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A. R. HENRY

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VARIABLE LOAD LIMITING SYSTEM FOR EXTENSIBLE MASTS AND BOOMS

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2 Sheets-Sheet 1

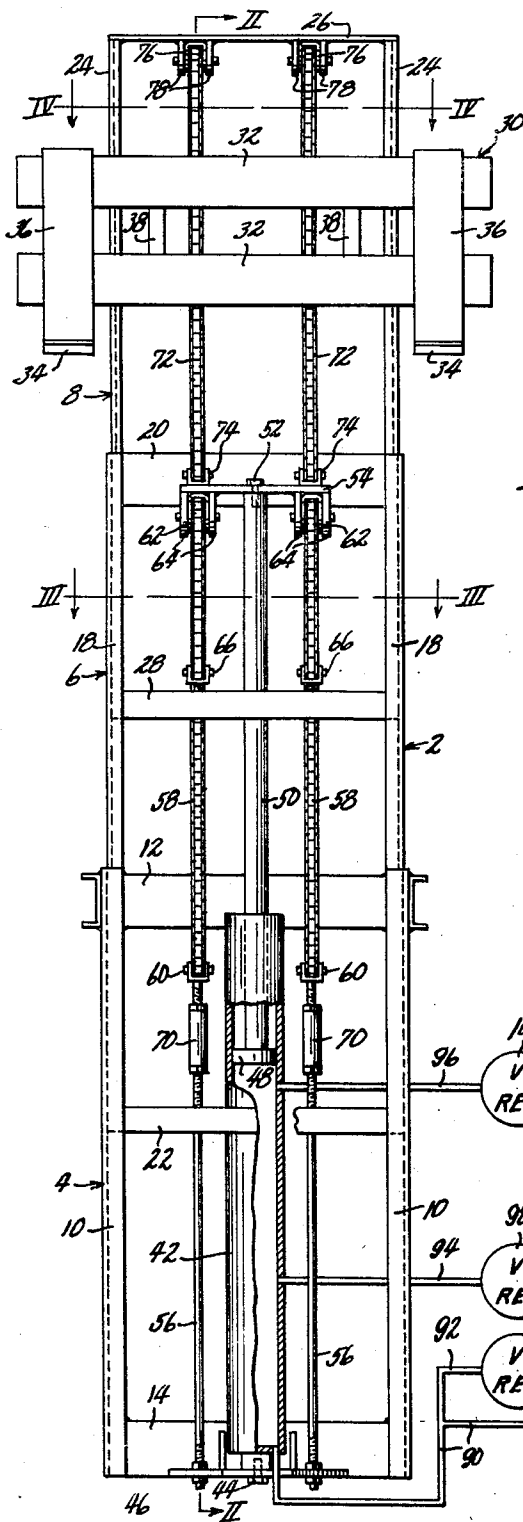
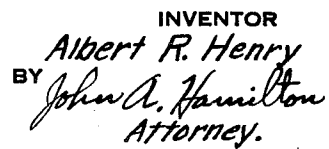


Fig. 1

INVENTOR
Albert R. Henry
BY John A. Hamilton
Attorney.

2,946,406

2 Sheets-Sheet 2



1

2,946,406

VARIABLE LOAD LIMITING SYSTEM FOR EXTENSIBLE MASTS AND BOOMS

Albert R. Henry, Salina, Kans., assignor to Henry Manufacturing Company, Inc., Topeka, Kans., a corporation of Kansas

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This invention relates to new and useful improvements in load handling apparatus, and has particular reference to apparatus wherein the load being handled is supported by an adjustably extensible mast, boom, or the like.

