

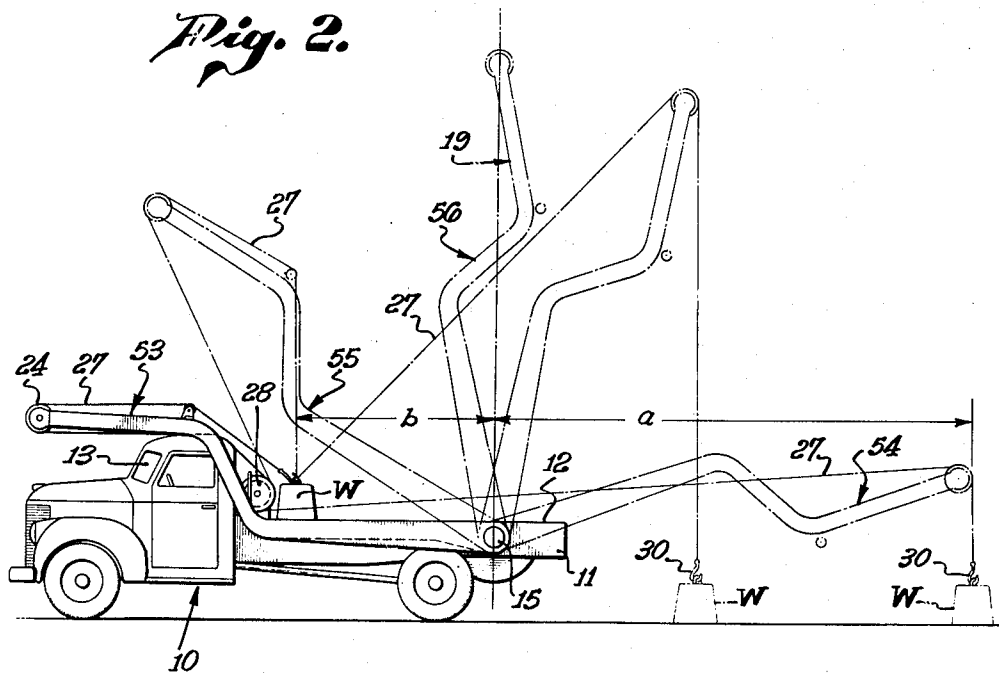
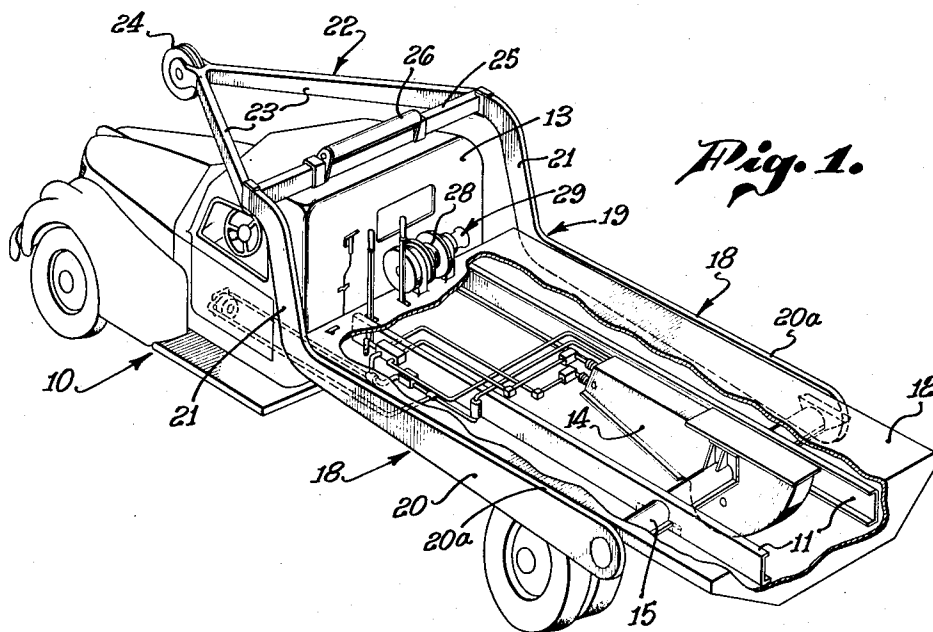
Sept. 14, 1954

J. A. OLSON
HOISTING APPARATUS

2,689,053

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3 Sheets-Sheet 1



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3 Sheets-Sheet 2



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3 Sheets-Sheet 3

Fig. 6.

