July 3, 1962 S. T. COMFORT 3,042,149

LIFT TRUCK MAST PULLDOWN CYLINDER ASSEMBLY

Filed June 1, 1961 3 Sheets-Sheet 1

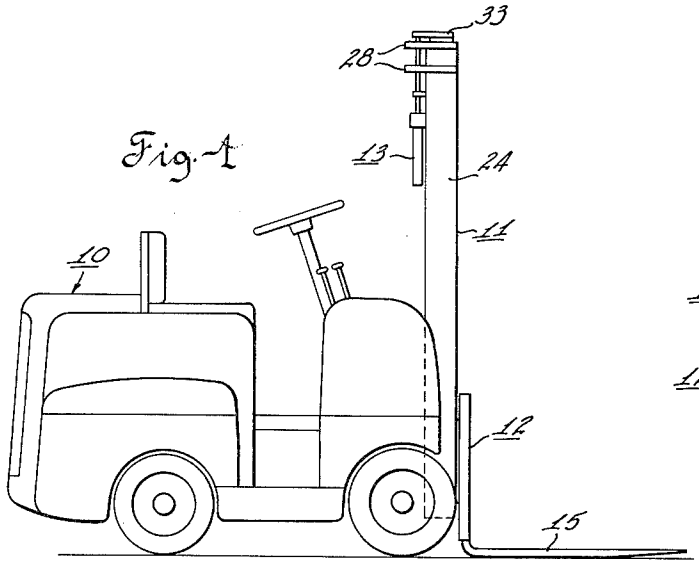



Fig. 1

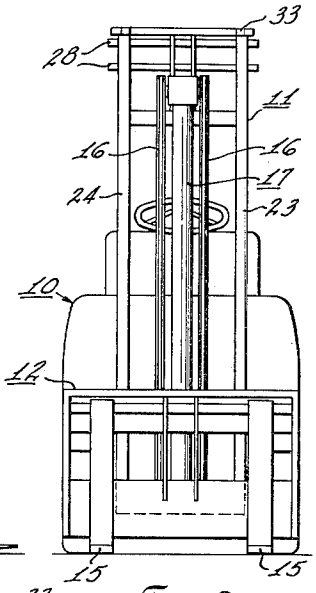



Fig. 2

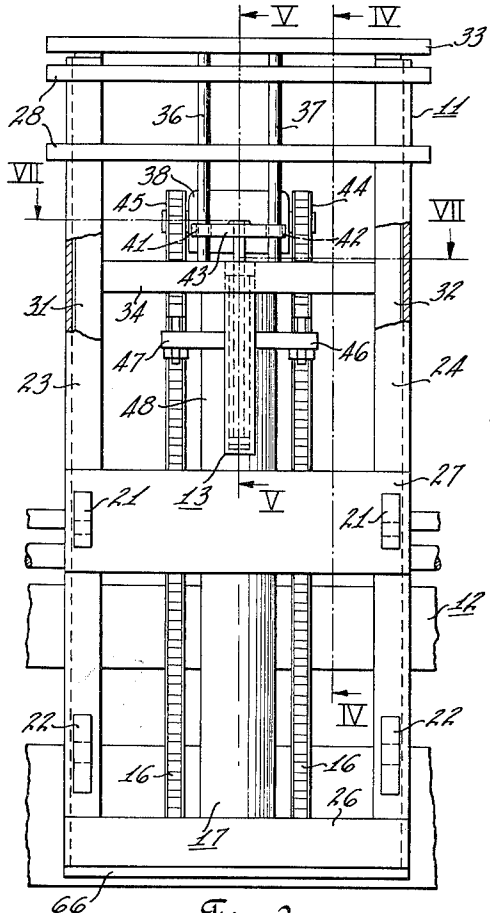



Fig. 3

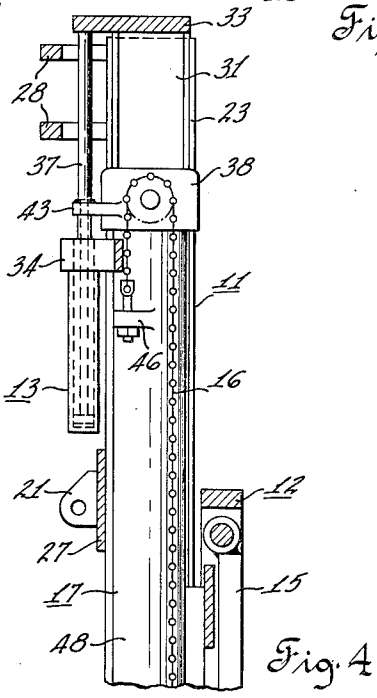



Fig. 4

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LIFT TRUCK MAST PULLDOWN CYLINDER ASSEMBLY

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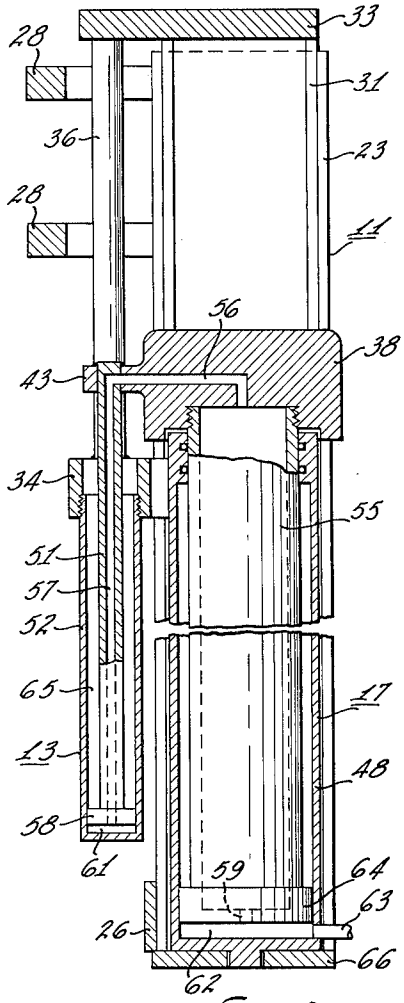



