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(54) Free stroke damping

(57) Device for the reduction of shocks in the lifting movement at a lifting truck of the kind that includes a lifting fork carriage (5) moveable vertically in a mast part (4) that in turn is movable and where the fork carriage in the mast part is lifted by means of a hydraulic cylinder (7) fastened in the upper end of the mast part. Its piston rod (9) is extendable downwards and over a pulley (8) in the lower end of the piston rod a chain (6) runs that from an upper fastening point in the mast part (4) runs down around the pulley (8) and up again over another pulley (15) fastened in the upper end of the mast part and then once again downwards to be fastened in the fork carriage (5). The hydraulic cylinders of the fork carriage and the mast parts are coupled in parallel but have such relative cross sections that the cylinder (7) of the fork carriage have smaller pressure requirement than the mast cylinders. In the frame of the truck or in a mast part (2) fastened to the truck frame a sensor (11) is arranged close to the lower end position of the piston rod (8) and for cooperating with this in such a way that when the piston rod (8) approaches its lower end position , that is the lifting carriage is approaching its upper end position in the mast part, the sensor is triggered. The sensor is coupled to the hydraulic means that feed hydraulic oil to the hydraulic cylinder reducing the oil flow so that the speed of the carriage is reduced close to the end of the travel of the carriage in the frame part (4) and at lowering the mast movement speed is reduced in the vicinity of the lower end position of the mast parts.

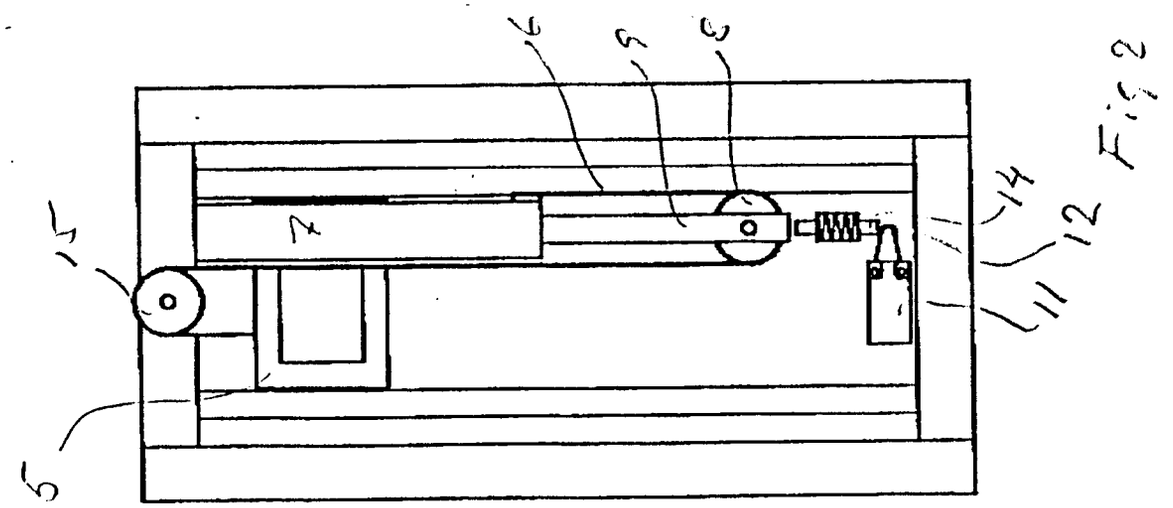

Fig 2

EP 0 716 040 A1

Description

At lifting trucks intended for the handling of goods on loading pallets into and out from storing racks it is known to arrange the load forks of the truck movable heightwise over the entire height of a frame or mast part that in turn is movable in a mast part fastened to the truck. It is further usual between these mast parts to arrange an intermediate mast part movable relative the other two so that the mast fastened to the truck in it self is telescopic increasing the lifting height with a minimum height of the truck. This enables a large lifting height without hindering the passage in and out through doors of for instance a warehouse. Normally the diameters of the hydraulic cylinders that take care of the movements of the different parts is chosen in such a way that with the cylinders coupled in parallel, at a lifting movement of the lifting forks at first these will be lifted in relation to the mast by a carriage carrying the forks being moved in relation to the first or inner mast part, that is the one that on the extending of the mast is situated on top. In this way the weight that has to be lifted when the lifts are low is minimized.

