhat by the increased separation of the end cross-rods as illustrated in FIGURE 4. Thus, if the anchor points are selected properly, there would be no effective change in the pulling force on the lines throughout the range of operation of the lazy tongs with the result that the force exerted by the spring would be substantially constant.

The force exerted by the spring is adjusted in accord with the contemplated load carried by the end of the boom structure. As a specific example of the equalizing of compensation of stresses in the inboard and outboard links resulting from the use of the spring structure, reference is again had to FIGURE 3. Assume that the boom is at full extension and at an elevation of approximately 20 degrees. Assume also that the load on the pivot point **17** as a consequence of a worker in the basket **18** is 300 pounds. With this load, there will be exerted at the pivot point **20**, for the particular dimensioning of the lever **16**, a force of 920 pounds. The effect of this latter force on the inboard and outboard cross-links **23** and **24** of FIGURE 3 in the absence of the spring structure **28** is a bending moment of 245 pounds on the inboard link **23** and a bending moment of 920 pounds on the outboard link **24**. If now the spring structure **28** is added to provide a force of approximately 280 pounds between the end cross bars **21** and **22** which force is applied to the ends of the inboard and outboard links, the bending moment of the inboard link **23** becomes 508 pounds and the bending moment of the outboard link **24** becomes 657 pounds. Thus, the maximum bending moment of 920 pounds has been considerably reduced and this moment transferred to the inboard link such that the resulting stresses in the links are rendered more equal. As a consequence, the inboard and outboard links may be designed to have substantially the same strength with the advantage that the entire boom structure may be more economically manufactured.

As a further matter of interest, under the foregoing conditions with the spring structure employed, and with the 300 pound load applied at the pivot point **17** as described, the tension in the inboard link is approximately 1,130 pounds and the compression in the outboard link **24** approximately 1,193 pounds. In the absence of the spring, the tension in the inboard link **23** would be 1,226 pounds and the compression in the outboard link **24**, 1,097 pounds. Thus, the tension and compression forces in the inboard and outboard links have been rendered more equal as a consequence of the use of the spring structure.

From the foregoing description, it will be evident that the improved boom construction of this invention provides a lazy tong type of boom arrangement wherein stress compensation is provided to the end that the various objects set forth are fully realized.

Modifications falling within the scope and spirit of this invention will occur to those skilled in the art. The stress compensated boom structure is therefore not to be thought of as limited to the specific embodiment set forth merely for illustrative purposes.

What is claimed is:

1. A stress-compensated boom structure comprising: a plurality of crossed links having their centers and ends pivotally connected to define a lazy tong structure, a first end of said structure constituting the base of said boom and the second end terminating in a load-carrying means; and a force-providing means at said second end between the far diverging ends of the last crossed links to exert a given force tending to move said ends together to collapse said crossed links when said lazy tong structure is in a given extended position, said force-providing means including tension means coupled to a portion of said boom structure closer to said first end than said far diverging ends such that said tension means develops a force on said force-providing means when said boom

is extended which results in an increase in the given force tending to move said ends together with increased extension of said lazy tong structure; whereby the stresses in the crossed links defining said lazy tongs resulting from the cantilevering of a load on the end of said boom are rendered more nearly equal to each other.

2. A stress-compensated boom structure comprising, in combination: a pair of lazy tongs each comprised of a plurality of outboard and inboard links crossing each other at their centers; cross-rods pivotally mounting corresponding ends and centers of said links in the respective lazy tongs making up said pair to permit extension and retraction of said lazy tongs in unison; means mounting first ends of said lazy tongs to define a base for said boom; a load-supporting means coupled to second ends of said lazy tongs defining the free end of said boom; and a force-providing means coupled to the end cross-rods pivoting said second ends of said lazy tongs to exert a given force in a direction to bring said end cross-rods closer to each other and having a given value for a given extended position of said boom and a given load on said load supporting means, said force providing means including tension means coupled to a portion of said boom structure closer to said first ends than said second ends such that said tension means develops a force on said force-providing means when said boom is extended which results in said given force remaining at least equal to said given value when said boom is retracted to move said end cross-rods further apart, whereby the stresses in the outboard and inboard links making up each of said lazy tongs are rendered more nearly equal than in the absence of said force-providing means.

3. The structure of claim **2**, in which said force-providing means comprises a mechanical spring and said tension means comprises tension lines extending from said spring in opposite directions towards said end cross-rods respectively; bearing means mounted on said end cross-rods around which said tension lines pass, said lines extending rearwardly from the free end of said boom generally towards said base and being respectively secured to said lazy tongs at points close to the cross-rods pivotally mounting the ends of the links opposite the ends between which said end cross-rods extend, such that extension of said boom results in a pulling force on said lines opposite to the bias force applied by said spring to thereby provide said force between said end cross-rods.

4. The structure of claim **3**, in which said spring comprises an helical compression coil with its axis extending normally to said end cross-rods generally in the plane thereof, said lines extending through said spring to connect to opposite ends of said spring such that pulling on said lines compresses said spring.

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