

[54] **LIFTING DEVICE**

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 [58] **Field of Search**..... 214/75 T, 77 P, 75 R

[56] **References Cited**  
**UNITED STATES PATENTS**  
 2,850,187 9/1958 Roberts ..... 214/77 P  
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 Farabow and Garrett

[57] **ABSTRACT**

A lifting device, for instance fitted as a lifting platform assembly to a truck, consisting of a lifting platform and one or more parallelogram-shaped articulated rod-systems, by which rods or arms this platform is directly or indirectly pivotally connected to a carrying structure fitted to the truck chassis. One parallelogram arm is capable of telescoping and the platform is driven and controlled by a hydraulic power system. The platform has four positions—lifted approximately vertically at maximum height, lifted horizontally at maximum height, lowered horizontally on ground and lowered in downward sloping position on ground. In moving through these three different motions, a single power cylinder means performs all three functions. The pivot point of one parallelogram arm is connected to the carrying structure through a rocking lever, and the power cylinder is pivotally attached to this rocking lever.

**7 Claims, 7 Drawing Figures**

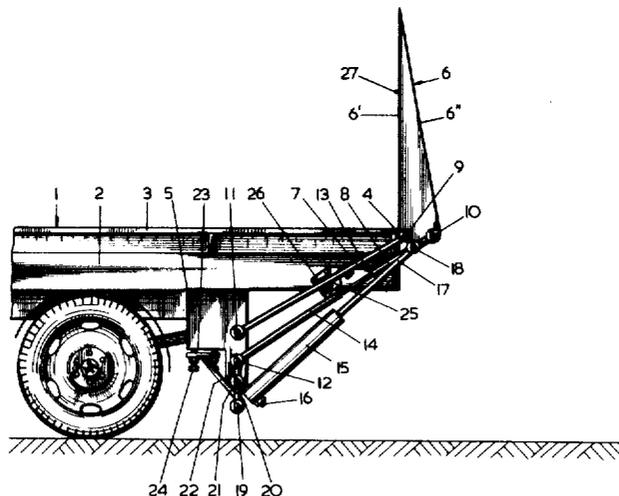


FIG. 1

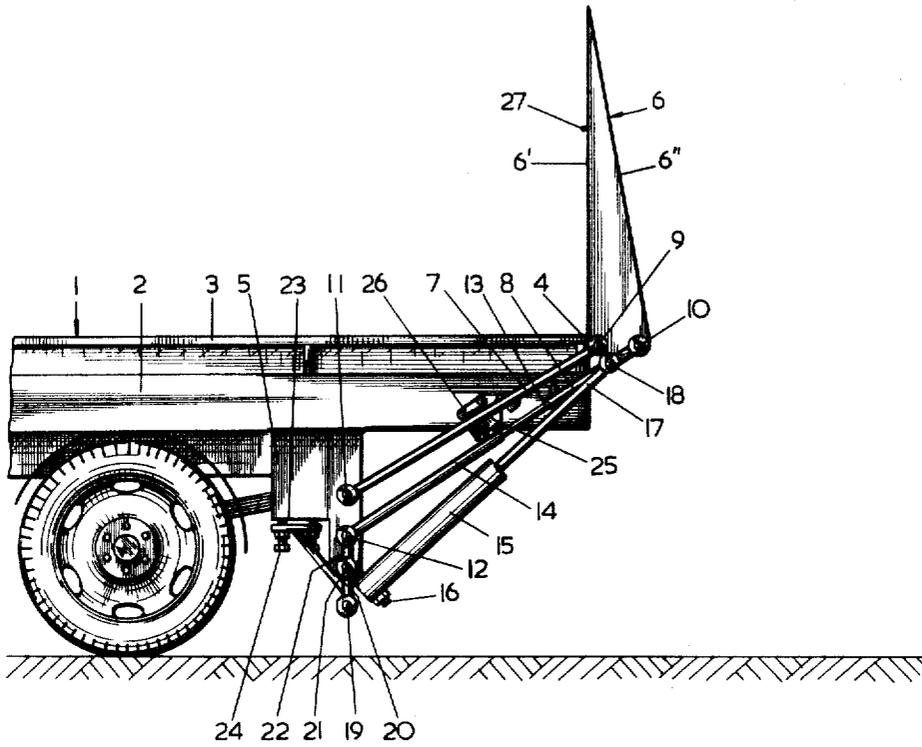


FIG. 2

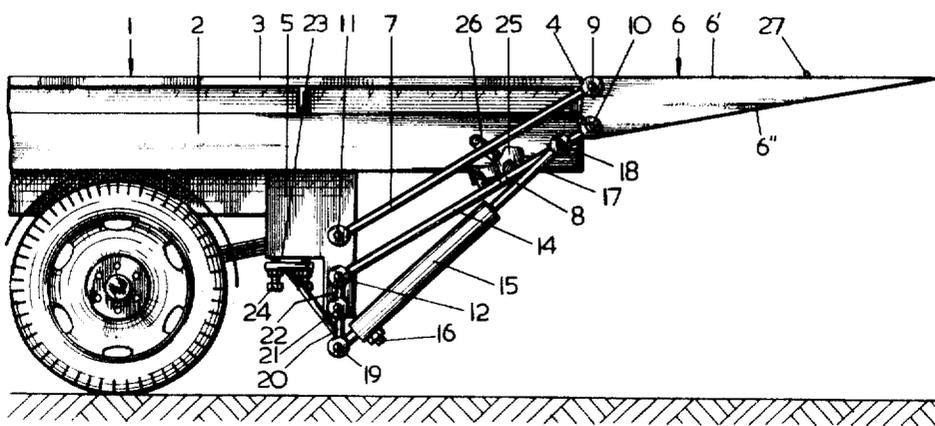


FIG. 3

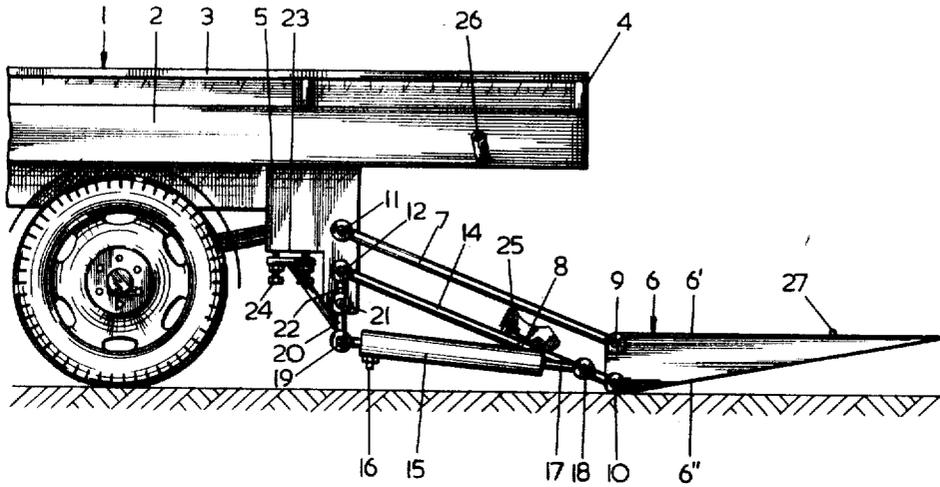


FIG. 4

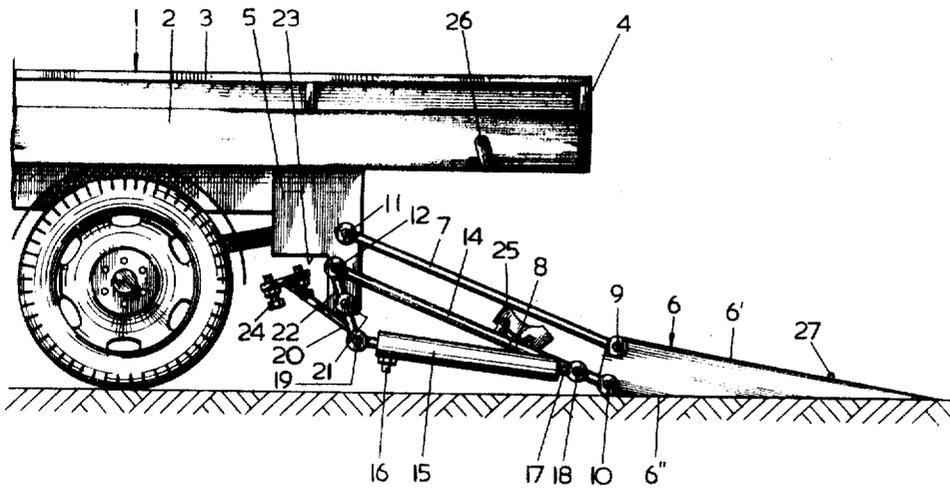
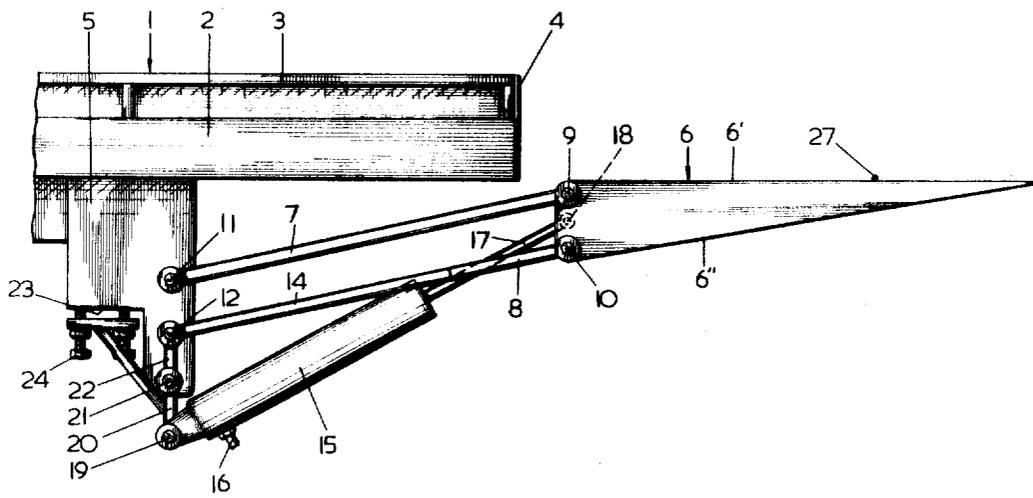




FIG. 7



