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[54] **DIGGING AND LIFTING DEVICE**
6 Claims, 6 Drawing Figs.

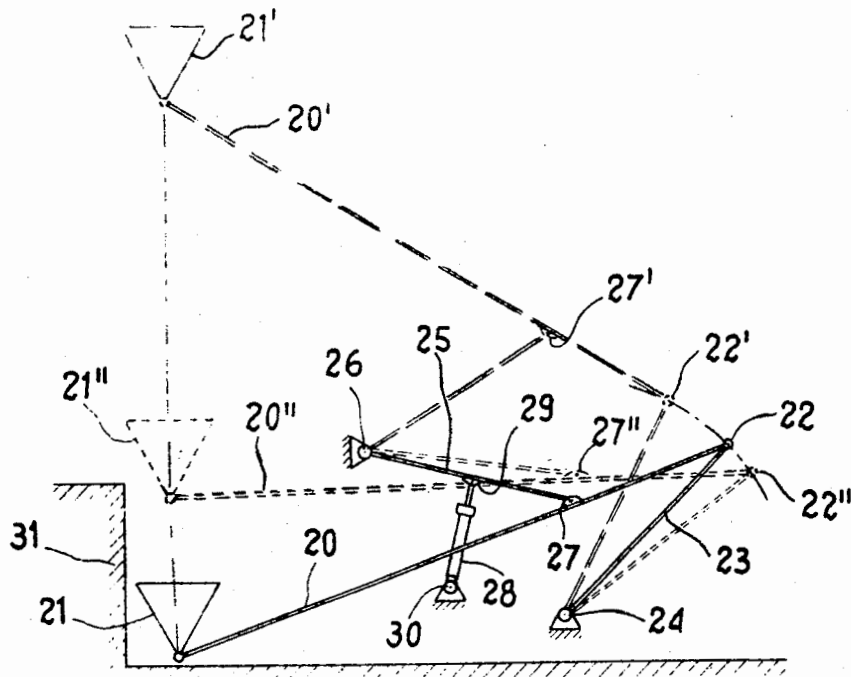
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140, 773, 774, 775, 776, 142; 37/103, 117.5

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ABSTRACT: A digging and lifting device having a bucket lifted by a pair of arms, each of which is on turn connected to the vehicle body through two connecting rods pivoted at one end and at an intermediate point thereof. The arms are in such a manner parallelly controlled by an articulated quadrilateral so to impart to the bucket a substantially vertical path. In addition, a pair of articulated parallelograms maintain the bucket parallel to itself while being lifted and a movable ballast provides to limit within an acceptable range the equipment gravity center shiftings during the bucket operation.



SHEET 1 OF 4

PRIOR ART Fig. 1

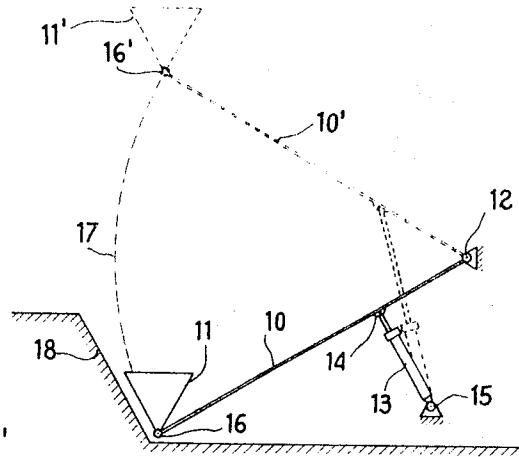


Fig. 2

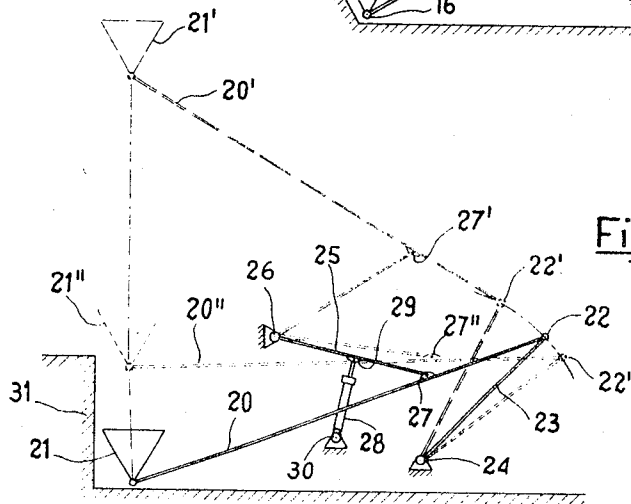
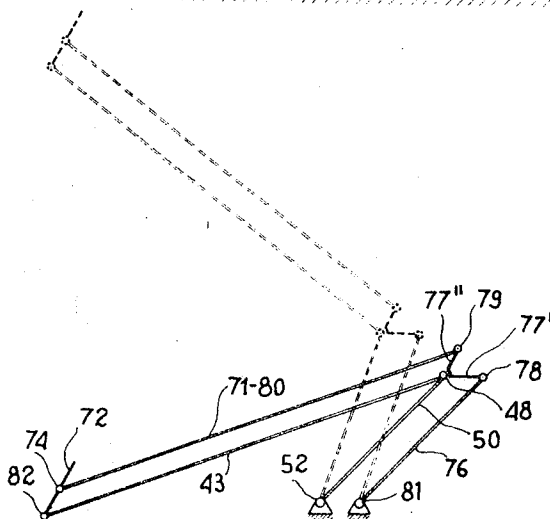


