

June 27, 1961

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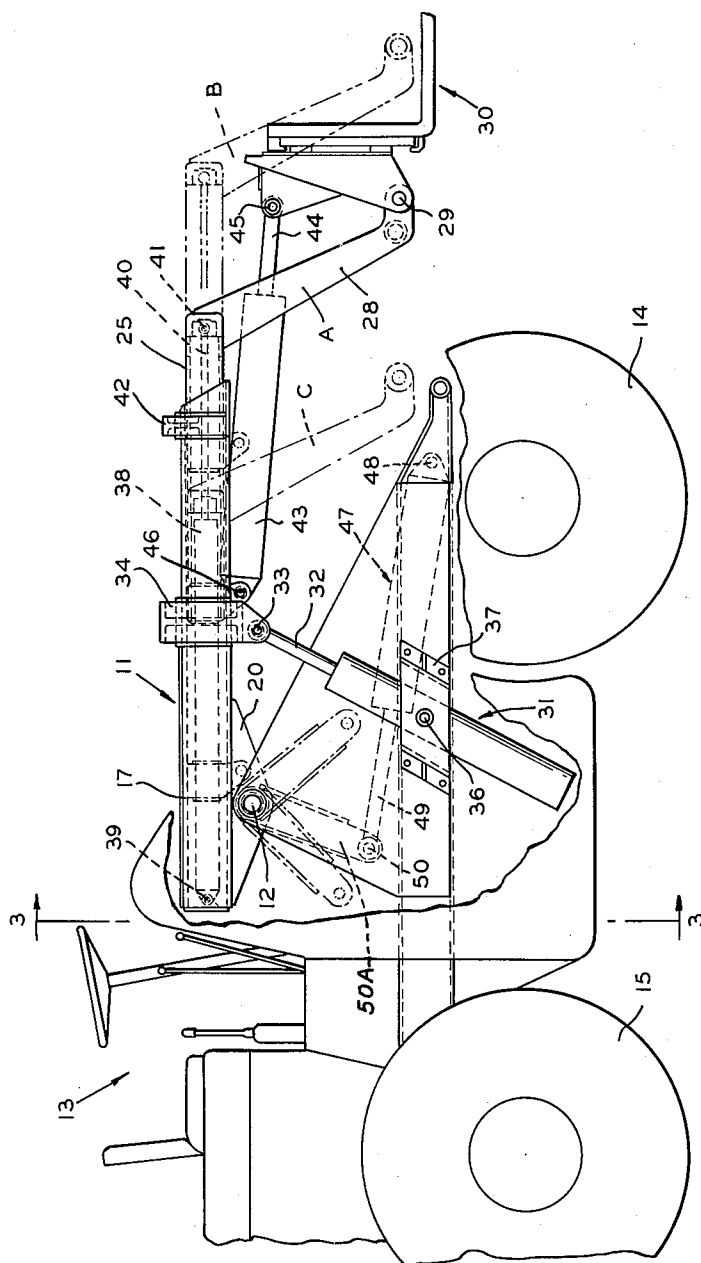
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MATERIAL HANDLING MECHANISM