## LIFTING DEVICE

This invention relates to a lifting device, for instance fitted as a lifting platform assembly to a truck, consisting of a lifting platform, one or more parallelogram-shaped articulated rod-systems, by which rods or arms this platform directly or indirectly being pivotingly connected to a carrying structure, this structure being fitted to for instance a truck chassis, one parallelogram arm being capable of telescoping, the platform being driven and controlled by a hydraulic power system, the platform having four positions — lifted approximately vertically at maximum height, lifted horizontally at maximum height, lowered horizontally on ground and lowered in downward sloping position on ground — and, in doing so, three different motions (three functions), a single power cylinder means being applied to perform all three functions, the pivoting point of one parallelogram arm viewing the carrying structure being connected to the carrying structure through a rocking lever, and the connection of the power cylinder viewing the carrying structure being pivotingly attached to this rocking lever.

Lifting devices of this kind are known in the art having a variety of forms and can for instance be applied to railway carriages, agricultural apparatus, trucks, aircraft, stationary installations and on all these places, where the extending parallelogram-shaped articulated rod-system can be accommodated without trouble. In the field of lifting platforms the German Offenlegungsschrift Pat. No. 1,580,379 describes a device which is basically similar to the one of this application. It also makes use of one power cylinder to perform all three functions. It has also got a rocking lever between the carrying structure and the end of one of the parallelogram arms and the power cylinder. The position of the pivoting point of the rocking lever is such that a special clamp must be withdrawn to enable the lifting platform to be lowered into the downward sloping position. This must be done by hand and does require therefore a separate action by the user of the lifting platform. It is furthermore considered as a disadvantage of this design that for moving the lifting platform from the horizontally lifted position at maximum height into the vertical one, first the parallelogram arms have to be locked. Only after this requirement has been fulfilled the power piston may be activated on the side, opposite to the power side being in use during normal lifting actions, to rotate the lifting platform into the vertical position. Apart from the required second special action of locking the parallelogram arms, the power cylinder must be a double acting one. This requires extra control equipment, piping and ducting, and does influence the economic side in negative sense. It is the aim of the present invention to find a cheaper solution, equally reliable and safe, and performing the same functions. There are several other known lifting platform assemblies which are even more complicated, having for instance two or more hydraulic power systems, to deal with some of the required functions. Others are lacking one or more of the functions. As an example the Dutch Pat. specifications Nos. 135,991 and 87,279 are mentioned in this respect.

