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(54) A mast structure for an industrial lift truck

(57) The invention relates to a mast structure (1) for an industrial lift truck. The mast structure comprises a first mast element (10), which is connected to a load engaging means such as a fork carriage, a second mast element (20), by which the first mast element (10) is carried and along which the first mast element (10) is movable, and a third mast element (30), by which the second mast element (20) is carried and along which the second mast element (20) is movable. A mechanical energy storage and transmission means (50) is provided to transfer force from a movement (M10) of the first mast element (10) to a movement (M20) of the second mast element (20). The mechanical energy storage and transmission means (50) is arranged to be charged by the movement (M10) of the first mast element (10) when the first mast element (10) approaches an end position along the second mast element (20), and to be discharged when a movement (M20) of the second mast element (20) along the third mast element (30) is initiated. Thereby, the energy stored in the mechanical energy storage and transmission means (50) is transferred into a movement (M20) of the second mast structure (20).

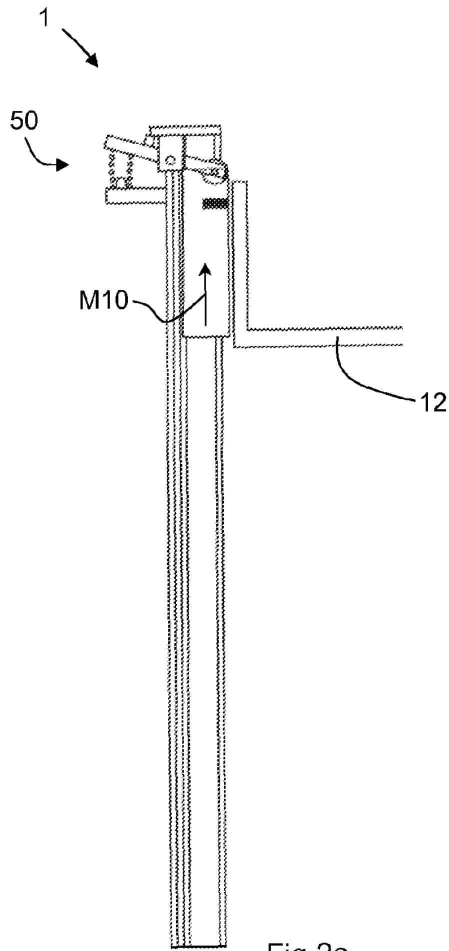

Fig 2a

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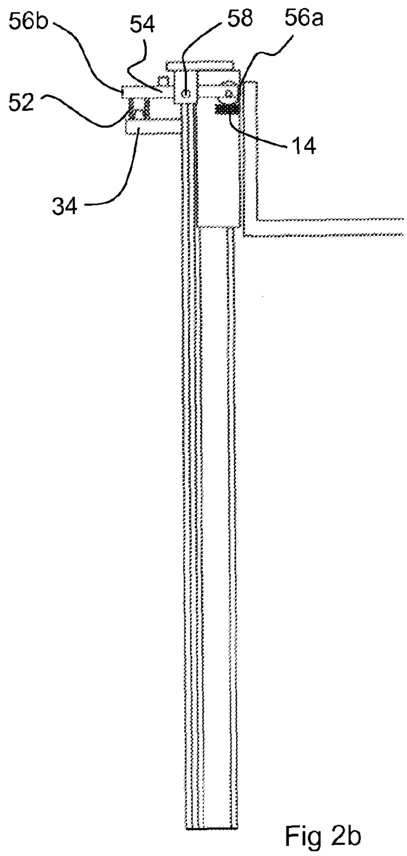

Fig 2b

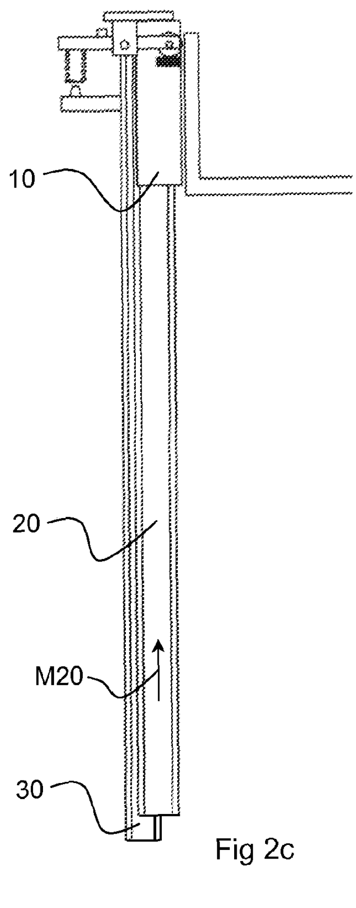

Fig 2c

Description

TECHNICAL FIELD

[0001] The present invention relates to mast structures of industrial lift trucks, and especially to the problem of achieving smooth transitions between lift operations of different mast components.