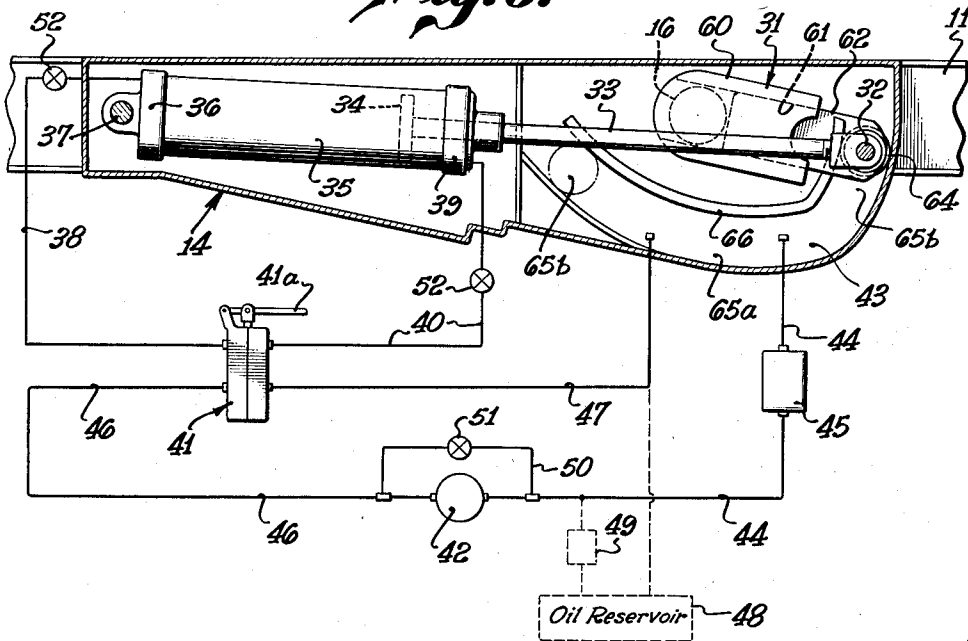


Fig. 7.

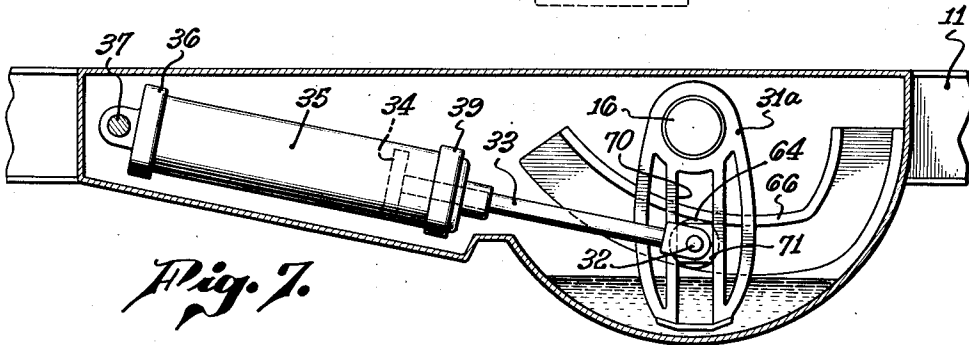
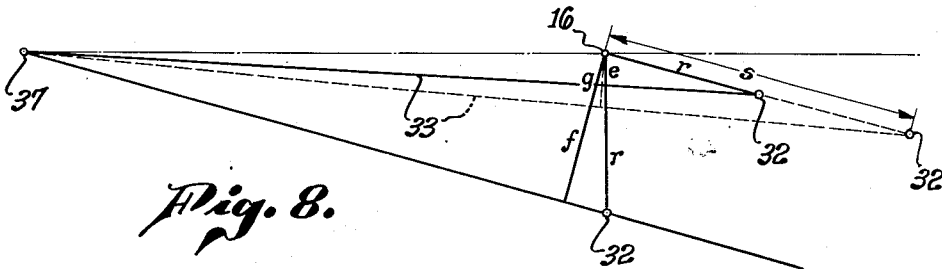


Fig. 8.