Fig. 5

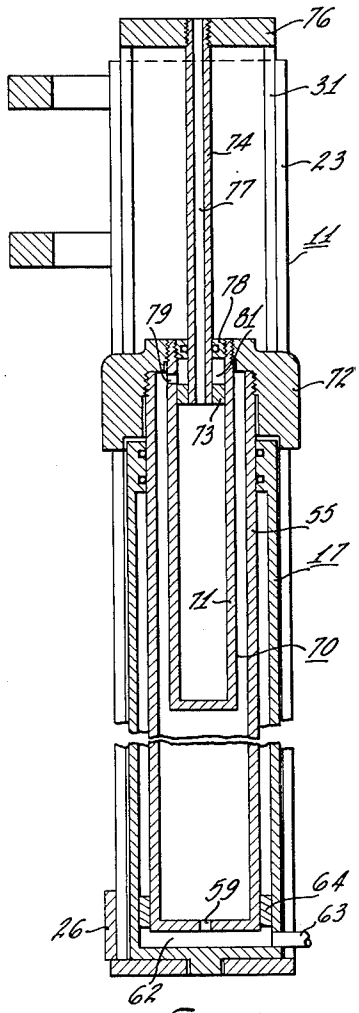



Fig. 6

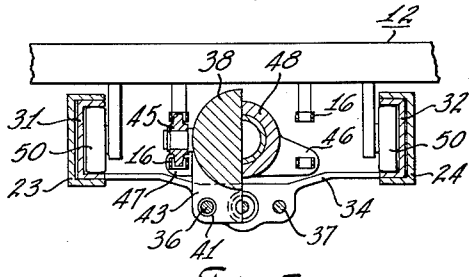



Fig. 7

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LIFT TRUCK MAST PULLDOWN CYLINDER ASSEMBLY

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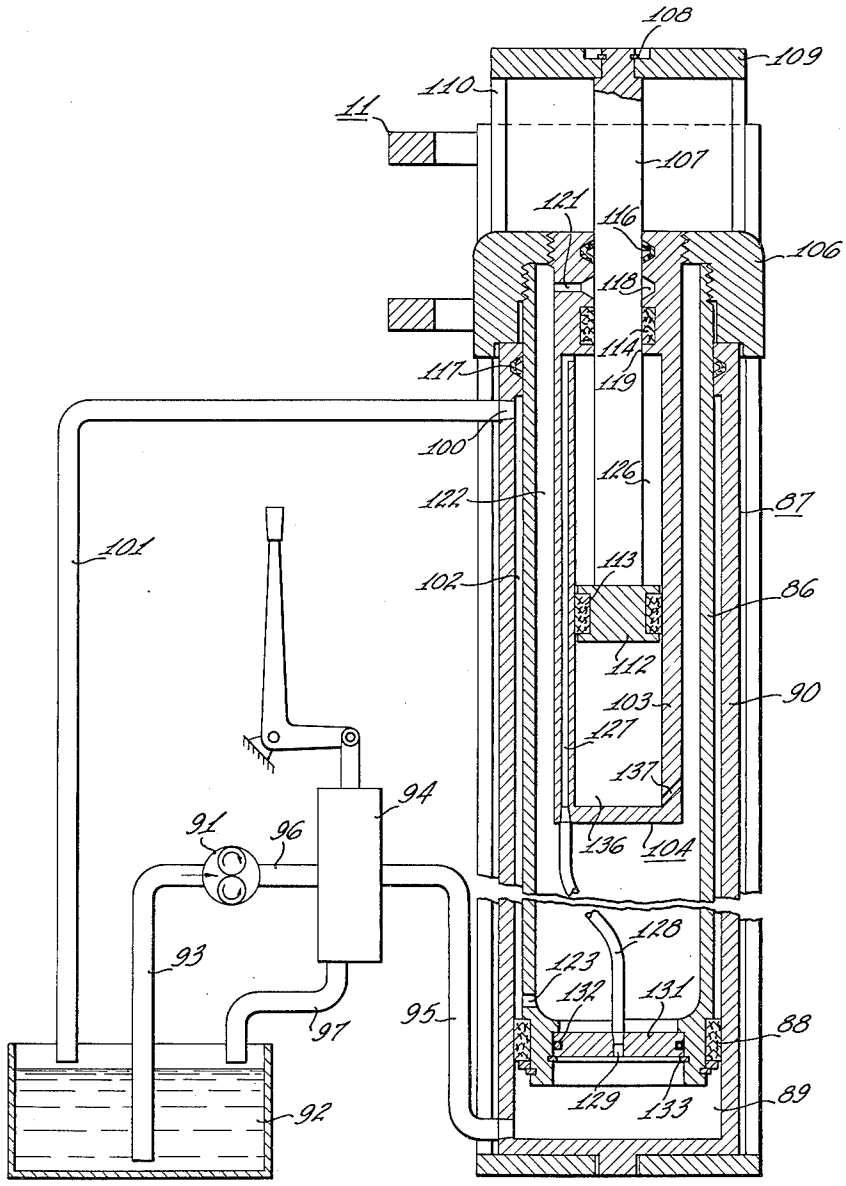



Fig. 8

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United States Patent Office 3,042,149 Patented July 3, 1962



3,042,149

# LIFT TRUCK MAST PULLDOWN CYLINDER ASSEMBLY

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Filed June 1, 1961, Ser. No. 114,134
15 Claims. (Cl. 187—9)

This invention relates to means for automatically biasing an extensible section of a multisection lift truck mast toward the lifting ram to insure proper cycling of such extensible section during raising and lowering operations.

In an extra lift type mast wherein the lifting ram and an extensible section of the mast have a lost motion connection, it is desirable that such section shall maintain a position of minimum overall height consistent with the movement of lifting ram and carriage for traveling through low doorways or in buildings with low ceilings. The lost motion connection permits raising of the carriage a predetermined distance above the ground before the ram engages the extensible mast to move it upwardly, and permits the carriage to lift the extensible section off the lift ram to obtain extra lift at the upper end of carriage travel. Two opposing frictional forces exist in an extra lift mast, these being the carriage to extensible section and the extensible section to stationary section. For instance, if during the lift the carriage to extensible section frictional force exceeds the extensible section to stationary section frictional force in an amount greater than the weight of the extensible section, the extensible section will lift at carriage speed thereby objectionably increasing the clearance height of the truck. If this condition exists during initial raising of the carriage, the free lift afforded by the lost motion connection between the lift ram and extensible section will be lost and if occurring during an intermediate range of lift the extensible section will be moved upwardly away from the lift ram thereby unnecessarily increasing the lift truck height.

If during lowering, the extensible section to stationary section frictional force exceeds the weight of the extensible section plus the carriage to extensible section frictional force, the extensible section will remain up until forced downwardly by the ram upon its reaching the lower limit of its lost motion connection with the extensible section. Upon deposit of the load, or upon movement of the carriage and mast sections to positions wherein the frictional forces are changed, the extensible section may drop the distance of the lost motion connection against the ram. In some lift trucks the lost motion may be as much as twelve inches and the extensible section may weigh 600 pounds or more. The resulting shock is damaging to structural components of the lift truck and is objectionably detracting to the truck operator.