BACKGROUND ART

[0002] In an industrial lift truck having a so called full free lift mast, the fork carriage is first lifted along a movable lifting mast by a separate hydraulic cylinder, a so called free lift cylinder. When the free lift cylinder has reached the end of its stroke, the fork carriage lift is continued by a main lift cylinder. The main lift cylinder raises the fork carriage together with the movable lifting mast. If the lifting operation is to be performed with continuous lifting speed, the transition between the free lift and the main lift involves instantaneous acceleration of the movable lifting mast to the lifting speed of the fork carriage. This acceleration corresponds to a mechanical impulse, which gives rise to a jerk, noise as well as abrupt and transient pressure changes in the hydraulic system. Said jerk is not only unpleasant for the operator, it may also damage the lift truck or fragile load carried thereby, or even cause the load to fall of the lift truck.

[0003] The problems associated with the transition between the free lift and the main lift occur in the same manner when lowering the fork carriage. Increasing raising and lowering speeds aggravate the problems.

[0004] GB2264282 A tries to overcome this problem by arranging a shroud or yoke that engages a strut in order to temporary stop the extension of the free lift cylinder during the free lift, so as to achieve an overlap in operation of the free lift cylinder and the main lift cylinder. A pad of plastics material is provided in order to minimise noise.

[0005] According to another known solution, the raising and lowering speeds are reduced at the transition between the free lift and the main lift. Such reduction can be incorporated in a control system or be delegated to the skill of the operator.

[0006] In the light of the known art, it is desirable to provide a mast structure that allows higher lifting speeds, while performing said transitions in a gentle and energy-saving manner. Further desired is a way to redesign existing industrial lift trucks so as to improve them in this regard.

SUMMARY OF THE INVENTION

[0007] The objective of the present invention is to achieve quicker and more efficient operation of industrial lift trucks. The objective has been achieved by means of a mast structure that comprises a first mast element, which is connected to a load engaging means such as a fork carriage, a second mast element, by which the first mast element is carried and along which the first mast element is movable, and a third mast element, by which the second mast element is carried and along which the second mast element is movable.

[0008] A mechanical energy storage and transmission means is adapted to transfer force from a movement of the first mast element to a movement of the second mast element. Said mechanical energy storage and transmission means is arranged to be charged by the movement of the first mast element when the first mast element approaches an end position along the second mast element, and to be discharged when a movement of the second mast element along the third mast element is initiated.

[0009] In this way, the energy stored in the mechanical energy storage and transmission means is transferred into a movement of the second mast structure.

[0010] The present solution is energy saving and highly reliable. It further allows higher operation speeds, i.e. faster lifting and lowering of the first mast element. In comparison with prior art systems, in which the raising and lowering speeds are reduced at the transition between the movement of the first mast element and the movement of the second mast element, the time needed for lifting/lowering from one extreme position to the other can be reduced by 2 seconds. This corresponds to an increase of efficiency of roughly 20 %. Yet, the switch-over of movement of the first mast element to movement of the second mast element, or vice versa, during extension/contraction of the mast structure, is smooth. The present design, which makes use of one single mechanical energy storage and transmission means only, functions for both lifting and lowering. The design is relatively cost-effective when it comes to manufacture and assembly, and does not require any sensors, controls, or other electronic equipment. Furthermore, the present invention allows retrofitting to existing industrial lift trucks, in order to increase their efficiency.

[0011] A first hydraulic lifting cylinder can be arranged to drive the first mast element, and a second hydraulic lifting cylinder can be arranged to drive the second mast element. Now, if the cylinders are connected as communicating vessels, the mechanical energy storage and transmission means will effect that the hydraulic pressure of the cylinders is gradually increased upon transition of movement between the first mast element and the second mast element.

[0012] The first mast element may be connected to a fork carriage, the second mast element may be a movable lifting mast, and the third mast element may be a stationary lifting mast that is fixed to a truck chassis. For increased lifting height, the third mast element may be a movable lifting mast which, in turn, is carried by a fourth mast element, which is a stationary lifting mast that is fixed to a truck chassis.

[0013] The mechanical energy storage and transmission means may comprise a spring element that is dimensioned to absorb the force to be transferred. It is pointed out that said force is not dependent on the load carried by the industrial lift truck, only the components of the lift truck as such must be considered. In order to adjust the characteristics of the mast structure, a spring element with variable spring constant can be put to use. The smoothness of the transition may be improved by the use of a spring element with a progressive spring constant.

