Jan. 30, 1968 K. SALNA ET AL 3,366,260

FORK LIFT VEHICLE

Filed March 11, 1965 2 Sheets-Sheet 1

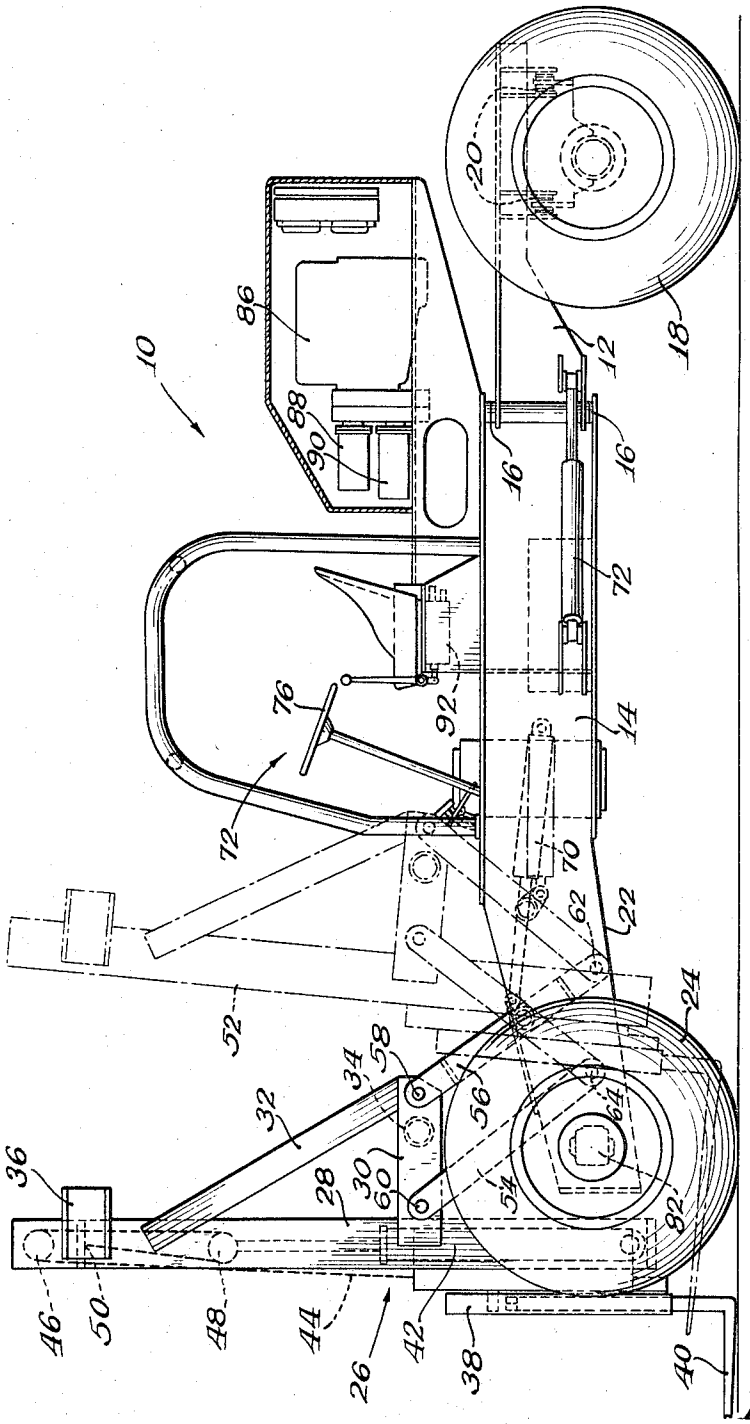



FIG. 1.