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UNITED STATES PATENT OFFICE

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HOISTING APPARATUS

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4 Claims. (Cl. 214—77)

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The present invention relates to hoisting apparatus, and to mechanical movements that may form part of such apparatus.

Certain types of hoisting apparatus may employ a pivoted boom in lifting and transporting a load from one point to another. The boom may be swung through a substantial arcuate extent to occupy various positions, which may range from substantially horizontal in one direction, through the vertical, to substantially horizontal in the opposite direction. When a load is carried by the free end of the boom, a greater torque is required to swing the boom from the substantially horizontal positions because the moment arm is greater. As the boom approaches the vertical, the effective moment or lever arm of the load decreases, and the torque required to swing the boom decreases, correspondingly.

Heretofore, a fluid or hydraulically operated cylinder, piston and crank mechanism has been coupled directly to the boom in effecting its swinging to the various positions above noted. The line of application of the hydraulic force provided by the cylinder and piston is located close to a dead center crank position, or coplanar with the crank mechanism, when the boom is substantially horizontally disposed. When in this position, the effective lever arm of the piston device on the crank is at a minimum value, and this minimum value occurs at a time when the torque load on the crank is at a maximum, in view of the horizontal disposition of the boom. Conversely, when the boom is in a vertical position, the torque load on the crank is at a minimum, but at this time, the effective lever arm of the piston device on the crank is at an unrequired maximum, at which the hydraulic mechanism is capable of imposing a maximum torque on the crank.

The foregoing arrangement and disadvantageous conditions are found particularly in boom hoisting apparatus mounted on motor trucks, trailers, boats, barges, and similar vehicles. In such vehicles, it is desirable to mount the operating mechanism as much as possible under the vehicle bed or load carrying platform. This is desirable, and has not heretofore been attainable without some interruption in the continuity in the bed or platform, which interferes with the load carrying utilization and capacity of the vehicle.

Accordingly, an object of the invention is to provide an improved hoisting apparatus capable of imposing an increased torque on the hoisting boom when the latter occupies substantially hori-

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zontal positions, or positions approaching the horizontal.

Another object of the invention is to provide a hoisting apparatus, in which the effective lever arm of the prime mover mechanism on the crank mechanism is increased when the boom occupies its substantially horizontal position or positions.

Another object of the invention is to provide an improved hoisting apparatus capable of operating under more uniform load conditions on the prime mover as the boom is shifted between horizontal and vertical positions.

A further object of the invention is to decrease the effective lever arm of the prime mover mechanism on the crank mechanism as the effective lever arm of the load on the boom decreases, thereby preventing wide load variations on the prime mover mechanism.

Yet a further object of the invention is to provide a hoisting apparatus particularly adapted for use on a vehicle, in which the apparatus does not interfere with the vehicle load carrying platform or bed, the horizontal surface of the latter remaining uninterrupted.

Still another object of the invention is to provide a hoisting apparatus embodying operating mechanism which requires less vertical distance for its operation, thereby enabling the mechanism to occupy a lesser vertical space.

A further object of the invention is to provide a hoisting apparatus in conjunction with a vehicle platform, in which the hoisting boom is capable of forming a continuation of the platform when not in use for hoisting purposes.

Still another object of the invention is to provide a hoisting apparatus embodying a crankshaft connected to the hoisting boom, which does not interfere with the movement or range of movement of the prime mover mechanism coupled to it.

Yet another object of the invention is to provide an improved mechanical movement for varying the throw of the crank mechanism. Such throw is increased or decreased in accordance with the load requirements on the mechanism, or in accordance with the particular instantaneous position that the mechanism occupies.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of several forms in which it may be embodied. Such forms are shown in the drawings accompanying and forming part of the present specification. These forms will now be described in detail, illustrating the general principles of the invention;

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but it is to be understood that such detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

Figure 1 is a perspective view, with parts being broken away, of a hoisting apparatus as installed on a motor vehicle;

Fig. 2 is a diagrammatic side elevation of the operation of the boom portion of the hoisting mechanism;

Fig. 3 is a longitudinal section through the prime mover and crank portion of the hoisting device;

Fig. 4 is an enlarged section taken along the line 4-4 on Fig. 3;

Fig. 5 is a fragmentary section taken along the line 5-5 on Fig. 3;

Fig. 6 is a somewhat diagrammatic view, similar to Fig. 3, illustrating the crank mechanism in another operative position, and also disclosing the hydraulic control system for the hoisting apparatus;

Fig. 7 is a somewhat diagrammatic view, similar to Fig. 3, of a slightly modified form of the invention; and

Fig. 8 is a diagrammatic representation of the variable effective movement of lever arms obtainable by the apparatus disclosed.

