

Sept. 12, 1967

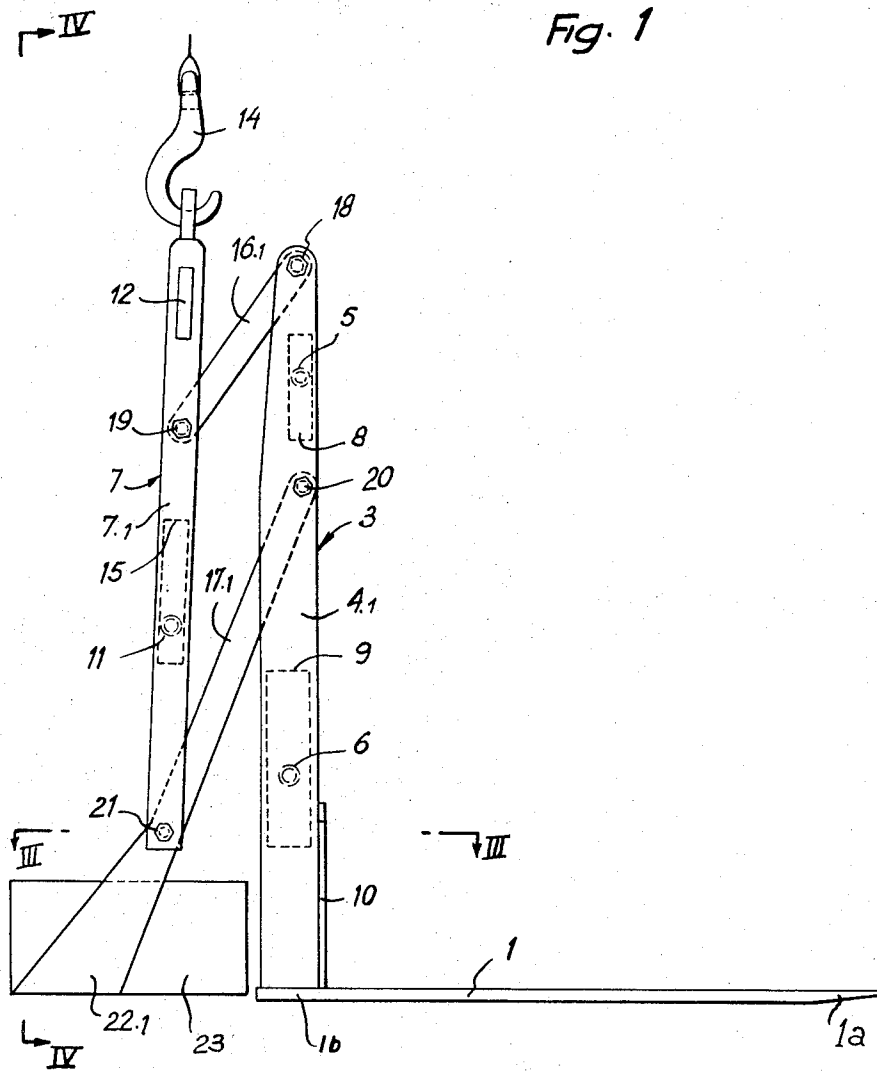
M. JEAN-MARIE ARCHER

3,341,243

MATERIAL HANDLING APPARATUS

Filed June 28, 1966

8 Sheets-Sheet 1



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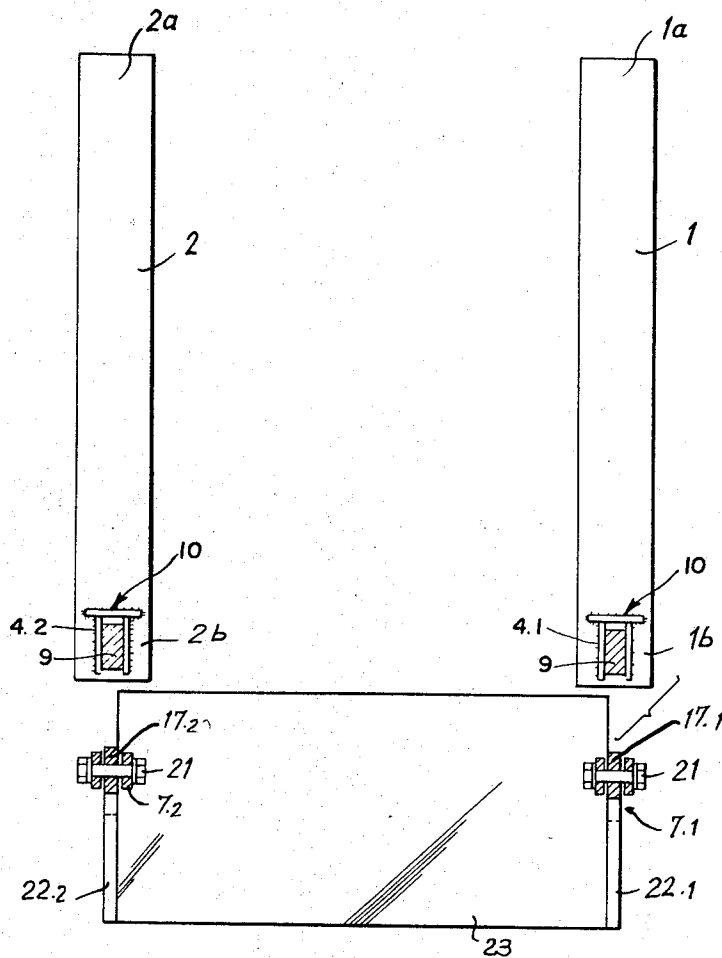