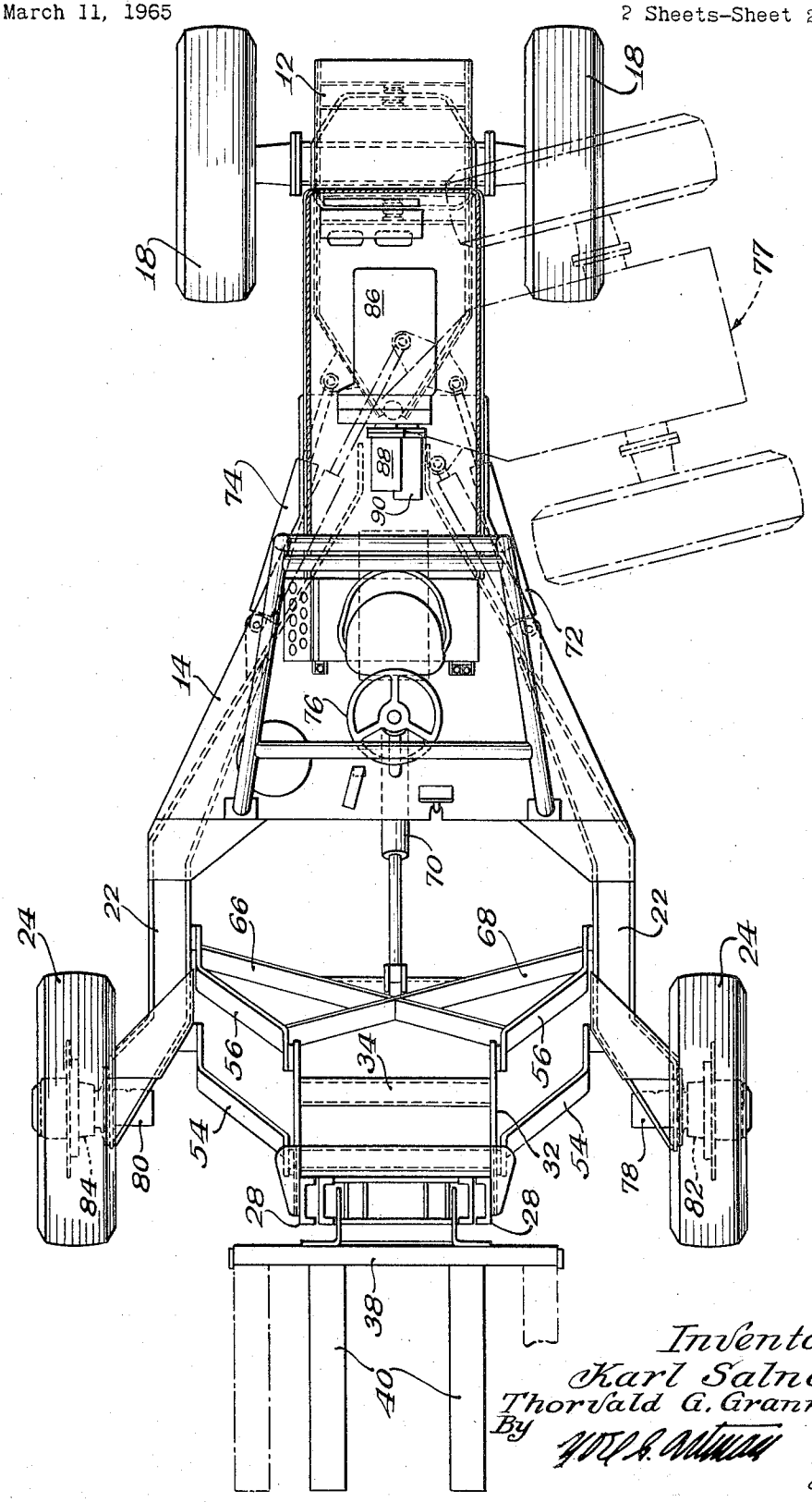
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FIG. 2.




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3,366,260

# FORK LIFT VEHICLE

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## ABSTRACT OF THE DISCLOSURE

A fork lift vehicle having an articulated frame with the front frame section bifurcated into forwardly extending members. A lifting mast supported by linkage means on the front frame is provided to lift a load forward of the frame and then move the load rearwardly for carrying between the frame members.

