

April 4, 1961

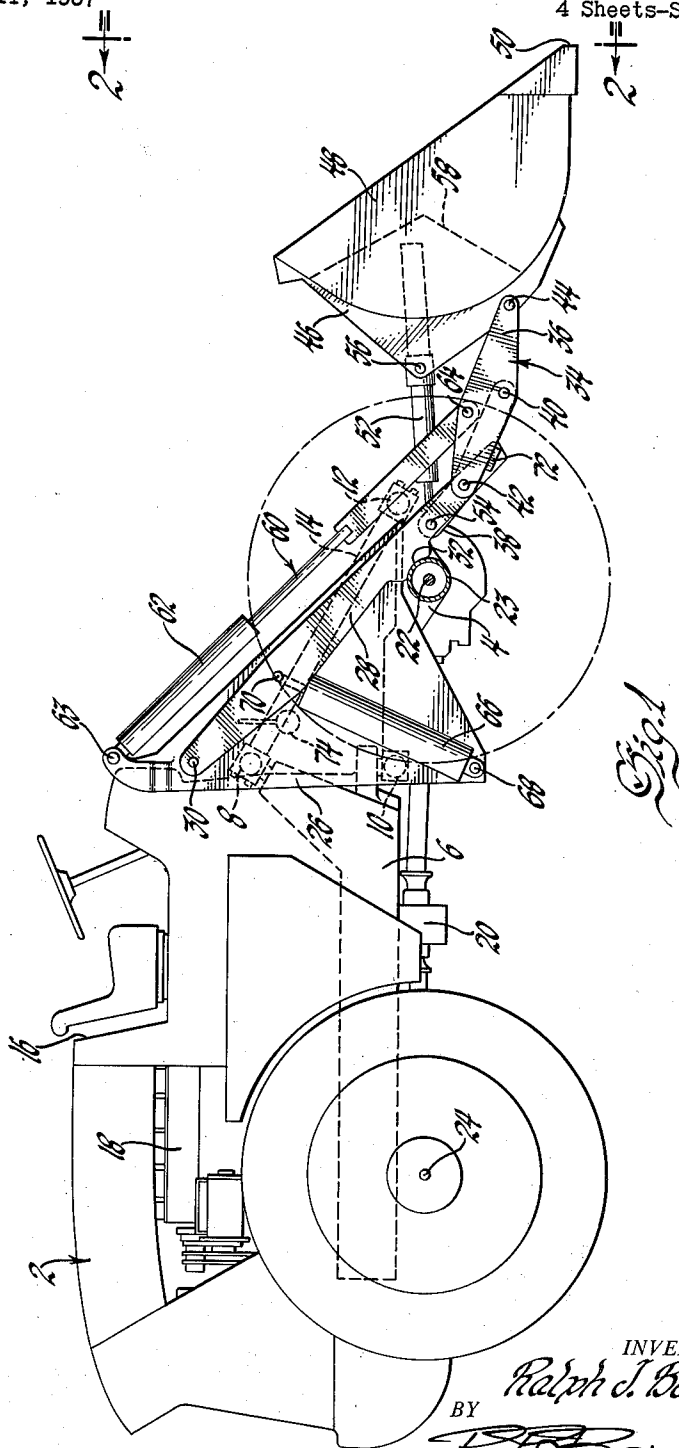
R. J. BERNOTAS

2,978,124

CRADLE LOADER

Filed Oct. 11, 1957

4 Sheets-Sheet 1



