

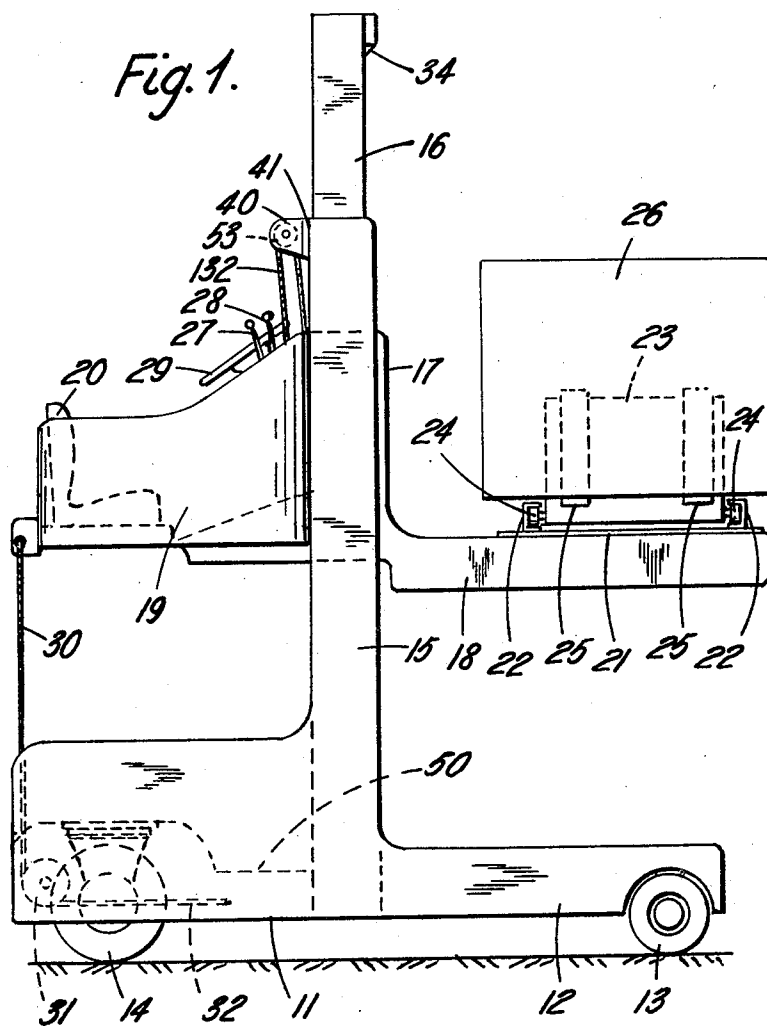
March 9, 1965

J. R. V. DOLPHIN ETAL
LOAD-LIFTING TRUCKS

3,172,500

Filed June 18, 1962

3 Sheets-Sheet 1



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Fig. 2.