When the load forks and the carriage in the first or innermost mast part reach its upper end position in this mast part the carriage strikes against a stop and the corresponding hydraulic cylinder can not lift any further and thereafter the parts of the mast are lifted and this is extended upwards. This first movement of the lifting forks is called free lift or free stroke and when it reaches its upper end position there in an abrupt shock or impact before the uppermost part of the mast begins to move. This impact is disturbing to the driver, result in great tension forces in the lifting parts and can also shake the load or result in unwanted tension waves in this. It is therefor desired to eliminate or dampen this movement transition so that it becomes softer and this is the object of the invention.

Since the hydraulic cylinder giving the free stroke lift of the loading forks and the fork carriage are lockated in the principally telescopic mast parts it is neither simple nor cheap to arrange controls or sensors for the movement of the load fork carriage in the mast part. Rubber coatings or stop springs does provide a certain damping, but not enough and will also be an expensive solution when the end stop of the piston constitutes end stop for the movement.

In accordance with the invention the above object can however be solved without any electrical or hydraulic connections having to be drawn via the lifting mast. This is in accordance with the invention done by using a free stroke lifting device including a piston for the free stroke that hangs down with the piston rod downwards, the outer end of the piston rod carrying a pulley for a lifting chain for the load forks that first runs down to the pulley and around this and up again to a pulley arranged in the mast part in which the carriage is moveable and therefrom down to the load fork carrying carriage. This known construction has among other thing the advantage that a movement for the load forks is obtained that is the double of the work stroke of the hydraulic cylinder. This permits not only a short hydraulic cylinder but is also a good solution for the movement of the load forks over the entire height of the retracted mast. As the hydraulic piston comes closer to its maximally extended position also the carriage carrying the load forks gets closer to its upper end position, where it strikes against stops arranged in the mast. Alternatively the stop for the movement of the carriage may be constituted by the end position of the piston.

Since the free stroke movement take place before the mast parts start to move the lower end position of the piston will not only be the same from time to time in relation to the mast part in which it is journaled but actually also in relation to the truck itself. This means that by arranging on the lower end of the free stroke piston (the one provided with the chain pulley) suitable actuation means for the actuation of a switch situated and mounted fast in the frame of the truck, the switch in turn can for instance via an electronic control reduce the speed of the electric motor that propels the hydraulic pump of the truck that in turn provide the free stroke piston with oil. In this way the velocity of the free stroke can be retarded just before the end position is reached. In this way the following shock at contact will be essentialls reduced. When then after the end of the free stroke the movable mast is extended the free stroke piston that is fastened in the inner mast part will move upwards with this and consequently the lower end of the free stroke piston will move away upwards in relation to the frame of the truck so that the actuation of said switch ceases and the pump may again be driven at full speed.

Since the control means for the motor can be placed in the above described way no long and expensive arranging of connecting leads out through and along the mast to the load fork carriage is necessary.

At the movement downwards the mast parts will always be retraced first before the free stroke is reversed, this due to the different weights and the different activation pressures of the hydraulic cylinders in the mast and the one controlling the free stroke. This means that also at a movement downwards an activation of said switch will occur before the mast part or the mast parts reach their lower end position. The shocklike contact on the movement downwards can therefor also be dampened by for instance using the engine in the lowering direction to control the oil flow from the hydraulic cylinders. A reduction of the engine speed means a braking of for the mast parts so that these have a reduced contact energy when they reach their lowest position. When then the load forks sinks further the piston rod of the free stroke cylinder moves upwards and release said switch so that once again full speed can be used for the lowering movement.