[0014] The mechanical energy storage and transmission means may be a compression spring that is arranged between means driving the first mast element and the third mast element. Alternatively, the spring is arranged between means driving the first mast element and the truck chassis. This corresponds to a simple and cost-effective solution.

[0015] The mechanical energy storage and transmission means may comprise a spring element and a lever arrangement, where the lever pivot is connected to the second mast element. A first end of the lever may be arranged to cooperate with the first mast element and a second end of the lever may be arranged to cooperate with the third mast element. Alternatively, the second end of the lever may be arranged to cooperate with the truck chassis. The spring element may be excluded if the lever arrangement comprises a resilient lever arm.

[0016] The objective of the present invention has further been achieved by means of an industrial lift truck comprising the above described mast structure.

[0017] The objective of the invention can also be achieved by means of a method for converting a mast structure of an existing industrial lift truck in order to even out the transition between lift operations of a first mast element and a second mast element. In said truck, the first mast element is connected to a load engaging means, such as a fork carriage, and is carried by and movable along the second mast element. In turn, the second mast element is carried by and movable along a third mast element.

[0018] The method comprises the step of arranging a mechanical energy storage and transmission means to operate between the first mast element and the third mast element. Alternatively, the mechanical energy storage and transmission means may operate between means driving the first mast element and the third mast element. The mechanical energy storage and transmission means is charged by the movement of the first mast element when the first mast element approaches an end position along the second mast element, and discharged when a movement of the second mast element along the third mast element is initiated.

[0019] Finally, the objective of the present invention can be achieved by a mechanical energy storage and transmission means which is adapted to be mounted on a mast structure of an industrial lift truck. Said energy storage and transmission means comprises a lever arm having a first lever arm end, a second lever arm end, and means for pivotally attaching the lever arm. The lever arm may be resilient. Alternatively, the mechanical energy storage and transmission means can be furnished with a spring element that is arranged to bear against the first or the second lever arm end.

[0020] Such an industrial lift truck comprises a first mast element, which is connected to a load engaging means such as a fork carriage, a second mast element, by which the first mast element is carried and along which the first mast element is movable, and a third mast element, by which the second mast element is carried and along which the second mast element is movable.

[0021] In this connection, the lever arm is adapted to be pivotally attached to the second mast element by the means for pivotally attaching the lever arm. The first lever arm end is adapted to cooperate with the first mast element and the second lever arm end is adapted to cooperate with the third mast element.

[0022] The mechanical energy storage and transmission means is arranged to be charged by the movement of the first mast element when the first mast element approaches an end position along the second mast element and to be discharged when a movement of the second mast element along the third mast element is initiated. In this way, the energy stored in the mechanical energy storage and transmission means is transferred into a movement of the second mast structure.

BRIEF DESCRIPTION OF THE FIGURES

[0023] Below, exemplary embodiments of the present invention are described.

[0024] References are made to the enclosed schematic figures, where

fig 1a-c shows a first example of a lift mast structure with a movable load engaging means, a movable lifting mast and a stationary lifting mast, where a mechanical energy storage and transmission means in the form of a helical compression spring is arranged between a hydraulic lifting cylinder driving the movable load engaging means and the stationary lifting mast, and

fig 2a-c shows a second example of a lift mast structure with a movable load engaging means, a movable lifting mast and a stationary lifting mast, where a mechanical energy storage and transmission means in the form of a lever arrangement and a helical compression spring is arranged between the movable load engaging means and the stationary lifting mast.

DETAILED DESCRIPTION

[0025] Figure 1 illustrates the mast structure 1 of an industrial lift truck. The structure is viewed from behind, i.e. from the side facing away from the load that is carried by the mast structure. Said load is normally engaged by load engaging means in the form of fork tines (not shown) which are connected to a fork carriage 10. Other examples of load engaging means are clamping jaws, platforms adapted to carry individuals and hooks for hoisting cables or wires.

[0026] The fork carriage 10 is shown as two transversal members. The above mentioned fork tines are attached to the fork carriage 10 and project away from the observer of the figure, the tines are not shown since they are covered by the fork carriage 10. The fork carriage 10 is movable along, i.e. up and down, a movable lifting mast 20. The movable lifting mast 20 comprises two uprights, crossing the transversal members of the fork carriage 10 at the left and the right end of the transversal members. The uprights are joined together by an upper transversal member 22.

[0027] A first hydraulic lifting cylinder 60, or a jack, is attached to the upper transversal member 22 of the movable lifting mast 20. The lifting cylinder 60 with its piston projects downwards. The first hydraulic lifting cylinder 60 is arranged to lift the fork carriage 10 by means of a chain 62 or a wire. Said chain 62 is attached to the housing of the first hydraulic lifting cylinder 60, and runs via a first and a second pulley 64, 66 to the fork carriage 10. The first pulley 64 is attached to the end of the lifting cylinder piston, and the second pulley 66 is attached to the upper transversal member 22 of the movable lifting mast 20. This arrangement allows the first hydraulic lifting cylinder 60 to elongate downwards while the fork carriage 10 moves M10 upwards, with a gearing of 1:2. Said movement is referred to as the free lift M10.