Fig. 3

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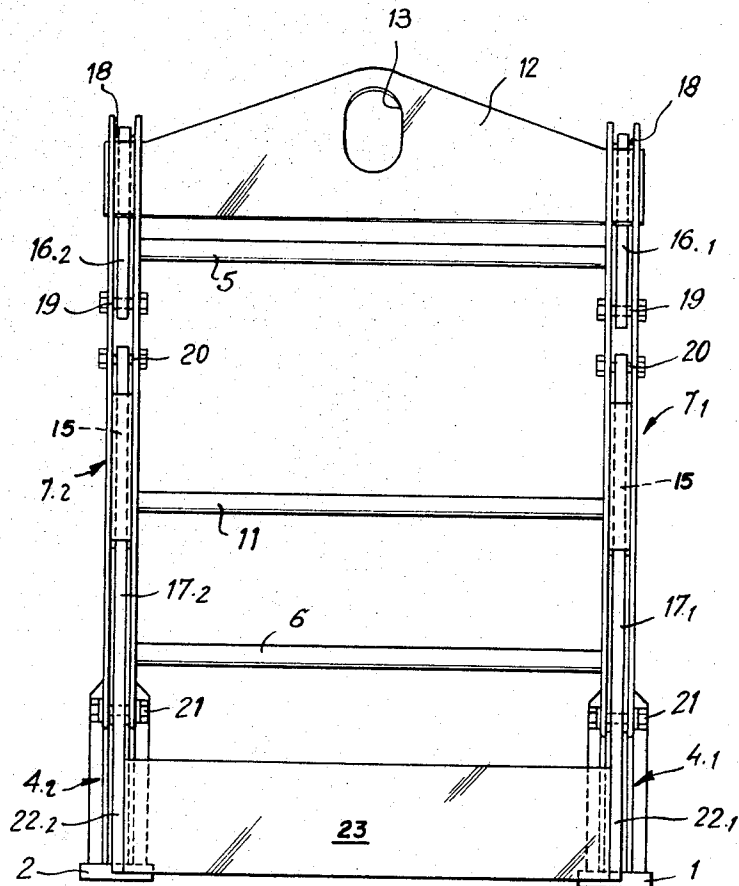


Fig. 4

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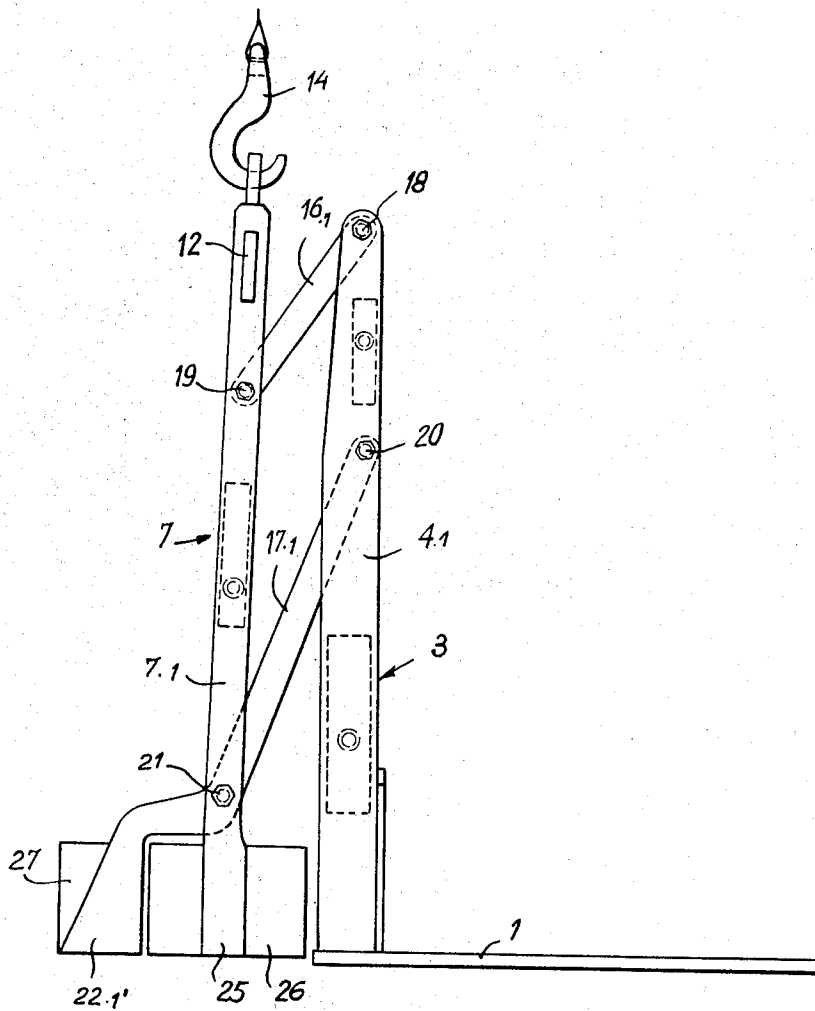


Fig. 5

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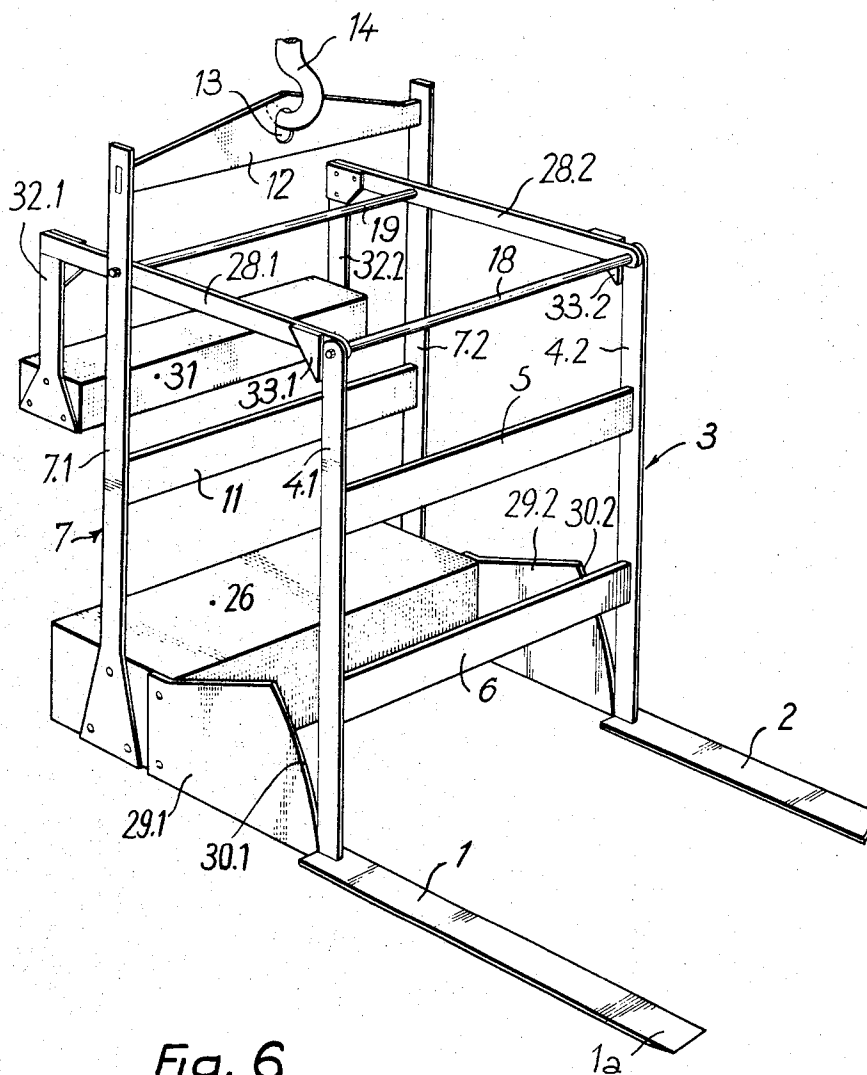