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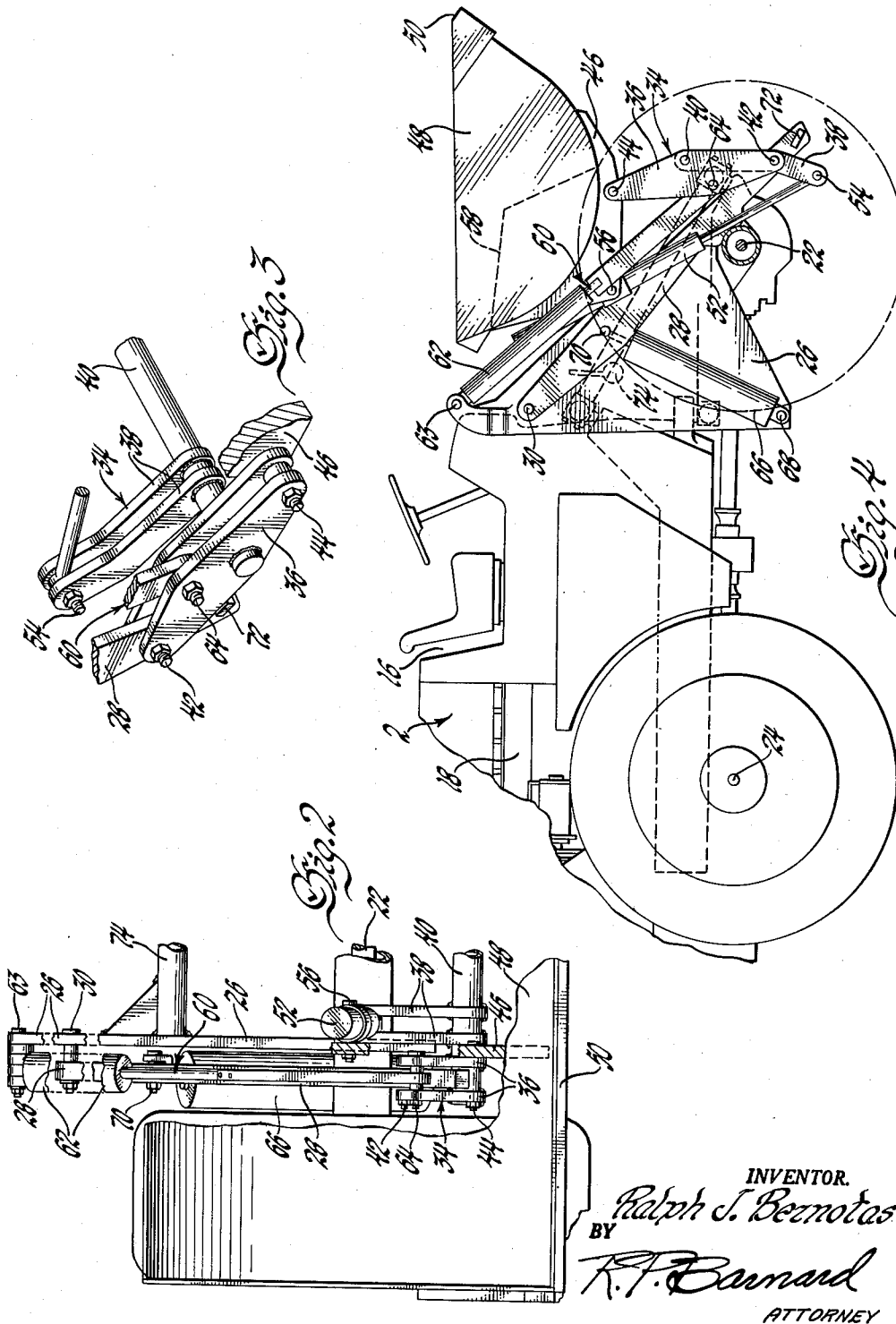
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CRADLE LOADER

