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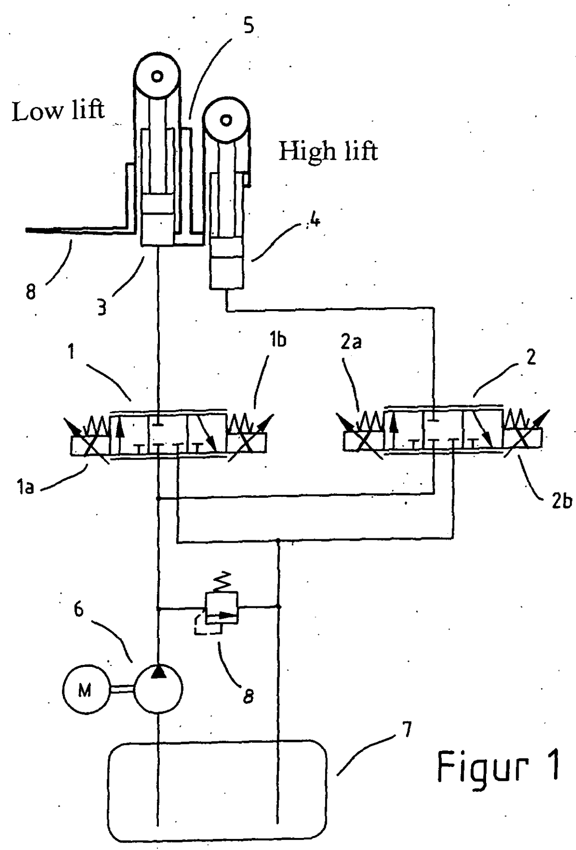
(54) Hydraulic lifting device for a telescopically extendable fork lift truck mast

(57) Device at fork truck where in a telescopically extendable mast in the outermost or uppermost mast section is arranged a movement journaling of movement of the forks over the major part of the height of the uppermost mast section, and where lifting movements are achieved hydraulically by means of one or several hydraulic pistons (4) for the lifting of the mast sections and one or several other hydraulic pistons (3) for the lifting of the forks (8) in relation to the uppermost mast section (5). In the feed conduits to the hydraulic cylinders proportional valves 1, 2 are arranged in order to, at the transition shift between low lift movement and high lift movement and vice versa successively control the oil flow to and from the cylinders of the different systems respectively so that an unnoticeable transition and constant speed is obtained.



Figur 1

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Description

[0001] In order to enable an efficient lifting from the ground plane up to maximum height it is at fork trucks known to use two lifting devices, a telescopic mast that at high lifts is extended, and a lifting device arranged in the outmost/uppermost telescoping element in the mast for movement height-wise over the major part of the height of this telescopic element. In this way the entire height of the mast is used for lifting movement. Lifting is normally taken care of by means of hydraulic cylinders with chain exchanges and transfers in order to achieve the long stroke. Since the lifting device in the outermost mast element thus does not have to lift any part of the comparably heavy mast one saves at small lifts, for instance at lifting, transport and putting down on the ground considerable energy and thereby battery charge. An advantage is further that one can connect the hydraulic cylinders of the two lifting systems in parallel, since at movement of the mast also the weight of this has to be lifted and at for instance the same piston area of the different lifting systems always the one with the smallest load will be lifted first and the second one when the stroke of movement is over for the first system, that is the free or low lift always goes first at lifting and at lowering.

[0002] A problem with this use of two lifting devices is however that the shifting between low lift (free lift) and high lift (mast lift) respectively result in a shock that on one hand is unpleasant for the driver and on the other hand of course shakes the goods and result in strains in the partaking parts. This is particularly disturbing when also the driver is lifted by the two co-operating lifting systems. In order to cure this it is known to use shock absorbers and it is also known to use a position switch that via a control system at the end of the free lift or low lift movement reduce the oil flow from the pump so that the hitting force in the movement becomes smaller. However there still remain the discontinuity in the movement and also often a shock even if it is reduced.

[0003] Furthermore the temporary lowering of the speed means a loss of time. Further it may be make it more difficult for the driver with the varying lifting speed when the forks are to be placed close to the upper end position of the free lift.