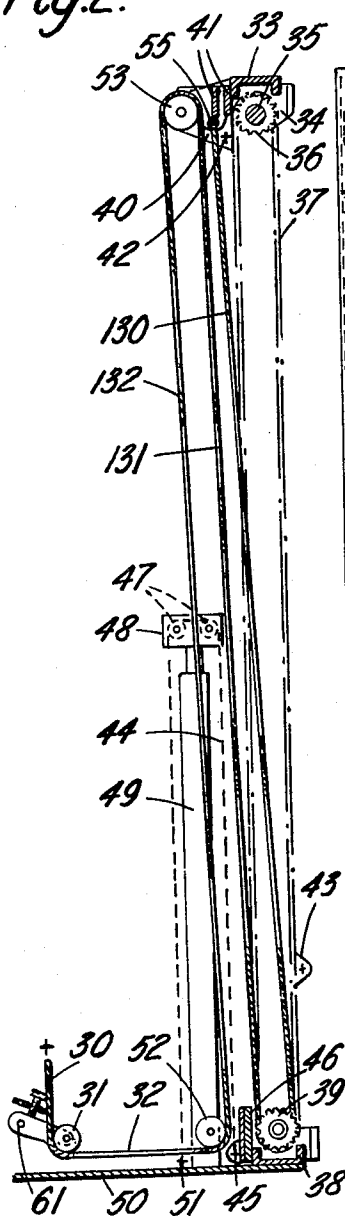
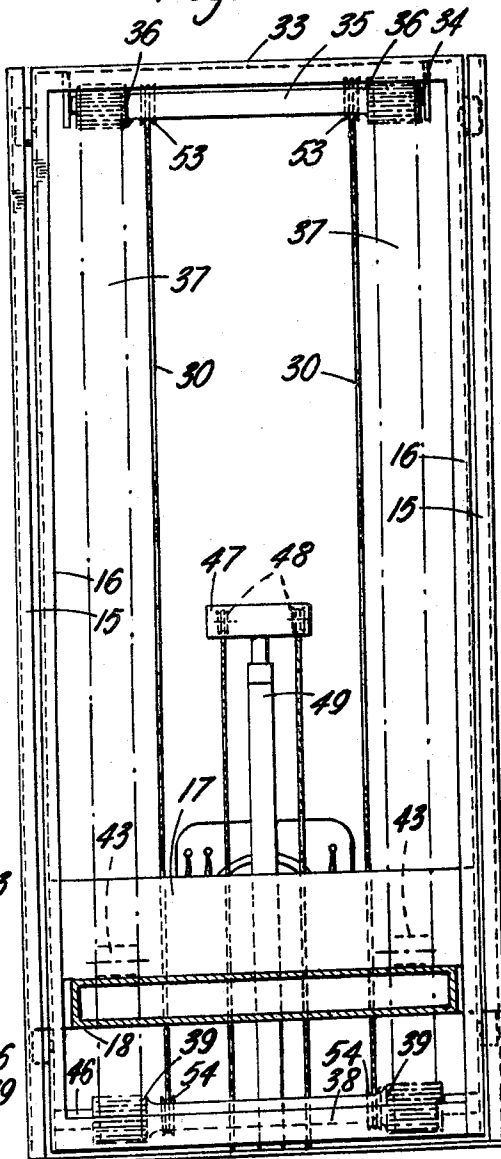


Fig. 3.



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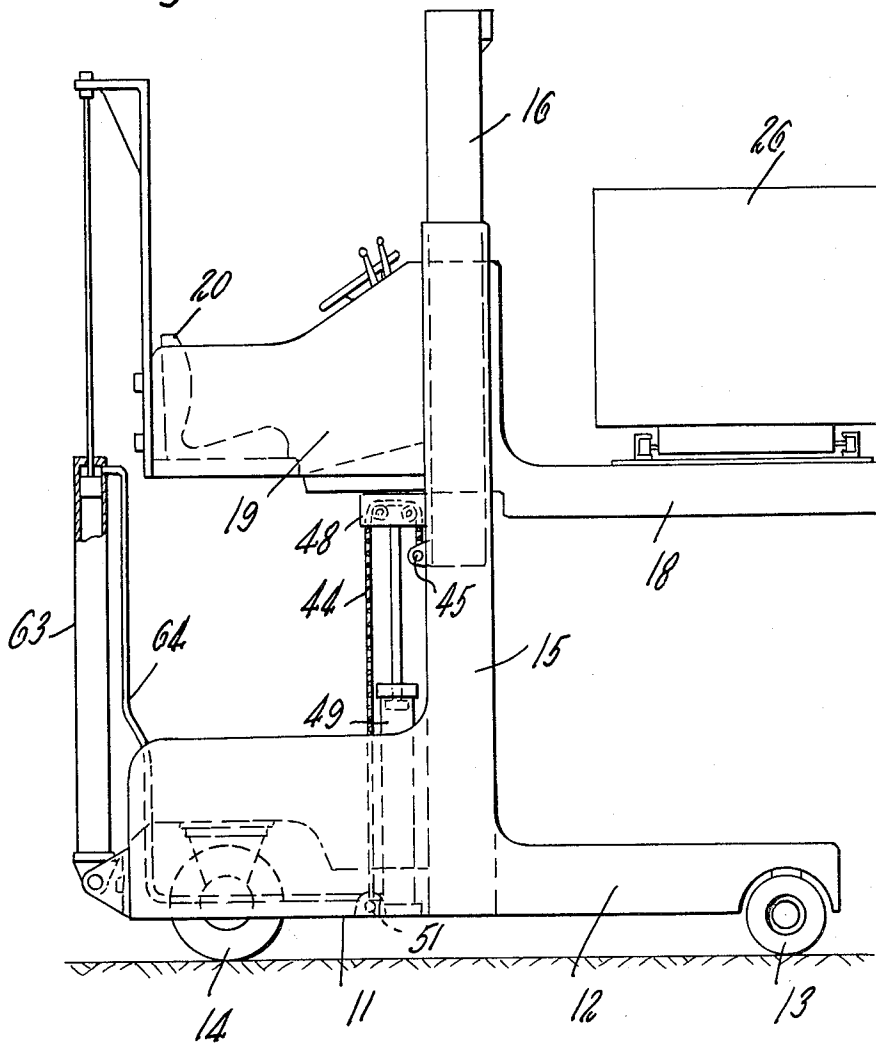
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Fig. 4.