In apparatus of this type, the mast, boom or the like, is commonly in the nature of a cantilever, being fixed at one end and unsupported at the other, with the load carried at or adjacent its free end. Thus if the mast or boom is adjustable in length, it will be apparent that the maximum load it can safely carry will be less when it is fully extended than when it is fully retracted. Heretofore, to my knowledge, it has been common practice to establish the rated maximum load to be imposed on the mast or boom as the load it can safely support when extended to its maximum length. Greater loads could be safely supported if the mast or boom were partially retracted, but would of course constitute an overload if the mast were thereafter extended. The necessarily low load rating of the device thereby established impaired the usefulness of the machine since it gave no indication that greater loads could be carried when the device was not fully extended, when as a matter of fact the device might be used at less than full extension for the greater part of its operation. Also, the low published rating was injurious to the product in a competitive market. At the same time, it is quite impractical to publish a different load rating for different degrees of extension of the mast or boom, since operators could not be expected to remember the resultant table of data nor to keep a close watch on the degree of extension of the device.

Accordingly, the principal object of my invention is the provision of a load limiting system whereby the mast or boom may be extended so far as may be safe for the particular load being carried thereby at any given time, but no farther. For example, if a mast can safely carry a load of one ton to a position of full extension, but can carry a load of two tons safely to one-half of full extension, and is actually carrying one and one-half tons, my system would permit only one-half extension of the mast. This limitation is automatic, requiring no attention from the operator. Generally, this object is accomplished in a mast or boom which is extensible hydraulically by means of a cylinder and piston, said cylinder being tapped at various points corresponding to various degrees of extension of the mast or boom, each of said taps being adapted to by-pass fluid from said cylinder, and being equipped with a relief valve set to open at a fluid pressure corresponding to the maximum load the mast or boom can safely support at the corresponding degree of extension.

Other objects are simplicity and economy of construction, efficiency and dependability of operation, and adaptability for use in a wide variety of applications.

With these objects in view, as well as other objects which will appear in the course of the specification, reference will be had to the drawing wherein:

Fig. 1 is a load-lifting mast shown partially extended, with parts broken away, and showing schematically my variable load limiting system in connection therewith,

Fig. 2 is a sectional view taken on line II—II of Fig. 1, and

Figs. 3 and 4 are enlarged sectional views taken respectively on lines III—III and IV—IV of Fig. 1.

2

Like reference numerals apply to similar parts throughout the several views, and the numeral 2 applies generally to a normally vertical mast such as is commonly used on high-lift fork trucks and the like. Said mast comprises a series of telescopically extensible sections 4, 6 and 8. Bottom section 4 comprises a pair of parallel, spaced apart channels 10 connected rigidly at their upper ends by cross-bar 12, and at their lower ends by cross-bar 14. Also attached to mast section 4 adjacent its lower end are lugs 16 by means of which the mast may be secured to a tractor vehicle, not shown. Intermediate mast section 6 comprises a pair of parallel, spaced apart channels 18 which are mounted slidably in channels 10. Channels 18 are rigidly interconnected at their upper and lower ends respectively by cross-bars 20 and 22. Top mast section 8 comprises a pair of parallel, spaced apart channels 24 which are mounted slidably in channels 18. Channels 24 are rigidly interconnected at their upper and lower ends respectively by cross-bars 26 and 28.

Carried by top mast section 8 is a fork carriage 30 comprising a pair of horizontally extending bars 32 disposed forwardly of the mast, a pair of forwardly projecting arms 34 each having at its rearward end a vertical portion 36 engaging and supported by arms 32, and a pair of roller supports 38 affixed to the rearward faces of arms 32 and extending rearwardly therefrom respectively in inwardly spaced relation from channels 24. Rotatably mounted on each of said supports are a pair of rollers 40 engaged in the adjacent channel 24. It will be understood that when the mast is fully retracted, the three sections 4, 6 and 8 thereof are substantially coextensive, and that fork carriage 30 is disposed at the lower ends thereof, or at ground level. As the mast is extended, intermediate section 6 is raised relative to bottom section 4, top section 8 is raised relative to intermediate section 6, and fork carriage 30 is raised relative to top section 8, all these operations occurring simultaneously.

