Aug. 6, 1968 L. S. MATHEW ET AL 3,395,820

FORKLIFT TRUCKS

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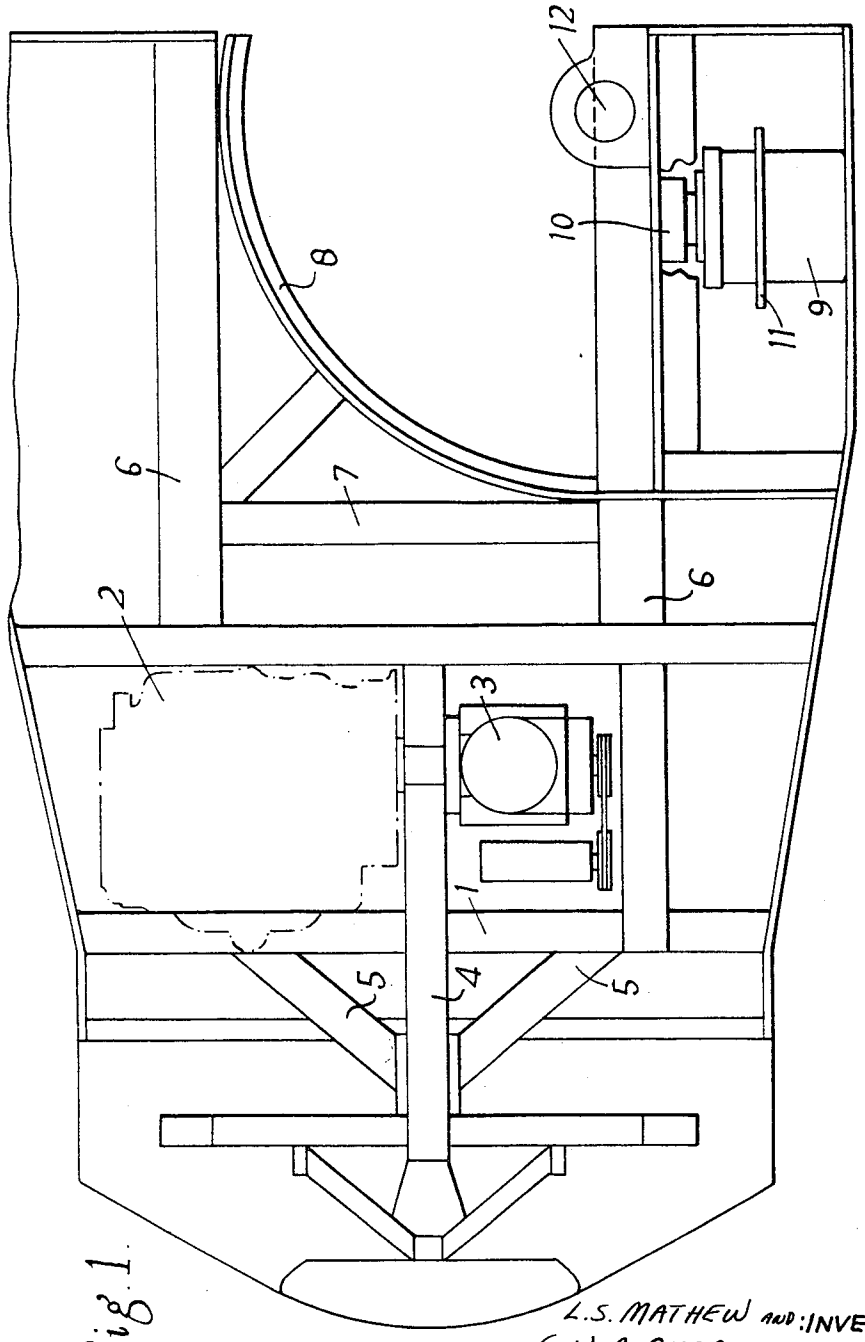

Fig. 1.

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Fig. 2.