Additionally it is desirable to prevent high pressure leakage of the biasing means, which I employ to insure proper cycling, from spilling onto the exterior of the mast components. In piston type lift rams, that is in lift rams having the high pressure fluid sealing packing on the piston rather than the cylinder, a leakage return line has heretofore been connected to the low pressure end of the single acting hydraulic cylinder to convey leakage to the hydraulic reservoir of the fluid system. When the biasing means of this invention is installed in a piston type lift ram, I have found that it is possible to also convey the high pressure leakage of the biasing means to the reservoir through the same return line.

It is an object of this invention to remedy the hereinbefore mentioned lifting and lowering sequence problem in an entirely satisfactory and economical manner.

It is a further object of this invention to provide a hydraulically actuated biasing mechanism for urging an extensible section of a lift truck mast downwardly toward the lifting ram.



It is a further object of this invention to provide a hydraulically biased device for urging an extensible section of a lift truck mast downwardly against the lift ram, the device being actuated by the same hydraulic pressure as is acting on the lift ram.

It is a further object of this invention to provide a means for biasing an extensible section of a multisection mast downwardly toward the lifting ram including a piston and cylinder disposed within the lifting ram and serving to guide the latter relative to the extensible section during lost motion movement therebetween.

It is a further object of this invention to provide a biasing ram between the extensible section of an extra lift mast and the lift ram therefor which is disposed within the lift ram and which has its lower end in free flow communication with the pressure fluid reservoir.

It is a further object of this invention to provide a biasing ram as hereinbefore described and wherein leakage past the high pressure rod packing of the biasing ram is bled internally of lift ram to the reservoir return line.

It is a further object of this invention to provide a biasing ram disposed within the cylindrical piston of the lift ram which is actuated by the pressure fluid of the lift ram to urge an extensible section of an extra lift mast toward the lift ram piston and wherein fluid leakage of the lift and biasing rams are conveyed by passage means to the fluid reservoir.

It is a further object of this invention to provide a biasing means for an extensible section of an extra lift mast which also retards downward movement of the extensible section as the latter moves toward contact with the lift ram.

These and other objects and advantages of this invention will become apparent when the following description is read in conjunction with the drawings in which:

FIG. 1 is a side view of a lift truck in which this invention is incorporated;

FIG. 2 is a front view of the lift truck shown in FIG. 1;

FIG. 3 is a rear view of the mast and carriage;

FIG. 4 is a view taken along the line IV—IV in FIG. 3;

FIG. 5 is a view taken along the line V—V of FIG. 3;

FIG. 6 is a view similar to FIG. 5 showing a second embodiment of this invention;

FIG. 7 is a view taken along line VII—VII in FIG. 3; and

FIG. 8 is a view of a third embodiment of this invention.

Referring to FIG. 1, a lift truck **10** includes a mast **11** at its forward end on which a load supporting carriage **12** is supported for vertical movement. A small hydraulic ram **13** is interposed between the inner section of the mast and the hydraulic lifting ram to insure proper cycling of the inner section of the mast.

Referring to FIG. 2 the carriage **12**, which includes a pair of forks **15**, is supported by a pair of chains **16** reeved over sprockets attached to the upper portion of the lift ram **17**.

Referring to FIGS. 3 and 4, a pair of brackets **21** are provided on the rear of the mast for connection to a pair of hydraulic tilt cylinders not shown. Another pair of brackets **22** are provided for pivotally attaching the mast to the lift truck chassis. The outer section of the mast includes a pair of channel members **23**, **24** interconnected by bottom brace **26**, bottom plate **66**, intermediate brace **27** to which the brackets **21** are welded, and a pair of upper braces **28**. The inner section of the mast includes a pair of channels **31**, **32** which are interconnected

by a top brace 33 and other braces including brace 34 intermediate the opposite ends of the channels. A pair of guide rods 36, 37 are rigidly secured to the upper brace 33 and the intermediate brace 34 of the inner section of the mast. As shown in FIGS. 3 and 7, the head 38 of the lifting ram 17 has a pair of bores 41, 42 which are larger in diameter than the diameter of the rods 36, 37. The rods 36, 37 extend through the bores 41, 42 formed in a rearwardly extending flange portion 43 of the head 38.