Fig. 6

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MATERIAL HANDLING APPARATUS

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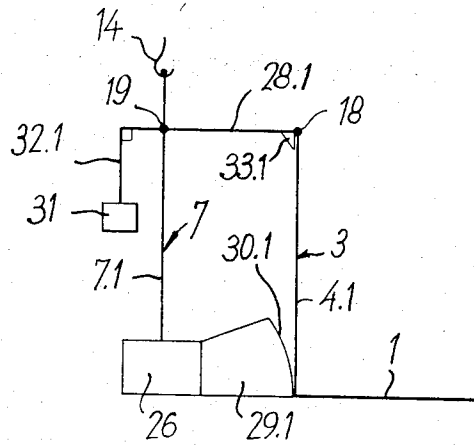
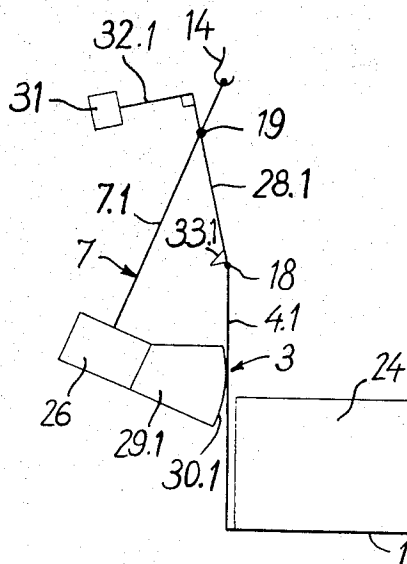


Fig. 7

Fig. 8



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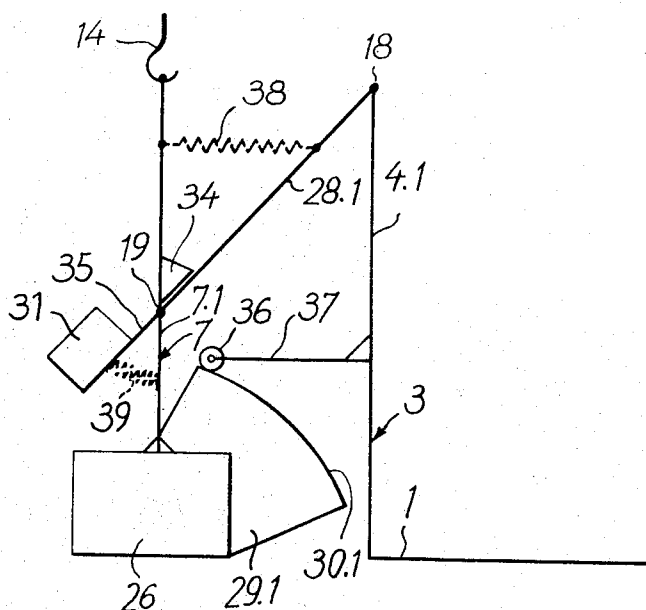


Fig. 9

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MATERIAL HANDLING APPARATUS

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Filed June 28, 1966, Ser. No. 561,074

Claims priority, application France, Apr. 2, 1965, 11,678; Nov. 25, 1965, 39,819; Feb. 18, 1966, 50,273

18 Claims. (Cl. 294—67)

ABSTRACT OF THE DISCLOSURE

A lifting device composed of an L-shaped lifting fork supported by a cable through the intermediary of a deformable linkage connected to the upright arm of the fork, the deformation of the linkage under the influence of a fork load moving a counterpoise carried at the lower corner of the linkage furthest removed from the fork in such a manner as to maintain the device in equilibrium while the load-supporting arm of the fork is maintained horizontal, no portion of the device extending into the space directly above the load-supporting arm.

This application is a continuation-in-part of copending application Serial No. 495,933, filed Oct. 14, 1965, and now abandoned.

Until recently, the technique used for storing different merchandise consisted in placing and, if desired, stowing the merchandise on pallets or piling them in baskets, said pallets or baskets then being stacked in piles. The pallets or baskets have therebeneath a free space for the insertion of the arms of a handling fork.

However, this technique which is known in the art as "palletization," has certain disadvantages. It is not possible to remove a unit, i.e., a pallet or a basket, from a pile at any level, without having previously removed the units thereabove, one by one. In order to remedy this and other disadvantages, the abovementioned technique has advanced toward a total independence, during storage, of each palletized unit and to this end, rows of carrier frames are installed at the storage location and are separated by access passages which are as narrow as possible, these frames defining spaces are intended to contain the palletized units. With such an arrangement, each unit may be removed separately regardless of its particular location.

In order to carry out these removals, either lifting cradles or overhead travelling stacking cranes, are generally used. In the case of lifting cradles, which are also provided with a handling fork, it is necessary to provide relatively large access passages, this resulting in a great loss of ground surface which could have been used for storage. It is also necessary to adapt the cradles to the particular use, particularly because they must be able to rotate on the spot. It is therefore necessary to provide equipment made of highly specialized components which are relatively costly. Moreover, if the merchandise is very long and not palletized (metal bars for example), it is no longer possible to cause the cradle to rotate on the spot in order to handle the merchandise, the cradle only being movable backward and laterally in a crab-like manner. Having regard to the great accuracy which is required for such maneuvering of the cradle, the personnel employed must be highly qualified and it is obvious that, in spite of this, the speed of operation is relatively low. To these above-mentioned disadvantages must obviously be added those which are peculiar to lifting cradles in general.

In the case of stacking cranes, the apparatus used is

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very specialized, very complex and very costly. This apparatus is generally constructed so that below the carriage of the crane is secured a column, along which is guided a vertical carriage provided with a handling fork. One of the other disadvantages of these cranes resides in the fact that it is necessary to pick up the loads with another handling means at the exits from the passages in the storage warehouse.