In service the problem is often met that the truck or the ground is not exactly horizontal or that there does exist an angle between the truck's platform and the ground. In all these cases making use of the lifting platform would be safer if the platform could be exactly ad-

justed in the horizontal plane, irrespective of the momentary position of the truck's platform in respect to the horizontal plane. To solve this problem is another aim of the present invention.

For the sake of working safely of the lifting platform, and in order to keep the control- and safety devices as simple as possible, it is necessary that the positions 1, 2, 3 and 4 should be exactly the shifting points between the motions X, Y and Z. During loading and unloading, the motions X, Y and Z may not shift unobserved into each other, in order to possess over a selective control system.

It is also advisable to have a single-acting power-cylinder instead of a double acting one, and a pushing instead of a pulling one, in view of the technical simplification and the lower price. The smaller the number of functional power cylinders can be, the lower the price and the simpler the control will be.

To make possible a motion Z from position 3 to position 4 vice versa, there should be interfered in the parallelogram-shaped rod-system. To be able to perform this with one and the same single-acting- pushing, power-cylinder, according to the invention, the fixed pivoting point of the rocking-lever on the carrying structure is positioned between the point of connection of the lower parallelogram arm and the point of connection of the power-cylinder on the rocking lever.

During a move from position 3 to position 4, the point of connection of the lower parallelogram arm viewing the carrying structure will move in that direction, which results in a retraction of the lower parallelogram arm. The power cylinder thereby will retract further.

The point of connection of the power piston viewing the lifting platform, can be located on two different places. According to the first possibility this point is located on that part of the lower telescoping parallelogram arm, which is nearest to the lifting platform. According to the second location, this point of connection of the power piston can be located on the short parallelogram arm which is part of the lifting platform or may be the carrying parallelogram arm to the lifting platform. For the first solution there is less power required to lift the platform from the horizontal position at maximum height to the vertical position at maximum height, but a locking latch must be fitted to the telescoping parallelogram arm to avoid any risk that the telescoping arm would telescope-out during the horizontal lifting procedure. This, in fact, would cause serious danger and should therefore be banished out. The second solution is absolutely safe without a locking latch over the telescoping arm, but requires a higher pressure in the power cylinder, to move the lifting platform from the horizontal into the vertical position. In case the first solution is applied, means for automatically locking the latch during all lifting actions of the platform can be fitted. Only for the vertically positioning of the platform, unlocking of the latch should be done by hand as a separate action. By choosing the second solution this complication is avoided.

To move the lifting platform with or without a load over Z from position 4 to position 3 a certain amount of work must be performed. A much bigger quantity of work has to be produced to lift the platform over Y from position 3 to position 2. Because the geometric position and dimensions of the different components of the moving system are such that an approximately two

times longer stroke must be covered by the piston for the motion Z compared to that for the motion Y, over Z the pressure in the hydraulic medium will be only half that over Y. Due to this, position 3 is clearly set. The same is due for position 2, because the lower telescopic parallelogram arm cannot telescope-out, either due to the locking latch, or to the fact that the maximum hydraulic pressure for lifting the maximum allowable load, is far less than the hydraulic pressure necessary for turning the platform over X. The last mentioned top-pressure in this system can only be reached when a lower set safety valve or other lift-limiting device is unlocked. In the whole hydraulic pressure field, including a safety margin, which is used during the lifting activities with or without loads, an unforeseen and unwanted move over X from position 2 to position 1 is impossible. Only an intended action will make the move over X possible. In position 1 the lifting platform forms a closing wall of the cargo hold of the truck. If the platform is locked in this position, the hydraulic system can be unloaded, resulting in position 1 being a rest position. Also position 4 is a rest position, in which the hydraulic system can be unloaded.