If desired means may be arranged on the load fork carriage itself also for the cooperation with the same

switch that is actuated by the free stroke piston so that this movement also is braked close to its lower end position. In order to avoid a speed reduction at lifting from the bottom position the activation of the switch may be such that reduction only exists on movement downwards of the fork carriage and not at movement upwards or movement speed restrictions may be arranged only to be active at lowering.

Instead of using the engine to control the speed reduction in the transition to and from the movement of the fork carriage in the mast this can be achieved by the activated switch or electrical sensors via for instance control electronics in these areas of movement restricting the opening degree for a corresponding proportional valve for the inlet or outlet of the oil.

Within the inventive thought one can also consider instead having a potentiometer that is controlled by a cam or ramplike part mounted on the lower end of the piston rod. In this way the movement transitions can be made even smother.

The invention is below to be described in an embodiment shown in the drawings. Fig 1 shows schematically mast and fork carriage in the lowermost position of the forks, fig 2 the position shortly before the end of the free stroke, fig 3 a started lifting of the mast and fig 4 the maximum uplifted position of the fork carriage.

The truck in the drawings includes a frame on which a mast constituted by three parts, of which one 2 is fastened to the frame. In the mast part 2 fastened to the frame an additional mast part 3 is slidable journaled heightwise and supports in turn yet another in this intermediate mast part movable mast part 4. In this way the mast can execute a telescopic movement with a great lifting height. In the mast part 4 that can be extended highest a carriage 5 is arranged carrying load forks. The carriage 5 is by means of a cylinder 7 and a chain 6 running over a pulley 8 arranged in the outer end of the piston rod movable over essentially the entire height of the inner mast section. The cylinder 7 for the movement of the load fork carriage in the mast section 4 is suspended in this up side down and the pulley carrying rod end reaches almost to the lower end of the inner mast section when it is fully extended.

In the frame of the truck or in the mast section 2 fastened in this a switch 11 is arranged, provided with a roller 12 in the end of an arm 13. The roller 12 can be actuated by a likewise in the frame or in the frame mounted mast part 2 vertically movable rod 14, that is pretensioned by means of a spring. The lower end of the free stroke piston will when the piston gets close to its lower end position act on the rod that in turn act on the switch 11 that in turn either reduce the drive speed of the hydraulic pump (at lifting) or restrict the open cross section of a proportional valve controlling the lowering flow of the hydraulic oil from the cylinder.

Through these measures a reduced speed will always be obtained when the load forks come close to their upper end position, and when the mast sections all at once are on their way towards their lower end position, this since the mast sections are so arranged that they at the extending or retraction all move in relation to each other so that they all at the same time reach their lowest position.

In fig 2 the free stroke is coming close to its end and the piston rod comes in contact with the rod 14, which means that the lifting movement is slowed down. When thereafter the free stroke is ended the mast starts to move as is shown in fig 3. Soon this movement brings the piston rod out of contact with the rod, the switch is freed and full lifting speed is again established.

At lowering the relation will be reversed and fig 3 shows the position just before the mast parts reach their lowest position. As is apparent the switch is then again activated lowering the speed until the position in fig 2 is achieved again, whereafter lowering can take place with maximum speed.

By means of only one switch, that can be arranged with simple location of the leads, not only the shock or impact that occur when the fork carriage has completed its free lift but also the shock when the mast parts reach their lowest end position is reduced or eliminated

If desired means can also be arranged on the fork carriage that act on the switch to give a reduced speed when the carriage comes closer to its lowest position in the mast, this since the fork carriage then also comes closer to the frame of the truck. In this way it is possible with only one switch or comparable control means to dampen all stops or shocks that occur at the use of the truck. The only stop remaining is that when the mast reaches its maximum extension or lifting. As is realized the truck in reality normally should never reach this position unless one has bought a truck with a too low lifting capacity. The invention is thus a very simple and practical solution to achieve the damping of movement at up to three different shocks or stops.

Within the scope of the invention one can of course instead of one switch use several switches instead, for instanceto get a ramped speed reduction.