The result of all this is that the technique of storage by palletization on carrier frames is very advantageous, but that the means used up to the present time for carrying out the removal of stored merchandise wherever it may be located, has numerous disadvantages. Of course, there are handling forks which are normally suspended from the end of the cable of a crane or other hoisting and conveying apparatus, but none of the known forks of this type can be used for removing, from any one of the spaces in a carrier frame, merchandise which may or may not be palletized. In effect, these forks are generally C-shaped and have a lower horizontal arm which is intended to support a load and an upper horizontal arm which is connected to the preceding one by means of the median portion of the "C" and which is intended to be suspended, at a judiciously chosen point, from the cable. In the case of certain types of C-shaped forks, the upper arm is provided with at least one balance weight. In other types, the upper arm is of such a shape so as to be able to hang from the cable at at least two different points according to whether the fork is unloaded or loaded. In yet other types, the upper arm is connected to the suspension cable by means of a link and a compensating spring enabling the vertical of the hooking point to be varied with respect to the fork, according to whether the latter is unloaded or loaded. Finally, in other types, the upper arm may be slanted in either one of two directions with respect to the upright portion of the fork, but is normally secured to the latter, and it is combined, by means of a link articulated at its end and a spring, to a lifting eye. It is unnecessary to continue with a further study of existing C-shaped forks, because the present invention is based on the realization that the upper arm of such a fork hinders the removal of the merchandise stored in the spaces of the carrier frame since, in operation, it will abut against the frame even before the lower arm of the fork has been able to move underneath the merchandise in question.

It results from the preceding description that it would be very important and advantageous, in the field of application in question, to be able to replace lifting cradles, stacking cranes, and so on, by a fork suspended from the end of a crane cable, but that it is impossible to be able to use a C-shaped fork for this purpose.

The present invention proposes the use of an L-shaped fork for carrying out the removal and the handling of the merchandise thus removed, this fork comprising at least one substantially horizontal arm which, at its end forming a heel, is integral with or secured to an upright carrier element.

When it is attempted to utilize an L-shaped fork in this manner, the problem which arises is that of being able to balance such a fork whether unloaded or loaded, while leaving free the space situated above the arm or arms thereof and while maintaining these arms substantially horizontal. In other words, these conditions must be maintained whatever may be the operating conditions, i.e., whether the fork be unloaded or whether it be supporting and lifting a load.

This problem appears to have been unsolvable to date, which seems to explain why the present state of the art is such that no fork of this type has appeared on the market, despite the existence of a substantial demand.

It is therefore an object of the present invention to overcome the above-noted drawbacks.

More specifically, it is an object of the present invention to overcome the drawbacks associated with the previously proposed suspended lifting forks of the prior art.

Another object of the present invention is to permit the ready handling of any individual unit stored on a carrier frame.

Yet another object of the present invention is to permit the attainment of a high density storage in which each individual unit is readily handled.

Still another object of the present invention is to permit the ready handling of individual units stored in a frame without requiring the provision of a clearance above the unit.

A still further object of the present invention is to provide simple and reliable apparatus for handling such units.

Still another object of the present invention is to eliminate the need for floor passages for the handling apparatus.

These and other objects are achieved according to the present invention by the provision of a novel lifting device for suspension from the end of the cable of a lifting and transporting apparatus of the travelling crane type. This lifting apparatus essentially includes an L-shaped lifting fork having at least one substantially horizontal arm defining a finger, and an upright carrier element having one end rigidly connected to one end of the arm. The device further includes at least one linkage connected to the carrier element near the other end thereof and forming, together with the carrier element, a deformable quadrilateral. There is also provided cable attachment means connected to the linkage near that upper corner of the quadrilateral which is furthest away from the fork, and at least one counterpoise carried by the linkage in proximity to that lower corner of the quadrilateral which is furthest away from the fork.

According to a first preferred form of construction, the quadrilateral is deformable only by variations of the angles between its adjacent sides and the linkage includes a rigid suspension element, at least one upper link, and at least one lower link which is longer than the upper link, each of the links having one end pivotably connected to the carrier element and the other end pivotably connected to the suspension element with the connection points of the links on the carrier element being closer together than the connection points thereof on the suspension element.

According to a second preferred form of construction, the quadrilateral is deformable by variations of at least some of the angles between its adjacent sides together with a related variation of the length of at least one of its sides. According to this form of construction, the linkage includes a rigid suspension element, at least one upper link having one end pivotably connected to the carrier element and the other end pivotably connected to the suspension element, means defining a camming surface carried by one of the elements, and a lower lever rigidly connected to the other one of the elements and bearing on the camming surface for movement therealong. The movement of the lever on the camming surface serves to produce a variation of the length of at least one of the sides of the quadrilateral.

The provision of a deformable quadrilateral permits the desired aim to be attained since, under the influence of a load placed on the arm of the suspended fork, this quadrilateral deforms and moves the at least one counterpoise away from the load, while moving the vertical passing through the suspension hook toward the load. A state of equilibrium is then attained and the load remains in a horizontal position on the fork arms when the fork is lifted. Moreover, the stability of the loaded fork

is ensured by the fact that the counterpoise is disposed in the lower portion of the linkage.

In addition, the space occupied by the loaded fork is relatively small, thus permitting on the one hand, relatively narrow passages to be provided in the warehouse and, on the other hand, the total available height beneath the crane to be used for storage.

According to one of the important features of the present invention, the linkage can be provided either with a single counterpoise or with a combination of a "loaded" counterpoise carried by the lower end of the suspension element and an "unloaded" balance element.

This "unloaded" balance element can be constituted by an additional counterpoise which, in the first form of construction described above, is carried by the free end of the lower link, and, in the second form of construction described above, is carried by an extension of the upper link, the upper link then forming a balance beam. This latter disposition of the "unloaded" counterpoise can also be used in the first-described form of construction.

The "unloaded" balance element can also be constituted by at least one spring interposed between two of the relatively movable members of the linkage for producing an effect which tends to maintain the fork arms substantially horizontal when the fork is unloaded so as to nullify the influence of the "loaded" counterpoise when the fork is in this condition.

The "unloaded" balance element can also be constituted by a combination of an additional counterpoise and at least one spring.

It is to be understood that the term "lifting fork" used throughout this specification is intended to include a structure having at least two substantially horizontal arms or one substantially horizontal arm defining a platform.

It is obvious that the application of this fork is not limited to the field of handling in a storage warehouse, such as set out herein-above, but may also extend to all fields which relate to lifting and moving a load which is accessible from above or below.