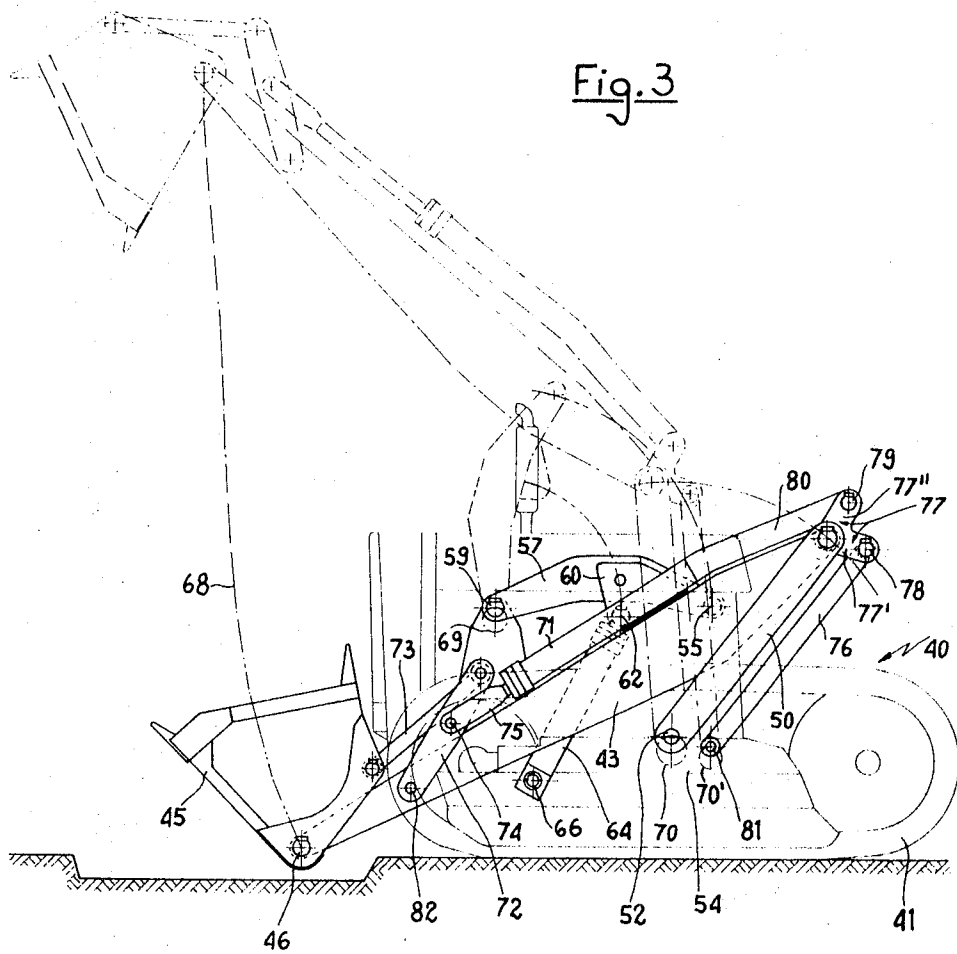
Fig. 5



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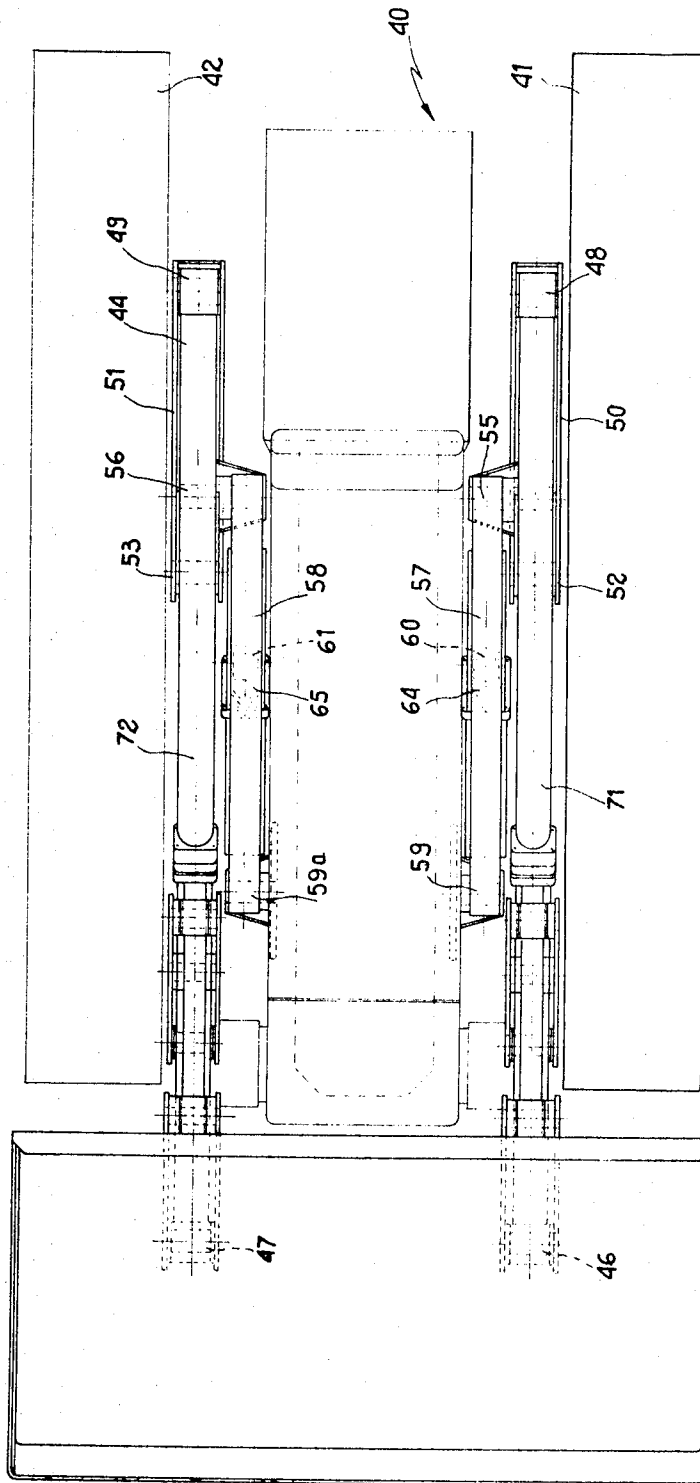