[0004] The invention has in view of the above problems as its object to make the shift between low lift and high lift softer and with reduced or entirely eliminated loss of time at the transition.

[0005] In accordance with the invention this object is solved by a valve being arranged in the hydraulic conduit to the low lifting cylinder. Furthermore a position sensor and/or altimeter is used to initiate said valve. When the low lift or free lift movement comes close to its upper end position the sensor or the altimeter restrict the oil feed to the cylinder for the low lift. The restriction can advantageously be progressive or ramped so that it is successively reduced to zero or almost zero.

[0006] When the oil feed to the low lift cylinder is restricted the pressure in the hydraulic circuit is increased in the same way as when according to previous technique the low lift cylinder abuts its upper end position stop. When the pressure rise the oil will instead be pumped into the usually two high lifting cylinders so that these start to lift the frame (mast) upward. At the same time as thus the speed of the movement in the low lift part is reduced the speed of the high lift part is increased and a very soft transition is obtained that to start with can be made entirely shock free and secondly the lifting speed can be kept entirely constant. The soft transition is obtained independent of the lifting speed that is controlled by the speed of the pump motor, that is controlled by the driver by means of the lift control handle defined lifting speed. Also at maximum speed the transition will be soft. If the driver change the speed during the transition this does not have any influence either.

[0007] If one choose the same piston area for the two lifting systems the lifting speed is maintained entirely unchanged at constant control position and pump speed respectively also in the transition range and if the driver stops the movement by stopping the oil flow to the piston systems in the middle of the ramping transition between these the movement height-wise of the fork is stopped, but since the mast is heavier this can be allowed to sink down slowly at the same time as the forks are lifted upwards precisely in the same amount and in the same degree due to an overflow between the cylinders in the different systems.

[0008] I relation to the previous solutions the invention has the advantage that one does lose any lifting time on the transition between the lifting devices as in the case with the speed lowering at the end of the low lift. Furthermore the placing of the forks in the transition area is facilitated since the fork speed is only controlled by the driver. Nor are there needed any special cylinders.

[0009] In a further development of the invention one can also provide the connecting tubing to the high lift cylinders with a valve enabling restriction. The use of a reduction valve in the connection tubing to the high lift cylinders allow soft breaking of the mast movement when the parts of this come close to the lower end position, which can be sensed with an altimeter and/or a position sensor. When this takes place the valve to the low lift cylinder is preferably open or opened so that when the mast is braked the low lift begin its lowering emotion. In the case with the same piston areas in the same way as in the lifting case at a stop (that is a disruption in the draining of oil from the lifting cylinders) in the transition range the mast will sink down with a simultaneous lifting of the forks that thus will look as if they are standing entirely still in the height direction.

[0010] The valve in the connection to the high lifting cylinders also makes it possible to use cylinders in the low lifting systems with a smaller piston area and a higher lifting pressure since it is possible to prevent the high lifting cylinders from movement by shutting off the feed to these during the entire low lift (below the transition area). This allows partly the use of less costly cylinders since they can be given smaller dimensions for the low lifting part and also reduce the amount of oil that has to be moved, which in tern reduce the losses due to flow, required oil volume in the truck etc. and furthermore the low lift cylinder or cylinders becomes easier to stow away so that the driver can obtain a better view.

[0011] The use of smaller piston areas in the low system also result in faster lowering movements of the low lift system, since the pressure also at lowering will be higher and the oil volume that is to be displaced becomes smaller.

[0012] The above mentioned restriction valves are advantageously electrically controlled proportional valves permitting together with the appropriate electronic control the use of well defined and constant maximum speeds over the entire lifting range without loss of time. If so should be desired also other movement schemes can be used then at the known devices. For instance high lift and low lift parts can in relation to each other be controlled in such a way that at a lowering movement the low lift part is always lowered first, which may provide the advantage that if movements are to take place high up in the storage rack a major part of these movements may be executed with only the low lifting part that weighs less and consequently requires less energy than if the entire mast is to be lowered and lifted again.