[0028] All the hitherto described components of the lift mast structure are carried by a stationary lifting mast 30 that is fixed to a truck chassis (not shown). One or two second hydraulic lifting cylinder(s) (not shown) is/are arranged on the stationary lifting mast 30 for lifting the movable lifting mast 20 together with the carriage 10, the hydraulic lifting cylinder 60, and so on. The second hydraulic lifting cylinder performs the so called main lift. The stationary lifting mast 30 is illustrated as two uprights, arranged laterally outside the uprights of the movable lifting mast 20. The uprights of the stationary lifting mast 30 are joined together by a lower transversal member 32.

[0029] The first hydraulic lifting cylinder 60 and the second hydraulic lifting cylinder are both connected as communicating vessels to a hydraulic pump (not shown). The hydraulic pump furnishes the lifting cylinders with hydraulic oil from a reservoir in order to perform lifting, and a valve arrangement (not shown) is provided for discharging the hydraulic oil out from the lifting cylinders back to the reservoir in order to lower the fork carriage. In this connection, a first hydraulic pressure P10 is required for the free lift and a second, higher, hydraulic pressure P20 is required for the main lift. This hydraulic arrangement is known in the art.

[0030] According to a first embodiment of the invention, a mechanical energy storage and transmission means 50 in the form of a spring element 52 is arranged on the lower transversal member 32 of the stationary lifting mast 30. The spring element may e.g. be a helical compression spring.

[0031] The lifting operation of the mast structure 1 will now be described with reference to figures 1a-c. Figure 1a illustrates the free lift. The fork carriage 10 is moving upwards, lifting the load (not shown) as is illustrated by the arrow M10. During the free lift, the movable lifting mast 20 is in its lowermost position. The fork carriage 10 is hoisted by means of the first hydraulic lifting cylinder 60, also called the free lift cylinder 60, and the chain 62, as has been described above.

[0032] As is shown in figure 1b, the first hydraulic lifting cylinder 60, which drives the fork carriage 10, engages the spring element 52 as the lifting cylinder piston approaches the end of its stroke. Upon further movement of the lifting cylinder 60 piston, the spring element 52 is compressed and mechanical energy is thus stored therein.

[0033] Thus, the arrangement of the spring element 52 implies that the hydraulic pressure P10 of the first and second hydraulic lifting cylinders must be gradually increased by the pump in order to continue the lift operation M10. The spring constant of the spring element 52 is preferably chosen so that the hydraulic pressure of the first and second hydraulic lifting cylinders amounts to the second hydraulic pressure P20, at the end of the free lift M10. In this way, the transition free lift M10 → main lift M20 is smooth and seamless.

[0034] Figure 1c illustrates the mast structure 1 during the main lift M20. As can be seen, the fork carriage 10 and the movable lifting mast 20 have moved upwards in comparison with the situation of figure 1 b. Further, the first lifting cylinder 60 is still at the end of its stroke, and the first lifting cylinder piston is no longer in engagement with the spring element 52. As is to be apprehended from a comparison of figures 1b and 1c, the mechanical energy stored in the spring element 52 has been supplied to the lifting operation of the movable lifting mast 20. In other words, the spring element 52 transfers energy from the free lift M10 (figure 1a) to the main lift M20 (figure 1c), or; the spring element 52 transfers force from the free lift movement M10 to the main lift movement M20.

[0035] Turning now to figure 2, a side view of another exemplary mast structure 1 of an industrial lift truck is illustrated. This embodiment is similar to that of figure 1, and the same references have been used for the same or corresponding elements. In figure 2, fork tines 12 attached to the fork carriage 10 are shown. The fork tines 12 and the fork carriage 10 may also be integrated into a single unit.

[0036] In the embodiment of figure 2, the mechanical energy storage and transmission means 50 is in the form of a lever arrangement 54. The lever arrangement 54 transfers force from the free lift movement M10 to the main lift movement M20.