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Fig. 4



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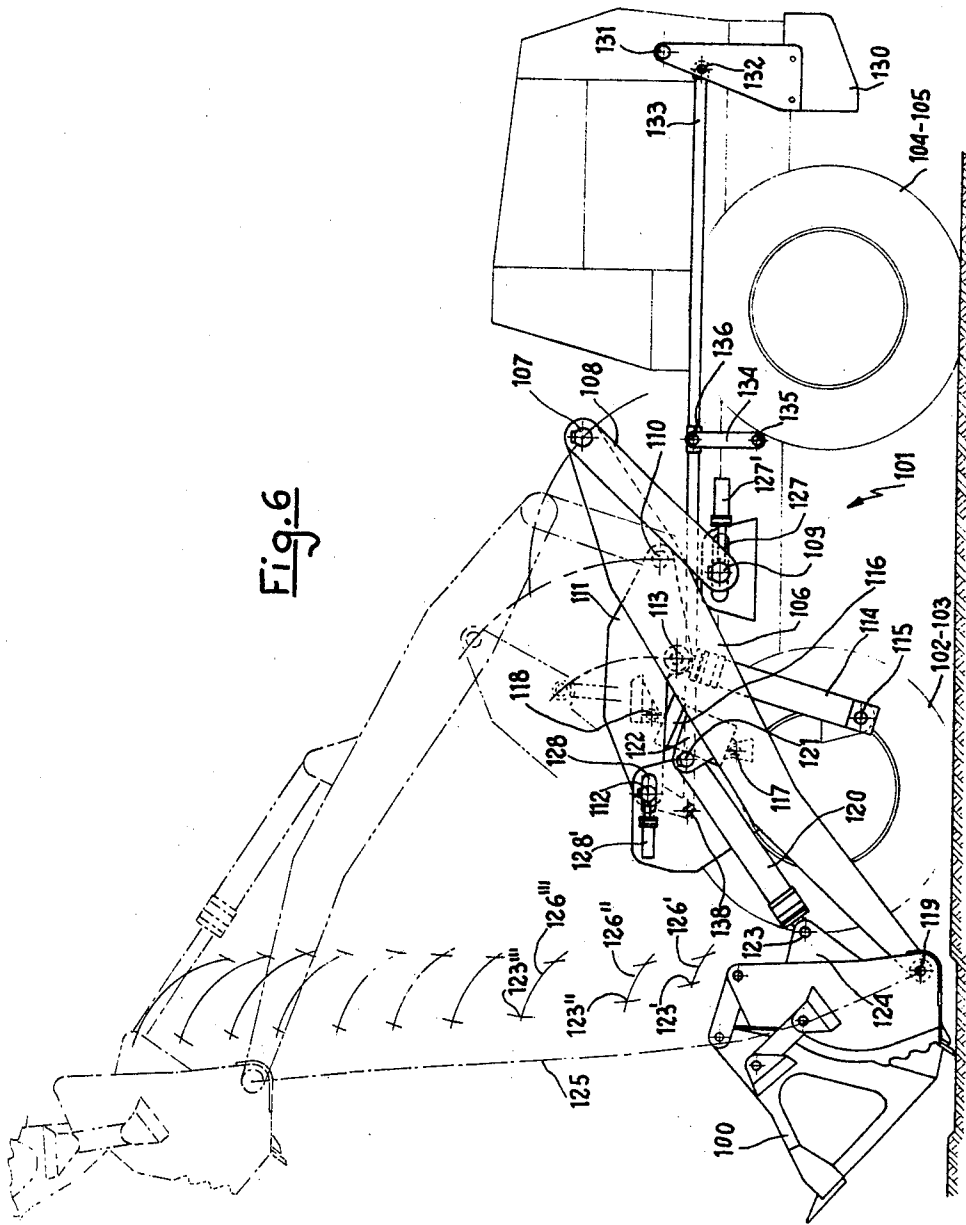