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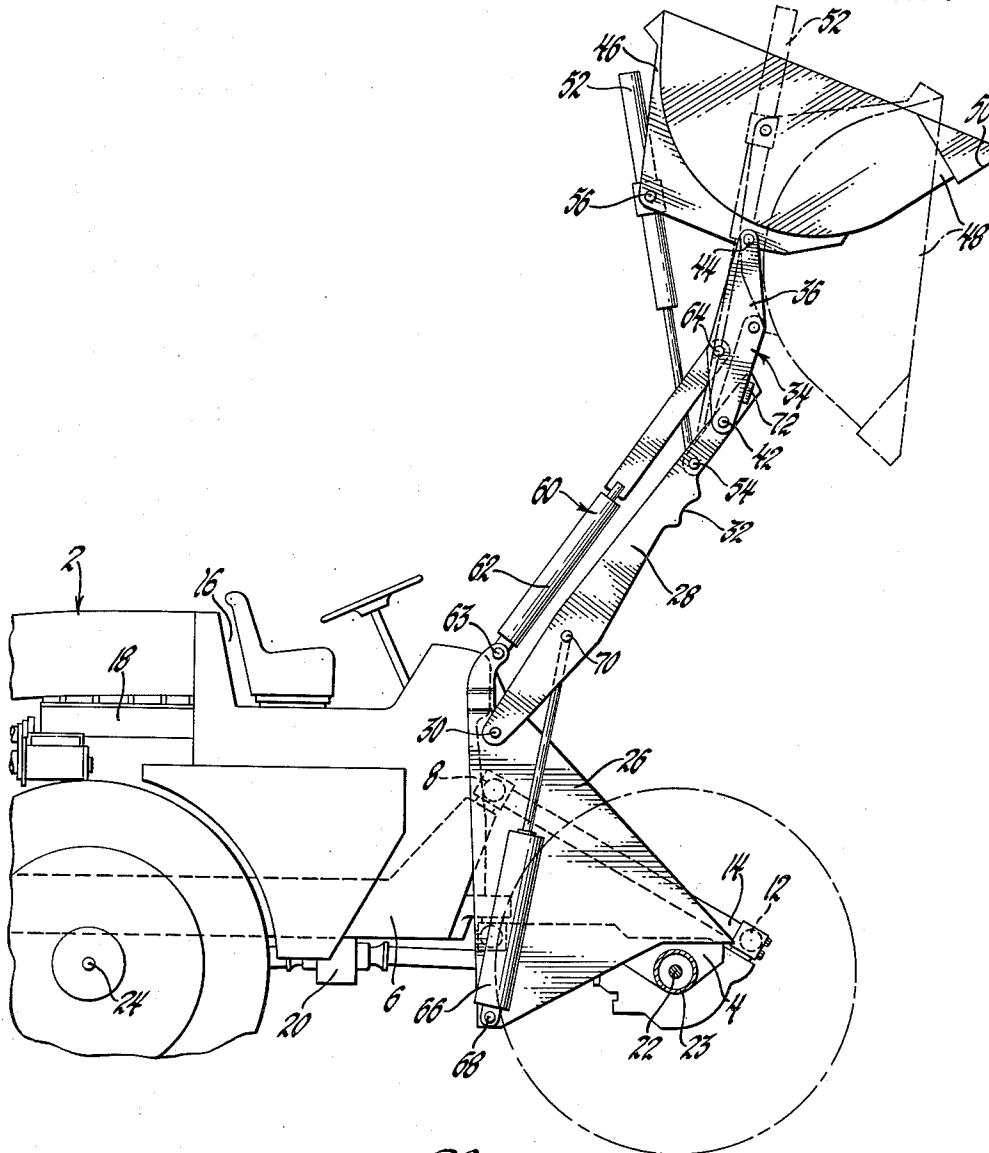