[0013] With electronic control it is further possible to control the two control systems independent of the piston areas so that the sum of their respective lift and lowering speeds becomes constant and in particular the maximally permitted. In the shifting range draining and feeding of oil respectively to the two systems take place in such a manner that the mast can sink down if it has been stopped in the ramping range by letting out oil from the high lift system, while a compensating oil volume is pumped in to the low lift cylinders. These and other movements can be controlled and checked by position switches and or altimeters. One also has the possibility to ascertain that the high lift part goes down completely at the lowering, so that not mistakenly, due to for instance a slow going low lifting part, that mast extends somewhat and thereby risk to get stuck in door openings.

[0014] At the use of an altimeter this can be used in combination with position sensors, but one can also consider to use two altimeters, one for the low lift and for the high lift. Within the concept of the invented thought one can also consider to use two hydraulic pumps each with its own motor, for instance one motor unit can be used to drive the low lift while the other pump can be used to drive the high lift.

[0015] Further advantages and characteristics of the invention are apparent from the patent claims and the following description of an embodiment shown in the enclosed drawing. In this Fig.1 and 2 schematically show a device in accordance with the invention and Fig. 3 a flow diagram of the oil feed to the two lifting systems when the transition range between the two lifting systems is passed.

[0016] In the schematic embodiment shown in the enclosed drawing two high lift cylinders have been referenced with 4 and two low lift cylinders with 3. The low lift cylinder or cylinders 3 are connected to the high lift part of a telescopic mast or frame 5. The frame 5 provides inertia in the system. Oil is feed from a hydraulic pump 6, 6' via two valves 1, 1' and 2, 2' from a tank 7. The valves 1, 1' and 2, 2' can both feed to, and drain oil from the lifting cylinders 3 and 4 respectively. A pressure limiter 8 is arranged after the motor and return at a to high pressure oil back to the tank 7 in sufficient amount to reduce the pressure to intended value. The valves are proportionally controlled electrically by an electronic unit that receives its commands from a lifting control and that furthermore includes a memory unit and a processor and connections for signals from position sensors and/or altimeters. The valves are separate units or built together to one unit that may be entirely separated from the lifting cylinders. Instead of an altimeter one can use a position sensor that registers when the forks come close to their end position in the outermost mast section and when the mast comes close to its bottom position respectively. When at lifting a signal comes from the position sensor for the end position of the low lift the feed passage 1, 1a' of the valve 1, 1' is successively restricted and the feed passage 2a, 2a' in the high lift valve is opened successively so that the speed of the forks in relation to the outermost mast section approaches zero when they approach the end position. In the case with an altimeter one can also consider to restrict entirely or almost entirely in the vicinity of the mechanical end position in order to reduce the mechanical strains. Advantageously one uses both altimeter and sensor for "close to end position" for the low lift movement. In particular at the use different cross sections of the lifting cylinders in the two systems it is possible at the use of altimeter to use the values from this to control not only the valves but also the pump speed in order to obtain an even (maximum) speed at movements in the height direction. The corresponding flow conditions are shown in Fig. 3. The sum of the oil flows to the two systems is constant and the transition takes place despite the comparatively short transition distance and time respectively that not even the difference in mass inertia is noticed.

[0017] At lowering instead the valve passages 1b and 2b are used for the draining of the oil back to the tank. At large frames (masts) alternatively at lowering the valve passages 1b' and 2b' are used that drain the oil via the pump back to the tank. The electric motor functions as a generator. A principal diagram is shown in Fig 2. The electric motor functions at lift as a usual DC or asynchronous motor. At lowering the motor working as a generator return energy to the battery package. The valve or the valves that are used are proportional valves (1', 1a', 2', 2a'). At this the valves may in addition to be used for soft transitions and end position ramping be used to keep the lowering speed even (maximum).

[0018] In addition to the above mentioned advantages it can be mentioned that if one choose a low lift cylinder that is thinner and works with a higher pressure and smaller oil volumes also more narrow conduits may be used which is cost reducing in it self and easier to handle since thinner hoses more easily can be bent over pulleys etc. The invention furthermore has the great advantage that it is easy to rebuild existing trucks since it is only a matter of changing valves conduits and control electronic since the invention can be used even at larger dimensions of the low lift cylinder. At service or renovation works also an older truck can be upgraded to more modem lifting comfort and even lifting speed.