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4 Sheets-Sheet 1

FIG. 1



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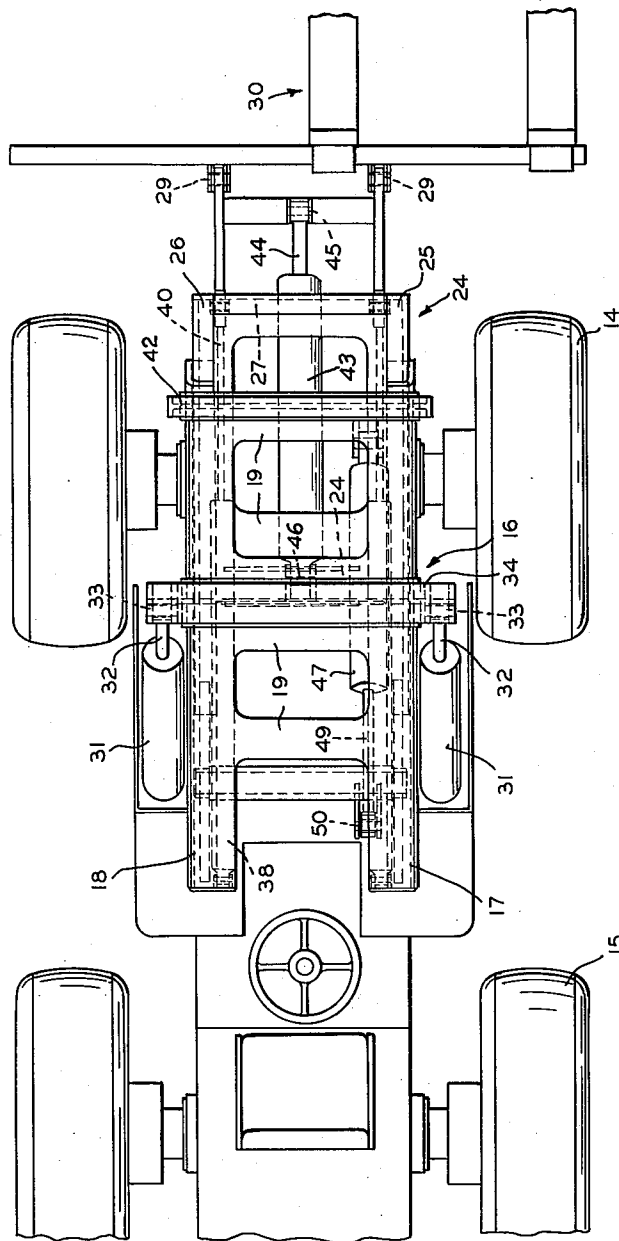
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MATERIAL HANDLING MECHANISM

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FIG. 2



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MATERIAL HANDLING MECHANISM

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FIG. 3

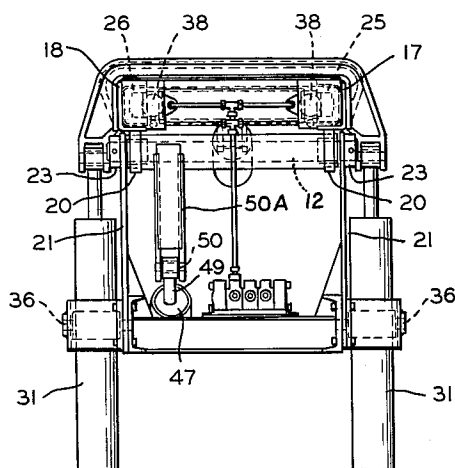
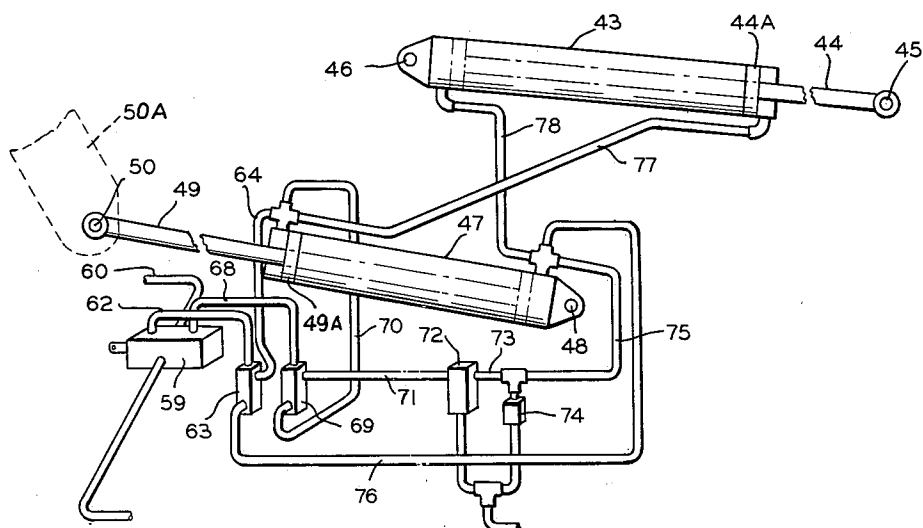