Fig. 5

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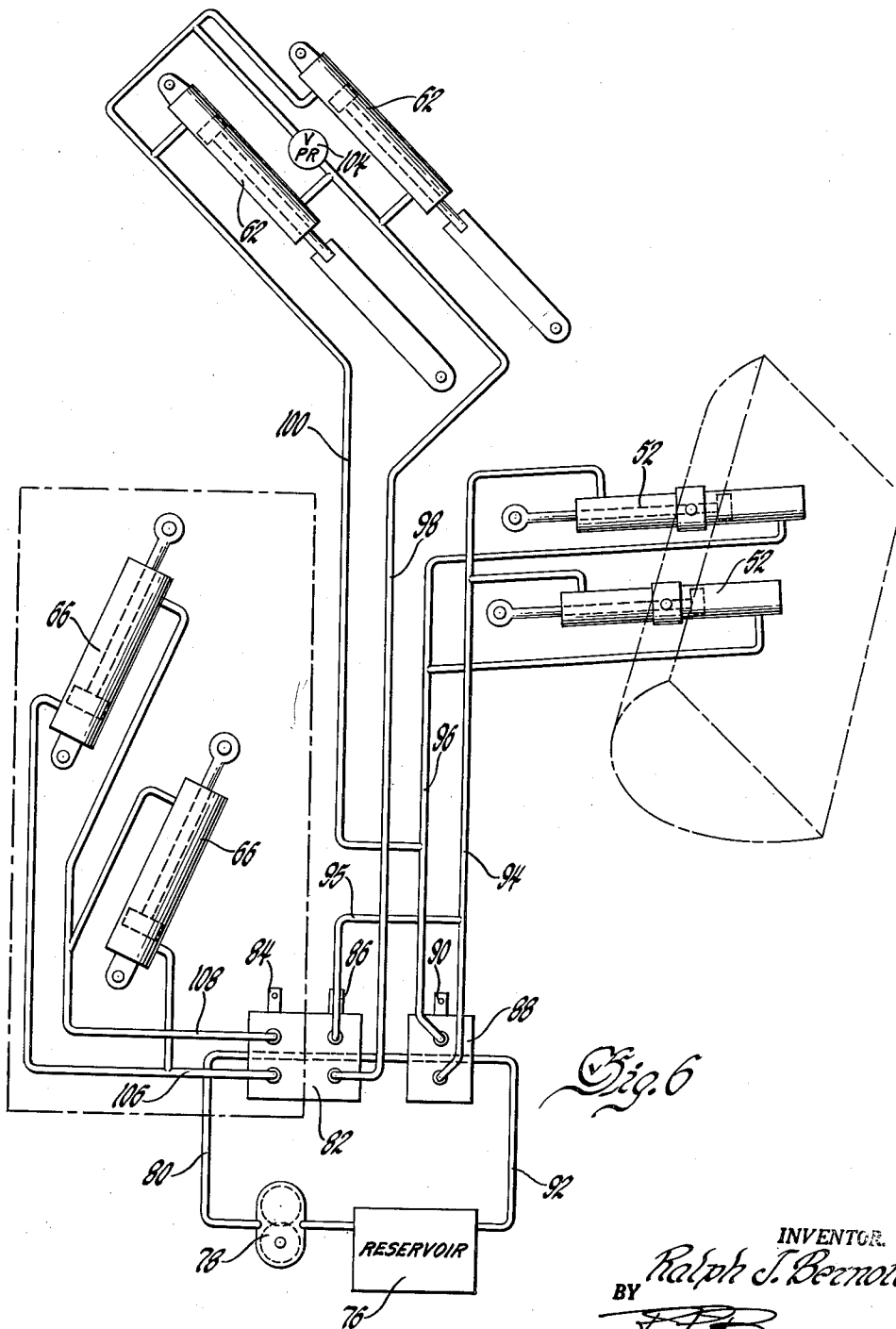
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CRADLE LOADER

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4 Sheets-Sheet 4



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2,978,124

CRADLE LOADER

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Filed Oct. 11, 1957, Ser. No. 689,530

6 Claims. (Cl. 214—140)

The present invention relates to material handling vehicles and, in particular, to a vehicle including a digging bucket and supporting mechanism therefor whereby the bucket and its load may be moved from a digging position to a cradled position in which sufficient vehicle stability exists for transporting the load and, moreover, to such a mechanism which may be utilized as desired to elevate the bucket to a high-lift dumping position for loading trucks and other conveyances.

Material handling vehicles of the general type herein contemplated are typically termed front end loaders, and normally include a bucket disposable in a digging position transversely and in front of the vehicle. Elevatable lift beams are pivotally connected on a horizontal transverse axis to the vehicle, and have their forward ends pivotally connected on a similar axis to the bucket structure. Suitable tilting linkage is operatively connected to the bucket to accomplish roll-back or "break-away tilting movement of the bucket from a digging to a load-retaining position. Thereafter, the lift beams may be elevated to dispose the bucket in a high-lift position for dumping the contents thereof into other vehicles.

Generally speaking, it is desirable to provide a basic vehicle which is adaptable to receive a range of loader linkages including buckets of varying sizes. In designing the basic vehicle, consideration must be given to the range of bucket sizes which are intended to be utilized with the vehicle. One basic design problem involves consideration of the fact that when the bucket is moved from a digging to a load-retaining position in which it is carried a short distance above the surface of the ground and forwardly of the vehicle, its cantilever support affects vehicle stability because of the moment of the bucket about the front vehicle axis or fulcrum means, or the forward portion of any other type of ground-engaging means employed to support the vehicle such as crawler tracks. Moreover, in conventional front end loaders, consideration must also be given to the fact that the moment arm of the bucket load will be increased at some intermediate position between the low level load-retaining position and the high-lift dumping position inasmuch as the cantilever lift beam structure swings the bucket in an arcuate path outwardly and upwardly from the load-retaining position. If the vehicle merely remains stationary and loads into a truck or other conveyance, the problem of instability due to the moment arm of the bucket load is not quite so critical, although sufficient counterweight must be provided to stabilize the vehicle as the bucket is swung out and up to the high-lift position for loading purposes as aforesaid. It will be appreciated, however, that if such a loader vehicle is to be used primarily as a digging and transporting implement as in stockpiling work in quarry operations, the effect of the bucket load on vehicle stability is exaggerated due to dynamic loading resulting from the vehicle traversing relatively large distances over rough terrain and at relatively high speeds and, of course, due to inertia forces imposed on the vehicle by sharp turning or braking of the latter for example.