Referring again to FIGS. 3 and 4, a pair of chains 16 are reeved over a pair of sprockets 44, 45, are attached to lugs 46, 47 secured to the outer cylinder element 48 of lifting ram 17 and to the bottom rear of carriage 12. Initial expansion of the ram 17 results in the carriage 12 moving upwardly a predetermined distance before the inner section of the mast is raised. As the head 38 of the upper portion of the ram moves upwardly into contact with brace 33 of the inner mast, the carriage will move twice the distance the ram expands. The distance the carriage has thus moved, is referred to as "free lift." During movement of the head 38 of the ram 17 from its position shown in FIGS. 3 and 4 to a position wherein the top of the head 38 is in contact with the lower surface of brace 33, the flange 43 of the head is guided by guide rods 36, 37. Additional expansion of the ram will move the inner section of the mast upwardly relative to the outer section of the mast.

Occasionally, a lift truck is subjected to abusive treatment, particularly in regard to being subjected to eccentric loads. Eccentric loading of the carriage results occasionally in the inner channels being distorted to such an extent that they hang up or stick in their sliding engagement with the outer channels. When the inner channels 31, 32 become distorted, the frictional resistance to movement between the inner channels and the outer channels 23, 24 may be sufficient to result in the head 38 of the ram moving away from its contact with the base 33 of the inner section of the channels during lowering of the carriage. The inner section of the mast will not be moved from its hung up position until the head 38 contacts the intermediate cross base 34 thereby forcing the inner section downwardly. Occasionally the hung up condition of the mast results only at certain relative positions between the inner and outer sections of the mast and once jarred loose from its hung up position, the inner section of the mast will slam down against the head 38 of the ram.

In certain situations where the carriage is eccentrically loaded, the prying action occurring between the carriage rollers 50 and the inner channels 31, 32 may cause the inner section of the mast to raise with the carriage. This is objectionable, since the free lift would be eliminated. This may be particularly objectionable where a load is being deposited in an area of limited overhead clearance, as for instance in a low ceiling warehouse or a railroad box car. It may also be objectionable in situations where a loaded truck must move through a doorway which is only slightly higher than the collapsed condition of the mast.

In order to cause the inner channels to properly cycle, I have provided a novel hydraulically actuated biasing device which urges the inner section of the mast downwardly toward head 38.

Referring to FIGS. 3, 4, 5 and 7, the small hydraulic ram 13 has the rod segment 51 of its piston 58 rigidly secured to flange 43 of head 38. The cylinder 52 of ram 13 is in threaded engagement with a threaded opening in intermediate cross brace 34. The hollow piston element 55 of the lift ram 17 is in threaded engagement with the head 38. A passage 56 extends from the hollow interior of piston 55 to the rod 51. The rod 51 is drilled to form a passage 57 connecting with passage 56 and extending to the bottom pressure chamber 61 defined by piston 58 and the lower portion of the cylinder



52. A hole 59 in the bottom of piston element 55 places the chamber 61 in ram 13 in fluid communication with the pressure chamber 62 of the lift ram 17. An inlet 63 in cylinder element 48 is connected to a source of pressure fluid in a conventional manner. Chamber 65 on the rod side of piston 58 in small ram 13 is in communication with the atmosphere. A conventional wear ring 64 is secured to the bottom end of piston element 55.

Upon full expansion of lift ram 17 the rearwardly extending portions of the carriage, to which rollers 50 are attached, will abut the underside of cross brace 33 and will have carried the extensible mast section comprising inner channels 31, 32 upwardly. The lost motion connection between the inner section and the piston head 38 permits the carriage which is moving at twice the speed of the head 38, to move the inner section upward relative to the piston head, thus providing extra lift. The illustrated type of mast is known as an "extra lift" mast.

During lowering of an extra lift mast from a fully extended condition the carriage will move downwardly permitting the inner section of the mast to also lower by gravity with it. However, if the extensible section to stationary section frictional force is greater than the force due to the weight of the extensible section plus the carriage to extensible section frictional force, the inner section will tend to not follow the carriage downwardly, and instead will merely be pulled down by the piston head until the relative forces change sufficiently to permit the extensible section to drop. Since the lost motion distance may be as great as a foot and the inner section of some lift trucks may weigh 600 pounds or more, the resulting shock to the truck is damaging to the lift truck structural components. The slamming of the inner section against the piston head may injure the hydraulic system components and the shock and noise are disturbing to the operator.