*Summary of the invention*

This invention pertains to fork lift vehicles. More particularly this invention pertains to fork lift vehicles with articulated frames to provide improved maneuverability, with hydrostatic drive to provide more efficient design of a fork lift vehicle, and with a two-position lifting mast to provide increased load-handling capabilities and stability for the vehicle.

In load-handling operations requiring movement over rough terrain, such as off-highway loading and traveling, the requirement for increased stability, safety and maneuverability becomes critical. Existing fork lift vehicle designs have failed to achieve these desired characteristics. Thus, fork lift vehicles with adequate tread and wheelbase to maintain stability and safety are cumbersome when precise maneuvering is required, such as during the loading and unloading operations. Furthermore, maneuverability is adversely affected by drive shaft angular limitations in the drive trains of existing vehicles.

Accordingly it is an object of this invention to provide a fork lift vehicle with improved stability and maneuverability by incorporating two articulated frame members in which one frame member is bifurcated and pivotally mounts a lifting mast which is capable of lifting the load in a forward position, or carrying the load in a position within the bifurcated frame member.

It is another object of this invention to provide a fork lift vehicle with a lift mast which is pivotally mounted between two frame members of the vehicle and in which hydraulic motors drive traction wheels mounted on the frame members.

It is still another object of this invention to provide a highly stable and maneuverable fork lift articulated vehicle which incorporates a lift mast longitudinally movable within a bifurcated frame member and in which a parallel motion mechanism maintains a substantially constant attitude of the lift mast.

Another object is to provide a fork lift vehicle with articulated frame members in which a lift mast moves a load to a carry position within the wheelbase of the vehicle and in which hydraulic motors provide the tractive effort for wheels mounted substantially underneath the load.

Yet another object is to provide a fork lift vehicle with hydraulic motors to power the lifting mast and in which traction wheels mounted substantially underneath the load are driven by hydrostatic motors.

The invention, both as to its organization and method of operation, taken with further objects and advantages thereof, will best be understood by reference to the following description, taken in conjunction with the accompanying drawings, in which:



*Description of the drawings*

FIGURE 1 is a side elevation view of an articulated fork lift vehicle incorporating the features of the present invention, and

FIGURE 2 is a top plan view of the fork lift vehicle of FIGURE 1.

*Description of the preferred embodiment*

Referring now to the drawings, and particularly to FIGURE 1, an articulated fork lift vehicle is indicated generally at **10**. The vehicle consists of rear frame member **12** which is articulated to front frame member **14** about an upright axis defined by the pivotal connections **16**. Rear wheels **18** are mounted about horizontal pivot axes at the pivotal connections **20** on the rear frame member. Front frame member **14** is bifurcated into a pair of spaced-apart and forwardly extending support members **22**. Traction wheels **24** are rotatably mounted at the forward end of either support member.

A conventional lifting mast **26** is provided and is mounted in the novel manner of this invention on the vehicle **10**. The lifting mast consists of vertically extending channel-shaped frame members **28** which are secured to a pair of horizontal frame members **30**. A pair of brace members **32** and a cross member **34** provide a rigid support for the lifting mast. A cross beam **36** is also rigidly secured to the upper margins of frame members **28**. A fork member **38** is mounted for vertical sliding movement along the inner edges of the frame members **28**. A pair of tines **40** are mounted on fork member **38** and are laterally adjustable in a conventional manner to any selected position as shown in the broken line view of FIGURE 2.

The fork member **38** is vertically movable to the desired height for engaging a load through operation of extensible hydraulic motor or ram **42**. A chain **44** is secured to fork member **38** and is threaded around pulley **46**, which is rotatably mounted to the upper end of frame member **28**. The chain is then threaded around pulley **48**, which is rotatably mounted on the rod end of hydraulic ram **42**, and the chain is then secured at **50** to the upper end of frame member **28**. Selective retraction and extension of hydraulic ram **42** through operation of a conventional hydraulic control system (not shown) will raise or lower the fork member **38**.