As has been mentioned before, the power cylinder according to this invention, is single acting and pushing and therefore of the utmost simplicity. If it is useful for reasons of occupied place or cost, to make use of two or more smaller power cylinders instead of one large, then this is possible by connecting the power cylinders mechanically and hydraulically parallel to each other. The total stroke should remain unaltered, to make possible all motions.

It should be noted that the blocking latch of the telescopic parallelogram arm is unloaded during almost all normal service positions and situations. This is an advantage and contrary to most of the other locking devices in previous art lifting apparatus. When the platform is wanted to be placed vertically, i.e., from position 2 to position 1, this is done with an unloaded platform. Also in this situation the locking latch is unloaded, therefore unlocking is easily performed. Due to the horizontal working position of the platform, the telescope will always automatically telescope-in, resulting in an automatic locking of the latch thanks to its own weight. The unlocking means is spring-loaded in its rest-position, in which the locking latch is locked. By moving the unlocking means into the unlocking position, the latch will be unlocked, freeing the telescope to move out.

Preferably the stroke of the power cylinder should be chosen sufficiently long, to enable the angle over which the platform can be pivoted from position 3 to position 4, to be larger than the top angle of the platform. By doing this, the top or point of the platform can touch the ground, also when the ground being not absolutely horizontal. It is, however, of greater importance, that the lifting platform will be held horizontal between position 3 and position 2, in order not to enlarge the risk that the load should fall off. According to present art, the lifting platform stays parallel to the truck floor during lifting and lowering, resulting in a sloping lifting platform when the truck floor also is sloping. This disadvantage is avoided according to the invention, by the rocking lever, which performs the dislocation of one of the points of connection of the parallelogram-shaped rod-system, having an adjustable stop.

In case the adjustment of the stop is wanted rather often, or that for instance for special applications during the lifting procedure or in the lifted position 2 with or without load an adjustment might be wanted, a small hydraulic power cylinder could be placed between the stop and the rocking lever. The control of it can take place separately, but it may also be integrated or even automated. If the platform might come to rest with its sharp end on a platform-quay, and in case the level of the truck would fall due to compressing its springs, part of the weight will come to rest on the platform and the whole lifting platform assembly, this being not wanted and even dangerous. By unloading this extra, small power cylinder and by having it telescope freely in and out, the main power cylinder can stay locked in that position to carry the load, the sharp end of the platform remaining free to move up and down within certain limits.

When putting the lifting platform into service from the rest position 1, the lifting platform will have to descend but also rotate into the horizontal position. In order to make sure that this action will take place automatically, without risking accidents or incorrect human actions, according to the invention the lifting platform should fulfil the requirement that there should be a minimum distance between the center of gravity of the unloaded platform and the line through the pivoting point of the platform. This formula reads:  $t > S \cos \phi [1/a + b - (1-1'/1') \sin \phi]$ . (The symbols can be found in the FIGS.).

As an example of a preferred embodiment according to the invention, a lifting platform for a truck has been chosen. In order that the invention may be fully understood, it will now be described with reference to the accompanying drawings.

FIG. 1 shows a lifting platform according to the invention in the approximately vertical position at maximum height, being position 1.

FIG. 2 shows the same lifting platform as in FIG. 1, in the horizontal position at maximum height, being position 2.

FIG. 3 shows the lifting platform in the horizontal position on the ground, being position 3.

FIG. 4 shows the lifting platform in downward sloping position on the ground, being position 4.

FIG. 5 shows schematically the mechanism for the static calculation.

FIG. 6 shows schematically the four different positions of the lifting platform and the three motions or functions through which the platform moves.

FIG. 7 shows the same lifting platform as in the previous figures, but without locking latch and with alternative position of the point of connection of the power cylinder viewing the platform, with the platform.

In the different figures corresponding parts are indicated with identical numbering.