FIG. 5



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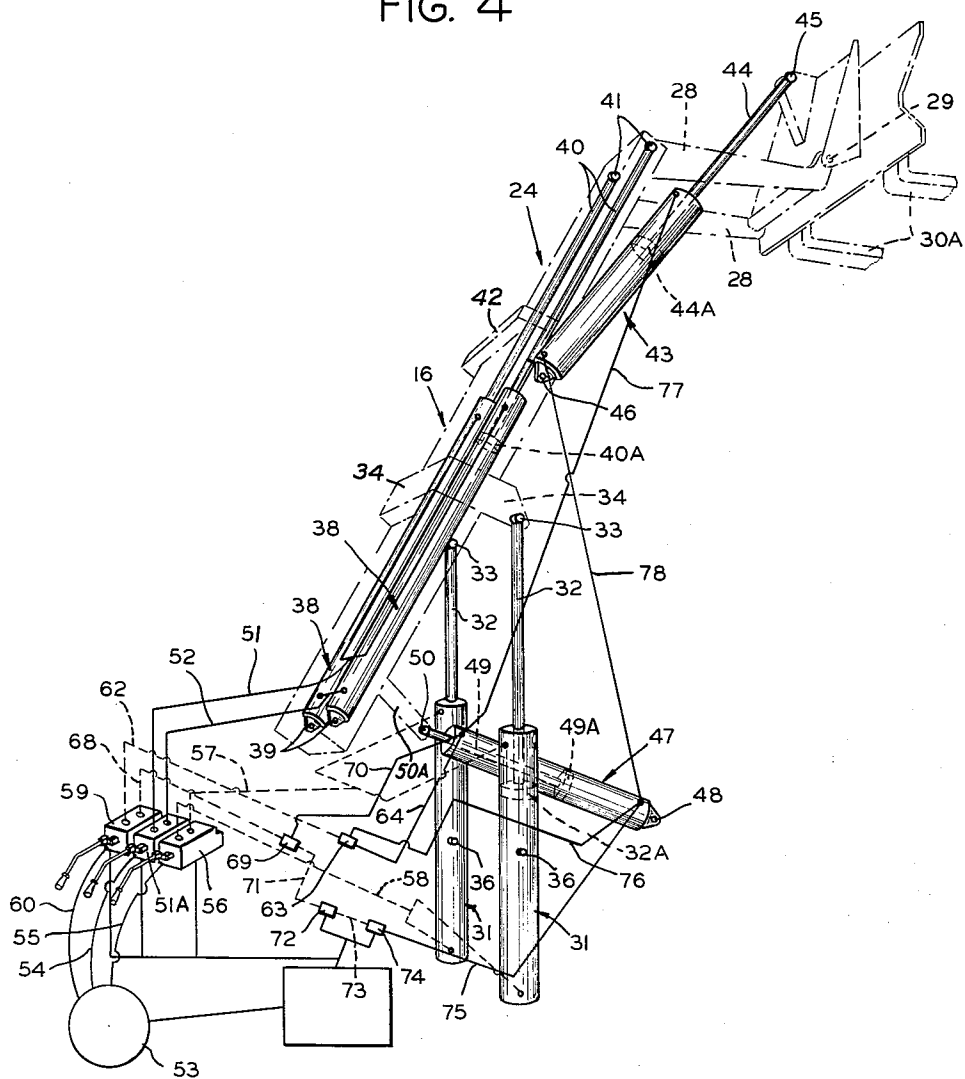
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MATERIAL HANDLING MECHANISM

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FIG. 4



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MATERIAL HANDLING MECHANISM

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3 Claims. (Cl. 214-140)

This invention relates to materials handling, engaging and loading equipment, particularly to such equipment when mounted on a mobile vehicle such as a tractor or the like and to novel and improved control mechanism therefor.

Conventionally, such devices have embodied a boom or mast pivotally mounted at one end to the forward end of the tractor and supporting a fork, shovel or other load engaging means pivotally mounted on its other end and operating means in the form of hydraulic rams or similarly operating mechanical means for independently raising and lowering the mast about its pivotal connection and tilting the load engaging means are also commonly provided. Successful operation of such devices in loading or other handling operations has been, however, largely dependent on the ability of the operator to move his tractor toward or away from the load in order to reach or release the load. Under some circumstances, as when working on rough terrain, this constitutes a real problem. Moreover, in raising and lowering the loaded fork, it is important to be able to maintain the angle of the fork either at parallel, i.e. 180 degrees with respect to the horizontal or inclined a few degrees therefrom to prevent premature dislodging or dumping of the load.

It is thus an important object of the present invention to provide a lift mechanism for a tractor or other vehicle by means of which its loading fork or other load engaging means may be elevated and outwardly extended and rotated to various positions of tilt.

Another object of the invention is to provide such a lift mechanism with means whereby the load engaging means may be rotated to a given angle of tilt relative to horizontal and maintained in said angular relation during the raising and lowering or extension and retraction of the load supporting mast.