The mast is operated by a hydraulic cylinder 42 disposed between and parallel to channels 10 of the bottom mast section. Said cylinder is secured at its lower end as by screw 44, to a shelf 46 affixed to cross-bar 14. Operable in said cylinder is a piston 48 to which is affixed an upwardly extending piston rod 50. Said piston rod is secured at its upper end, as by screw 52, to a shelf 54 affixed to cross-bar 20 of intermediate mast section 6. Thus intermediate section 6 is raised relative to bottom section 4 by the direct action of cylinder 42 and piston rod 50.

At each side of cylinder 42, a tie bolt 56 is secured in shelf 46, and extends upwardly parallel to said cylinder. A chain 58 has one end thereof secured to the upper end of each bolt 56, as at 60. Said chain extends upwardly, and is trained over a pulley 62 rotatably mounted between ears 64 affixed to and depending from shelf 54 of the intermediate mast section. Each of said chains extends thence downwardly from pulley 62, and is secured as by fastener 66 to a horizontal shelf 68 affixed to bottom cross-bar 28 of top mast section 8. Each tie bolt 56 is equipped with a turnbuckle 70 by means of which the two chains 58 may be equalized in tension. Thus it will be seen that as intermediate mast section 6 is extended upwardly from bottom section 4, chains 58 will function to extend top section 8 upwardly from section 6.

A pair of chains 72 are each secured at one end to shelf 54, as by fasteners 74 and extend upwardly therefrom. Each of said chains is then trained around a pulley 76 mounted rotatably between a pair of ears 78 affixed to and depending from top cross bar 26 of the top mast section, and has its opposite end secured, as by a fastener 80 to a horizontal shelf 82 affixed to one of bars 32 of fork frame 30. Thus as top mast section 8 is extended upwardly from intermediate section 6 by

chains 58, chains 72 function to elevate fork frame 30 relative to said top section.

While I have shown and described a specific mast, it will be obvious that my load limiting system is equally adaptable to many types of masts, booms, and the like, or stated more generally, to any type of extensible load-supporting member the capacity of which varies inversely to its degree of extension.

The load limiting system forming the subject matter of this invention is incorporated in the hydraulic system of cylinder 42, and is shown schematically in Fig. 1. Said system includes a hydraulic pump 84 which draws fluid from a reservoir 86 through conduit 88, and delivers said fluid under pressure through conduit 90 to the lower end of cylinder 42. A conduit 92 interconnects conduit 90 back to reservoir 86, and a relief valve 93 is interposed in conduit 92. A plurality of conduits 94 and 96 are interconnected into cylinder 42 at consecutively greater distances from the lower end of the cylinder, and are each connected into conduit 92. Relief valves 98 and 100 are interposed respectively in conduits 94 and 96. Reservoir 86 and pump 84 would ordinarily though not necessarily, be mounted on the tractor or other vehicle to which the mast is attached, and pump 84 driven by the engine of the tractor, or by other suitable power unit. Relief valves 92, 98 and 100 would ordinarily be mounted on the mast to reduce the length of the conduits necessary.

The operation of the device is believed readily apparent. As the mast 2 is extended, piston 48 of course traverses cylinder 42. It will be seen that for each load supported by fork carriage 30, there will be a specific, uniform pressure in the cylinder, and that the load the mast can carry will depend on its degree of extension. Obviously the mast when short and stiff can withstand a greater bending stress than when fully extended and consequently relatively flexible. Assume that the mast can safely support a load of three tons for the first one-third of its extension, two tons up to two-thirds of its extension, and only one ton during the final one-third of its extension. Under these circumstances, conduits 94 and 96 are interconnected into the cylinder at its third-points. Relief valve 98 is set to open at a fluid pressure corresponding to a load of two tons on the carriage 30, and valve 100 is set to open at a fluid pressure corresponding to a load of one ton on carriage 30.