It is intended that the small biasing ram 13 will exert enough force on the extensible section to cause it to cycle properly. The stroke of the ram 13 is at least equal to the distance which the ram head 38 moves from its contracted position shown in FIGS. 3, 4 and 5 to the position where the head 38 contacts the top brace 33. In other words, the stroke of the ram 13 is at least equal to the distance of the lost motion connection between head 38 and inner section brace 33. The pounds per square inch pressure exerted in chamber 61 of biasing ram 13 is the same as the pound per square inch fluid pressure in the chamber 62 of lift ram 17. During carriage descent, the weight of the carriage and piston element 55 will impose a pressure in ram 17, and consequently ram 13, sufficient to cause the ram 13 to overcome the resistance to movement of inner channels 31, 32. The head 38 will move away from cross brace 33 in the final stage of lowering the carriage.

When raising the carriage 12, the first expansion of lift ram 17 causes the piston element 55 to move upwardly until its upper end comes into load supporting contact with the top of the inner section. During this initial expansion of ram 17, the biasing ram 13 as it expands, keeps the inner section from moving up with the carriage as it might be inclined to do because of friction therebetween. The distance that the carriage has thus been raised without increasing mast height, is referred to as free lift.

In FIG. 6, a second embodiment of my invention is illustrated. In this embodiment a small biasing ram 70 has small cylinder 71 secured by threaded engagement with the head 72 which in turn is secured to piston 55 of lifting ram 17. A small piston 73 is disposed within the cylinder 71 and has a rod segment 74 connected thereto which extends upwardly and is secured, by threaded engagement, with the top brace 76 of the inner channels 31, 32. The rod 74 has a drilled passageway 77 placing the lower end of the cylinder 71 in com-

munication with the atmosphere. A threaded packing nut **78** is in threaded engagement with cylinder **71** and is in sealing relation to the piston rod **74**. Hydraulic pressure fluid is admitted to the rod side of the hydraulic ram **70** through a hole **79** in the upper end of the cylinder **71**, thereby placing the pressure chamber **81** in fluid communication with pressure chamber **62** of the lift ram **17**. This second embodiment has an advantage of compactness over the first embodiment. Also rod **74** serves as the guide rod between the lift ram **17** and the inner section of the mast thereby eliminating the need for rods **36, 37** previously described herein.

Referring to FIG. 8 showing a third embodiment of this invention, the extra lift mast **11** is equipped with a piston type lift ram, that is the piston **86** of lift ram **87** carries a pressure packing **88** at its lower end to seal the pressure chamber **89** at the bottom of cylinder **90**. Fluid is supplied under pressure to chamber **89** by a pump **91** drawing fluid from a reservoir **92** through conduit **93**. A manually controlled valve **94** is provided to selectively connect the ram supply conduit **95** with pump output conduit **96**, block flow to or from conduit **95** or connect conduit **95** to a reservoir return line **97**. A leakage return line **101** is connected to a leakage return port **100** at the upper end of cylinder **90** to place the nonpressurized chamber **102** of ram **87** in fluid communication with the reservoir **92**.

The cylinder **103** of a small biasing ram **104** is detachably screwed into a threaded opening in the top of piston head **106**. A combined piston and guide rod **107** is connected at its upper end by a snap ring **108** to cross brace **109** of the extensible section **110** of the mast **11**. The lower end of the piston rod **107** is secured to a biasing piston **112** carrying a high pressure packing **113**. Another high pressure packing **114** is interposed between the rod **107** and the cylinder **103**. A wiper gland **116** is installed near the exterior end of cylinder ram **103** between the rod **107** and cylinder **103** and a similar wiper gland **117** is between the lift piston **86** and lift cylinder **90** near the upper end of the latter. The glands **116, 117** are low pressure seals which prevent foreign particles from entering the rams and prevent low pressure fluid from leaking from the upper ends of the rams. A leakage passage in the form of an internal groove **118** is formed in the upper end of rod bore **119** of cylinder **103**. Any leakage of high pressure fluid past packing **114** will flow into groove **118** thence through leak passage **121** to the interior chamber **122** of cylinder piston **86** which communicates with low pressure chamber **102**, through passage **123**.