In FIG. 1 the rear side of the truck is indicated with 1, 2 being the chassis member, 3 the truck's loading floor, 4 the end of the loading floor and 5 the carrying structure to the chassis for the lifting device. The lifting platform 6, with a closed load side 6' and a generally open ground side 6'', is supported on the parallelogram arms 7 and 8, forming part of the parallelogram-shaped articulated rod-system. By means of the pivoting points 9 and 10, the lifting platform is pivotingly connected to the parallelogram arms 7 and 8, these arms being themselves coupled to the carrying structure 5 at the pivot-

ing points 11 and 12. The lower parallelogram arm 8 can telescope in and out at 13, the telescoped-in position being limited by means of a shoulder 14. The hydraulic power cylinder 15, being single acting and pushing, is equipped with a single connection 16 for the pressure medium. At its other end the piston rod 17 is extending. The pivoting points 18 and 19 act as reaction points for the power cylinder. The point 18 is situated on a short distance from the pivoting point 10 on the lower parallelogram arm 8. The pivoting point 19 is situated at one end of the rocking lever 20, the pivoting point 12 of the lower parallelogram arm being connected to the other end of the rocking lever 20. The fixed pivoting point 21 is located between the points 19 and 12, about which the rocking lever 20 can rotate. The part of the rocking lever 20 situated between the pivoting point 21 and the point of connection 12 with the parallelogram arm 8, is indicated with 22. To take up the reaction forces during the lifting procedure, the rocking lever 20 must rest against the stop 23. If it is wanted, for instance whenever the loading floor 3 of the truck is sloping forward or backward instead of being horizontal, the position of the rocking lever 20 is made adjustable by means of the adjusting bolts 24 in relation to the stop 23, to be able to adjust during the lifting procedure the loading side 6' of the platform 6 exactly horizontally. By doing so, it is possible to adjust the line through the centers of the pivoting points 11 and 12 towards the loading floor 3 at an angle, which deviates from 90°.

In and between the positions 2, 3 and 4 (FIGS. 2, 3 and 4) the telescoping parallelogram arm 8 is telescoped-in against the shoulder 14 and is locked by the automatic latch 25. The latter is urged in position 2 by the unlocking means 26, which is connected to the carrying structure, into the locked position, if the latch might not have been come into the locked position automatically due to wear or dirt. By voluntary unlocking the latch 25 by the unlocking means 26, it can be unlocked, after which the platform can be positioned vertical from position 2 into position 1. In the vertical or nearby vertical position 1, the whole lifting platform assembly can be locked with the help of, non-illustrated, latches 27, in order to unload the hydraulic system.

In order to ascertain that the lifting platform will, after unlocking of lock 27, not only descend in vertical position, but will rotate simultaneously to the horizontal position, it is necessary (see FIG. 5) that the distance  $t$  between the center of gravity of the empty platform and the interconnecting line through the pivoting points 9 and 10, be larger than the minimum value from the following equation:

$$t > S \cos \phi [(1/a + b) - (1-1'/1') \sin \phi]$$

To contribute to the understanding of the way of working of the device, the following information may be useful. If the hydraulic power system is unloaded, i.e., without pressure, but nevertheless filled with hydraulic medium and the control means are closed, the lifting platform will descend a little at the unlocking of the latches 27 and after that it will remain in that position, borne by the since then compressed hydraulic medium. If there can bleed hydraulic medium through the control device, the piston rod 17 will move into the cylinder 15, fluid bleeding away through connection 16. Then the lifting platform will begin to descend and to

rotate from the vertical to the horizontal position. About half way the total lifting height, the platform will arrive at the horizontal position, the latch 25 locking automatically the telescopic parallelogram arm 8. By continued bleeding of the hydraulic medium, the undermost part of the platform near the pivoting point 10, will touch the ground, the platform still being in horizontal position. By terminating the bleeding of hydraulic medium from the power cylinder 15 through the control means, position 3 can be blocked. In this position the piston of the power cylinder 15 has not yet arrived at the end of its stroke. By continued bleed of the hydraulic medium from the power cylinder, position 4 will be reached because the pivoting point 12 is allowed to dislocate, the rocking lever 20 pivoting about the fixed point 21, until the ground-viewing side 6'' of the lifting platform touches the ground and/or the piston in the power cylinder 15 arrives at the end of its stroke. It is clear that the stroke of the cylinder 15 should be made sufficiently long, to have some spare stroke left to compensate for possible deviations from the horizontal level of the ground. The lifting platform being unloaded or loaded (within the limits set by the strength of the design), has no influence on the working cycle as described above. The lifting cycle takes place in the reciprocal sequence. As soon as position 2 has been reached, the latch 25 will come to rest against the unlocking device 26. A part of the control and safety system may be connected to the unlocking device 26 by means of switches or valves. If the latch might not have locked the telescope during the above-described start-up due to wear or dirt, then it will at this very moment be urged into the locked position. As long as the latch 25 stays in the locked position, it is impossible to telescope-out the parallelogram arm 8, thereby prohibiting a start of the displacement X to the vertical position 1. In this way an absolute safety will be guaranteed. Only by voluntary unlocking of the unlocking means 26, the latch 25 can be unlocked, to start with motion X by continued expelling the piston out from the power cylinder 15. At the end of the motion X, the lifting platform can be blocked in this position by means of the not illustrated latches 27. Furthermore it is possible to fit non-illustrated latches, to lock the lifting platform also in position 2.