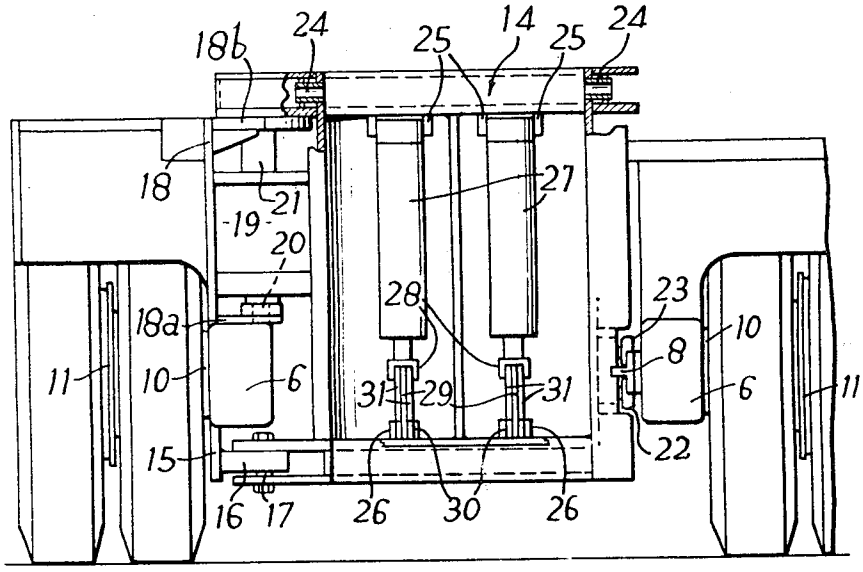
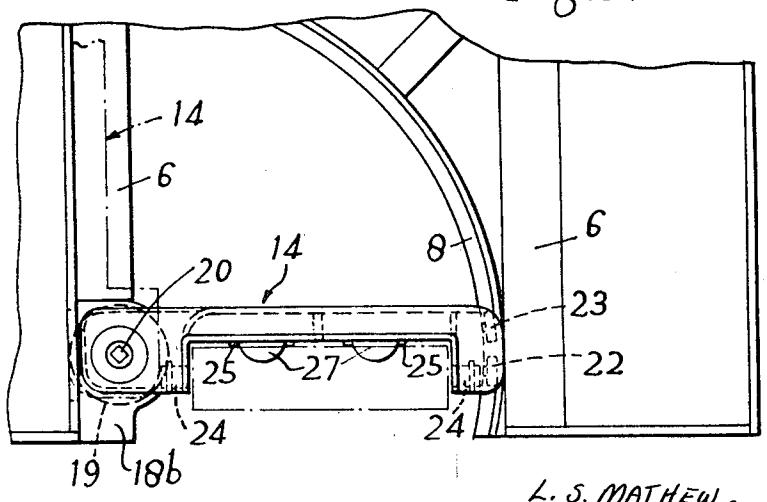


Fig. 3.



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FORKLIFT TRUCKS

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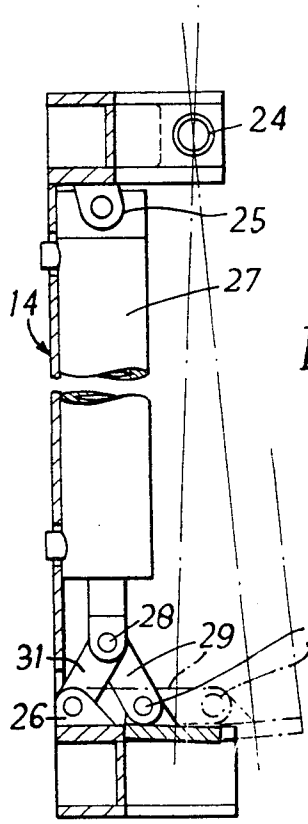

Fig. 4.