The high pressure chamber **126** of biasing ram **104** is in free fluid communication with the high pressure chamber **89** of the lift ram through passage means including a passage **127** in the cylinder **103** and a conduit **128** interconnecting passage **127** and chamber **89**. The upper end of conduit **128** is in threaded engagement with a threaded terminal portion of passage **127** and the lower end is in threaded engagement with a threaded end of bore **129** formed in a plug **131**. The plug **131** is sealed to piston **86** by O-ring **132** and is held in place by a snap ring **133**. A dashpot chamber **136** is formed in the lower end of biasing ram **104** which communicates with the interior of piston **86** through one or more oblique bleed holes **137**. In some installations a dashpot will not be required and in such case the lower end of the cylinder will be open. In other installations it may be desirable to provide the dashpot to retard or regulate any downward slamming movement of the inner section **110** should it cycle improperly.

Thus a low pressure passage means has been provided internally of the lift ram for conveying fluid leakage from the biasing ram to the leakage return port **100**. This passage means includes chambers **102, 122, 136**, passages **123, 121, 137** and groove **118**.

From the foregoing description of the third embodiment it is seen that an extremely novel and useful biasing device has been provided to effect proper cycling of the extensible section of an extra lift mast, wherein the leakage of the rod and piston packing of the biasing ram are conveyed internally of the lift ram to the leakage return line. Accordingly no fluid leakage will spill on the exterior of the mast components and floor of the area in which the truck operates. The low pressure chamber **136** of the biasing ram is in communication with the reservoir rather than the atmosphere and such arrangement is advantageous where the air carries abrasive foreign particles.

Although only three embodiments of this invention are illustrated, it should be understood that it is not intended to limit this invention except as necessitated by the scope of the appended claims.

What is claimed is:

1. A vertical mast for a lift truck comprising: a first mast section secured to the lift truck; a second mast section mounted on said first mast section for vertical reciprocal movement relative thereto; a lift ram having a pair of relatively expansible and contractible elements; means mounting one of said elements on said first section, the other of said elements being spaced vertically from a position of load supporting contact with said second section by a predetermined distance when said lift ram is in its contracted condition; a hydraulic ram disposed within said other element of said lift ram having cylinder and piston components, one of said components being secured to said second section and the other of said components being secured to said other element; and an open fluid passage between the pressure chamber of said lift ram and the pressure chamber of said hydraulic ram, said hydraulic ram urging said second section and other element toward said position of contact with one another when the fluid in its pressure chamber is subjected to pressure.

2. A vertical mast for a lift truck comprising: a first mast section secured to the lift truck; a second mast section mounted on said first mast section for vertical reciprocal movement relative thereto; a lift ram having a pair of relatively expansible and contractible elements; means mounting one of said elements on said first section, the other of said elements being spaced vertically from a position of load supporting contact with said second section by predetermined distance when said lift ram is in its contracted condition; a hydraulic ram disposed within said other element of said lift ram and having cylinder and piston components forming a pressure chamber on one side of said piston, one of said components being secured to said second section and the other of said components being secured to said other element; an open fluid passage between the pressure chamber of said lift ram and the pressure chamber of said hydraulic ram, said hydraulic ram urging said second section and other element toward said position of contact with one another when its pressure chamber is subjected to fluid under pressure; and means placing the other side of said piston in communication with the atmosphere.

3. A vertical mast for a lift truck comprising: a first mast section secured to the lift truck; a second mast section mounted on said first mast section for vertical reciprocal movement relative thereto; a lift ram having a pair of relatively expansible and contractible elements; means mounting one of said elements on said first section, the other of said elements being spaced vertically from a position of load supporting contact with said second section by a predetermined distance when said lift ram is in its contracted condition; means for guiding said other element relative to said second section and for biasing the latter toward said position of contact including a hydraulic ram disposed within said other element of said lift ram having cylinder and piston components, one of said components being secured to said second section and the other of said components being secured to said other ele-

ment; and an open fluid passage between the pressure chamber of said lift ram and the pressure chamber of said hydraulic ram, said hydraulic ram urging said second section and other element toward said position of contact with one another when the fluid in its pressure chamber is subjected to pressure.

4. The structure set forth in claim 3 and further comprising a passageway placing the side of said piston opposite said pressure chamber of said hydraulic ram in communication with the atmosphere.