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Therefore, in designing a basic vehicle to be equipped with a given range of bucket sizes, consideration must be given to providing sufficient counterweight for the cantilevered bucket to maintain vehicle stability. Another factor to be considered is the provision of a power plant which may be efficiently and effectively employed to power the vehicle throughout the range of loads desired so that the vehicle will not be under-powered or over-powered for any particular load. This situation limits the range of bucket sizes useable with conventional loaders. In other words, since it is desirable to use the gross vehicle weight empty, and particularly the resultant force thereof at the rear of the vehicle ground-engaging means such as a rear axle, as the counterweight moment force, a conventional loader vehicle designed to be equipped with a range of buckets beginning, for example, with one capable of carrying a one and a half yard load will generally not be able to efficiently handle a six yard bucket load. In designing the vehicle for a bucket range beginning with a one and a half yard bucket, a particular power plant was contemplated. However, when the larger six yard bucket is placed on the vehicle, it is generally necessary to place additional counterweight opposite the fulcrum point of the vehicle from the bucket for stability purposes which results in an under-powered vehicle.

Naturally, it is more efficient and therefore quite desirable to use as large a bucket as possible for loading operations, although under some conditions a much smaller bucket is often employed more effectively such as in a situation where the load to be dug is in a somewhat inaccessible area. On the other hand, almost without exception, the very large bucket will be used in stockpiling operations, where the material is usually very accessible, to obtain a maximum load per trip. Additionally, it is obviously advantageous to have buckets of varying sizes for a particular vehicle so that the optimum bucket size may be employed in a given circumstance. However, if a vehicle designed for use with a smaller bucket or range of buckets in loading operations is then equipped with a larger bucket for a stockpiling operation involving transportation of the load by the vehicle itself, additional counterweight must be added to stabilize the bucket load which results in the aforescribed under-powered vehicle.

It is, therefore, a principal feature and object of this invention to provide a material handling structure of the type aforesaid with which a relatively greater range of bucket sizes may be employed with a given vehicle than heretofore possible without inducing instability in the vehicle, and which effect results without the addition of counterweight, or the addition of less counterweight than heretofore possible, to the vehicle.

It is another principal feature and object of this invention to provide a material handling structure comprising a digging and carrying bucket in combination with a vehicle having ground-engaging supporting means, and means for moving the bucket relative to a fulcrum portion of the vehicle ground-engaging means to change the moment exerted by the bucket load about the fulcrum to enhance vehicle stability.

It is another feature and object of this invention to provide a vehicle of the type aforescribed with a cradle loader structure including a bucket, and means for moving the loaded bucket into a cradled position in which it is closer to the fulcrum portion of the vehicle ground-engaging means than when disposed in a digging or low level load-retaining position, thereby reducing the moment exerted by the bucket load about the fulcrum and reducing the effect of the inertia forces passing through the bucket.

It is yet another object of this invention to provide the

aforementioned cradle loader structure with means for disposing the loaded bucket in a cradled position substantially between the vertical planes through the vehicle ground-engaging means, and a short distance from the vehicle fulcrum to minimize the effect of inertia and moment forces on the stability of the vehicle.

According to another feature and object of this invention, it is intended to provide a cradle loader vehicle comprising a bucket disposable in a digging position forwardly of a vehicle front axle which serves as a fulcrum, and support means associated with the bucket whereby the latter may be moved rearwardly toward the vehicle rear axle and relative to the fulcrum from a digging position to a cradled position in which the stability of the vehicle about the fulcrum is improved without utilizing additional counterweight.

More specifically, it is a feature and object of this invention to provide a cradle loader structure for a vehicle comprising a bucket disposable forwardly of the vehicle front axle or fulcrum in a digging position, and which bucket is operatively connected to the vehicle by pivotal cradle levers which may be swung in relatively large arcs to move the bucket rearwardly from a digging to a cradled position in which it is adjacent the front axle and below the horizontal line of sight of the vehicle operator.