[0037] The lever arrangement comprises a lever arm

54 having a first lever arm end 56a and a second lever arm end 56b. The lever arm 54 comprises a pivot pin 58, by means of which the lever arm 54 is pivotally connected to a corresponding aperture in the movable lifting mast 20. Said connection may also be realized e.g. by a bolt connection or a hinge arrangement. The first lever arm end 56a is adapted to cooperate with a shoulder means 14 that is attached to the fork carriage 10. A roller can be attached to the first lever arm end 56a, in order to reduce friction forces between the shoulder 14 and the lever arm. At the end of the free lift M10, said shoulder means 14 engages the first lever arm end 56a, and subsequent upward movement of the fork carriage 10 pivots the lever arm 54 about the pivot connection 58. On the other side, the second lever arm end 56b is adapted to cooperate with the stationary lifting mast 30. In this example, the second lever arm end 56b cooperates with a projection 34 of the stationary lifting mast 30. A helical compression spring 52 is arranged between the second lever arm end 56b and the stationary lifting mast 30, or, more precisely, the projection 34 of the stationary lifting mast 30. In this example, the compression spring 52 is fixed to the lever arm 56b, alternatively, it can be fixed to the projection 34 of the stationary lifting mast 30. Also, the spring 52 may be arranged between the shoulder means 14 and the first lever arm end 56a.

[0038] The purpose of the lever arrangement 54 is to store and to transfer energy. Thus, instead of arranging a compression spring 52 at one end of the lever 54, the lever itself may be resilient. This corresponds to using a plate spring as lever arm 54. A combination of a plate spring 54 and a helical compression spring 52 can also be put to use.

[0039] The lifting operation of the mast structure 1 will now be described with reference to figures 2a-c. Figure 2a illustrates the free lift M10, as has been described with reference to figure 1a. No hydraulic lifting cylinders are shown in figure 2, but it is to be appreciated that a similar hydraulic lifting cylinder and chain arrangement as that of figure 1 can be put to use.

[0040] In figure 2b, the free lift M10 has reached its end position and the compression spring 52 is fully compressed or charged. A comparison of figure 2a and figure 2b reveals that the fork tines 12 have been displaced upwards. Figure 2c illustrates the beginning of the main lift M20. As can be seen, the fork tines 12 have again moved upwards, this time due to the upwards movement of the movable lifting mast 20, and compression spring 52 is again fully extended. Since the lever arm 54 is attached to the movable lifting mast 20, the force that was supplied during the free lift M10 to compress the spring 52 has now been transferred to the main lift M20.

[0041] As has been described with reference to figure 1, the spring constant of the compression spring 52 and/or the lever 54 is preferably chosen so that the hydraulic pressure amounts to the second hydraulic pressure P20, at the end of the free lift M10.

[0042] In the embodiments of figures 1 and 2, the mast structure has been described as comprising a fork carriage 10, a movable lifting mast 20 and a stationary lifting mast 30. However, the lifting mast denoted reference numeral 30 may also be a movable lifting movable. The mast structure 1 then comprises a first movable lifting mast 20 and a second movable lifting mast 30, the second 30 movable lifting mast carrying the first movable lifting mast 20. Yet another lifting mast (not shown), a stationary lifting mast, is then required to carry the second movable lifting mast. It is common to arrange first and second movable lifting masts 20, 30 that move together at the same time during the main lift. Often, the first lifting mast 20 moves at twice the speed as the second lifting mast 30.

[0043] Furthermore, the reach of the mast structure 1 can be increased by incorporating a greater number of movable lifting mast. It is to be apprehended that the present mechanical energy storage and transmission means 50 is applicable in all these cases. Where a number of independently movable lifting mast are utilized, more than one mechanical energy storage and transmission means 50 can be put to use

[0044] In both exemplary embodiments above, a first and a second hydraulic lifting cylinders are used to lift the load and extend the mast structure. However, it is to be appreciated that the present mechanical energy storage and transmission means 50 can also be applied where other lifting arrangements are utilised. Such arrangements incorporate e.g. one single hydraulic lifting cylinder or an electric motor driving a wire drum. Also in these cases, the mechanical energy storage and transmission means 50 will provide a smooth transition from free lift M10 to main lift M20.

[0045] It is preferred that the spring element 52 is able to absorb as a minimum a force corresponding to 50 % of the hydraulic pressure increase between free lift and main lift. 50 % is enough since the spring element operates between the first mast element 10 and the stationary lifting mast 30. The spring characteristics shall be chosen so that the whole inertia energy needed to accelerate the movable lifting mast 20, and where provided additional moving mast elements, to the corresponding maximum speed can be stored in the spring element 52. This normally requires the spring element 52 to be dimensioned to absorb a force above said 50 %. Theoretically, at very low lifting speeds, where no inertia is present, the spring element 52 need only be able to absorb a force corresponding to 50 % of the hydraulic pressure increase between free lift and main lift. Dimensioned correctly, there will be an overlap between the free lift and the main lift. Such an overlap is desirable.