Still another object of the invention is to provide a lift mechanism for a tractor or the like embodying an extensible mast or boom pivotally connectable at one end to the tractor and supporting a loading fork or other engaging means at its outer end pivotally mounted thereon whereby the operator may, without moving his tractor, reach out with the load engaging means, retract and raise and lower the same in addition to maintaining a given angle to which the load engaging means has been tilted during said raising, lowering, retracting and reaching out with the load engaging means.

A further object is to provide in combination with such a pivotally mounted extensible mast and load engaging means, a pair of cylinders, one being a slave cylinder and the other a tilt cylinder, which are interconnected with each other and individually mounted between the vehicle and a fixed portion of the mast and between the movable portion of the mast and said load engaging means in a manner such that change in pressure in one is accompanied by an opposite change of pressure in the other cylinder whereby in the raising, lowering, pivoting and extending of the mast the angular relation of the load engaging means to the horizontal will remain constant or substantially so.

Still another object is to provide means whereby the pressure in the tilt cylinder, which is mounted between the extensible portion of the mast and the load engaging means, may be varied independently of and without effecting a simultaneous change in the slave cylinder so as

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to tilt the load engaging means to a new angle when desired.

Still another object is to provide compensating means for automatically redistributing fluid on opposite sides of the plunger in the slave cylinder when the plunger is actuated by the raising or lowering of the mast and the load engaging means has been previously so tilted about its pivot as to move the plunger in the tilt cylinder to a position where the tilt cylinder will not respond to demand for more fluid by the slave cylinder.

Many other objects and advantages of the invention will become apparent from the description of a preferred embodiment of the invention which follows. It is further to be understood that many changes and modifications of the embodiment of the invention as hereinafter described may be had without departing from the spirit of the invention as defined in the appended claims.

Now referring to the drawings:

FIGURE 1 is a side elevational view of a tractor having a material loading, lifting or handling mechanism according to the present invention mounted on the forward end thereof;

FIGURE 2 is a plan of the embodiment of my invention as shown in FIGURE 1;

FIGURE 3 is a view taken along lines 3-3 in FIGURE 1 looking in the direction indicated by the arrows;

FIGURE 4 is a view somewhat diagrammatic of the loading or lifting mechanism separated from the tractor and showing the hydraulic piping and cylinders to effect the various required motions; and

FIGURE 5 is an enlarged fragmentary and diagrammatic showing of the two interconnected slave cylinders and the operating means and pressure relief means employed in conjunction therewith.

Referring to said several views wherein like parts are identified by like reference numerals and first to FIGURE 1, a materials loading, lifting or handling device is illustrated as comprising an extensible mast 11 pivotally connected as at 12 to a mobile vehicle such as tractor 13 having a pair of front wheels 14 and a pair of rear wheels 15 steeringly operated by means and suitable linkage, not shown. Extensible mast 11 is thus illustrated as wheel or tractor-borne, and it is to be understood that in keeping with the spirit of the invention extensible mast 11 might be pivotally mounted to any other suitable vehicle.

As seen by a comparison of FIGURES 1, 2 and 3 with each other, the extensible mast 11 comprises a main frame 16 comprising a pair of parallel, spaced U-channelled members 17 and 18 joined by reinforcing cross pieces 19 and provided with triangular ear sections 20 welded to the inner ends thereof which are pivotally connected to portions 21 of the tractor by means of shaft 12 passing through aligned openings provided in said portions 21 and sections 20. Collars 23 or other suitable means are pinned to the outer ends of said shaft 12 to prevent its lateral displacement and pivotally secure said main frame 16 to the body of the tractor 13.

A secondary frame 24 is provided comprising a pair of parallel spaced U-channelled members 25 and 26 which telescopically fit within U-channelled members 17 and 18, respectively, of the main frame 16 so as to be slidably adjustable longitudinally thereof. Said U-channelled members 25 and 26 are also joined by reinforcing members 27 to give strength and rigidity to the structure. Rigidly mounted on the forward or outer ends of the telescopic channel members 25 and 26 are a pair of angled portions 28 between which is pivotally connected, by pin means 29 a load engaging means, such as a fork, shovel or the like, indicated generally at 30.