[0019] By the use of a smaller piston dimension of the low lift cylinder or cylinders also at emptying the pressure will be higher and thereby the draining speed faster so that also the free lift lowering can take place with maximally permitted speed.

[0020] At movements upward the invention provides an unnoticeable transition between low lift and high lift and a soft damping of the movement when the mast comes close to the its upper most position.

[0021] At movement downwards the invention provides a soft transition between high lift and low lift that is at damping of the arriving of the mast to the bottom position and a softly braked lower end position of the forks in the low lift part and a fast lowering of the low lift.

Claims

1. Device at fork truck where in a telescopically extendable mast in the outermost or uppermost mast section is arranged a movement journaling of the movement of the forks over the major part of the height of the uppermost mast section, and where lifting movements are achieved hydraulically by means of one or several high lift cylinders for the lifting of the mast sections and one or several low lift cylinders for lifting of the forks in relation to the uppermost mast section, at which the low lift cylinders and high lift cylinders are in parallel connected to a pump for the feed of oil under pressure, and at which the cross sections of the cylinders and possible exchange rates are so chosen that at the feed of oil the forks are always lifted first and first when this movement is complete the oil flows on to the high lift cylinders requiring a higher pressure, **characterized in that** in a feed conduit to the low lift cylinder or cylinders a valve is arranged and for this a control is arranged that towards the end of the movements stroke of the forks upwards in the uppermost mast section successively restricts the feed of oil to the low lift cylinder so that the oil instead successively increasingly is fed to the high lift cylinders during continued lifting movement of the forks.

2. Device at fork truck were in an telescopically extendable mast in the outermost or uppermost mast section a movement journaling is arranged for the movement of the forks over the major part of the height of the uppermost mast section, and were lifting movements are achieved hydraulically by means of one or several high lift cylinders for the lifting of the mast sections and one or several low lift cylinders for the lifting of the forks in relation to the uppermost mast section, at witch the low lift cylinders and the high lift cylinders are in parallel connected to a pump for the feed of oil under pressure, and at which the cross sections of the cylinders and possible exchange rates are so chosen that at the feeding of oil the forks are always lifted first and first when this movement has been executed the oil flows further on to the high lift cylinders requiring a higher pressure, **characterized in that** in a feed conduit to the high lift cylinder or cylinders a valve is arranged and for this a control is arranged that towards the end of a lowering movement of the mast successively restricts the oil drain from the high lift cylinders so that that oil instead successively increasingly is drained from the low lift cylinders during the continued lowering movement of the forks.

3. Device at fork truck were in a telescopically extendable mast the outermost and uppermost mast section is arranged a movement journaling for the movement of the forks over the major part of the height of the uppermost mast section, and where lifting movements are achieved hydraulically by means of one or several high lift cylinders for the lifting of the mast sections and one or several low lift cylinders for the lifting of the forks in relation to the uppermost mast section, at which the low lift cylinders and the high lift cylinders in parallel are connected to one or several pumps for the feeding of oil under pressure, **characterized in that** in the connection conduits the high lift cylinder or cylinders and low lift cylinder or cylinders valves are arranged, and for these valves a control is arranged that towards the end of a lifting or lowering movement of the mast or the forks in the uppermost mast section successively restrict the oil feed to and the oil drain from respectively the high lift cylinders and the low lift cylinders respectively so that shocks are avoided in the end positions and in particular so that in the shifting between movement of high lift cylinders and low lift cylinders and reverse the shift takes place successively and without stopping of the forks.

4. Device according to claim 1, 2 or 3 **characterized in that** the valve or valves are proportional valves.

5. Device according to any of the preceding claims, **characterized in that** the valves also take care of the connection to oil tank and oil pump respectively.

6. Device according to any of the claims 3 - 5, **characterized in that** the low lifting hydraulic cylinder is dimensioned for a lifting hydraulic pressure essentially coinciding that of the high lift cylinders.

7. Device according to any of the preceding claims 1 - 5, **characterized in that** the low lifting hydraulic cylinder is dimensioned for a lifting hydraulic pressure that differs from that of the high lifting cylinders.

8. Device according to any of the preceding claims, **characterized in that** the cross sections of low lift cylinders and high lift cylinders are the same so that a constant lifting speed can be achieved.