Additional objects and advantages of the present invention will become apparent upon consideration of the following description when taken in conjunction with the accompanying drawings in which:

FIGURE 1 is an elevational view of a first embodiment of a fork according to the present invention, suspended in the unloaded, or free, position.

FIGURE 2 is a view similar to FIGURE 1 but illustrating the loaded position.

FIGURE 3 is a cross-sectional view taken along the line III—III of FIGURE 1.

FIGURE 4 is an end view taken along the line IV—IV of FIGURE 1.

FIGURE 5 is a view similar to that of FIGURE 1 showing a second embodiment of a fork according to the present invention.

FIGURE 6 is a simplified perspective view showing another embodiment of a fork according to the present invention.

FIGURE 7 is a pictorial line diagram corresponding to an elevational view of the arrangement of FIGURE 6 showing the relation between the various elements when the fork is unloaded.

FIGURE 8 is a view similar to that of FIGURE 7 showing the relation between the elements when the fork is supporting a load.

FIGURE 9 is a view similar to that of FIGURE 7 showing a modified form of construction for the arrangement of FIGURE 6.

The embodiment of the present invention illustrated in FIGURES 1 to 4 and the embodiment of FIGURE 5 are identical to another insofar as concerns their general structural arrangement and kinematic organization. The two embodiments differ primarily in the arrangement of their counterbalance means. Therefore, the initial portion

of the following description will refer to the common elements of both embodiments together, it being noted that these common elements are given the same reference numerals in the figures relating to the two embodiments.

Thus, referring to FIGURES 1 to 5, there is shown a fork composed of two substantially horizontal arms 1 and 2 extending parallel to one another. Their free ends 1a, 2a are tapered for the sole purpose of facilitating their insertion under palletized merchandise, while their other ends 1b, 2b define shoulders which are secured to, or rendered integral with, an upright carrier element, or frame 3 in any suitable manner, e.g. by welding.

This carrier frame includes two uprights 4.1 and 4.2 connected together by means of tubular cross bars 5 and 6. In order to facilitate the connection, which will be described in detail below, between the carrier frame 3 and a suspension element, or frame 7, each of the uprights 4.1 and 4.2 is constituted by two flat or profiled members spaced apart from one another and secured together by means of spacer strips 8 and 9 occupying a limited area in order to leave passages in certain regions, between the two members of each upright. In order to strengthen the connection of the uprights 4.1 and 4.2 of the frame 3 with arms 1 and 2, vertical plates 10 are provided. The different elements of the L-shaped fork thus formed are joined together preferably by electric arc welding.

Similarly, the suspension frame 7 comprises two uprights 7.1 and 7.2 connected together by means of a tubular cross piece 11 and a connecting plate 12 in which is arranged an opening 13 (FIGURE 4) for the passage of a lifting hook 14 fixed to the end of the cable of the hoist of a crane, or at the end of the cable of any other lifting or conveying apparatus, such as a jib crane, for example. The uprights 7.1 and 7.2 are situated opposite the uprights 4.1 and 4.2, on the other side thereof from the arms 1 and 2. These uprights 7.1 and 7.2 are also each constituted by two flat or profiled members spaced apart by means of a spacer strip 15 and a respective end of the connecting plate 12. Thus, free passages are arranged between the two members of each upright 7.1 and 7.2, as has also been provided between the members of each upright 4.1 and 4.2. The frame 7 is also preferably of welded construction.

As FIGURES 1 and 2 clearly show, the upright 4.1 of the carrier frame 3 is connected to the upright 7.1 of the suspension frame 7 by means of a short upper link 16.1 and a long lower link 17.1. The ends of these links are engaged in the passages which have been left free between the members constituting each of the above-mentioned uprights and they are pivotally connected to axes 18, 19, 20 and 21, respectively traversing the members of the uprights. The axes 18 and 20 of the upright 4.1 are relatively close to one another, while the axes 19 and 21 of the upright 7.1 are relatively far apart. Thus, the links 16.1 and 17.1 cooperate with the uprights 4.1 and 7.1 to form a quadrilateral having unequal opposite sides, the quadrilateral being deformable only by having the angles between adjacent pairs of sides varied.

The same kinematic connection is formed between the uprights 4.2 and 7.2 by two links 16.2 and 17.2 which are identical with regard to their length, arrangement and pivotable connection, to links 16.1 and 17.1. Thus, the links 16.2 and 17.2 cooperate with the uprights 4.2 and 7.2 in order to constitute another deformable quadrilateral having unequal opposite sides which is fully identical with the first-described quadrilateral and which produces the same effect as the latter.

According to the first embodiment of FIGURES 1 to 4, the long lower links 17.1 and 17.2 are integral, beyond the pivot axes 21, with projections 22.1 and 22.2, respectively, between which extends a single counterpoise 23 fixed, by welding for example, to these projections. The center of gravity of this counterpoise is disposed on the opposite side of axes 21, from the frame 4.1 when the de-

formable quadrilaterals are flattened (FIGURE 1). Consequently, when the unloaded fork is lifted, by the hook 14, the weight 23 tends to flatten the deformable quadrilaterals 4.1, 16.1, 7.1, 17.1 and 4.2, 16.2, 7.2, 17.2 (positions shown in FIGURE 1) and the influence of this weight with respect to the vertical line through the point of fork suspension is such that the arms 1 and 2 of the fork are horizontal or have a slight downward inclination in a direction toward their free ends 1a and 2a.

When a load 24 (FIGURE 2) is placed on the arms 1 and 2, and when the lifting hook 14 lifts the frame 7, the above-mentioned deformable quadrilaterals spread out (position shown in FIGURE 2). This movement tends, on the one hand, to move the weight 23 away from the load 24 and, on the other hand, to move this load toward the vertical line passing through the suspension hook 14. These combined effects cause the loaded fork to be counterbalanced and the arms 1 and 2 to remain horizontal or to assume a slight-upward inclination in a direction toward free ends 1a and 2a in order to provide a more secure retention of load 24 and, hence, to permit the fork to be moved more rapidly. Of course this result is obtained by suitably choosing the lengths of the four arms of each deformable quadrilateral, the distance from the axes 19 to the lifting hook 14 and the distance from the axes 20 to the arms 1 and 2 (the axes 18 being situated on the upper part of the frame 3 and the axes 21 on the lower part of the frame 7) and finally the mass and the position of the center of gravity of the counterpoise 23.