5. A vertical mast for a lift truck comprising: a first mast section secured to the lift truck; a second mast section mounted on said first mast section for vertical reciprocal movement relative thereto; a lift ram having a pair of relatively expansible and contractible elements; means mounting one of said elements on said first section, the other of said elements being spaced vertically from a position of load supporting contact with said second section by a predetermined distance when said lift ram is in its contracted condition; means for guiding said other element relative to said second section and for biasing the latter toward said position of contact including a hydraulic ram disposed within said other element having a piston component with a rod segment secured to said second section and having a cylinder component secured to said other element; and an open fluid passage between the pressure chamber of said lift ram and the pressure chamber of said hydraulic ram on the rod side of said piston.

6. The structure set forth in claim 5 and further comprising a passageway in said hydraulic ram subjecting the chamber on the other side of said piston to atmospheric pressure.

7. The structure set forth in claim 6 wherein said passageway is an opening extending axially through said rod.

8. A vertical mast for a lift truck comprising: a nonextensible section secured to the lift truck, an extensible section mounted on said nonextensible section for reciprocal movement relative thereto, a lift ram mounted on the lower end of said nonextensible section having an upper end spaced below the top of said extensible section a predetermined distance, a biasing ram of smaller diameter than said lift ram having cylinder and piston components, one of said components being secured to said extensible section of the mast and the other of said components being secured to said upper end of said lift ram, and an open fluid passage between the pressure chamber of said lift ram and the pressure chamber of said biasing ram, said biasing ram urging said extensible section and said upper end of said lift ram toward one another when the fluid in said pressure chambers is subjected to pressure.

9. A vertical mast for a lift truck comprising: a pair of sections interconnected for relative reciprocal movement, a lift ram mounted on the lower end of one of said sections having an upper end spaced below the top of the other of said sections a predetermined distance, a biasing ram of smaller diameter than said lift ram having cylinder and piston components with a pressure chamber on one side of said piston, one of said components being secured to said other section of the mast and the other of said components being secured to said upper end of said lift ram, an open fluid passage between the pressure chamber of said lift ram and the pressure chamber of said biasing ram, said biasing ram urging said other section and said upper end of said lift ram toward one another when the fluid in said pressure chambers is subjected to pressure and means for maintaining the other side of said piston at low pressure.

10. An extra lift mast for a lift truck comprising: a pair of relatively reciprocable mast sections, a piston type lift ram having cylinder and piston elements interposed between said sections, a pressure fluid supply port and a leakage return port in said lift ram, cooperating abutments formed on one of said sections and one of said elements, the abutment on said one section being spaced vertically above the other abutment when said lift ram is contracted, a lost motion connection between said one element and said one section including a guide rod secured at its upper end to said one section and extending within said one element, a biasing piston secured to said rod within said one element, a cylindrical surface within said one element in complementary fluid sealing engagement with said biasing piston, a fluid seal between said one element and said rod, a fluid seal between said piston and said cylindrical surface, passage means placing the pressure chamber on the rod side of said biasing ram in fluid communication with said pressure fluid supply port, and passage means internally of said lift ram for conveying fluid leakage from said biasing ram to said leakage return port.

11. In a lift truck having an extra lift mast wherein a fluid supply conduit and a leakage return conduit are connected respectively to pressure and leakage chambers at opposite ends of a piston type lift ram employed to elevate the carriage and an extensible section of the mast, the combination comprising: biasing ram having piston and cylinder components connected, respectively, to said extensible section and said ram, said cylinder component being disposed within the upper end of said ram, and fluid passage means connecting opposite ends of said biasing ram to said pressure and leakage return conduits, respectively, whereby said biasing ram urges the upper end of said extensible section downwardly toward the upper end of said lift ram when said pressure chamber is pressurized.

12. The structure set forth in claim 11, wherein said fluid passage means includes a fluid passageway within said lift ram between the pressure chamber of said lift ram and the upper end of the cylinder component of said biasing ram.

13. The structure set forth in claim 12 wherein said fluid passage means further includes a low pressure fluid passageway within said lift ram for connecting said leakage chamber of said lift ram in fluid communication with the lower end of said cylinder component.

14. The structure set forth in claim 13 wherein said fluid flow means further comprises a fluid flow restrictor to regulate contraction of said biasing ram.

15. The structure set forth in claim 13 and further comprising a high pressure packing carried by said cylinder component in sealing engagement with said piston component, a low pressure seal carried by said cylinder component in sealing engagement with said piston component and spaced axially above said high pressure packing, and a leakage passage in said cylinder component intermediate said packing and seal in fluid communication with said low pressure passageway.

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