Fig. 6

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DIGGING AND LIFTING DEVICE

BACKGROUND

This invention relates to a device for lifting preferably loose materials, and in particular to a digging and lifting device of the type comprising a grabbing or excavating bucket. In more detail, the present invention relates to the field of power shovels as fitted on tractors or like tracked, half-tracked, wheeled or like self-propelling means, which comprise a standard bucket adapted to be driven upwardly along a soil escarpment that is being formed, or a grabbing bucket. In either cases, said bucket is lifted to dump the soil or other excavated material onto transport means, which may be e.g. a tipper or like truck.

As already well known, the digging and lifting devices of the type above described generally comprise an arm, or a pair of arms, adapted for supporting the bucket and having their opposite ends pivotally connected with a stationary pivot point, which is usually located at the highest possible level on the vehicle body in order to attain the greatest possible lifting height with the smallest possible arm length.

However such an arrangement results in many drawbacks from both viewpoints of digging sharpness and of dump easiness, as well as from the viewpoint of physical and mechanical balance of the whole digging equipment. Amongst such drawbacks which will be fully described later on a prominent one is that the curved path of a conventional bucket does not allow an easy formation of suitable and convenient soil escarpments, e.g. vertical or substantially vertical escarpments, while on the other hand the bucket is brought, at the upper end of its path, into a position which is approximately above the vehicle or at any rate—unless very long and thus expensive and hardly controlled arms are utilized—very near to vehicle. As it can be readily appreciated, when the bucket lies in such a position, the dumping of soil or like materials onto a truck becomes very difficult and can be effected only onto the end thereof and not onto the middle section, as it would be obviously convenient and desirable.

A further drawback inherently caused by said curved path of conventional buckets is represented by the highly erratic positions taken by the center of gravity of digging equipment in the course of lifting operation, which results in undesirable instability of the equipment and in heavy wear of load-bearing transmission elements. Moreover, large variations occur both in the required lifting power—which results in the necessity to have a prime mover proportionally overdimensioned—and in the bucket lifting speed, which varies according to different positions taken by the axis of the lifting jack or jacks in respect to the fixed pivot point at which the arm is pivotally connected to the vehicle.

The above and further drawbacks of the already known digging equipments are obviated by the device according to the invention, which also provides novel and advantageous features for said digging and lifting means. The device according to the invention is essentially characterized in that the arm or each arm by which the bucket or like lifting means is supported is pivotally linked to at least one pair of connecting rods which are on turn pivotally connected to the vehicle frame in such a manner as to form an articulated quadrilateral therewith, being said articulated quadrilateral arranged in such a manner as to constrain the bucket or like means to follow a preestablished lifting path, different from an arc of circle and in particular to follow the contour of a rational soil escarpment, as well as to dump the lifted material from an advantageous position. In particular, two bucket supporting arms, located substantially parallel with each other on either side of vehicle, may be provided, each arm being controlled by a pair of connecting rods, parallel to connecting rods of the opposite arm, which are pivotally connected to the arm at the end opposite to that carrying the bucket and at an intermediate point of the same, the connecting rods being in turn pivotally connected to the vehicle body.

In order to take full advantage of a path opportunely calculated for the operations to which the device is designed, each pair of connecting rods is pivotally connected with the related arm in such a manner as to bring about, in each position thereof, a compensation of the deviations from a substantially vertical path which would be suffered by the bucket when the supporting arm thereof swings on its pivotally connected end, as stationary maintained; such compensation is obtained by shifting said arm end in an opposite direction by the action of said related pair of connecting rods. Thus, an advantageous path can be obtained, having an initial portion close to the vehicle, a substantially vertical middle portion and an end portion allowing to have the material to be dumped under the most convenient conditions.