The hoisting apparatus is disclosed in the drawings as applied to a motor truck 10 having the usual side channels or rails 11 of the chassis, which support the bed or platform 12 disposed to the rear of the operator's or driver's cab 13.

The hoisting mechanism is carried by the chassis channels 11. As shown most clearly in Fig. 4, the mechanism, with the exception of the boom, is disposed within a suitable enclosure including a central, longitudinally extending housing 14 for the hydraulic prime mover mechanism and crank mechanism, and transverse tubular housings 15 on opposite sides of the central housing, extending through the chassis channels 11 to a point outside the truck platform 12. The tubular housings 15 are suitably secured to the central housing 14 and serve as a means for supporting the latter.

A tubular crankshaft mechanism is disposed within the housings 14, 15. This mechanism has oppositely directed tubular shaft portions 16 rotatably supported in bearings 17, in the tubular housing members 15. The shafts extend beyond the outer ends of the tubular housings 15, where they are connected to the side members 18 of the boom 19 and provide a pivotal support for the boom. Each side member includes a leg portion 20, which is adapted to lie adjacent the side edges of the bed 12, and a foot portion 21, integral with the leg portion, which extends transversely to the latter in order that both opposed foot portions may be welded, or otherwise suitably secured, to a triangular boom portion 22, which is offset with respect to the leg portions 20. This triangular portion includes a pair of inclined members 23 suitably welded, or otherwise secured, to the foot portions 21 and joined together at their apex to provide a suitable rotatable support for a sheave or pulley 24. A cross brace 25 extends across the ends of the foot portions 21 and is suitably welded, or otherwise secured thereto to complete the triangular section 22. This cross brace 25 carries a chafing roller 26, over which the cable 27 of the hoisting mechanism may ride.

The offset portion 22 of the boom 18 is provided to allow it to be disposed snugly along and over

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the vehicle cab 13 when not in use, to occupy a minimum vertical height, as illustrated in Figs. 1 and 2.

As is evident from Fig. 1, the triangular offset portion 22 rests in a substantially horizontal position when the boom 18 is not in use, in which position the upper edges 20a of the leg portions 20 preferably occupy a position substantially coplanar with the upper surface of the truck platform 12, thereby increasing the effective area of the platform. The boom 18 may be swung from the collapsed position over the vehicle 10 disclosed in Fig. 1, through a generally vertical position and to a rearward, substantially horizontal position, in which the sheave 24 at the end of the boom extends a substantial distance beyond the axis of the crankshaft (see Fig. 2).

Regardless of the position which the boom occupies, it may be operatively connected to a suitable load or weight W by means of the cable 27. As disclosed in the drawing, the cable extends around the winding drum 28 of a power winch 29 located adjacent the operator's cab 13. This winch may be operated in a known manner by the truck engine through a suitable power take-off device (not shown). The cable 27 extends from the winding drum 28, over the sheave 24 and across the chafing roller 26. The free end of the cable may be suitably secured to the load W, as through the use of a crane hook 30 or the like.

When the boom 18 is in position for raising and lowering loads, the power winch 29 may be suitably operated to wind or unwind the cable 27 from the drum 28, and correspondingly raise or lower the load. When the sheave axis is disposed forwardly of the chafing roller axis, the cable 27 is still free to operate, since the engagement of the cable with the roller 26 will merely rotate the latter, since it functions as a guiding or idler roller.

The pivoting of the boom 18 about the crankshaft axis is accomplished through suitable manipulation of the crank mechanism. This crank mechanism includes adjustable crank arms 31 secured to the inner ends of the tubular shaft members 16, carrying a crank pin 32 at their outer ends, on which the end of a piston rod 33 is pivotally mounted between the crank arms 31. The piston rod is connected to a piston 34 slidable within a cylinder 35, having its head end 36 oscillatably mounted upon a hinge pin 37 secured to the housing 14. Fluid may enter the head end of the cylinder 35 through a suitable conduit 38 to move the piston 34 and piston rod 33 rearwardly. It may also enter the rod end 39 of the cylinder 35 through a suitable line or conduit 40 to move the piston 34 and piston rod 33 in the opposite direction. During this movement, the cylinder may accommodate itself to the vertical shifting of the piston rod 33 by rocking upon its hinge pin 37.