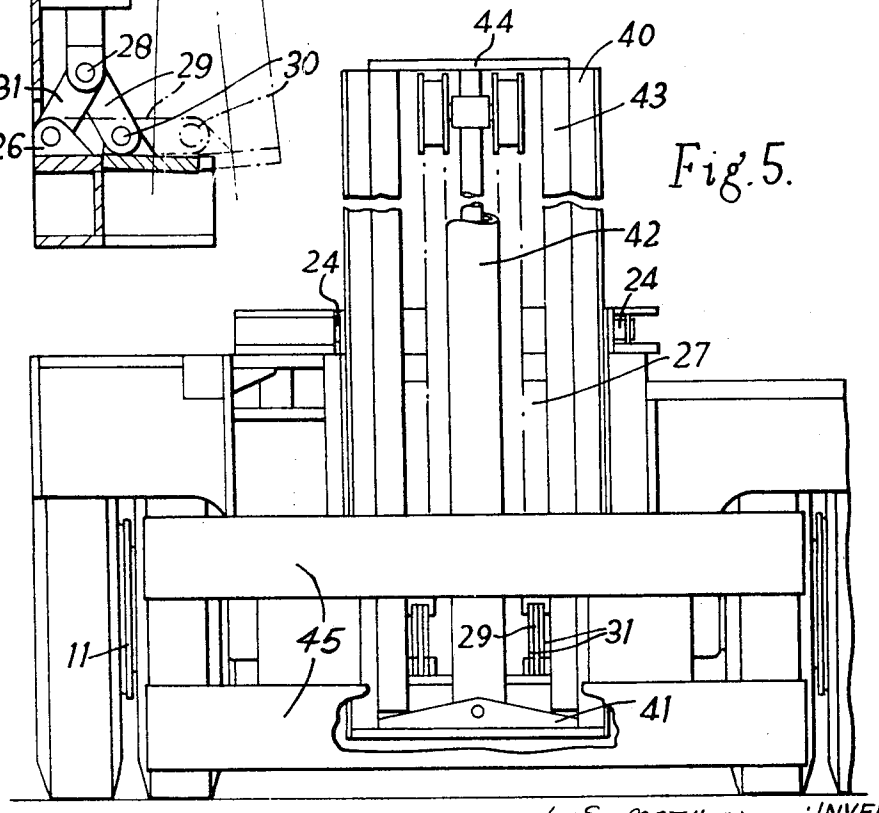

Fig. 5.

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Patented Aug. 6, 1968

3,395,820

FORKLIFT TRUCKS

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Claims priority, application Great Britain, Apr. 22, 1965, 17,123/65
8 Claims. (Cl. 214—671)

ABSTRACT OF THE DISCLOSURE

A lift truck comprising a chassis having a pair of forwardly extending members, outwardly extending members supported by said forwardly extending members, front wheels carried by the respective outwardly extending members, driving means coupled to said front wheels for driving them, a mast support arm positioned between said forwardly extending members and hinged at one end to one of said forwardly extending members about a substantially vertical axis, turning means coupled to said mast support arm for turning said mast support arm about said hinge axis, a mast structure hingedly mounted on said arm about a horizontal axis and comprising a first guide which is fixed against vertical movement and a moving guide slidingly mounted on said first guide, said first guide extending downwardly to a position close to the ground, and the frame of said lift truck permitting an unobstructed swinging movement of said arm and mast structure from a forwardly facing position to a position substantially at 90° thereto.

The present invention relates to lift trucks and in particular to lift trucks of the type in which the mast swings about a vertical axis to permit the load to be carried lengthwise of the machine. Such machines are advantageous particularly for handling timber, steel girders and similar long loads.

We have already described in our copending patent application No. 423,983 a lift truck, in which the mast slews about a vertical axis arranged off the centre line of the machine, whilst in the forward-facing position of the mast, the middle of the mast lies substantially on the centre line of the machine. This arrangement was adopted so that, in the slewed position, the centre of gravity of the load lies fairly close to the centre line of the machine.

It is an object of the present invention to overcome certain practical objects to that machine which become apparent particularly when it is intended to carry rather large loads in the region of 12,000 lbs. and upwards.

In the machine described in our said copending patent application No. 423,983, the lower end of the fixed guide of the mast terminates considerably above ground level to permit the lower end of the mast to swing over the front axle when the load is slewed.

As a consequence, in practice it is necessary to employ a telescopic lifting ram for the moving guide of the mast in a machine of the type described in patent application No. 423,983.

Telescopic lifting rams are relatively undesirable for lift trucks because of their relatively high initial cost. They are also undesirable because they do not raise the load at constant rate and because, other things being equal, higher hydraulic pressures are required. It is therefore an object of the present invention to construct a lift truck, which retains the general advantages of the machine described in patent application No. 423,983 and, at the same time, employs a normal type of single-extension hydraulic ram, i.e., a ram in which the piston rod

can be extended by a distance somewhat less than the overall length of the cylinder.

In order to achieve this result it is proposed to employ a normal type of mast, in which the moving guide and stationary guide are of substantially the same length and the foot end of the lifting ram body is supported on a cross member of the stationary guide quite close to the ground, whilst the top end of the litfing ram body extends upwardly quite close to a cross member at the top end of the moving guide, when the moving guide is lowered.

In order to achieve the desired result without excessive overhang of the mast in front of the axis of the front wheel, it is necessary to eliminate the front axle of the machine.

According to the present invention a lift truck of the type in which the mast swings about a vertical axis is characterised by a frame having a pair of forwardly extending members, outwardly extending members being supported by said members and carrying the front wheels, means for driving said front wheels, a mast support member positioned between said forwardly extending members and hinged at one end thereof to one of said forwardly extending frame members about a substantially vertical axis, means for turning said mast support member about said hinge axis, a mast, comprising a stationary guide and a moving guide, hinged to said mast support member about a substantially horizontal axis, said stationary guide extending downwardly to a position close to the ground (i.e. having a ground clearance of 6 to 12 as is usual in conventional forklift trucks), the frame of said lift truck being arranged so that the mast support and mast can be swung rearwardly through an angle of substantially 90° from a forward facing position to a sideways facing position.