The lifting mast **26** is mounted for pivotal movement from a lifting position forward of the traction wheels **24** of the vehicle as shown in FIGURE 1, to a carry position within the wheelbase of the vehicle as shown in the broken line view at **52** in FIGURE 1. This movement cradles the load between support members **22** for travel of the vehicle between loading and unloading locations so that the weight of the load is stabilized between the wheels of the vehicle. Furthermore, a slightly rearward tilting of the lifting mast is desirable during its rearward movement as a precaution against accidental forward discharge of the load from the tines **40**. To accomplish such a rearward movement two pairs of links **54** and **56** interconnect each of the support members **22** with a respective side of the frame member **30**. The links **54** and **56** are of substantially equal length, and the distance between the points of pivotal attachment of each pair of links on the support member **22** is substantially equal to the distance between the points of pivotal attachment to the other ends of the links on the corresponding side of the frame member **30**. This design will afford a parallelogram construction which will result in a substantially constant attitude of the lifting mast during its pivotal movement. The slight backward tilting of the lifting mast between the two positions shown in FIGURE 1 is accomplished by providing

a somewhat larger distance between the points of pivotal connection **58** and **60** of the links to the frame member **30** as compared to the corresponding distance between the points of pivotal connection **62** and **64** on the support member **22**.

A pair of crossed braces **66** and **68** are connected between the right and left links **56** by suitable means such as welding. An extensible hydraulic motor or ram **70** is pivotally mounted at one end to front frame member **14** and at its other end to the crossed braces **66** and **68**. Selective extension and retraction of hydraulic motor **70** through operation of a conventional hydraulic circuit (not shown) will move the lifting mast between the forward loading position and the rearward carry position.

Steering of the vehicle **10** is effected by selective adjustment of the angular relationship between the frame members **12** and **14**. A pair of hydraulic motors or rams **72** and **74** are provided on either side of the vehicle to accomplish this steering function. Rams **72** and **74** are pivotally connected at one end to front frame member **14** and at their other ends to rear frame member **12**. A conventional hydraulic steering pump (not shown) operates responsive to the position of the steering wheel **76** to direct hydraulic fluid under pressure to the rams **72** and **74**.

With reference to FIGURE 2, the broken line view **77** of rear frame member **12** illustrates the relative positions of the frame members **12** and **14** during the lefthand turning movement of the vehicle **10**. This is accomplished by retraction of ram **72** with simultaneous extension of ram **74**. Similarly, a right-hand turning movement is effected by retraction of ram **74** with simultaneous extension of ram **72**.

Transmissions **82** and **84** are provided between motors **78** and **80** and the traction wheels **24**. These transmissions may be of a two-speed, high-reduction, regenerative planetary gear set type as disclosed in applicant's copending application entitled "Motorized Wheel" filed Feb. 24, 1965, and assigned to the same assignee as the present invention.

Power for the hydrostatic motors and hydraulic rams is supplied from prime mover **86** which may be of the internal combustion type. The prime mover **86** drives a pair of hydraulic pumps **88** and **90** which deliver pressurized fluid to the control valve **92** through hydraulic circuits (not shown) to the motors and rams. The construction and operation of the control valve **92** and the hydraulic circuits is explained in detail in the copending application by Thorvald G. Granryd, Ser. No. 192,481, filed May 4, 1962, and entitled "Hydrostatic Arrangement for Tractor Loaders."

The hydrostatic drive arrangement of the present invention in combination with the bifurcated frame structure provides optimum characteristics for a fork lift vehicle. Thus, a heavy drive train between the prime mover and the motors is eliminated while the tractive effort is applied at the forward wheels **24** which are positioned substantially beneath the load at all times. With the weight of the load thus positioned over the traction wheels maximum efficiency is obtained.