Claims

1. A mechanical energy storage and transmission means (50) adapted to be mounted on a mast structure (1) of an industrial lift truck,
which energy storage and transmission means (50)

comprises

- a lever arm (54) having a first lever arm end (56a) and a second lever arm end (56b), and
- means (58) for pivotally attaching the lever arm (54),
- wherein the lever arm (54) is resilient and/or the mechanical energy storage and transmission means (50) further comprises a spring element (52) that is arranged to bear against the first or the second lever arm end (56a, 56b),

which industrial lift truck comprises

- a first mast element (10), which is connected to a load engaging means such as a fork carriage,
- a second mast element (20), by which the first mast element (10) is carried and along which the first mast element (10) is movable,
and
- a third mast element (30), by which the second mast element (20) is carried and along which the second mast element (20) is movable,

wherein the lever arm (54) is adapted to be pivotally attached to the second mast element (20) by the means (58) for pivotally attaching the lever arm (54), the first lever arm end (56a) is adapted to cooperate with the first mast element (10), and
the second lever arm end (56b) is adapted to cooperate with the third mast element (30),
whereby the mechanical energy storage and transmission means (50) is arranged to be charged by the movement (M10) of the first mast element (10) when the first mast element (10) approaches an end position along the second mast element (20), and
the mechanical energy storage and transmission means (50) is arranged to be discharged when a movement (M20) of the second mast element (20) along the third mast element (30) is initiated, whereby the energy stored in the mechanical energy storage and transmission means (50) is transferred into a movement (M20) of the second mast structure (20).

2. The mechanical energy storage and transmission means (50) of claim 1, comprising a spring element (52) that is dimensioned to absorb the force to be transferred.

3. The mechanical energy storage and transmission means (50) of claim 2, wherein the spring element (52) is a spring element with a variable spring constant.

4. The mechanical energy storage and transmission means (50) of claim 2 or 3, wherein the spring element (52) is a spring element with a progressive spring constant.

5. The mechanical energy storage and transmission means (50) of any preceding claim, wherein the spring element (52) is a helical compression spring.

6. The mechanical energy storage and transmission means (50) of any preceding claim, wherein the lever arm (54) is a plate spring.

7. The mechanical energy storage and transmission means (50) of any preceding claim, comprising a spring element (52) and a lever arrangement (54), the lever pivot (58) being connectable to the second mast element (20), a first end (56a) of the lever being arranged to cooperate with the first mast element (10) and a second end (56b) of the lever being arranged to cooperate with the third mast element (30).

8. The mechanical energy storage and transmission means (50) of any one of claims 1-6, wherein the mechanical energy storage and transmission means (50) comprises a spring element (52) and a lever arrangement (54), the lever pivot (58) being connectable to the second mast element (20), a first end (56a) of the lever being arranged to cooperate with the first mast element (10) and a second end (56b) of the lever being arranged to cooperate with the truck chassis.

9. The mechanical energy storage and transmission means (50) of any preceding claim, comprising a lever arrangement (54) with a resilient lever arm (54), the lever pivot (58) being connected to the second mast element (20), a first end (56a) of the lever being arranged to cooperate with the first mast element (10) and a second end (56b) end of the lever being arranged to cooperate with the third mast element (30) or the truck chassis.

10. The mechanical energy storage and transmission means (50) of any
preceding claim, wherein the means (58) for pivotally attaching the lever arm (54) is a pivot pin which is adapted to be pivotally connected to a corresponding aperture in the second mast element (20).

11. The mechanical energy storage and transmission means (50) of any
preceding claim, wherein the first lever arm end (56a) comprises a roller for low friction cooperation with the first mast element (10).

12. The mechanical energy storage and transmission means (50) of any
preceding claim, wherein
the mast structure (1) comprises a first hydraulic lifting cylinder (60) and second hydraulic lifting cylinder

connected as communicating vessels, the first hydraulic lifting cylinder (60) driving the first mast element (10) and the second hydraulic lifting cylinder driving the second mast element (20), a first hydraulic pressure (P10) being required for driving the first mast element (10) and a second, higher, hydraulic pressure (P20) being required for driving the second mast element (20),
wherein the spring constant of the spring element (52) and/or the lever arm (54) is chosen so that the hydraulic pressure of the first and second hydraulic lifting cylinders amounts to the second hydraulic pressure (P20), at the end of the lift (M10) of the first mast element (10).

13. The mechanical energy storage and transmission means (50) of any
preceding claim, wherein
the mast structure (1) comprises a first hydraulic lifting cylinder (60) and second hydraulic lifting cylinder connected as communicating vessels, the first hydraulic lifting cylinder (60) driving the first mast element (10) and the second hydraulic lifting cylinder driving the second mast element (20), a first hydraulic pressure (P10) being required for driving the first mast element (10) and a second, higher, hydraulic pressure (P20) being required for driving the second mast element (20),
wherein the spring element (52) and/or the lever arm (54) is able to absorb as a minimum a force corresponding to 50 % of the hydraulic pressure increase between first hydraulic pressure (P10) and the second hydraulic pressure (P20).