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LOAD-LIFTING TRUCKS

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11 Claims. (Cl. 187—9)

This invention comprises improvements in or relating to load-lifting trucks.

Load-lifting trucks, such as fork trucks, are commonly used in stores, or like places in works, for lifting loads off the ground or off shelving or racking and it is usual for such trucks to have a mast with a carriage on it which can travel up and down the mast and thereby raise or lower the load. The load-supporting means on the carriage necessarily project from the carriage in a direction away from the mast and apply a tipping moment to the mast and hence to the whole truck, resistance to which has to be provided for in the design of the truck, commonly by a counterweight at the back of the truck, but this leaves the mast subject to severe bending moments and in the case of telescopic masts, increases the difficulty and the weight of the design. It is an object of the present invention to reduce bending moment on the mast, due to the load, and it is a further object of the invention to reduce the necessity for the employment of counterweights, and the overall weight of the truck.

According to the present invention, in a load-lifting truck having a mast and a carriage movable up and down the mast with load-supporting means projecting from the carriage away from the mast in one direction, flexible means are provided engaging the carriage at a position offset from the mast in the opposite direction for applying a balancing force to balance the load, and guide means are provided on the extensible mast, the flexible means being led in a path such that they interconnect the carriage at the said position, the guide means and the carriage at a position nearer the mast so as to allow movement of the carriage up and down, while maintaining said balancing force.

Preferably, in order to give the operator a better view of the way in which the load-supporting means is engaged with the load and better control of the load handling, an operator seat is provided on the carriage so that the operator moves up and down with the load. Preferably, in order to assist the balancing of the load, the operator seat is made to project from the carriage in the opposite direction from the load-supporting means, that is to say in the same direction as that in which the extensible means for applying force to balance the load are offset from the mast, and conveniently the means for applying force to balance the load may be attached to the back of the operator's seat.

The flexible means may be led in such a path in relation to the fixed portion of the mast and to the extensible portion thereof that any movement of the carriage and the extensible portion of the mast so adjusts the length of path that the said flexible means is taken-in or paid-out in accordance with movement of the carriage and remains in tension during such movement. Preferably, where, as is commonly the case, the carriage is constrained to rise at twice the speed of the extensible portion of the mast, the chain or cable is guided downwardly from the offset portion of the carriage to a guide on the truck body, thence to a guide at the upper end of the fixed portion of the mast, downwardly to a guide at the lower end of the extensible portion of the mast, the end being fixed to the upper end of the fixed portion of the mast.

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When a cable is used to balance the load the guides may be pulleys. Preferably two chains are used as the flexible means, one at each side of the mast, and corresponding sprockets at each side of the mast over which the chains run, are mounted so that they rotate together. Preferably a tensioner is provided to maintain chain tension in the event of stretching of the chain.

The following is a description, by way of example, of certain constructions in accordance with the invention, reference being made to the accompanying drawings, in which:

FIGURE 1 is a diagrammatic side elevation of one construction,

FIGURE 2 is a diagrammatic side elevation showing the run of cables and chains in the construction shown in FIGURE 1,

FIGURE 3 is a front elevation of the construction shown in FIGURE 2, and

FIGURE 4 is a diagrammatic side elevation showing a modification.