A system for controlling the entry and discharge of fluid into the cylinder 35 is illustrated in Fig. 6. The conduit or intake and exhaust line 38, to the head end 36 of the cylinder is connected to a suitable control valve 41, which may have a manually operable lever 41a. Similarly, the intake and exhaust line 40 runs from the rod end 39 of the cylinder to the control valve 41. Fluid under pressure may be supplied to either end 36 or 39 of the cylinder by an oil pump 42, that may be driven by the truck motor through a suitable power take-off device (not

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shown). The fluid pressure pump 42 draws oil from a suitable sump or reservoir 43, which may be located at the lower portion of the central housing 14, through a suction line 44, in which a filter 45 may be interposed. The pump 42 discharges the oil into another pipe 46 running to the control valve 41, from where the oil under pressure may pass to either the head or rod end 36 or 39 of the cylinder 35 through their respective intake and exhaust lines 38, 40, depending upon the position of the control valve.

The control valve 41, by itself, forms no part of the present invention and is well known. When in one position, the pump 42 may supply oil under pressure to the head end 36 of the cylinder, the rod end 39 of the cylinder and its conduit 40 being arranged for an exhausting condition, the fluid from the rod end passing from the valve 41 through a return line 47 to the oil reservoir 43. Conversely, the control valve 41 may be manipulated, so that the line 38 running to the head end 36 of the cylinder exhausts through the return line 47 to the reservoir 43, while the line 40 running to the rod end 39 of the cylinder receives fluid under pressure from the pump 42.

As an alternative arrangement, a separate oil reservoir 48 may be used, from which the pump 42 draws oil, or other fluid, through a filter 49 into its intake or suction line 44.

Any excess fluid displaced by the pump 42 may flow back to the suction line 44 through a bypass 50, which includes a pressure relief valve 51 that will open at a predetermined pressure, so as to avoid the imposition of too great a pressure in the cylinder 35. As a precautionary measure, safety check valves 52 may be incorporated in the intake and exhaust lines 38, 40 leading to the cylinder.

Since the boom 18 is secured to the crankshaft portions 16, operation of the cylinder and piston mechanism will rotate the crank mechanism to effect a corresponding pivotal movement of the boom. The cylinder and crank mechanism is arranged to avoid the piston rod ever being in a dead center position, whether such position is head end dead center or crank end dead center. The range of movement of the piston 34 in the cylinder 35 is such as to swing the crank arms 31 through a comparatively wide angle. As an example, the crankshaft might swing through an angle of about 160 degrees in shifting the boom 18 from a forward, generally horizontal position adjacent the truck platform 12 and over the operator's cab 13, to a rearward, generally horizontal position, at which the boom is effective to elevate or place a load W from or on a particular location.

When the boom is in its substantially horizontal positions 53, 54, such as disclosed in Fig. 2, the effective lever arm of the load W on the boom, or the lever arm of the boom, itself is at a maximum. Thus, as shown in Fig. 2, the lever arm of the load W in the extreme right position is the distance a . This lever arm progressively decreases as the boom is elevated towards a position 56, in which the load W extends directly over the boom axis, and in which the boom 18 is considered as being vertical. As the boom is swung from this vertical position in a forward direction, the effective lever arm of the load W increases again. This lever arm is designated by b in Fig. 2.

The crank mechanism, however, when the effective lever arm of the load W is at its maxi-

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mum, is located in such position that its effective lever arm is at its minimum. This condition is represented diagrammatically in Fig. 8, in which it is evident that the effective lever arm e of the piston rod 33 is much smaller than the effective lever arm f of the piston rod when the boom is disposed vertically. Similarly, as the boom 18 moves forwardly of the motor vehicle, the effective lever arm g of the piston rod 33 on the crank decreases until it reaches a minimum when the boom is disposed in a generally horizontal position, with its forward end 22 over the operator's cab 13.