9. Device according to any of the preceding claims 1 - 7, **characterized in that** the area of the piston or pistons in the low lifting system is smaller than for the high lifting system so that a high lowering speed can be achieved.

10. Device according to any of the preceding claims, **characterized in that** a sensor is arranged in the proximity of the upper end position of the forks in relation to the upper mast section.

11. Device according to any of the preceding claims, **characterized in that** it is provided with a lift height measuring device for low lift and/or high lift.

12. Device according to any of the preceding claims, **characterised in that** a position sensor is arranged in the lower end of the movement of the forks in the uppermost mast section.

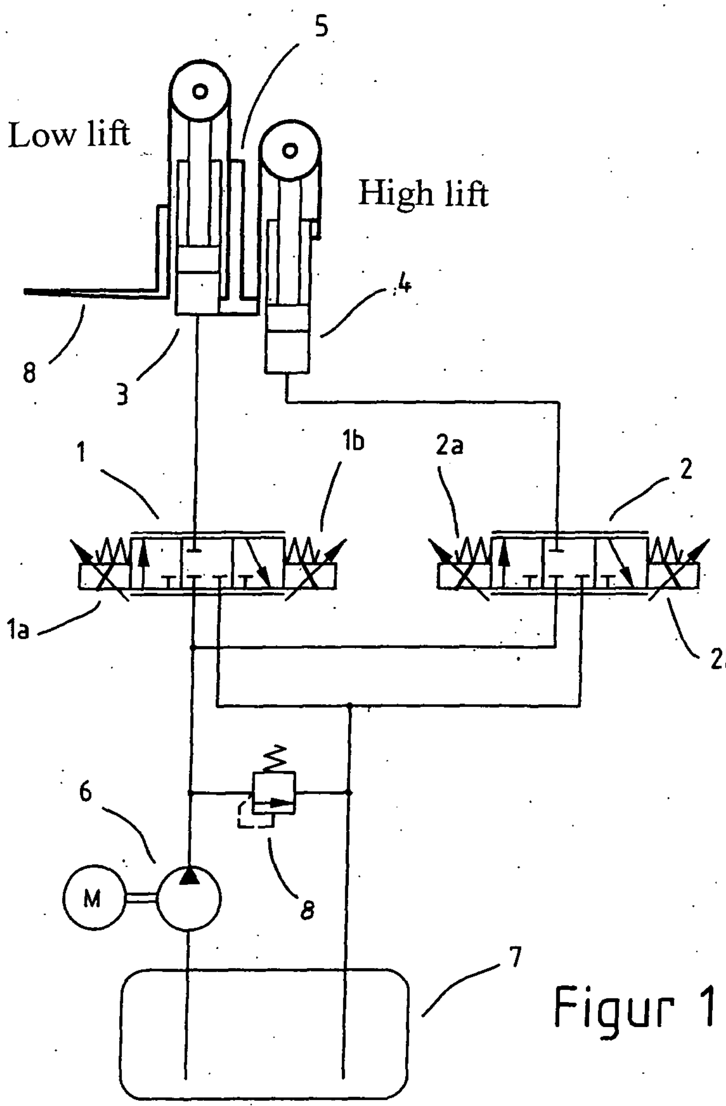
13. Device according to any of the preceding claims, **characterized in that** it includes two motors for the driving of the lifting cylinders.

14. Device according to any of the preceding claims, **characterized in that** it includes a electronic control unit for the control of the valves.