Thus a load of three tons may be lifted until piston 48 passes over and uncovers conduit 94, whereupon valve 98 will open responsively to the cylinder pressure, and by-pass fluid back to reservoir 86. The mast cannot be extended further till the overload is removed. If the load is between one and two tons, the load may be lifted until piston 48 uncovers conduit 96, whereupon relief valve 100 will open, thereby by-passing fluid to the reservoir and preventing further extension of the mast. If the carriage load is less than one ton, neither of valves 98 or 100 will open, and the mast may be extended to its full height. Relief valve 93 may be set to open at a fluid pressure corresponding to a load of three tons, or the maximum safe load, on carriage 30.

Thus the mast is automatically protected against overloading, and the protective system does not require the attention of the operator. Any number of conduits 94, 96, etc., desired could be used to provide any desired sensitivity of control. The system does not require resetting or other attention after an overload has occurred, but will automatically return the mast to operation when the overload is corrected.

While I have shown and described a specific embodiment of my invention, it will be readily apparent that numerous minor changes of structure and operation could be made without departing from the spirit of the invention as defined by the scope of the appended claims, and it is accordingly desired that my protection be extended to in-

clude all subject matter properly falling within the purview of said claims.

What I claim as new and desire to protect by Letters Patent is:

1. In combination, an extensible elongated load supporting member adapted to be supported rigidly adjacent its one end and to carry a load adjacent its opposite end, the maximum load which can be safely supported by said member decreasing with the degree of extension thereof, power means operable when energized to extend said load member between minimum and maximum lengths, and load limiting means operable at an intermediate station in the extension of said load member to render said power means ineffective responsively to the load supported whenever the load supported by said load member exceeds a predetermined amount.

2. The combination as recited in claim 1 including a series of said load limiting means operable respectively at a series of stations in the extension of said load member, said limiting means being operable at smaller loads consecutively as said stations represent greater degrees of extension of said load member.

3. The combination as recited in claim 1 wherein said power means constitutes a hydraulic cylinder, a piston operable in said cylinder, and means operable to deliver fluid under pressure to said cylinder to drive said piston in a direction to extend said load member, and wherein said load limiting means constitutes a conduit communicating with said cylinder at an intermediate point thereof, and a pressure relief valve disposed in said conduit and operable to open to vent said cylinder whenever the fluid pressure in said cylinder exceeds a predetermined level.

4. The combination as recited in claim 1 wherein said power means constitutes a hydraulic cylinder, a piston operable in said cylinder, and means operable to deliver fluid under pressure to said cylinder to drive said piston in a direction to extend said load member, and wherein said load limiting means constitutes a series of conduits communicating with said cylinder at spaced points therealong, and a pressure relief valve disposed in each of said conduits, said valves being operable to open, whereby to vent said cylinder, at consecutively lower cylinder pressures in a direction of travel of said piston representing extension of said load member.

5. The combination as recited in claim 1 wherein said load member constitutes a series of elongated, telescopically engaged sections, wherein said power means comprises a hydraulic piston and cylinder operable to extend the first two of said sections relatively and mechanical means whereby each subsequent section is extended from the preceding section by the relative movement of the two preceding sections, and wherein said load limiting means comprises means operable to vent said cylinder at a point intermediate the ends thereof whenever the fluid pressure at that point in said cylinder exceeds a predetermined level.

6. The combination as recited in claim 1 wherein said load member constitutes a series of elongated, telescopically engaged sections, wherein said power means comprises a hydraulic piston and cylinder operable to extend the first two of said sections relatively and mechanical means whereby each subsequent section is extended from the preceding section by the relative movement of the two preceding sections, and wherein said load limiting means comprises means operable to vent said cylinder at a series of stations spaced apart between the ends thereof, the vent at each of said stations being operable to open whenever the cylinder pressure at that station exceeds a predetermined level.

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