Although it is not indispensable, it may be advantageous to provide at least one stop means (as will be described in detail in connection with FIGURES 6 to 9) between two of the sides of each of the deformable quadrilaterals, the sole purpose being to limit the maximum deformation of the quadrilateral when the fork is unloaded. It might also be desirable to provide stop means (not shown) between two sides of each quadrilateral for limiting the maximum spreading out of the quadrilateral when the fork is loaded.

According to the second embodiment shown in FIGURE 5, the uprights 7.1 and 7.2 of the suspension frame 7 are integral with projections 25, extending downward beyond the axes 21. A main counterpoise 26 is mounted between the projections 25 and fixed to the latter by welding, for example. The weight 26 has for its primary purpose to balance the loaded fork, substantially in the same manner as the counterpoise 23 of the first embodiment. This main counterpoise 26 is moreover associated with an "unloaded" balance element constituted by an additional counterpoise 27 mounted and fixed between the respective projections 22.1' and 22.2' of the long links 17.1 and 17.2. The additional counterpoise is provided for correcting the balance when the fork is unloaded, for the sole purpose of ensuring that the arms 1 and 2 of the latter will be horizontal, which would not occur if the unloaded fork were acted on solely by the main counterpoise 26. This embodiment having two independent counterpoises is particularly advantageous because it permits the initial adjustments of the balancing position, under loaded and unloaded conditions, to be facilitated, these adjustments preferably being made when the manufacture of the fork is nearly completed.

It will be clear that the additional balance weight 27 may be replaced by a spring interposed between two constituent parts of the deformable quadrilaterals for urging the quadrilateral into a flattened configuration. The choice of the tension of this spring is determined as a function of the position of the center of gravity of the main counterpoise 26. The "unloaded" balance element could also be constituted by a combination of a counterpoise and a spring connected as described above.

Under some circumstances, it might be desirable to be able to control the orientation of the fork in such a way that the arms 1 and 2 are perfectly horizontal, regardless of the size of the load being supported. One simple ar-

range for performing such an operation is shown in FIGURE 2 to include a flexible connecting element, here constituted by a pull chain 40, disposed between the lower cross bar 6 of upright frame 3 and the cross bar 11 of the suspension element 7. One of the chain is permanently attached to a tab 41 rigidly connected to cross bar 6, and the chain passes through an opening in a tab 42 rigidly connected to cross bar 11. The chain is so arranged that it can be pulled through the opening in tab 42 so as to vary the effective length of the chain portion between the elements 3 and 7. The dimensions of the opening in tab 42 are such that the chain links can be pulled therethrough when they extend perpendicular to the tab, but will not pass therethrough when they extend parallel to this tab. Therefore, in order to establish a desired chain length between the elements 3 and 7, it is only necessary to pull the chain through the opening in tab 42 until the desired link extends through the opening and to then rotate the following link so that its ends abut against the tab portions surrounding the tab opening. The length of the chain between the elements 3 and 7 is determined as a function of the weight of the load to be carried. It is of course possible to employ any other suitable type of element in place of the chain 40.

In the embodiments illustrated in FIGURES 1 to 4 and 5, each linkage formed by an upright of the suspension element 7, an upper connecting link and a lower connecting link constitutes, together with the corresponding upright of carrier element 3, a quadrilateral which can be deformed only by producing variations in the angles between its adjacent sides.

This quadrilateral could also, according to the present invention, be constructed so as to be deformable both by variations of at least some of the angles between adjacent pairs of sides and by variations of the length of at least one of its sides. Such a form of construction is illustrated in the embodiment of FIGURES 6 to 8 and in the modified form thereof illustrated in FIGURE 9.

In the embodiment of FIGURES 6 to 8, the uprights 4.1 and 7.1, which are situated on the same side of the fork, are connected together at their upper ends by a link 28.1. Similarly, the uprights 4.2 and 7.2 which are situated on the other side of the fork, are connected together by a link 28.2. The links 28.1 and 28.2 are pivotally connected to the uprights by means of axes 18 and 19 extending between the uprights 4.1 and 4.2 of the carrier element 3 and the uprights 7.1 and 7.2 of the suspension element 7, respectively.

A principal counterpoise 26 is disposed and connected between the lower ends of the uprights 7.1 and 7.2 of the suspension element 7. Counterpoise 26 is rigidly connected to the uprights 7.1 and 7.2 and to the supporting plates 29.1 and 29.2 each of which plates is mounted at a respective end of counterpoise 26 so as to be coplanar with a respective one of the uprights 4.1 and 4.2. Plates 29.1 and 29.2 are formed with camming surfaces 30.1 and 30.2, respectively, against which a respective one of the uprights 4.1 and 4.2 bears. Each of the uprights 4.1 and 4.2 shown in FIGURE 6 is actually constituted by two flat or profiled members so as to have the same structure as that shown in the embodiments of FIGURES 1 to 5. However, only one flat member of each of these uprights is shown in FIGURE 6 for the sake of simplicity. Each of the camming surfaces 30.1 and 30.2 is normally engaged between the two flat members of its respective upright 4.1 or 4.2 in such a manner as to prevent these camming surfaces from moving laterally out of contact with their respective uprights.

The linkage formed by upright 7.1, link 28.1, and supporting plate 29.1 forms, together with the upright 4.1, a quadrilateral which can be deformed by variations of at least some of the angles between its adjacent sides and of the length of at least one of its sides. The same is true for the identical quadrilateral formed by upright 7.2, link 28.2, supporting plate 29.2 and upright 4.2. In the embodiment of FIGURES 6 to 8, the effective lengths of the quadrilat-

eral sides defined by the plate 29.1 and upright 4.1 will both vary with variations in the weight of the load supported by arms 1 and 2. These length variations are of course accompanied by variations in the angles between upright 7.1 and link 28.1, link 28.1 and upright 4.1, and upright 4.1 and the quadrilateral side constituted by plate 29.1. The same holds true for the quadrilateral on the other side of the fork.

These length variations of the quadrilateral sides are attributable to the fact that, as the weight of the load on arms 1 and 2 increases, the point of contact between camming surfaces 30.1 or 30.2 and the respective upright 4.1 or 4.2 moves upward along both the camming surface and the upright. In other words, the distance of the point of contact from the axis 18 and from a line through the center of gravity of counterpoise 26 and parallel to axis 18 varies simultaneously with the variations of the angle between the upright and a line defining the quadrilateral side formed by the supporting plate.