A pair of hydraulic cylinder assemblies 31 are located on opposite sides of the tractor 13 having their plunger stem 32 pivotally connected by pin means 33 to the op-

posite ends of a bracket 34 or the like, welded or otherwise secured to the main frame 16. Such cylinder assemblies are actuatable to elevate and lower the mast 11 and thereby load engaging means 30 about its pivotal connection 12 with tractor 13. The fluid cylinders of assemblies 31 are pivotally connected to the sides 21 of the tractor in any convenient manner and in FIGURE 1 of the drawing are shown as connected by pivot means 36 to a housing assembly 37 which is bolted or riveted to the sides 21 of the tractor. Preferably, the cylinders are thus pivotally connected intermediate their ends rather than at the extreme outer ends of the cylinders to increase the controllable range through which the mast 11 may be swung about its pivotal connection 12 in raising and lowering the load engaging means 30.

One of the features of the invention is the adjustability of the secondary frame 24 of the extensible mast 11 relative to its supporting main frame 16 which permits the operator to reach out with and retract the loading fork 30 without having to move the tractor. This is conveniently and smoothly accomplished by a pair of hydraulic fluid operated reach cylinders 38 which are located between and alongside of the channel members 17 and 18. Such are pivotally connected at 39 to a suitable boss or the like provided at the inner end of the channelled members 17 and 18 of the mast's main frame 16 and have a stem 40 of their plungers pivotally connected, as at 41, to the forward brace or reinforcing members 27 of said secondary frame 24.

As illustrated by dotted lines in FIGURE 1, through suitable actuation of the plunger in reach cylinders 38, it is possible for the operator to conveniently and smoothly extend angled supporting arms 28 on the ends of the secondary frame 24 which carry the fork 30 or other loading device, to a position B beyond A (indicated in full lines) or retract it to a position C as determined by the range of reciprocal movement of the plungers in their respective cylinders 38. It will be noted also that the secondary frame 24 and main frame 16 are so constructed that the secondary frame, in its fully retracted position, indicated by C, is withdrawn well beyond the outer end of the main frame 16, the reinforcing portions 27 of said frame 24 passing beneath the reinforcing portions 19 and supporting brackets 34 and 42 of the main frame 16, thus further contributing to the strength and rigidity of the construction. If desired, the main frame 16 and its channelled members 17 and 18 could be of a length such as to enclose the channelled members of the secondary frame even to their fully extended position at B.

Tilting of the load engaging means is accomplished by a tilt cylinder 43 having a plunger stem 44 pivotally connected, as at 45, to the upper end of the fork 30 at a location spaced above its pivotal connection 29 with arms 28. As shown in FIGURES 1 and 2, the cylinder 43 is pivotally mounted at its one end to one of the reinforcing cross pieces 27 of the secondary frame 24 by pin means 46. Such cylinder is located on the underside of the secondary frame and so does not interfere with the extension and retraction of said secondary frame within the main or pivotally connected frame portion 16 of the mast 11.

A servo or slave cylinder 47 is also shown pivotally connected at one end by pivot means 48 to the forward end of the tractor beneath the mast 11, such having a plunger reciprocally mounted therein with its stem 49 pivotally connected at 50 to a short arm 50A rigidly secured to shaft 12 (see FIGURE 3). Stem 49 thus moves with the rotation of the mast 11 about its pivot center 12. The servo cylinder 47 is in hydraulic circuit with tilt cylinder 43 for a purpose which will hereinafter be made clear.

Referring now to FIGURE 4, wherein the various mechanisms described are somewhat diagrammatically illustrated for ease of understanding, the hydraulic controls and their operation as are required for the tilting, raising and lowering and reaching out and retracting of the fork 30 in the use of the device will now be explained.

Preferably, for greater control and smoothness of operation the reach cylinders 38, the elevating cylinders 31, as well as tilt cylinder 43, are of the double action type. That is to say, for example in the case of the reach cylinders 38, a first set of conduit lines 51 connect one end of the cylinders 38 with the operator's control valve 51A while a second set of conduits 52 connect the opposite end of the cylinders with such valve control 51A. Thus, by suitable actuation of the valve 51A pressurized fluid may be supplied from the pump 53 via conduit 54 to either line 51 or 52 for exerting pressure on either side of the plunger 40A. For example, if the valve control 51A is actuated to supply fluid through line 51 the effect will be to build up a pressure on the upper side of plungers 40A to force the secondary frame 24 and fork carried thereby toward the pivotal connection 12. Conversely actuation of control valve 51A to force fluid through lines 52 will have the opposite effect, namely to further extend the mast 11. Thus, a very positive smooth and accurate control of the reaching action may be had.