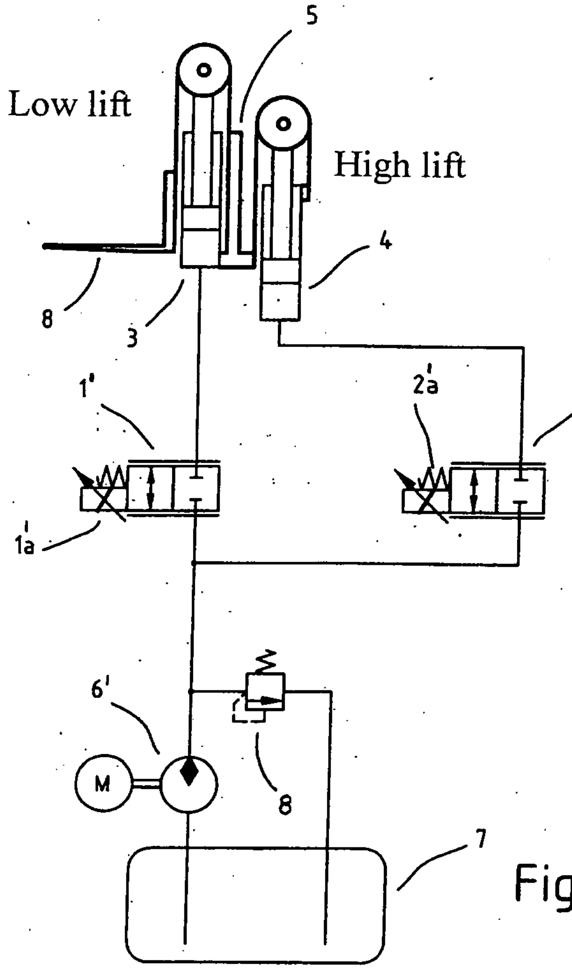
15. Method for the control of the transition between lifting movements carried out with different lifting cylinders, in particular low lifting and high lifting cylinders, **characterized in that** at the initiating of the transition the feed to the presently working cylinder is restricted and fed to the other one so that a soft transition is achieved.

16. Method according to claim 12, **characterized in that** at stops in the transition range the low lift system is lowered to its lowermost position while the low lift part is raised in a corresponding amount.

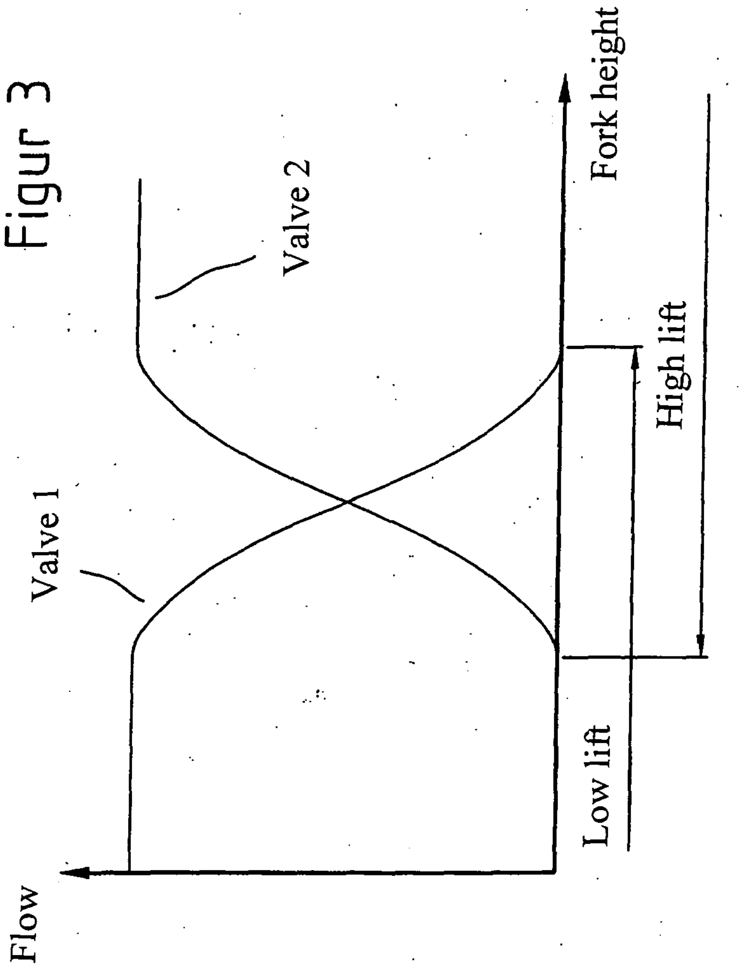
17. Device according to any of the claims 1- 4 or 6 - 16, **characterized in that** it is so arranged that the oil at lowering is fed back through the pump that drives the motor that at this serves as generator and returns energy to the batteries.



Figur 1



Figur 2



Figur 3