In order to control the relation between these two length variations of the quadrilateral sides, i.e., the relation between the effective length of the quadrilateral side formed by the upright 4.1 and the effective length of the quadrilateral side formed by plate 29.1, it is only necessary to give camming surface 30.1 an appropriate profile. For example, the profile of this camming surface can be elliptical, parabolic, etc. This profile can even have any arbitrary configuration which is determined purely experimentally on the basis of the intended function of the particular lifting fork. Regardless of the shape chosen, it is most desirable that the camming surface profile be such that the effective length of the quadrilateral side defined by the supporting plate will decrease as the point of contact between the surface and its corresponding upright moves upward along the camming surface.

It should of course be appreciated that other means may be provided for producing a variation of the effective lengths of the quadrilateral sides as a function of the angle between the quadrilateral sides defined by the supporting plates and the uprights which they contact. For example, sliders could be mounted on the supporting plate and the upright and could be connected together through the intermediary of a mechanism which transforms the above-mentioned angular variation into linear movements of the two sliders.

The upper cross piece 12 of the frame 7 is shown to be provided with an opening 13 disposed above the axis 19 for the insertion of a lifting hook 14 from which the fork according to the present invention is to be suspended. However, this hook could be arranged to engage another portion of the fork and in particular to be placed around the center of axis 19 or to support an additional cross piece connected between links 28.1 and 28.2 in a region between axes 18 and 19.

The center of gravity of counterpoise 26 is preferably situated in the median plane of the suspension element 7 and, in this case, the counterpoise 26 cooperates with an additional "unloaded" counterpoise 31 disposed on the opposite side of the suspension element 7 from the carrier element 3. This additional counterpoise 31 is mounted between the lower ends of supporting members 32.1 and 32.2, each of which is rigidly connected to a respective one of the links 28.1 and 28.2 and oriented at right angles thereto. Each of the supporting members 32.1 and 32.2 cooperates with its respective link 28.1 or 28.2 to form a balance beam which is pivotable about the axis 19. The weight of the additional counterpoise 31 is selected so that its moment arm with respect to axis 19 perfectly balances the moment arm, with respect to the same axis, of the fork constituted by arms 1 and 2 and frame 3 when the fork is unloaded, the weight of counterpoise 31 then balancing the weight of the fork through the intermediary of balance beams 28.1 to 32.1 and 28.2 to 32.2.

It would also be possible, according to the present invention, to eliminate the counterpoise 31 and to cause the fork to be balanced when in its unloaded condition by

displacing the center of gravity of principal counterpoise 26 so that it is situated on the opposite side of frame 7 from frame 3.

The embodiment of FIGURE 6 also includes stops 33.1 and 33.2 each rigidly connected to a respective one of the links 28.1 and 28.2 and positioned for limiting the degree of pivotal motion of uprights 4.1 and 4.2 with respect to links 28.1 and 28.2. These stops are positioned for preventing the angle between link 28.1 and upright 4.1, for example, from attaining a value which is below that which is to exist when the fork is unloaded. In the embodiment of FIGURE 6, where the links 28.1 and 28.2 are substantially horizontal when the fork is unloaded, this minimum angle is no less than 90°.

When the arrangement shown in FIGURE 6 is suspended by means of a hook 114 and is unloaded, the apparatus has the configuration shown pictorially in FIGURE 7. On the other hand, when a load 24 is placed on the arms 1 and 2 and the fork is lifted upward by hook 14, the quadrilaterals defined by the fork linkage deform in the manner illustrated in FIGURE 8. The links 28.1 and 28.2 pivot about the axis of frame 3, while the uprights 7.1 and 7.2 of suspension element 7 pivot around the axis 19 of links 28.1 and 28.2. In addition, the lower ends of uprights 7.1 and 7.2 are held away from the uprights 4.1 and 4.2 by the plates 29.1 and 29.2. This deformation of the quadrilaterals tends, on the one hand, to maintain a substantial spacing between the counterpoise 26 and the load 24, and, on the other hand, to bring the load 24 closer to the vertical line passing through the point of suspension of the fork on hook 14.

At the same time, the influence of the additional counterpoise 31 increases because the moment arm of this counterpoise increases with respect to the above-mentioned vertical line.

These combined effects permit the loaded fork to be balanced so as to maintain the arms 1 and 2 substantially horizontal, or even slightly ascending in a direction toward their free ends 1a and 2a. Moreover, it may be noted that when the weight of the load increases, the distance between the points of contact of the camming surfaces 30.1 and 30.2 and the axis 18 decreases. However, at the same time, the distance of these points of contact from the center of gravity of the counterpoise 26 also decreases since the profile of the camming surfaces 30.1 and 30.2 is given the form described previously.

The fork is thus satisfactorily balanced even if the weight of the load varies between relatively wide limits.

Turning now to FIGURE 9, there is shown in pictorial form a modification of the embodiment of FIGURE 6. In the modified form of construction illustrated in FIGURE 9, the pivot axis 19 between links 28.1 and 28.2 and uprights 7.1 and 7.2 is situated near the center of elements 7, and preferably closer to counterpoise 26 than to hook 14. The links 28.1 and 28.2 are arranged so that when the fork is unloaded they will be inclined downwardly in a direction from frame 3 to frame 7.

The structure of FIGURE 9 is also provided with abutments 34 rigidly connected to uprights 7.1 and 7.2 and disposed in line with the links 28.1 and 28.2 for limiting the maximum angle which can exist between the links and the uprights when the fork is unloaded. In this embodiment the additional "unloaded" counterpoise 31 is carried by support arms 35 which extend in line with, and which are rigidly connected to, the links 28.1 and 28.2. The counterpoise 31 is mounted on top of the support arms 35.

The structure of FIGURE 9 also includes bars 37 rigidly connected to uprights 4.1 and 4.2 at a point near the center of these uprights, the bars 37 extending perpendicular to the uprights 4.1 and 4.2. At the free end of each of the bars 37 is disposed a freely rotatable cam follower wheel 36 which bears against a respective one of the camming surfaces 30.1 and 30.2. As may be seen, the bars 37 are so arranged that the follower wheels 36

extend a substantial distance behind carrier element 3. Since the contact between plates 29.1 and 29.2 and the respective uprights 4.1 and 4.2 is effectuated through the intermediary of a freely rotatable follower wheel 36, movements leading to changes in the positions of the points of contact on camming surfaces 30.1 and 30.2 are substantially frictionless. As a result, the ability of the apparatus to rapidly and accurately correct for equilibrium variations when the fork is loaded is greatly improved. This result is particularly advantageous when it is desired to subject a loaded fork to a relatively rapid translational movement since the apparatus will then be capable of rapidly and accurately compensating for any disequilibriums occurring as a result of the creation of dynamic forces due to the load inertia.