The previously specified features of this invention will be now described in full detail, along with further inventive features as shown by the device embodying the invention, with reference to preferred embodiments thereof as shown in the accompanying drawings, being both description and drawings given as not restrictive examples of the range of the invention.

DRAWINGS

FIG. 1 diagrammatically shows the conventional means by which the motions of a bucket can be controlled.

FIG. 2 diagrammatically shows the means according to the invention by which the motions of a bucket are controlled.

FIG. 3 is a side view of a first embodiment of the device according to the invention, in a tracked power shovel fitted with a standard bucket.

FIG. 4 is a plan view of power shovel of FIG. 3.

FIG. 5 diagrammatically shows a device according to the invention, by which the bucket is kept parallel to itself while being lifted.

FIG. 6 shows a second embodiment of a power shovel with a grabbing bucket and a movable ballast adapted to compensate the gravity center shiftings as caused by the bucket travel.

PREFERRED EMBODIMENTS

Referring now to FIG. 1, it diagrammatically shows drive means for an arm 10 by which a grabbing bucket 11 is lifted. Such arm 10 is connected to a pivot point 12, firmly secured to the tracked vehicle body and is operated by a jack 13 which on turn is pivotally connected at 14 to the arm 10 and at 15 to the tracked vehicle body, in such a manner that any point of the bucket 11, e.g. the pivot point 16, is compelled to travel along a path 17, consisting of an arc of circle. Such curved path necessarily results in the formation of a soil escarpment 18 which is inclined with respect to the vertical plane. Said escarpment shape is not presently accepted, since vertical or nearly vertical escarpments are preferred, being such escarpments retained by the successive application of soil supporting means. Moreover, the bucket 11, when in its fully lifted position 11', is usually too close to vehicle body and thus a dump of material onto the middle section of a truck or similar transport means is not possible. It would be possible to prevent such drawback by providing a sufficiently long arm 10, which however is more expensive, more difficult to control and in addition requires also greater continuous power ratings of lifting means; consequently, the general trend is directed toward a decrease of arm length. Due to such restrictions, imposed upon the size of arm 10, the pivot point 12 thereof usually needs to be located at an inconveniently high level in order to allow the bucket 11 to be raised to a sufficient height for a convenient dumping, without requiring a too large extension of piston rod of hydraulic jack 13.

Further ill-effects of the already known drive means are to be traced back to the shiftings of the equipment gravity center in respect to a vertical plane when the bucket is being lifted, which results in a marked instability of the equipment, as well as in heavy wears of the load-carrying transmission elements, which are subjected to variable stresses owing to a varying weight distribution while the equipment is in operation. In ad-

dition, a widely variable lifting force is required in the known drive means between the lowest position of the arm 10 and the highest position 10' thereof, which results in an excessively variable lifting rate when a constant extension rate of the piston rod of jack 13 is maintained, due to different positions taken by the axis 14, 15 of said jack 13 in respect of the arm pivot point 12.

The above drawbacks are wholly prevented or at least reduced by the driving means according to the invention, substantially as shown in FIG. 2, wherein only one lifting arm is diagrammatically shown, as in FIG. 1.

As shown in FIG. 2, such arm 20 for lifting the bucket 21 has not its end 22 directly connected to the body of a vehicle, being said end pivotally connected instead to a first connecting rod 23 which is in turn pivotally connected at 24 to the tracked vehicle or the like. A second connecting rod 25 is pivotally connected at 26 to the vehicle body and at 27 to an intermediate point of arm 20, the latter connecting rod being preferably acted upon by a hydraulic jack 28 connected thereto at 29 approximately at the middle of connecting rod 26 and pivotally connected to the vehicle at 30.

As it can be readily appreciated, said driving means for the bucket 21 allow to have the bucket 21 moved along any suitable path, by suitably positioning the pivot points of the connecting rods 23 and 25, and in particular along a path by which due account is taken of the previously specified factors, whereby ensuring the equipment operation under the best conditions. Thus, a soil escarpment 31 very close to a vertical plane can be obtained, while at the same time the bucket can be brought into a dump position 21' in which it is suitably spaced from the vehicle body without need of increasing the length of arm 20, but on the contrary with the possibility of reducing this length due to the action of connecting rod 23.

Amongst the various advantages, the following ones are to be emphasized: the pivot points 24, 26 and 30 can be kept in such a low position on the vehicle that no supporting frame is needed; the arm can be lifted with nearly constant power input and speed; and finally a lifting can be performed without having the equipment gravity center to undergo an unnecessarily large shifting. It is clear that by connecting the connecting jack 28 to the middle of connecting rod, a relatively short-stroke movement is obtained. Such a short-stroke movement permits use of a sturdier lifting arm or jack than is employed with prior art devices.