According to another feature and object of this invention, it is intended to provide a material handling vehicle with a digging bucket, a bucket tilt mechanism operatively connected to the bucket for rolling the latter from a digging to a low level load-retaining position, and mechanism for cradling the bucket from the aforementioned low level load-retaining position, the bucket tilting and cradling mechanisms respectively including fluid-operated jacks connected by suitable fluid circuit means whereby exhausted fluid from the cradling jack will be directed to the tilting jack as the bucket is elevated, and in accordance with the degree of elevation, to automatically roll the bucket forwardly to maintain it in a non-spilling attitude relative to the ground.

It is another object of this invention to provide a cradle loader vehicle of the type aforescribed comprising a bucket movable from a digging or low level load-retaining position to a cradled position by pivotal cradle levers, the cradle levers being pivotally connected to lift beams carried by the vehicle whereby the vehicle may also be used as a high-lift loader.

Moreover, according to yet another object of this invention, the cradling structure aforescribed is so adapted with the lift beams for high-lift loading as to carry the bucket in an upward path closer to the vehicle and its supporting means, and particularly its fulcrum point, than heretofore possible with conventional structures, thereby enhancing vehicle stability when used in high-lift loading.

In general, these and other objects of this invention are attained by providing a material handling structure for a vehicle comprising a bucket disposable in a digging position forwardly of the vehicle, elevatable lift beam members pivotally connected at their rear ends to the vehicle and at their forward ends to cradle levers which, in turn, are pivotally connected to the bucket. Bucket tilting or rolling jacks are operatively connected between the aforementioned cradle levers and the bucket to move the latter from a digging to a low level load-retaining position. Moreover, positioning linkages including a jack are provided to pivot the cradle levers about their connections to the elevatable beam members to swing the bucket from a low level load-retaining position upwardly and rearwardly in an arcuate path having a relatively short radius to a cradled position adjacent the vehicle front axle and below the horizontal line of sight of the vehicle operator. As a consequence, even when a relatively large bucket is employed, the load retained thereby is cradled rearwardly toward the vehicle fulcrum

point, such as the vehicle front axle, thereby reducing the moment of the bucket load so that the latter may be transported over rough haul roads at relatively high speeds and for great distances, and without the necessity of adding an appreciable counterweight, if any, to the vehicle.

These and other objects, features and advantages of this invention will appear more fully hereinafter as the description of the invention proceeds, and in which reference is made to the following drawings showing a preferred embodiment of the invention and in which:

Figure 1 is a side elevation of a vehicle equipped with the material handling structure of this invention, the bucket thereof being disposed in a digging position;

Figure 2 is a fragmentary view, partly broken away to expose various parts, taken on line 2-2 of Figure 1;

Figure 3 is a fragmentary perspective view showing the connection of the material handling bucket to its supporting and operating linkage;

Figure 4 is a view showing the bucket of Figure 1 disposed in the cradled position;

Figure 5 is a view showing in full line the position of the bucket in the high-lift position for loading other vehicles, while the dotted line position thereof shows the disposition of the bucket when dumping; and

Figure 6 is a schematic illustration of the fluid system employed to operate the bucket and its supporting structure.

Referring now to the drawings, there is shown a rubber-tired tractor 2 comprising a forward frame section 4 and a rear or main frame section 6 which are operatively connected by means of vertically aligned ball joints 8 and 10, the lowermost one of which directly connects the adjacent ends of the frame sections, while the uppermost joint is connected to a similar joint 12 on the forward frame section by a compression link or torque brace 14. The joints 8 and 10 form a vertical axis about which the two frame sections are relatively articulable by suitable means (not shown) for steering, the joints 10 and 12 defining a horizontal longitudinally extending axis of relative frame oscillation to insure that diametrically opposite wheels cannot leave the ground simultaneously which would result in complete loss of drive by reason of the differential action in the front and rear drive axles. Mounted behind the vehicle operator's compartment 16 is a power plant 18 for transmitting drive through the transmission 20 to the front and rear drive axles 22 and 24, respectively, which drive the ground-engaging rubber tires. For a more complete and detailed description of a vehicle of this type, reference may be made to my copending application, Serial No. 629,933, filed December 21, 1956. Although the material handling structure of this invention is preferably utilized on such a vehicle, it will be apparent as the description proceeds that such a structure may be used on other vehicles whether they be of the four-wheel drive type as shown in the drawings, or whether they have front and rear axles or other ground-engaging means such as crawler tracks.