Although some time is lost due to the speed reduction according to the invention, the avoiding of the shocks otherwise influencing the truck and that easily trigger oscillations in forks and load give an increased precision compensating and regaining this little loss of time.

The control of the movement may in an alternative embodiment include a magnetic sensor or switch means that have its status altered when a magnet on the piston rod passes the sensor.

Claims

1. Arrangement for the damping of shocks and impacts in the lifting movement at a truck of the kind that includes a load fork carriage (5) movable vertically in a mast part (4) that in turn is movable verti-

cally, and where the fork carriage in the mast part (4) is lifted by means of a hydraulic cylinder (7) the piston rod (9) of which is extendable downwards and over which lower end over a pulley (8) a wire (6) or chain runs that from an upper fastening point in the mast part (4) runs down around the pulley and up to a pulley (15) fastened to the upper end of the mast pat and from this pulley once again down to the fork carriage (5), the hydraulic cylinders belonging to the fork carriage and the mast parts are coupled in parallel but have such respective cross sections between them that the cylinder of the fork carriage has a lower pressure requirement than the cylinders of the mast, **characterized in** a sensor or switch being arranged in the vicinity of the lower end position of the lower end of the piston rod (9) and for cooperation with this in such a way that when the piston rod is coming close to its lower end position, that is the lifting carriage is shortly below its upper end position in the mast part, the sensor or switch is triggered by the piston rod or means on this and the switch being coupled to the hydraulic means that feed hydraulic oil to the hydraulic cylinder for a reduction in the oil flow so that the lifting speed is retarded in the vicinity of the upper end position of the carriage in the closest mast part (4).

2. Device according to claim 1, **characterized in** the sensor or switch and means for the control of the speed reduction for the movement of the hydraulic piston being such that a smooth speed change is achieved.

3. Device according to claim 2, **characterized in** the sensor being constituted by a potentiometer.

4. Device according to claim 1, **characterized in** the load fork carriage also being provided with means that in the vicinity of the lower end position of the load fork carriage cooperate with the same sensor that is affected by the lower piston rod end of the lifting cylinder, giving a reduced speed also as the carriage come close to its bottom position.

5. Device according to any of the claims 2 to 4, **characterized in** the sensor means being constituted by a switch that is triggered by a control part that when it comes in contact with the lower end of the piston rod immediately influence the switch and that then during the continued movement of the piston rod can be deflected resiliently downwards, but retaining the switch position.

6. Device according to claim 5, **characterized in** the control part being constituted by a vertically moveable sliding part.

7. Device according to any of the previous claims 1-4 **characterized in** the sensing means being constituted by a magnetic device with a magnet fastened to the piston rod end and magnetic switch means for instance in the frame of the truck.

8. Device according to claim 7, **characterized in** the sensor, when the magnet has passed it, remain in the same state until the magnet passes in the other direction.