An arrangement of connecting rods 23, 25 in respect of arm 20 similar or substantially similar to that as shown in FIG. 2 is particularly advantageous for the attainment of the above stated purposes. In fact, such an arrangement gives the possibility to accomplish a suitable compensation of deviations from a substantially vertical path to which the bucket would be subjected should the pivot point 22 be kept stationary. Such compensation is brought about as a consequence of a shifting of pivot point 22 in an opposite direction, caused by the combined action of connecting rods 23 and 25. In particular, the pivot point 22 will tend to move backwards to a position 22'', in the course of a first portion of the bucket path, which substantially corresponds to the portion of path which would shift the bucket outwardly should the pivot point 22 be kept stationary. Then, the pivot point 22 is shifted from the position 22'' in an opposite direction, until attaining its final position 22', whereby to compensate the inward deviations to which the bucket 21 would be subjected (i.e. from the position 21'' to position 21') should the pivot point 22 be kept stationary.

The above feature allows in a rather easy manner a substantial vertical bucket path to be maintained along its whole travel; any deviation from said vertical path, which could possibly be considered as desirable can be easily obtained by a suitable shifting of the pivot points 24 and 26. It is to be observed that the above stated advantageous feature is obtained due to the fact that in the lowest position of arm 20 the pivot point 26 of connecting rod 25 is higher than the axis of said arm, whereby in the course of lifting operation a position is at-

tained wherein the axis 26—27'' of connecting rods 25 is parallel to axis of the arm 20'' which position defines the point wherein an inversion in the shifting direction of the pivot pint 22 occurs.

Referring now to FIGS. 3 and 4, a description will be given of a first embodiment of the drive mechanism already examined with reference to FIG. 2 as embodied in a power shovel equipped with a standard bucket. Said shovel is fitted on a tractor 40 movable on tracks 41 and 42, and its digging and lifting motions are performed by two arms 43 and 44, to which the bucket is connected at the pivot points 46 and 47. Each arm 43 and 44, which are kept always parallel with each other, is pivotally connected to its opposite end 48 and 49, respectively, to a first connecting rod 50 and 51 respectively, that is in turn pivotally connected to the fixed pivot point 52 and 53 respectively on the tractor frame 54. Further connecting rods 57, 58 located misaligned in respect of related arm are pivotally connected at one end to intermediate points 55, 56 of arms 43, 44 and at the opposite end to the pivot points 59 59a on the tractor frame. Fast with said further connecting rods 57, 58 are two plates 60, 61 to which a pair of lifting jacks 64, 65 are pivotally connected at 62, 63, being the opposite ends of said jacks pivotally connected at 66, 67 to the tractor frame. The operation and advantages of above stated lever arrangement have been already described with reference to FIG. 2, so that it will be sufficient only to state that, when a standard bucket it utilized as in this case a substantially vertical path such as that indicated by the reference number 68 can be obtained by the pivot point arrangement shown in said FIG. It is to be observed that the bucket 45, when in its final position as shown with dash-and-dot lines lies at a relatively large horizontal distance from the tractor body, whilst it is very close thereto in its lowest starting position.

The path 68 can be modified at the convenience both in the manufacturing stage e.g. by an arrangement of pivot points different from that shown in the figures, and while the equipment is in operation, by the provision of means allowing said pivot points to be shifted steplessly or along a row of preestablished positions. Said means may be in the form of a row of holes provided in the tractor frame wherein the pivot points can be conveniently arranged or—as stated in more detail later on—of a combination of guides and control means for said pivot points, or finally—as shown in FIG. 3—by having the pivots 52 and 59 and the pivot points on the other side of the tractor corresponding thereto eccentrically secured to the frame, whereby said pivots can be forcibly moved along a circumference having a suitably selected diameter, as e.g. the circumference 69 and 70.

Fitted on the bucket supporting arms 43 and 44 are means adapted to control the bucket motions in respect of the related pivot points 46 and 47. Such means may consist of a pair of hydraulic jacks 71, 72 located parallel to related arm and each acting through a leverage system as shown in FIG. 3, which consists of two levers 72, 73 pivotally connected to each other as well as to the arm 43 and to the bucket 45, the lever 72 being also pivotally connected at 74 to the extensible piston rod 75 of jack 71. It is thus possible to obtain a tilting bucket as shown in the upper section of FIG. 3, as well as, by suitably controlling the jack 71, a compensation of the successive inclinations of arms while being lifted, whereby to keep the bucket 45 always parallel to itself. This latter result can be also attained through mechanical means (as shown in FIG. 3) that consist for each arm 43 of a lever 76 and of an angle bar 77, pivoted at 48 and hinged at 78 to said lever 76 and at 79 to a further lever 80 that is directly secured to the fast end of jack 71. By such design, as diagrammatically shown in FIG. 5, the above stated compensation can be easily obtained and the bucket is always kept parallel to itself without necessity of utilizing the jack 71 which may be considered to this purpose as a rigid and inextensible rod.