From the foregoing, it is apparent that the effective lever arm of the piston rod 33 on the crank tends to be the least when the torque requirements on the fluid motor 33, 34, 35 are the greatest, and that the lever arm tends to be the greatest when the torque requirements are the least. This anomalous situation is minimized by the present invention.

In the present invention, the effective lever arm of the piston rod 33 on the crank mechanism is increased when the load W on the boom 18 is acting through a greater effective lever or moment arm. Also, the effective lever arm of the rod 33 on the crank mechanism is decreased when the moment arm of the load on the boom decreases. In this manner, the effective moment arms of the piston rod on the crank mechanism are brought closer together in value, in order that the hydraulic prime mover mechanism 35 may be subjected to a more nearly constant load condition during movement of the boom 18.

The foregoing objective is achieved by varying the throw of the crank pin 32 in accordance with the angular position of the crank arms 31. Thus, the crank pin 32 has a greater throw, or is located a greater distance from the axis of the crankshaft 16, when the boom 18 occupies its substantially horizontal positions, than when the boom occupies its vertical position. By referring to Fig. 8, it will be noted that by increasing the distance of the crank pin 32 from the crankshaft axis, the effective lever arm of the rod 33 is increased. Thus, if the crank pin is located distance r from the crankshaft axis, the effective lever arm is e . If located the greater distance s from the crankshaft axis (for the same position of the boom 18), the effective lever arm is the greater distance g . This condition pertains to an increased throw of the crank pin when the boom is disposed in either a forward or rearward position with respect to the vehicle. The decreasing of the crank throw when the boom is in substantially its vertical position also reduces the effective lever arm of the piston rod on the crank mechanism.

The particular apparatus disclosed in the drawing effects an automatic change in the throw of the crank pin 32 in accordance with the angular position of the crank arms 31 and of the boom 18. Thus, each crank arm 31 includes a guide member 60 suitably secured, as by welding, to the inner end 16 of the crankshaft. This guide member has a radial slot or groove 61, in which a slidable crank arm portion 62 is mounted. The free ends of the slidable arm elements 62 are formed as bosses 63 in which the crank pin 32 is received, and beyond which the crank pin projects.

Followers 64 are mounted on the outwardly projecting ends of the crank pin, each roller being located within a cam groove 65 formed by an inner cam track member 66 suit-

ably attached to the housing 14, and by an outer cam track member 67, which may be formed by the curved portion of the intermediate housing 14. The cam groove 65 is shaped in such manner as to cause its portion 65a vertically below the crankshaft 16 to be located a lesser distance from this shaft than the grooved portions 65b disposed laterally or substantially horizontally of the crankshaft. Thus, as the piston rod 33 moves the crank arms 31 angularly, the follower rollers 64 on the crank pin 32 ride within the opposed stationary grooves 65 to vary the distance of the crank pin 32 from the crankshaft axis, thereby varying the throw of the crank pin 32 and effective lever arm of the piston rod 33 on the crank arms 31.

By referring to Fig. 3, it will be noted that the crank arm 31 is disposed in a vertical position, corresponding to the vertical position occupied by the boom 18. The cam groove 65a is there located closer to the axis of the crankshaft. As the piston 34 and piston rod 33 move rearwardly, to swing the crank arms 31 and crankshaft 16 in a counter-clockwise position to the location shown in Fig. 6, the follower rollers 64 ride in the cam grooves 65 and increase the length of the crank arms 31, to increase the throw of the crank pin 32, which effects an increase in the effective lever arm of the rod 33 on the crank arms 31 and crankshaft 16.

Similarly, shifting of the piston rod 33 in the opposite direction, to a position in which the crank arms 31 approach the right, causes the follower rollers 64 riding in the cam groove 65 to increase the length of the crank arms 31 and the throw of the crank pin 32, in order to correspondingly increase the effective lever arm of the rod 33 on the crank mechanism.

The foregoing is diagrammatically illustrated in Fig. 8. If the throw of the crank pin 32 is assumed to be r , the effective lever or moment arm of lever 33 when the boom 18 is in its forward, generally horizontal position will be at the distance e . If the crank throw is increased to the distance s , it is evident that the effective lever arm is increased considerably to the distance g , for the same angular position of the crank mechanism and boom.