It will be understood that the gap between the forwardly extending frame members must be slightly greater than the width of the mast stationary guide, but need not be equal to the width of the carrier frame of the mast, since the mast will not be slewed to the sideways facing position except when the carrier frame has been raised sufficiently for the load to clear the wheels and superstructure of the machine. There must be an unobstructed quadrant between the frame members in which the mast can swing. Preferably an arcuate trackway is provided at the edge of such unobstructed quadrant and acts as a support for a roller carried at the end of the mast support member remote from the hinge.

All forklift trucks are kept as compact as possible to enable them to operate within restricted spaces. For this reason the overall width of the front of the machine is kept as small as possible. To achieve this the front wheels are preferably driven by individual hydraulic or electric motors, arranged co-axially of the wheels. Conveniently the shaft of the motor is secured in a bracket on the frame to act as a stub axle, whilst the body of the motor rotates about the shaft and is provided with a flange to which one or two wheels are bolted.

Reference is now made to the accompanying drawings wherein:

FIGURE 1 is a plan view of the lift trucks, with the mast and mast support member omitted.

FIGURE 2 is a front view of the lift truck with the mast omitted.

FIGURE 3 is a corresponding part plan view.

FIGURE 4 illustrates a means for tilting the mast.

FIGURE 5 is a front view of the mast.

Referring to FIGURE 1, it will be seen that the frame of the forklift truck comprises a pair of main transverse members 1, which serve as bearers for an engine 2 and hydraulic pump 3. A conventional, trunnion-mounted rear axle with steerable wheels supports a rearwardly ex-

tending frame member 4, which is directly connected to the members 1 and is further connected to them by diagonal tie members 5.

Main longitudinal frame members 6 extend forwardly of the main transverse members. These members 6 are heavy box-section members and are not connected to each other near their front ends. They are connected to each other by a torque-resisting member 7 and an angle-section trackway 8, which also helps to stiffen the frame.

A hydraulic motor 9 (only one shown) is mounted on each frame member 6, the shaft of the motor being non-rotatably secured in a bracket 10, secured to the frame member 6, whilst the rotating body of the motor is provided with a flange 11 for bolting to twin wheels.

The position of the vertical pivot axis of the mast support member is indicated at 12 in FIGURE 1.

Referring now to FIGURES 2 and 3, the hinge for a mast support member, generally indicated at 14 is comprised of a downwardly extending heavy plate 15, welded underneath the left-hand frame member 6 and an upwardly extending fabricated channel bracket 18, welded on top of the box 6. The plate 15 carries a block 16, having an aperture for a hinge bolt 17. A rotary hydraulic actuator 19 has its body secured to the bracket 18*b*. The spigot 20 of the hydraulic actuator finds a location in the lower plate 18*a* of the bracket 18, whilst the upper end of the shaft 20*a* is splined into a sleeve 21, which finds a bearing in the upper plate 18*b* of the bracket 18 and is secured to mast support member 14, so that actuation of the actuator 19, swings the mast support member and, with it, the mast about the vertical axis 12.

From the part plan view shown in FIGURE 3, it can be seen that the end of the mast support member 14, remote from the hinge axis 12, carries rollers 22, 23, which respectively ride on the upper and lower surfaces of the track 8, thus taking the strain off the hinge. The rollers 22, 23 can be replaced by slide members, preferably of low-friction material.

The stationary guide of the mast is pivoted to the mast support member by means of pivot pins, which are held in bosses 24 at the top of the mast support member 14. The mast is tilted by means of a pair of hydraulic rams 27, the body of each of which is pivoted to the mast support member 14 by the downwardly facing clevises 25. The piston rod of each ram 27 is connected to the centre pivot 28 of a toggle linkage, one arm 29 of which is pivoted at 30 to the bottom end of the stationary guide of the mast, whilst the other arm 31 is pivoted to the support member 14 at a clevis 26.

It will be seen that the pivots 24 and 30 are so arranged in relation to each other that the mast may be tilted slightly forward when the rams 27 are fully retracted, whilst it is tilted somewhat backward when the rams 27 are fully extended.

The mast is illustrated in FIGURE 5 for completeness. The mast is an entirely conventional mast comprising a stationary guide 40, having a bottom transverse member 41 to which the bottom end of the cylinder of a lift ram 42 is pivoted, and a moving guide 43, having a top transverse member 44, to which the top end of the piston rod of the lift ram 42 is pivoted. A carrier frame 45 for the lift forks rides on the moving guide 43 in the conventional manner and is raised at double the rate of the moving guides 43 by cables or chains connected to the stationary guide and passing over pulleys at the upper end of the piston rod of the lift ram.