The device utilized for keeping the bucket 45 always parallel to itself while being lifted is diagrammatically shown in FIG. 5, being in said diagram utilized the same reference nu-

merals of FIG. 3 with the addition of arms 77' and 77'' of angle bar 77, the pin 81 by which the lever 76 is hinged to tractor frame and the pin 82 by which the lever 72 is hinged to arm 43. Moreover, the assembly consisting of rod 80, jack 71 and related rod 75 is diagrammatically shown by a single rod 71—80. Referring now to said FIG. 5, it can be observed that two articulated parallelograms are formed by the assembly of said rods, i.e. a first parallelogram consisting of rods 76, 77', 50 and the line through the points 52 and 81, and a second parallelogram consisting of the rods 77'', 71—80, 72 and 43. It will be therefore obvious that in the course of motions caused by the connecting rod 50, the first articulated parallelogram is forced to keep the side 77' always parallel to itself, since said side 77' must remain parallel to the line through the two fixed points 52 and 81. As the lever 77' maintains its orientation, the lever 77'' correspondingly maintains its own orientation, being rigidly connected to the former one in such a manner as to move always parallel to itself. Thus the opposite side 72 of the second articulated parallelogram will remain always parallel to itself too and to lever 77'', whatever the motions of arm 43 may be. Referring again to FIG. 3, it is obvious that due to the existing connection, when the lever 72 is kept always parallel to itself the bucket 45 will also be kept parallel to itself while being lifted.

A second embodiment of this invention is shown in FIG. 6. This embodiment relates to a grabbing bucket 100 fitted on a tractor 101 mounted on wheels 102, 103 and 104, 105, the bucket being operated on either tractor sides (only the tractor side shown in the figure will be considered in the following description) by an arm 106 pivotally connected at 107 with a first connecting rod 108. Said rod 108 is on turn connected at a pivot pint 109 with the vehicle frame, being said arm pivoted at 110 to a second rod 111, that is pivotally connected at 112 with the vehicle frame. Pivotally connected at 113 with said lever 111 is a jack 114 which on turn is pivoted at 115 and with which a compensating jack 116 is associated, this latter jack being pivotally connected at 117 with the vehicle frame and at 118 with the rod 111. Pivotally connected at 119 with the outer end of arm 106 is a bucket 100 operated by the jack 120 which is pivoted at 121 on the gusset 122 welded to arm 106 and pivotally connected at 123 with the bucket gusset 124. In this latter case the successive inclination of movable arm is compensated by conveniently operating said jack 120, which automatically provides through the drive mechanism by which the jack 116 is operated to keep the bucket always parallel to itself while being lifted; however, as an alternative, recourse may be made also to previously described mechanical means.

With the considered grabbing bucket it is particularly important to have a bucket path with a lowermost position very close to tractor and an uppermost position as far as possible therefrom. Such a path can be easily obtained as shown at 125 through the means according to the invention and in particular by the arrangement of levers and pivot points as shown in FIG. 6 wherein 126', 126'', 126'''... are the arcs of circumference along which the point 123 can be caused by the jack 120 to travel around the rotation center 119 in the different successive positions of the latter while the bucket is being lifted.

Even in the latter embodiment the shape of path 125 can be modified by the previously specified means adapted to change the position of pivot points and in particular of pivot points 109 and 112. In the latter embodiment two elongated slots 127, 128 within which the pivots 109 and 112 can be suitably shifted under the control of jacks 127' and 128' or the like are provided. In such a manner, as in the preceding case, it is possible to have the whole space of a plane extending between two limiting paths covered by a point of the bucket, thereby hereby adapting the bucket to different applications each time as required.

In the presently considered case, wherein a bucket path rather different from the vertical one is required, proportional shiftings of the equipment gravity center will obviously occur

while the load is being lifted. To prevent the ill effects which would be caused by such shiftings of the gravity center in respect of vertical plane wherein it originally lies, means are provided which are suitably shifted while the bucket is being lifted, thereby maintaining said gravity center within an acceptable range about its initial position. Such means may consist of movable ballast 130, as shown in FIG. 6, pivotally connected at 131 with the tractor frame in a position opposite to that of bucket in respect of the equipment gravity center. Said movable ballast is pivotally connected at 132 with a controlling rod 133 adapted to shift outwardly or inwardly the ballast according to bucket motions, thereby displacing the ballast gravity center and hence the equipment gravity center in such a manner as to substantially equalize the bending moments, as caused by the ballast and by the bucket in respect of a fixed point on the tractor body. Said rod 133 which is guided in its intermediate position by the connecting rod 134 pivoted at 135 and 136 is advantageously controlled by the motions of connecting rod 111, through the lever 137 which has one end secured thereto and the opposite end pivotally connected at 138 to said control rod 133. In such a manner, a displacement of ballast 130 is obtained, which corresponds to the angular motion of lever 111 and thus to bucket liftings and substantially to the outward shiftings thereof.

It is understood that, while the invention has been disclosed with particular reference to digging equipments, it can however be applied also to all other equipments wherein a lifting is generally required along a path more or less different from an arc of circle.