It is, accordingly, apparent from the foregoing description that the torque that can be imposed by the prime mover mechanism on the crank mechanism is increased when the torque requirements are greatest, and is decreased when the torque requirements are of lesser extent. In this manner, the load on the hydraulic prime mover mechanism is prevented from fluctuating widely and is more nearly constant.

A modified form of variable throw crank pin device is disclosed in Fig. 7. In this form, crank arms 31a are secured to the inner ends of the crankshaft portions 16. These arms are provided with generally radial slots or guides 70, in which bearing blocks 71 are slidable. The crank pin 32 is mounted in these bearing blocks and extends beyond the bearing blocks, where the follower rollers 64 are mounted on them. These rollers are movable within the cam grooves 65, in the same manner as in the other form of the apparatus. As in the other form of the invention, the end of the piston rod 33 is pivotally mounted on the crank pin 32 between the crank arms 31a.

It is apparent that as the piston 34 moves within its cylinder 35, to shift the rod 33 and rock the crank arm 31a and crankshaft members 16, the follower rollers 64 ride in the grooves 65 and

cause the guide blocks 71 to move within the radial slots 70 of the crank arms 31a, thereby varying the distance of the crank pin 32 from the crankshaft axis.

It is to be noted that there are no elements of the mechanism projecting through the vehicle platform 12, which retains an uninterrupted surface for the loading, conveying and unloading of articles. In this manner, the capacity of the vehicle is increased. By decreasing the length of the crank arm 31 or 31a as it moves through the vertical position, the mechanism extends below the truck platform 12 to a lesser extent, requiring less vertical space below the truck bed for the device. By providing the divided crankshaft arrangement, in which the piston rod 33 is movable between the crank arms 31 or 31a, the crank shaft 16 may be moved by the rod 33 to a greater angular extent, which enables the boom 18 to be moved through a correspondingly greater angular extent, all without interference from the crankshaft 16.

The inventor claims:

1. A hoisting apparatus comprising a chassis, a horizontal pivotal support on said chassis, a boom fixed on said pivotal support for raising and lowering movements from a first substantially horizontal position through the vertical and to a second substantially horizontal position in the opposite direction, a crank arm on said pivotal support, a crank pin slidably mounted on said crank arm for movement toward and from the axis of the pivotal support, a cam connected to said chassis and means operatively connected to said crank pin and engaging said cam for positively moving the crank pin so that the crank pin is closest to the pivotal axis when the boom is in its vertical position and so that said crank pin is farthest from said pivotal axis when the boom is in either substantially horizontal position, and means for applying a force on said crank pin in a direction transverse to the axis of the pivotal support whereby the crank pin and the boom are moved through an angle substantially greater than a right angle and approaching a straight angle so that the mechanical advantage effective for raising and lowering the boom more closely approaches the load requirements than a fixed crank pin.

2. The invention according to claim 1 in which the crank arm has a radially extending guide groove, arm elements slidably mounted in said guide groove of said crank arm, and the crank pin is fixed on said arm elements so that the crank pin may move radially toward and from the axis of said pivotal support.

3. The invention according to claim 1 in which the crank arm is provided with a radially extending slot and the crank pin is slidably mounted in said radially extending slot and the crank pin includes a portion projecting from said crank arm and into positive operative relation to said cam.

4. A vehicle having a flat bed for supporting a load, a pivotal support mounted below said flat bed for rotation about an axis which is substantially horizontal, boom members fixed to the pivotal support outside of the outline of the flat bed, said boom members being connected together at a location spaced from the pivotal support, and having a clear space therebetween for a substantial distance from the axis to the connected together location, said boom members being so shaped that a substantial portion of the length thereof lies below the upper surface of the

flat bed for maintaining a substantially unobstructed flat bed when the boom is in its stored inoperative position, said boom members being movable to a substantially horizontal position in an opposite direction from said stored position, a crank arm fixed on said pivotal support and extending in a radial direction generally opposite the direction of said boom members so that the crank arm is maintained below said flat bed at all times; means for moving a crank pin on said crank arm for movement toward and from said axis, a cylinder and piston mounted on said chassis and connected to the crank pin for moving said pivotal support and the boom members carried thereby through an angle approaching a straight angle, a cam mounted in fixed relation with respect to said chassis and engaging said crank pin and shaped to move said crank pin toward said axis when the boom members are generally vertical and to move said crank pin away from said axis when the boom members are in either substantially horizontal position.

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