FIGURE 9 also illustrates that the "unloaded" counterpoise 31 can be replaced by, or combined with, at least one spring connected between the suspension element 7 and the links 28.1 and 28.2 for urging the links into a position relative to element 7 which corresponds to the unloaded condition of the fork. For example, FIGURE 9 shows a tension spring 38 connected between a point on link 28.1 and a point on upright 7.1 above pivot axis 19. A similar spring would be connected between link 28.2 and upright 7.2. This spring 38 could be replaced by, or combined with, two compression springs 39 each connected between one of the support members 35 and a respective one of the uprights 7.1 and 7.2 at a point below axis 19.

The weights of counterpoises 23, 26, 27, and 31 are preferably determined and fixed permanently on the fork. However, these counterpoises might be arranged so that their weight is adjustable (counterpoise having a plurality of dismountable parts) and/or their position is adjustable (sliding or pivoting assembly of the counterpoises together with a locking means) or variable during operation (free and oscillating or sliding weights).

It should be understood that the present invention also contemplates modifications wherein the springs and abutment means shown in FIGURES 6 to 9 can be incorporated in the embodiments of FIGURES 1 to 5.

It will be understood that the above description of the present invention is susceptible to various modifications, changes, and adaptations, and the same are intended to be comprehended within the meaning and range of equivalents of the appended claims.

What is claimed is:

1. A lifting device for suspension from the end of the cable of a lifting and transporting apparatus of the traveling crane type, comprising, in combination:
 - (a) an L-shaped lifting fork having at least one substantially horizontal arm defining a finger, and an upright carrier element having one end rigidly connected to one end of said arm;
 - (b) at least one linkage connected to said carrier element near the other end thereof and forming, together with said carrier element, a deformable quadrilateral;
 - (c) cable attachment means connected to said linkage near that upper corner, of said quadrilateral which is farthest away from said fork; and
 - (d) at least one counterpoise carried by said linkage in proximity to that lower corner of said quadrilateral which is farthest away from said fork.
2. An arrangement as defined in claim 1 wherein said quadrilateral is deformable only by variations of the angles between its adjacent sides and said linkage comprises: a rigid suspension element; at least one upper link; and at least one lower link which is longer than said upper link; each of said links having one end pivotably connected to said carrier element and the other end pivotably connected to said suspension element, the connection points of said links on said carrier element being closer together than the connection points thereof on said suspension element.

3. An arrangement as defined in claim 2 wherein said linkage carries two counterpoises one of which is mounted on the lower end of said suspension element, and said lower link has a projection which extends beyond the pivotable connection of said lower link to said suspension element, the other one of said counterpoises being mounted on said projection.

4. An arrangement as defined in claim 2 wherein said linkage further comprises a projection rigidly connected to said lower link and extending beyond the pivotable connection of said lower link to said suspension element, and said counterpoise is carried by said projection.

5. An arrangement as defined in claim 1 wherein said linkage comprises a rigid suspension element defining one side of said quadrilateral, and said counterpoise is mounted on the lower end of said suspension element, said arrangement further comprising an additional balance element carried by said linkage for maintaining the equilibrium of said arrangement when said fork is unloaded.

6. An arrangement as defined in claim 5 wherein said additional balance element is constituted by an additional counterpoise.

7. An arrangement as defined in claim 5 wherein said additional balance element is constituted by at least one spring disposed between two of the sides of said quadrilateral for maintaining said fork arms substantially horizontal when said fork is unloaded and for nullifying the influence of said counterpoise when said fork is unloaded.

8. An arrangement as defined in claim 5 wherein said additional balance element is constituted by a combination of an additional counterpoise carried by said linkage and at least one spring connected between two sides of said quadrilateral.

9. An arrangement as defined in claim 1 further comprising at least one stop means disposed between two sides of said quadrilateral for limiting the deformation of said quadrilateral when said fork is unloaded.

10. An arrangement as defined in claim 1 wherein said carrier element is constituted by a frame having two uprights connected together by cross bars, there are provided two linkages each connected to a respective one of said uprights to form a deformable quadrilateral, and the sides of said quadrilateral which are opposite said uprights are connected together to form a rigid suspension element.

11. An arrangement as defined in claim 10 wherein one of said cross bars of said carrier element is disposed near the lower end thereof and said suspension element comprises at least one cross bar, said arrangement further comprising flexible connecting means connecting together said at least one bar of said carrier element and said cross bar of said rigid suspension element for determining the maximum permissible separation between said elements.

12. An arrangement as defined in claim 1 wherein said quadrilateral is deformable by variations of at least some of the angles between its adjacent sides together with a

related variation of the length of at least one of its sides, and said linkage comprises: a rigid suspension element; at least one upper link having one end pivotally connected to said carrier element and the other end pivotally connected to said suspension element; and means defining a camming surface carried by one of said elements and supporting the other one of said elements for movement therealong; whereby movement of said other element with respect to said camming surface produces a variation of the length of at least one of the sides of said quadrilateral.

13. An arrangement as defined in claim 12 wherein said upper link is provided with a projection which extends beyond the pivotable connection of said upper link with said suspension element, and wherein said linkage carries two counterpoises one of which is mounted on said projection, whereby said upper link, said projection and said counterpoise constitute a balance beam.

14. An arrangement as defined in claim 12 wherein said means defining a camming surface has one end rigidly connected to said rigid suspension element and has its other end, which constitutes said camming surface, supporting said carrier element.

15. An arrangement as defined in claim 14 further comprising: a bar having one end rigidly connected to said carrier element; and a freely rotatable cam follower wheel mounted on the other end of said bar and bearing against said camming surface.

16. An arrangement as defined in claim 14 wherein said means defining a camming surface is shaped for causing the length of the side of said quadrilateral extending between said suspension element and said carrier element to decrease progressively as the weight of the load applied to said fork increases.

17. An arrangement as defined in claim 16 wherein said means defining a camming surface is shaped in such a way that the length of a line which is perpendicular to said camming surface and which extends between said camming surface and the median plane of said suspension element decreases progressively from the lower end of said camming surface to the upper end thereof.

18. An arrangement as defined in claim 1 wherein said fork is disposed to one side of a vertical plane passing through said cable attachment means and the center of gravity of said counterpoise is disposed to the other side of such vertical plane.

References Cited

UNITED STATES PATENTS

2,514,307	7/1950	Boyd	294—82
2,987,339	6/1961	Kaplan	294—82 X

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