Obviously many modifications and changes of the present invention are possible in the light of the above teachings. Therefore, it is to be understood that the invention is not limited to the details specifically described and illustrated, and that within the scope of the appended claims it may be differently practiced.

I claim:

1. A lifting device preferably for loose materials and in particular a digging and lifting device equipped with a standard or grabbing bucket of the type mounted on self-propelled industrial vehicles or the like and comprising material lifting means, arm means by which said material lifting means is provided with first and second ends and an intermediate portion therebetween, a first connecting rod having first and second ends, said first end of said first connecting rod being pivotally connected to the vehicle frame at a first point, said second end of said first connecting rod being pivotally connected to said arm means in said intermediate region, a second connecting rod having first and second ends, said first end of said second connecting rod being pivotally connected to said vehicle frame at a second point, said second end of said second connecting rod being pivotally connected to said arm means at said second end of said arm means, said first and second points and the pivot connections be between said arm means and said first and second connecting rods forming vertexes of an articulated quadrilateral, said first connecting rod being moved in a direction opposite to the direction of movement of said arm means, wherein said material lifting means follows a substantially vertical preestablished lifting path wherein said first connecting rod being acted upon by a lifting jack, said jack being pivotally connected at one end to an intermediate point of said first connecting rod and at the opposite end to the vehicle body.

2. A device according to claim 1, wherein said lifting jack is connected to said first connecting rod at approximately the middle thereof.

3. A device according to claim 2 wherein said lifting jack is provided with a relatively short-stroke motion.

4. A lifting device preferably for loose materials and in particular a digging and lifting device equipped with a standard or grabbing bucket of the type mounted on self-propelled industrial vehicles or the like and comprising material lifting means, wherein arm means by which said material lifting means is provided with first and second ends and in intermediate por-

tion therebetween, a first connecting rod having first and second ends, said first end of said first connecting rod being pivotally connected to the vehicle frame at a first point, said second end of said first connecting rod being pivotally connected to said arm means in said intermediate region, a second connecting rod having first and second ends, said first end of said second connecting rod being pivotally connected to said vehicle frame at a second point, said second end of said second connecting rod being pivotally connected to said arm means at said second end of said arm means, said first and second points and the pivot connections between said arm means and said first and second connecting rods forming vertexes of an articulated quadrilateral, said first connecting rod being moved in a direction opposite to the direction of movement of said arm means, wherein said material lifting means follows a substantially vertical preestablished lifting path, and comprising means for shifting the pivot means formed at the connections of the first ends of said first and second connecting rods, and said vehicle frame, said means consisting of a plurality of holes aligned on the vehicle body and adapted to accommodate pivot pins.

5. A lifting device preferably for loose materials and in particular a digging and lifting device equipped with a standard or grabbing bucket of the type mounted on self-propelled industrial vehicles or the like and comprising material lifting means, wherein arm means by which said material lifting means is provided with first and second ends and an intermediate portion therebetween, a first connecting rod having first and second ends, said first end of said first connecting rod being pivotally connected to the vehicle frame at a first point, said second end of said first connecting rod being pivotally connected to said arm means in said intermediate region, a second connecting rod having first and second ends, said first end of said connecting rod being pivotally connected to said vehicle frame at a second point, said second end of said second connecting rod being pivotally connected to said arm means at said second end of said arm means, said first and second points

and the pivot connections between said arm means and said first and second connecting rods forming vertexes of an articulated quadrilateral, said first connecting rod being moved in a direction opposite to the direction of movement of said arm means, wherein said material lifting means follows a substantially vertical preestablished lifting path, and comprising means for shifting the pivot points formed at the connections of the first ends of said first and second connecting rods and said vehicle frame, said means consisting of hydraulic shifting means by which respective point pins are shifted within seats provided on the vehicle frame.

6. A lifting device preferably for loose materials and in particular a digging and lifting device equipped with a standard or grabbing bucket of the type mounted on self-propelled industrial vehicles or the like and comprising material lifting means, wherein arm means by which said material lifting means is provided with first and second ends and an intermediate portion therebetween a first connecting rod having first and second ends, said first end of said first connecting rod being pivotally connected to the vehicle frame at a first point, said second end of said first connecting rod being pivotally connected to said arm means in said intermediate region, a second connecting rod having first and second ends, said first end of said connecting rod being pivotally connected to said vehicle frame at a second point, said second end of said second connecting rod being pivotally connected to said arm means at said second end of said arm means, said first and second points and the pivot connections between said arm means and first and second connecting rods forming vertexes of an articulated quadrilateral, said first connecting rod being moved in a direction opposite to the direction of movement of said arm means, wherein said material lifting means follows a substantially vertical preestablished lifting path, said first ends of said first and second connecting rods being provided with respective pivot pins, said respective pivot pins being eccentrically and adjustably attached to the vehicle frame.