The truck comprises a low chassis 11 having two forwardly projecting straddle legs 12 with ground wheels 13 at their front ends, the rear portion of the chassis being provided with steerable power driven ground wheels 14. A mast 15 stands up from the chassis at the position where the straddle legs 12 begin, the mast consisting in its bottom portion of two inwardly directed channel-section members within which slides a telescopic portion 16 of the mast also consisting of inwardly directed channel members. The construction of these parts is well-known and need not be further described except to say that, as the mast bears less bending moment than is usual in a truck of this kind, it may be of somewhat lighter construction. The devices for raising and lowering the mast are hereinafter further described and within the inner section 16 of the mast there is supported a rising and falling load-carrying carriage 17 which runs on rollers which fit in the channels of the inner mast section and guide it up and down. Such rollers may be of the usual construction for guiding carriages, but as it is not necessary for them to resist such tipping moments as are usual in load-lifting carriages, the force upon them is much reduced compared with the usual constructions. The carriage 17 extends across the space between the two sides of the inner mast 16 and it has a forwardly projecting platform 18 on which load-carrying means are mounted and a rearwardly projecting frame 19 which houses an operator's seat 20.

Instead of the forwardly projecting platform 18 there may be forks if desired, but preferably, as shown in the drawings, let into the upper surface of the platform 18 is a turntable 21 which houses two parallel guides 22 in the form of channel-shaped rails on which runs a reach carriage 23 having rollers 24 to run in the guide rails 22. Mounted on the reach carriage 23 are forks 25 for supporting a load 26.

By means of the turntable 21 the forks 25 can be caused to project either forwardly or to right or left of the platform 18. They are shaped so that when the reach carriage is run to the end of the guide rails 22 they overhang the sides of the platform and their upper surfaces are made so that they stand up above the level of the guides 22 to the minimum possible extent, so that the height from the underside of the platform 18 to the top of the forks is the least possible. The carriage is shaped so that the platform can descend between the sides of the straddle legs 12 and when the carriage 17 is in its lowermost position the undersides of the forks are only just above the upper surfaces of the straddle legs 12. Indeed, if necessary the projecting portions of the forks can be cranked so that they will extend downwards and then outwards at ground level, provided there is no

objection to the resultant limitation in the extent of their reach movement. The reach movement, the rotation of the turntable 21 and the rising and falling movements of the carriage are controlled by hydraulic means mounted on the parts and controlled from the operator's seat 20 by levers 27, 28. The movements of the truck are effected by the steering and driving wheels 14 which are controlled by remote control connections from a steering wheel 29 and an appropriate accelerator pedal and brake pedal under the control of the operator on the platform. Such remote control means are in themselves well-known and need not herein be described further.

With the parts arranged as described the weight of the operator and his seat tends to balance the load but the combined weight of the operator and seat will not normally be sufficient to counteract the combined weight of the platform 18, the reach parts mounted on it and the load and the true balancing load is applied by means of a cable or chain 30 attached to the back of the operator's seat and extending downwardly parallel to the mast to guide-pulley means 31 on the chassis.

In the construction being described there are two cables or chains 30, one at each side of the operator seat and two guide pulleys on the chassis and the chains extend forwardly from the guide pulleys 31 in a horizontal direction as shown at 32. It is linked up with the means for extending the masts 15, 16 so that the rate of pay-out or take-in of chain is the same as the rate of lifting or lowering the carriage 17 on the mast. If accurately done, this will relieve the mast of all bending moment and the roller mounting between the carriage and the mast will only have to take care of any bending moment which may be necessary to compensate for any lack of accuracy in the application of balancing force by the chains 30 to the carriage.

The means for paying-out or taking-in the chains 30 may vary and may be mechanical or hydraulic. The preferred construction is shown in FIGURES 2 and 3.