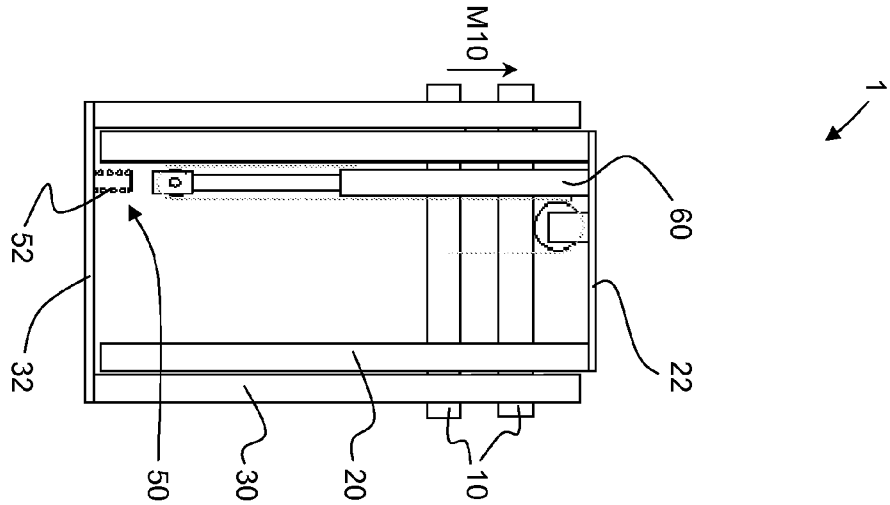

Fig 1a

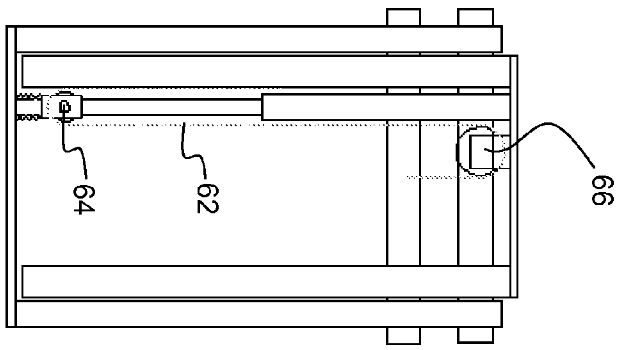

Fig 1b

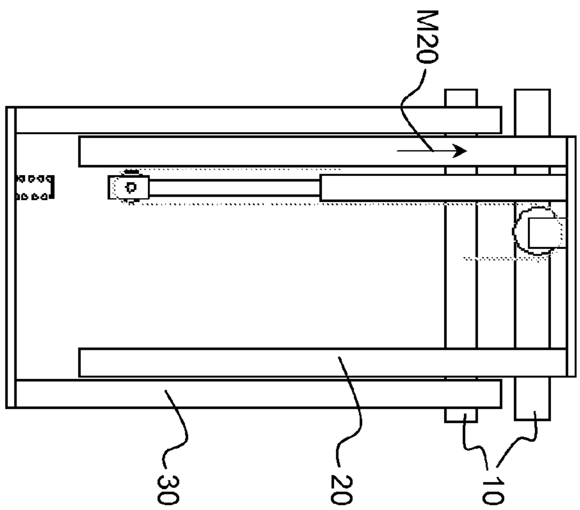

Fig 1c

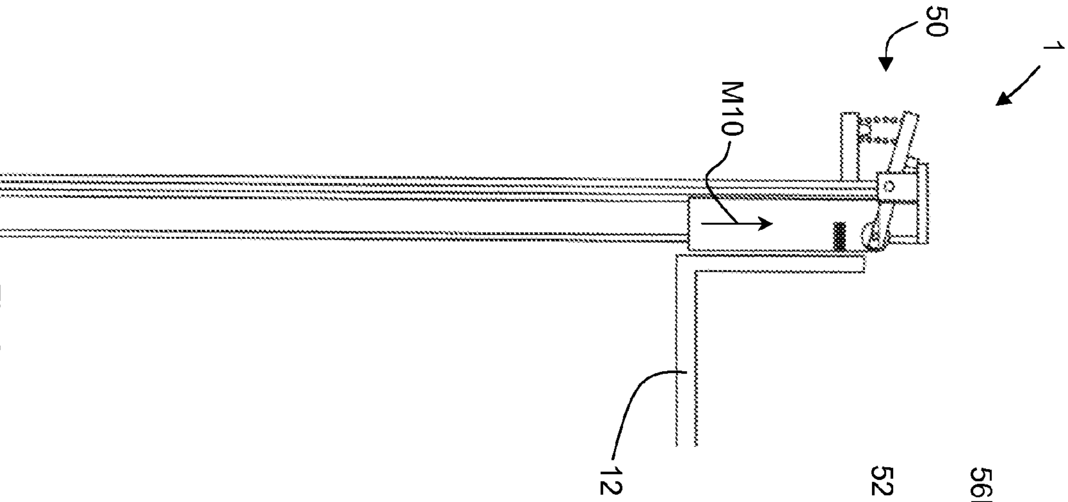

Fig 2a

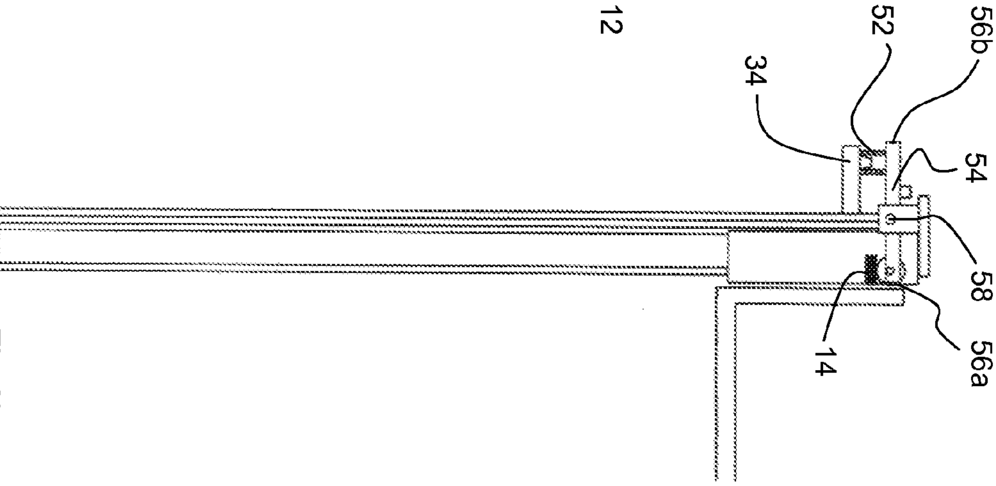

Fig 2b

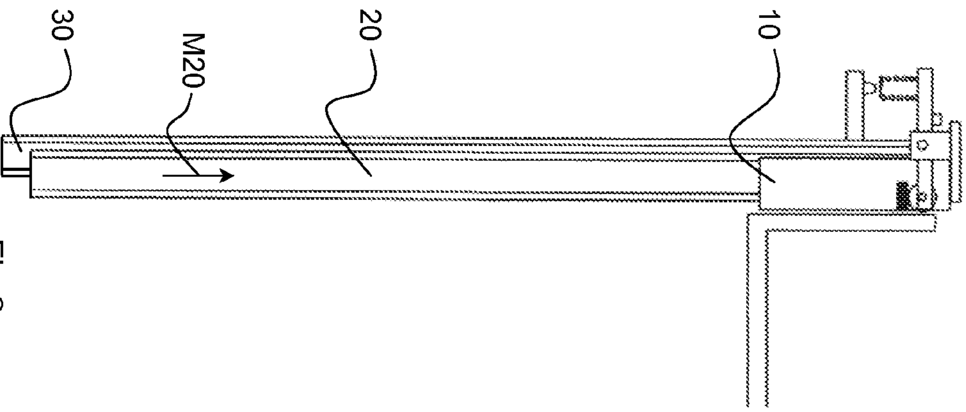

Fig 2c

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EUROPEAN SEARCH REPORT

Application Number
EP 11 17 1959

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	GB 976 247 A (ELECTRO HYDRAULICS LTD) 25 November 1964 (1964-11-25) * column 4, line 107 - line 116; figure 8 *	1	INV. B66F9/08 B66F9/22
A	US 5 657 834 A (PLAUGHER RANDALL D [US] ET AL) 19 August 1997 (1997-08-19) * figure 1 *	1	
A	DE 197 10 556 A1 (JUNGHEINRICH AG [DE]) 17 September 1998 (1998-09-17) * abstract; figure 2 *	1	

TECHNICAL FIELDS SEARCHED (IPC)

B66F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	19 September 2011	Serôdio, Renato

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CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
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T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 11 17 1959

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19-09-2011

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 976247 A	25-11-1964	NONE	
US 5657834 A	19-08-1997	NONE	
DE 19710556 A1	17-09-1998	EP 0866026 A2	23-09-1998

EPO FORM P0459

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- GB 2264282 A **[0004]**