In a similar manner, conduit 55 connects control valve 56 to pump 53 so that fluid can be selectively supplied via lines 57 to the upper side of plungers 32A in the elevating cylinders 31 or by lines 58 to connect valve 56 to the lower side of said plungers 32A. Thus, by suitable operation of control valve 56, oil may be pumped from the supply source through line 57 to lower the mast 11 and fork 30 about pivot 12; line 58 under that condition acting as a return for the oil being driven out of cylinder 31. Conversely, valve 56 may be operated to direct fluid through line 58 to the underside of plunger 32A forcing the plungers upwardly to elevate the mast 11 and fork 30. In this circumstance, line 57 functions as a return line for releasing the excess fluid on the top side of the cylinder as it is moved to extended position.

A third manually controlled slide valve 59 communicates via line 60 to pump 53 and the supply source. Such valve is connected to the left end of servo cylinder 47 by way of conduit 62, pressure relief valve 63 and conduit 64, and also by way of conduit 68, pressure relief valve 69 and conduit 70. Slide valve 59 is also connected to the right-hand end of servo cylinder 47 by way of conduit 68, pressure relief valve 69, conduit 71, pressure relief valve 72, conduit 73, check valve 74 and conduit 75. Finally, valve 59 is also connected to the right-hand end of the cylinder 47 by conduit 62, pressure relief valve 63 and conduit 76. Conduits 77 and 78, respectively connect the left and right hand ends of cylinder 47 to the upper and lower ends of tilt cylinder 43. The operation of the hydraulic circuitry will be explained in detail hereinafter.

Assuming, for the present, that control valve 59 is closed, a closed circuit will exist between cylinders 47 and 43, through conduits 77 and 78. As a result of the intercircuity between cylinders 47 and 43 the actuation of the piston of one cylinder in one direction serves to actuate the plunger of the other cylinder in an opposite direction so that the actions of the two cylinders when control valve 59 is closed are each subservient to the other and in reverse directions.

Thus, for example, upward rotation of mast 11 about pivot 12 by actuation of lift cylinders 31, results in a counterclockwise rotation of arm 50A which actuates stem 49 and plunger 49A of cylinder 47 toward a collapsed position. The cylinder fluid displaced thereby flows through conduit 78 to cylinder 43, with actuating plunger 44A being moved therein toward its extended position which through the pivotal connection of the plunger stem 44 with engaging means 30 has the effect of rotating the fork in a clockwise direction about axis 29 a proportionately similar amount. As previously pointed out, the fluid displaced by plunger 44A is returned to cylinder 47 via conduit 77.

Lowering of the mast by actuation of lift cylinders 31 in the opposite direction reverses the above sequence,

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i.e., lever arm 50A is rotated clockwise with the mast 11 about pivot 12 to extend plunger 49A thereby displacing a volume of fluid to the upper end of cylinder 43 through conduit 77 returning to the right-hand end of cylinder 47 through conduit 78. This action causes rotation of the engaging means 30 in a counterclockwise direction about its pivot 29.

The design of the interlocked slave and tilt cylinders 47 and 43 and the actuation of their respective plungers 49A and 44A plus their connection with the lever arm 50A and fork 30 is such that the fork tongs 30A will be maintained in a pre-set angular relation, such as parallel with respect to the horizontal during any and all rotational movement of the mast 11 between minimum and maximum elevation limits. As will be apparent, since cylinder 43 is pivotally connected at its lower end to the extensible portion 24 of the mast 11, as previously described, energization of the reach cylinders 38 to actuate plungers 40A in either collapsed or extended direction does not alter the pre-set angular relation of the fork tongs 30A since the latter are effectively maintained in their pre-set position by the cooperation of the two cylinders 47 and 43. This will be the case whether the reach cylinders 38 and lift cylinders 31 are separately or simultaneously operated.

In the condition of operation in which the angle of elevation of the mast is fixed (see FIGURE 4), the slave piston 49A will be stationary due to the lack of rotational movement of the mast. If valve 59 is then opened, in a direction to collapse the tilt cylinder 43, the fork or load engaging means 30 will rotate in a counterclockwise direction about its axis 29 at the given elevation of the mast as in this condition, the pump 53 supplies fluid through valve 59, conduits 62, 64 and 77 to the upper end of tilt cylinder 43. Since the slave piston 49A is incapable of movement due to the fixed angular position of the mast, the fork or load engaging means 30 will tilt independently about its axis 29. Oil on either side of the slave piston 49A is inoperative and the movement of the tilt piston 44 is downwardly or to the left as viewed in FIGURE 4 to discharge oil through conduit 78, 75, 73, and 72 for return to the tank or reservoir for the pump.