It is also well known that the basic work cycle in a fork lift truck is the lifting function. The traction wheels and associated drive train perform only a secondary function of moving the vehicle between loading and unloading locations. With the present invention the full power from the prime mover can be delivered to the fork member **38** through fluid pressure from a selected one of the hydraulic pumps **88** and **90**. For the traveling function, however, power is delivered to the traction wheels from one or both of the pumps **88** and **90** in a manner explained in the copending application Ser. No. 192,481, filed May 4, 1962.

The articulated feature of this invention also affords improved maneuvering characteristics for a fork lift vehicle. A vehicle incorporating features of the present invention is well adapted to carrying a load over rough terrain because the articulated design allows a long wheel base while yet retaining a high degree of maneuverability by means of a small turning radius. The longer wheel base will afford greater stability and safety while the vehicle has an increased capability to spot position the lifting mast during the loading and unloading operations.



A further advantage with the present invention is that with the load cradled between the support members rearwardly in the carry position the weight of the load itself will act through the pairs of links **54** and **56** to maintain the lifting mast in the carry position. Furthermore, in the carry position the tines **40** do not project any substantial distance in front of the tires **24**. Both of these features afford improved safety characteristics.

It is thus seen that applicants have afforded a novel fork lift vehicle which provides improved maneuverability during loading and unloading while achieving increased stability and safety for the vehicle during travel with the load over rough terrain.

It will be understood that various changes in the details, material, steps, and arrangement of parts, which have been described and illustrated in order to explain the nature of the invention, may be made by those skilled in the art within the principle and scope of the invention and expressed in the appended claims.

What is claimed is:

**1.** In a load lifting and carrying vehicle the combination including: a frame having two ends; first wheel means mounted on one end of the frame; a pair of spaced apart support members integral with the other end of the frame and extending forwardly of the vehicle to define an open area therewith; second wheel means mounted on each of the support members; first and second pairs of links pivotally attached at one end thereof to respective support members, each pair of links extending upwardly from the support members, the points of pivotal attachment of each pair of links to the support members being spaced apart a certain distance; a lifting mast pivotally attached to the other ends of the links, the points of pivotal attachment of each pair of links to the lifting mast being spaced apart a greater distance than said certain distance whereby the mast rotates backward relative to the vehicle during movement of the mast to a position intermediate the support members.

**2.** In a load lifting and carrying vehicle the combination includin: a frame having a first section and a second section, the first section being articulated to the second section about a substantially upright axis; first wheel means mounted on the first section; a pair of spaced apart support members integral with the second section and extending longitudinally from the vehicle to define an open area therewith; second wheel means mounted on each of the support members; motor means mounted on each of the support members to drive the second wheel means; first and second pairs of links of substantially equal length and pivotally attached at one end thereof to respective support members, each pair of links extending upwardly from the support members, the points of pivotal attachment of each pair of links to the support members being spaced apart a certain distance; a lifting mast pivotally attached to the other ends of the links, the points of pivotal attachment of each pair of links to the lifting mast being spaced apart a greater distance than said certain distance whereby the mast rotates backward relative to the vehicle during movement of the mast to a position intermediate the support members.

**3.** In a load lifting and carrying vehicle the combination including a frame having a first section and second section, the first section being articulated to the second section about a substantially upright axis; first wheel means mounted on the first section; a pair of spaced apart support members integral with the second section and extending forwardly of the vehicle to define an open area therewith; second wheel means mounted on each of the

support members; a source of fluid under pressure; hydraulic motor means mounted on each of the support members and connected with the source of fluid under pressure to drive the second wheel means; first and second pairs of links of substantially equal length and pivotally attached at one end thereof to respective support members, each pair of links extending upwardly from the support members, the points of pivotal attachment of each pair of links to the support members being spaced apart a certain distance; a lifting mast pivotally attached to the other ends of the links, the points of pivotal attachment of each pair of links to the lifting mast being spaced apart a greater distance than said certain distance whereby the mast rotates backward relative to the vehicle during movement of the mast to a position intermediate the support members.



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