FIG. 7 shows an alternate preferred embodiment of the lifting device according to the invention. In this embodiment the locking latch 25 and its unlocking means 26 can be dropped, resulting in a simpler and cheaper product. This can only safely be done, if the pivoting point 18, being the point of connection of the power cylinder at its side viewing the platform, will be moved to a position between the pivoting points 9 and 10, being the points of connection between the two long parallelogram arms and the short parallelogram arm near the platform.

It is shown from statical calculations that both embodiments of the lifting device according to the invention are safe under all circumstances and able to perform in the correct sequence all movements. The pressure levels in the hydraulic medium are so different during the motions Z and Y that there exists a sufficient big margin to meet with unforeseen circumstances, as may be formed by e.g. pivoting points with abnormal friction due to wear or lack of service.

I claim:

1. In a lifting device, for instance fitted as lifting platform assembly to a truck, a lifting platform, one or more parallelogram-shaped articulated rod-systems, by which rods or arms this platform is directly or indirectly pivotingly connected to a carrying structure fitted to the truck chassis, one parallelogram arm being capable of telescoping, and the platform being driven and controlled by a hydraulic power system, the platform having four positions: lifted approximately vertically at maximum height; lowered horizontally on ground; and lowered in downward sloping position on ground and, in doing so, three different motions, a single power cylinder means being applied to perform all three motions, the pivot point of the lower parallelogram arm being connected to the carrying structure through a rocking lever, and the power cylinder means being pivotingly attached at one end to this rocking lever, characterized in that the power cylinder means is single acting and pushing, and the fixed pivot point of the rocking lever on the carrying structure is located between the point of connection of the lower parallelogram arm and the point of connection of the power cylinder means on the rocking lever.

2. The lifting device according to claim 1, in which the lower parallelogram arm telescopes and the point of connection of the opposite end of the power cylinder means is located on this lower arm, and a locking de-

vice locking the telescopic parallelogram arm against telescoping in or out during all motions, except during the rotation to or from the approximately vertical position.

3. The lifting device according to claim 2, in which the locking device of the telescoping parallelogram arm locks automatically, but can only be unlocked voluntarily in the horizontal position at maximum height of the platform.

4. The lifting device according to claim 1, in which the opposite end of the power cylinder is connected to the platform between the pivot points of the upper and lower parallelogram arm with the short parallelogram arm near the platform.

5. The lifting device according to claim 1, in which the single power cylinder means comprises a plurality of two or more single acting pushing power-cylinders mechanically and hydraulically connected in parallel and functioning together as one power cylinder.

6. The lifting device according to claim 1, in which the rocking lever is fitted with an adjustable stop to adjust the platform in a horizontal position, although the loading floor of the truck may slope.

7. The lifting device according to claim 6, in which the rocking lever is connected through a power cylinder to the carrying structure.

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UNITED STATES PATENT OFFICE  
CERTIFICATE OF CORRECTION

Patent No. 3,842,997 Dated October 22, 1974

Inventor(s) Gerrit W. J. Sprikkelman

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

IN THE HEADING:

Below "Foreign Application Priority Data" insert  
--May 18, 1973 Netherlands .....7307017--.

Signed and sealed this 11th day of February 1975.

(SEAL)

Attest:

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