In the reverse operating condition wherein valve 59 is moved to connect the left or lower end of the tilt cylinder to the pump and the right end thereof to the tank, pressurized oil is supplied via conduit 68, pressure relief valve 69, and conduits 71, 73, 75 and 78 to the lower end of the tilt cylinder 43. Oil returns to the tank from the right-hand or piston rod end of cylinder 43 through conduits 77, 64, valve 63 and conduit 62. In this condition the slave cylinder is again inactive with the oil connecting the same to the relief valves 63 and 69 which open under predetermined extreme operating conditions to permit one-way flow through one of the overload lines 70 or 76 to the related ends of both of the cylinders 43 and 47.

In another condition of operation, with valve 59 closed, the tilt piston 44A in its extreme extended position and the lift cylinders energized to elevate the boom thereby also actuating the slave piston to the right in FIGURE 4 or toward its collapsed position, obviously the oil applied to the tilt cylinder will be inoperative because the latter resides in its extreme position. Movement of the slave piston to the right thereby causes relief valve 69 to lift which connects the large volume or right hand end of the slave cylinder 47 with the small volume end thereof through conduits 75, 73, 71 and 70. Relief valve 72 is provided in conduit 71 so that the volume of fluid displaced from the right end of the slave cylinder in excess of that volume receivable in the left end of the cylinder may be vented back to the tank. From this, it will be understood that even though the operator has actuated the tilt cylinder to an extreme extended position in which the fork or load engaging members are pointed substan-

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tially vertically downward followed by energization of the lift cylinders to lower the boom, no damage to the system will result because of the provision of the relief valves 69 and 72.

In a reverse of the above situation, wherein the tilt cylinder or piston is actuated to an extreme collapsed position so that the fork or loading engaging means 30 is pointed substantially vertically upward, it is possible to again individually actuate the lift cylinders to lower or raise the boom. Again the oil in the tilt cylinder is inoperative as is the oil supplying the now closed valve 59. In this case, extended movement of the slave piston opens relief valve 63 permitting oil to flow through conduits 64 and 76 to the large or right hand end of the slave cylinder, as viewed in FIGURE 4. Because the oil volume moved out of left hand end of the cylinder is less than that receivable in the right hand end thereof, check valve 74 is provided to open at a predetermined low pressure in the large or right hand end of the slave cylinder to supply additional oil from the tank.

In summary the hydraulic system of my invention may be considered to comprise a main hydraulic circuit defined by a first branch circuit extending from valve 59 and including conduit 62, pressure relief valve 63, conduit 64, and conduit 77 for connecting the left and right hand ends, respectively, of slave cylinder 47 and the tilt cylinder 43; a second branch circuit including a conduit 68 extending from valve 59, pressure relief valve 69, conduit 71, conduit 73, conduit 75, and conduit 78, to provide for connection of the right and left hand ends, respectively, of the slave cylinder 47 and the tilt cylinder 43. Further, the main hydraulic circuit includes a conduit 76 connecting pressure relief valve 63 with the aforesaid second branch circuit, and a second conduit 70 which connects pressure relief valve 69 with the aforesaid first branch circuit. The hydraulic system is further defined by an auxiliary hydraulic circuit connected between sump and the afore-described second branch circuit and includes the pressure relief valve 72 connected between conduits 71 and 73; and the low pressure check valve 74 connected by a T connection between conduit 73 and the conduit 75; fluid under pressure from a pressure source, such as pump means 53, is conducted by conduit 60 to valve 59 for distribution by actuation of the latter as already described.

From the foregoing, it will be seen that a vertical fork control mechanism is provided by which the fork or load engaging means may be elevated and outwardly extended and rotated to various positions of tilt or control to maintain a preselected horizontal position irrespective of variations, in elevation retraction or extensions thereof.

While I have herein shown and described my unique control mechanism in association with a particular type of load engaging means and a particular lift truck apparatus, nevertheless it will be recognized that various changes, modifications and substitutions of equivalents may be made therein without necessarily departing from the spirit and scope of the invention. As a consequence it is not my intention to be restricted to the particulars of the embodiment herein described and illustrated except as may appear in the following appended claims.