The length of the cylinder of the lift ram 42 is substantially equal to the length of the fixed guide 40 and thus it is only necessary for the lift ram to be a single-extension ram for it to be able to lift the moving guide 43 to the fullest extent.

In an alternative construction intended to reduce slightly the overall width of the machine the rather bulky hydraulic actuator 19 is not used. In this alternative the mast support member 14 carries a hydraulic motor at its free end and this drives a pinion, which engages an arcuate rack carried by or concentric with the trackway 8.

We claim:

1. A lift truck comprising a chassis having a pair of forwardly extending members, outwardly extending members supported by said forwardly extending members, front wheels carried by the respective outwardly extending members, driving means coupled to said front wheels for driving them, a mast support arm positioned between said forwardly extending members and hinged at one end to one of said forwardly extending members about a substantially vertical axis, turning means coupled to said mast support arm for turning said mast support arm about said hinge axis, a mast structure hingedly mounted on said arm about a horizontal axis and comprising a first guide fixed against vertical movement and a moving guide slidingly mounted on said first guide, said first guide extending downwardly to a position close to the ground, and the frame of said lift truck permitting an unobstructed swinging movement of said arm and mast structure from a forwardly facing position to a position substantially at 90° thereto.

2. A lift truck as claimed in claim 1 in which said forward extending members are unconnected at their forward ends to thereby form an open ended substantially U-shaped frame, and said mast support arm is hinged to the forwardly extending member within the U-shaped frame.

3. A lift truck as claimed in claim 1 wherein the mast support arm has a pair of apertured bosses projecting forwardly from an upper part thereof, pivot means engaged in said bosses and supporting said first guide of said mast structure between said bosses, a hydraulic ram carried in a substantially vertical position behind said first guide by the mast support arm, and a pivoted linkage connecting said mast support arm and said first guide at a position below the horizontal hinge mounting between the support arm and said first guide, said pivoted linkage being connected to said ram for movement between positions in which the first guide is respectively slightly inclined forwardly and slightly inclined rearwardly in relation to the vertical

4. A lift truck comprising a chassis having a pair of forwardly extending members laterally spaced apart and unconnected at their forward ends, outwardly extending members supported by said forwardly extending members, front wheels carried by the respective outwardly extending members, means for driving said front wheels, a mast support arm positioned between said forwardly extending members and hinged at one end to one of said forwardly extending frame members about a substantially vertical axis, means for turning said mast support arm about said vertical axis, an arcuate track member arranged between said forwardly extending frame members and concentric with the vertical pivot axis of the mast support member, means carried by the mast support arm and engaging the track for supporting the free end of said arm, a mast structure comprising a first guide which is hingedly mounted on said arm about a horizontal axis, which is fixed against vertical movement, and which includes a transverse member close to the foot end thereof, and a moving guide which is slidingly mounted on said first guide and which includes a transverse member close to the head end thereof, said first guide extending downwardly to a position close to the ground, and the frame of said lift truck being arranged to permit an unobstructed swinging movement of said mast structure from a forwardly facing position to a position substantially at 90° thereto, and a single-extension hydraulic ram mounted to extend between the transverse member of said fixed guide and a transverse member of said moving guide.

5. A lift truck comprising a chassis carrying an extensible mast structure which includes a first guide fixed against vertical movement, a carrier frame mounted on

the mast structure for movement up and down the mast structure, said chassis having a pivot whereon the mast structure is supported for pivoting movement into a forwardly facing position and into a laterally facing position about a vertical axis, the chassis comprising two spaced forwardly projecting frame members on which the front wheels of the truck are respectively mounted, and said pivot for the mast structure being carried by one of said frame members at the forward end of that frame member, whereby the mast structure can be rotated backwardly through substantially 90° about the pivot from the forwardly facing position to bring the carrier frame into said laterally facing position.

6. A lift truck according to claim **5** including an arcuate track centered on the vertical pivot axis of the mast structure and extending between said two frame members, and support means on the mast structure to support the mast structure at a location remote from said vertical axis which support means rests on and is movable along the arcuate track.

7. A lift truck as claimed in claim **6** in which said mast structure has a mast support arm mounted for pivoting movement about said vertical axis, having the support

means mounted thereon and carrying the mast structure.

8. A lift truck as claimed in claim **7** in which said means for swivelling the mast structure includes a rotary motor comprising a fixed part which is secured to the chassis and a second part which is drivingly rotatable relative to the first part about said vertical axis and which is connected to the support arm to turn it in relation to the chassis.

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