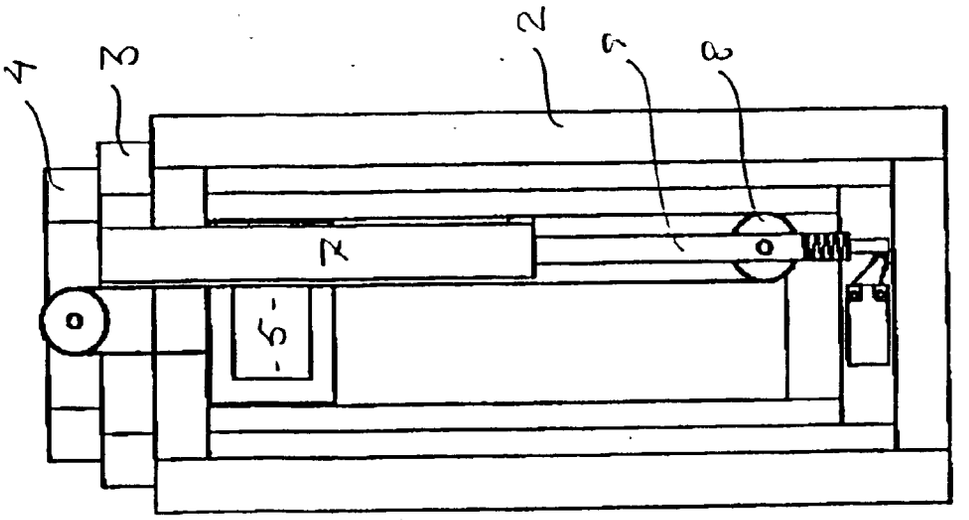

Fig. 3

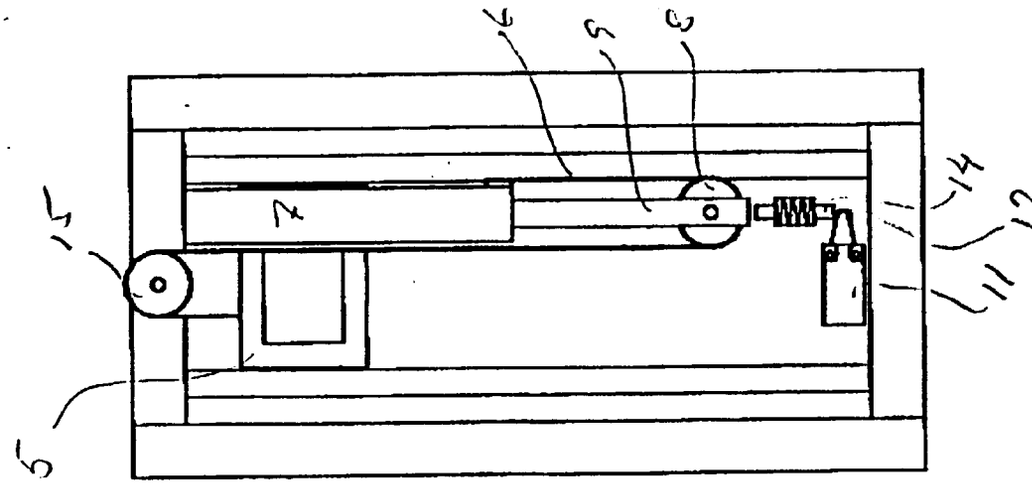

Fig. 2

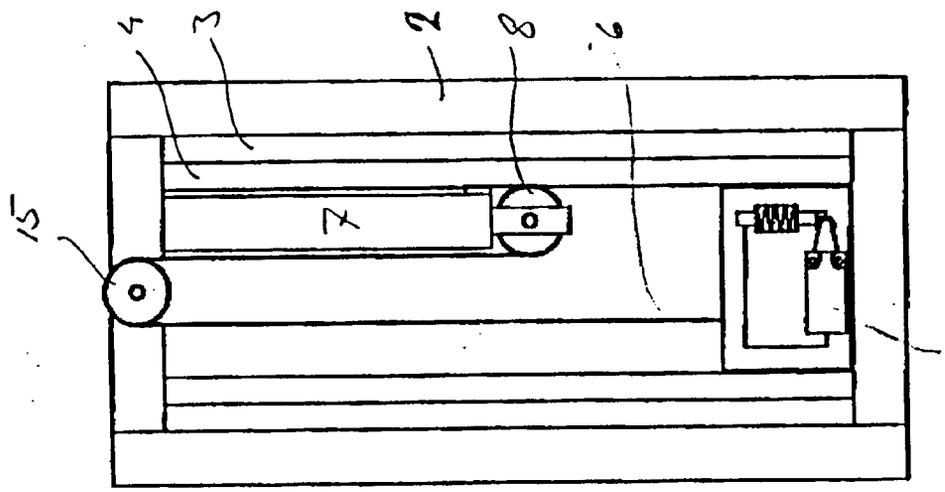

Fig. 1

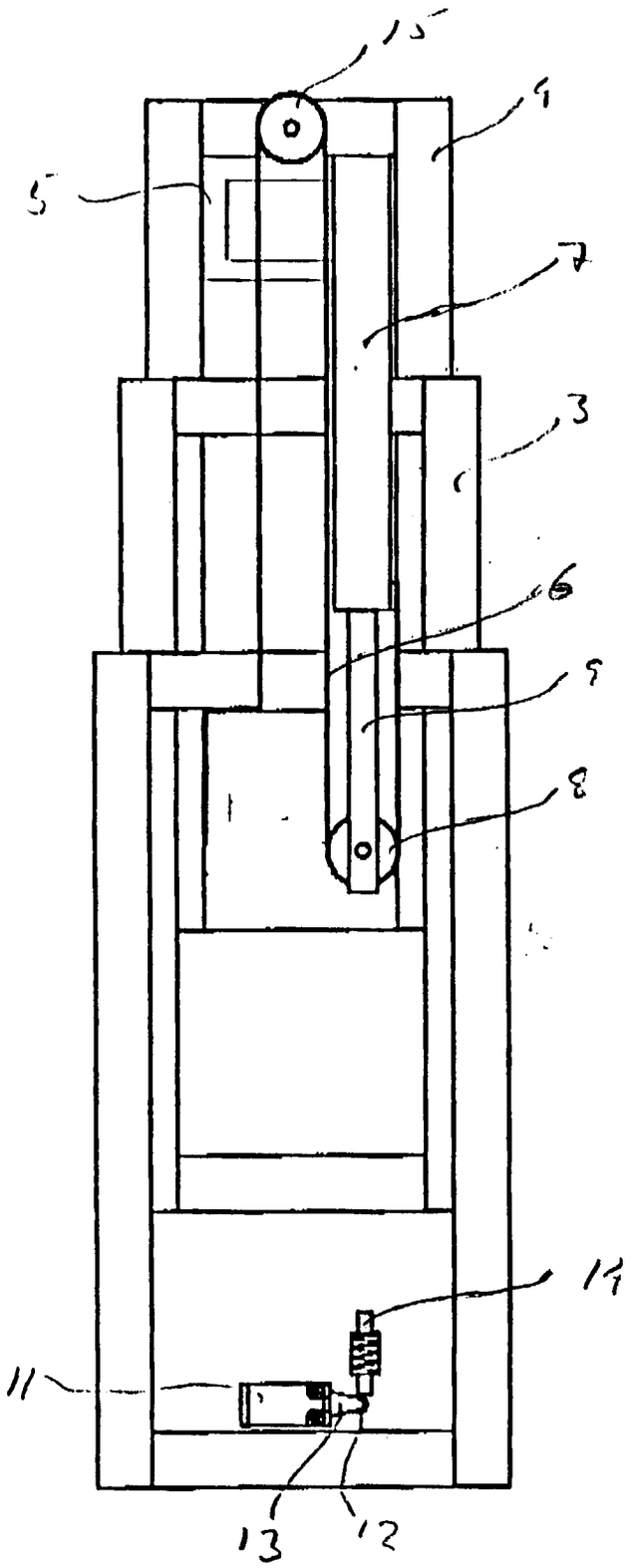

Fig 4

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EUROPEAN SEARCH REPORT

Application Number
EP 95 85 0205

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	GB-A-2 053 153 (JUNGHEINRICH KG) 4 February 1981 * the whole document *	1	B66F9/08 B66F9/20
A	DE-A-19 13 575 (CLARK EQUIPMENT COMP.) 9 October 1969		
A	EP-A-0 509 659 (MITSUBISHI HEAVY IND LTD ;MHI SAGAMI HIGHTEC KK (JP)) 21 October 1992		
A	US-A-5 022 496 (KLOPFLEISCH KIM A ET AL) 11 June 1991		
A	DE-B-11 74 262 (CLARK EQUIPMENT COMP.) 16 July 1964		
			TECHNICAL FIELDS SEARCHED (Int.Cl.6) B66F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	21 February 1996	Van den Berghe, E

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