I claim:

1. For use in a device of the class described including mast means pivotally secured at one end to the main frame of a vehicle and supporting at its outer end load engaging means pivotal about an axis parallel with the pivotal axis for the mast means, the combination of a tilting piston and tilting cylinder assembly having connection with the mast means and the load engaging means for effecting pivotal movement of the latter, a slave piston and slave cylinder assembly having connection with the mast means and main frame of the vehicle to provide for relative movement of said slave piston and said slave cylinder by pivotal movement of the mast means about its pivotal axis on the frame, a main hydraulic

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circuit comprising a first branch circuit including a first pressure relief valve and connecting one end of each of said tilting and slave cylinders to provide for passage of fluid therebetween, a second branch circuit including a second pressure relief valve connecting the other ends of said tilting and slave cylinders to provide for passage of fluid therebetween, a first conduit connecting said first pressure relief valve with said second branch circuit, a second conduit connecting said second pressure relief valve with said first branch circuit, pump means for delivering fluid under pressure, control valve means between said pump means and said main hydraulic circuit, said control valve means being positionable for closing off flow of fluid under pressure from the pump means to said first and second branch circuits, and said control valve means being positionable to selectively connect said first and second branch circuits with fluid under pressure from said pump means.

2. For use in a device of the class described including mast means pivotally secured at one end to the main frame of a vehicle and supporting at its outer end load engaging means pivotal about an axis parallel with the pivotal axis for the mast means, the combination of a tilting piston and tilting cylinder assembly having connection with the mast means and the load engaging means for effecting pivotal movement of the latter, a slave piston and slave cylinder assembly having connection with the mast means and main frame of the vehicle to provide for relative movement of said slave piston and said slave cylinder by pivotal movement of the mast means about its pivotal axis on the frame, a main hydraulic circuit comprising a first branch circuit including a first pressure relief valve and connecting one end of each of said tilting and slave cylinders to provide for passage of fluid therebetween, a second branch circuit including a second pressure relief valve connecting the other ends of said tilting and slave cylinders to provide for passage of fluid therebetween, a first conduit connecting said first pressure relief valve with said second branch circuit, a second conduit connecting said second pressure relief valve with said first branch circuit, a source of fluid, pump means having connection at its inlet with said source of fluid for affording fluid under pressure at its outlet, control valve means between the outlet of said pump means and said main hydraulic circuit, said control valve means being positionable for closing off flow of fluid under pressure from the outlet of said pump means to said first and second branch circuits, said control valve means being positionable to selectively connect said first and second branch circuits with fluid under pressure from the outlet of said pump means, and an auxiliary hydraulic circuit including high and low pressure responsive valves connecting said second branch circuit of main

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necting said main hydraulic circuit with said source or fluid.

3. For use in a device of the class described including mast means pivotally secured at one end to the main frame of a vehicle and supporting at its outer end load engaging means pivotal about an axis parallel with the pivotal axis for the mast means, the combination comprising a tilting piston and tilting cylinder assembly having connection with the mast means and the load engaging means for effecting pivotal movement of the latter, a slave piston and slave cylinder assembly having connection with the mast means and main frame of the vehicle to provide for relative movement of said slave piston and said slave cylinder by pivotal movement of the mast means about its pivotal axis on the frame, a main hydraulic circuit comprising a first branch circuit including a first pressure relief valve and connecting one end of each of said tilting and slave cylinders to provide for passage of fluid therebetween, a second branch circuit including a second pressure relief valve connecting the other ends of said tilting and slave cylinders to provide for passage of fluid therebetween, a first conduit connecting said first pressure relief valve with said second branch circuit, a second conduit connecting said second pressure relief valve with said first branch circuit, a source of fluid, pump means having connection at its inlet with said source of fluid for affording fluid under pressure at its outlet, control valve means between the outlet of said pump means and said main hydraulic circuit, said control valve means being positionable for closing off flow of fluid under pressure from the outlet of said pump means to said first and second branch circuits, said control valve means being positionable to selectively connect said first and second branch circuits with fluid under pressure from the outlet of said pump means, and an auxiliary hydraulic circuit including high and low pressure responsive valves connecting said second branch circuit of main hydraulic circuit with said source of fluid.

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