In FIGURE 2 the top cross-member of the inner mast is indicated at 33 and it carries brackets 34 between which are supported a cross shaft 35 carrying two sprockets 36 over which run two chains 37. The bottom of the inner mast is shown at 38 and it carries two similar sprockets 39. The chains 37 run round the sprockets 39 and are endless. Strictly, although FIGURE 2 has been described as a side elevation, it is an elevation only in so far as the chains and sprockets are concerned; the top and bottom 33, 38 of the mast are shown in section. Behind each chain 37 there is a bracket 40 which is supported from top framing 41 which unites the sides of the outer mast and the bracket 40 is secured at 42 to one of the links of the chain 37. The chain 37 also carries on that part of it which lies in front of the sprockets 36, 39 a lug 43 for attachment to the carriage 17. The disposition of the sprockets and their chain 37 can most easily be seen in FIGURE 3 of the drawing which shows the carriage 17, a section through the forwardly projecting platform 18 of the carriage and the points where the lugs 43 are attached to the chains. The effect is that if the inner mast is lifted relatively to the outer mast the carriage is caused to rise relatively to the inner mast and the speed of rise of the carriage 17 relatively to the ground is twice the speed of rise of the inner mast. The lifting of the inner mast 16 relatively to the outer mast is effected by chains 44 shown in dotted lines in FIGURE 2 in order to distinguish them from the other chains. The chains 44 are attached to lugs 45 on the back of a cross-member 46 which extends across the back of the inner mast. The chains 44 pass over guide sprockets 47 on a head 48 which is fixed on a ram of a hydraulic cylinder 49 standing on the flat body 50 of the chassis 11. From the head 48 the chains 44 extend downwardly to a fixed anchoring point 51 on the chassis. Extension of the ram of the hydraulic jack cylinder 49 will there-

fore lift the inner mast relatively to the outer one. It will be understood that the rearwardly projecting portion 19 of the carriage 17 is made with apertures to pass the head 48 and the various chains and that the chains and jacks and their associated parts have been omitted from FIGURE 1 in order to obviate unduly complicating the figure.

The means for taking-in and paying-out the balancing chains 30 are as follows: The chains, after passing under the guide-pulleys 31, pass horizontally to the underside of guide-pulleys 52 mounted on a spindle supported from the base 50 on each side of the jack cylinders 49. The chains pass upwardly to guide-pulleys or sprockets 53 carried on the bracket 40 on the back of the outer mast and thence downwardly to guide-pulleys 54 which are co-axial with the sprockets 39. Thence the chains run up to an anchorage point 55 on the cross-members 41 of the fixed portion of the mast.

It will be noted that the pulleys 54 and the sprockets 39 being mounted on the bottom of the inner mast rise at the same speed as that mast and that the first bight 130 of the chain 30 from the fixed point 55 to the pulley 54 on the bottom of the inner mast will not move. Consequently the second bight 131 of the chain will move upwardly at double the speed of the inner mast which is equal to the rate of rise of the carriage attached to the lug 43 and the third bight 132 will be paid out downwardly at the same speed that the carriage moves upwardly. The bight 132 is directly connected to the part 30 which is attached to the rear of the carriage and therefore the chain is paid-out at the same rate at the rear at 30 as the carriage is rising and it will maintain a constant downward pull on the carriage. Each pulley 31 is mounted on a pivoted lever 61 and is urged downwardly by a screw 62. The effect is that the heavier the load on the forks 25 the stronger the tension in the chains 30 which are attached to the rear of the carriage.

It will be noted that if the turntable 21 is operated to present the forks 25 to the left or right so that the load 26 overhangs to one side or other of the truck there will be a lateral load on the mast 15 which is not balanced by the chains 30, but this lateral load the mast is well adapted from its shape to withstand, the sides of the mast being well spaced apart. The fore-and-aft component of the bending moment set up by the load is what is compensated by the chains 30.

Instead of the cable or chain 30 there might be a telescopic hydraulic jack 63 (FIG. 4) connected to the back of the frame 19 and interlinked through tubing 64 with the jack means 49 which lift the carriage so that the jack 63 always exerts a downward force proportional to the upward force required for lifting the carriage.

It will be understood that in FIGURE 2 the mast structure (except the head 33 and foot 38 and adjacent parts) is omitted in order to show more clearly the run of the chains. Also the carriage is omitted and the chains themselves are arbitrarily distinguished from one another by showing the chains 30 as though they were cable; the chains 37 by chain lines; and the chains 44 by dotted lines.

We claim:

1. A load-lifting truck comprising a truck body, an extensible mast including a fixed first mast portion mounted on the truck body and a second mast portion movable up and down the fixed mast portion, a carriage movable up and down the second mast portion, means interlinking movement of the carriage with that of the second mast portion so that the carriage moves upwardly faster than the second mast portion, means for lifting the second mast portion and thereby the carriage through said interlinking means, load supporting means mounted on the carriage and projecting away from the mast in one direction, a member for applying a balancing downward force to the carriage at a point offset from the mast on the opposite side to the load supporting means and means for applying balancing downward force to said member

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which means are interconnected with the second mast portion and its lifting means so that the balancing force applied is proportional to the load on the second mast portion.

2. A load-lifting truck comprising a truck body, an extensible mast including a fixed first mast portion mounted on the truck body and a second mast portion movable up and down the fixed mast portion, a carriage movable up and down the second mast portion, means interlinking movement of the carriage with that of the second mast portion so that the carriage moves upwardly faster than the second mast portion, means for lifting the second mast portion and thereby the carriage through said interlinking means, load supporting means mounted on the carriage and projecting away from the mast in one direction, a member on the carriage for applying a balancing downward force to the carriage at a point offset from the mast on the opposite side to the load supporting means and means co-operating between said member and a part fixed relatively to the truck body for applying balancing downward force to said member, which means are interconnected with the second mast portion and its lifting means so that the balancing force applied is proportional to the load on the second mast portion.

3. A load lifting truck comprising a truck body, an extensible mast including a fixed first mast portion mounted on the truck body and a second mast portion movable up and down the fixed mast portion, a carriage movable up and down the second mast portion, load supporting means mounted on the carriage and projecting away from the mast in one direction, a flexible tension member which interconnects a first position on the carriage offset from the mast in the opposite direction and a second position on the fixed first mast portion for applying a balancing force at the first position to balance the load on the load supporting means, said second position being nearer the load supporting means than is the first position, and guide means round which the tension member extends between the first and second positions, one part of which guide means is fixed relative to the truck body and another part of which is connected to move with the carriage such that the tension member allows movement of the carriage while maintaining said balancing force.

4. A truck as claimed in claim 3, wherein the carriage is constrained to rise at twice the speed of the second mast portion, wherein the guide means comprises a first guide on the truck body, a second guide at the upper end of the fixed mast portion and a third guide at the lower end of the second mast portion, and wherein the flexible tension member has one end secured to the carriage at said first position, extends thence past the first guide, the second guide and the third guide, the end being fixed to the upper end of the fixed mast portion.

5. A truck as claimed in claim 3, wherein two such flexible tension members are provided side by side and extend parallel to each other to share the balancing force, which members are respectively constituted by two chains, and wherein the guide means comprises at least one pair

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of sprockets over which the chains run, which sprockets are mounted for rotation together.

6. A truck as claimed in claim 3, wherein a tensioner is provided to maintain the tension in the tension member in the event of stretching thereof.

7. A truck as claimed in claim 3, wherein the flexible tension member is led in such a path in relation to the fixed mast portion and to the second mast portion that any movement of the carriage and the second mast portion so adjusts the length of path that the said flexible tension member is taken-in and paid-out in accordance with movement of the carriage and remains in tension during such movement.

8. A load-lifting truck as claimed in claim 3, wherein an operator seat is provided on the carriage so that the operator moves up and down with the load.

9. A load-lifting truck as claimed in claim 8, wherein in order to assist the balancing of the load the operator seat is offset from the mast in the opposite direction from the load-supporting means.

10. A truck as claimed in claim 9, wherein the flexible tension member for applying a balancing force on the carriage is attached to the carriage at the back of the operator seat.

11. A load lifting truck comprising a truck body, an extensible mast including a fixed first mast portion mounted on the truck body and a second mast portion movable up and down the fixed mast portion, a carriage movable up and down the second mast portion, means interlinking the carriage with the second mast portion so that the carriage moves upwardly faster than the second mast portion, load supporting means mounted on the carriage and projecting away from the mast in one direction, a first hydraulic jack connected between the truck body and a first position on the carriage offset from the mast in the opposite direction, a second hydraulic jack connected between a second position on the second mast portion and the truck body which second position is nearer the load supporting means than is the first position, and a hydraulic interconnection between the two jacks such that the first jack exerts a downward force on the carriage at said position proportional to the upward force exerted by the second jack to lift the second mast portion and the carriage.

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