As the description of the material handling structure now proceeds, reference will be made primarily to the linkages located at one side of the vehicle 2 inasmuch as the mirror image thereof, except as herein noted, is disposed on the opposite side of the vehicle as is well known in the art. A pair of laterally spaced supporting plates or pillars 26 are welded or otherwise rigidly secured to the front frame section 4 of the vehicle. A pair of laterally spaced lift beams 28 have their rearmost ends pivotally connected at 30 on a horizontal transverse axis to the pillars 26, and extend forwardly and downwardly inboard of the vehicle tires. Each lift beam has a portion 32 intermediate their ends which as shown in Figs. 1 and 4, are contoured to rest upon the housing 23 of the front axle.

The cradle lever mechanisms 34 each include an out-

board lever member 36 and an inboard lever member 38 which are welded or otherwise secured to a shaft 40 which extends transversely of the vehicle. The outboard lever 36 comprises spaced plates, as shown more particularly in Fig. 3, which embrace the lower end of each lift beam 28 for pivotal connection thereto at 42 and for pivotal connection at 44 to rearwardly projecting mounting plates 46 welded or otherwise rigidly secured to the rear surface of the bucket or bowl 48 which is equipped with a cutting edge 50.

Double acting bucket tilt jacks 52 each include a piston rod pivotally connected at 54 between the spaced plates of the inboard cradle levers 38, the cylinder elements thereof being trunion-mounted at 56 to the plates 46 disposed to the rear of the bucket. Narrow vertical housings 58 project into the bowl of the bucket for receiving the cylinder elements of the bucket tilt jacks 52.

Positioning linkages 60 each include a jack 62 having its cylinder element pivotally connected at 63 to the uppermost portion of each pillar 26 on a horizontal transverse axis, the piston of the jacks being connected through suitable linkage to the outboard levers 36 at 64. Lift beam jacks 66 have their lowermost ends pivotally connected at 68 to the supporting pillars, and their uppermost ends pivotally connected at 70 to the lift beams.

A laterally outwardly extending plate 72 is provided on the lowermost end of each of the lift beams 28 to act as a stop engaging the outboard levers 36 of the cradle lever mechanisms when the bucket is in the lowermost digging position as shown in Fig. 1, and when the bucket has been raised to a high-lift position as shown in full line in Fig. 5 preparatory to the actuation of the tilt jacks 52 to dump the bucket. As a consequence, in either of these extreme positions, the stop plates 72 prevent the positioning jack-linkages 60 from going over-center about the pivotal connections 42 of the cradle lever mechanisms to the lift beams.

A suitable number of transversely extending reinforcing tubular members 74 may be secured between the supporting pillars 26 to rigidify the structure.

Referring now to Fig. 6, there is shown a hydraulic system which may be utilized to control the various jacks of the aforescribed structure. A reservoir or tank 76 is adapted to supply fluid under pressure through the pump 78 and pressure line 80 to the open center valve 82 having a manually operated valve spool 84 therein to control the supply of fluid to and from the lift jacks 66, and a valve spool 86 to control the supply of fluid to and from the jacks 62 of the positioning linkage 60. Moreover, another open center valve 88 having a manually operable valve spool 90 is provided to control fluid flow to and from the bucket tilt jacks 52. A suitable return line 92 places the respective open center valves in communication with the tank 76 as is well known in the art.

The specific details of the open center valves 82 and 86 have not been disclosed inasmuch as they are commercially available items well known in the art. Suffice it to say that they are so constructed as to normally permit circulation of actuating fluid from the pressure line 80 to the return line 92 through their "open centers" with the valve spools in the unactuated or hold position wherein no fluid pressure flows in the individual jack circuits. When a valve spool is shifted, pressure fluid is directed from pressure line 80 through one valve port to one side of the jack involved, while exhaust fluid therefrom is delivered back through another valve port to the return line 92.

The double acting bucket tilt jacks 52 may be retracted to roll the bucket rearwardly about the pivot point 44 on the cradle lever mechanism to "break-away" the bucket from a digging position and dispose it in a low level load-retaining position by manipulation of valve spool 90 to supply pressure fluid to the line 94 and

exhaust fluid through the line 96. The double acting positioning jacks 62 may be actuated by the valve spool 86 to supply pressure fluid to the line 98 thereby causing them to retract to cradle the bucket while, at the same time, exhausting fluid from the other sides of the positioning jacks through the line 100 to the bucket tilt jack line 96. During this operation, exhaust from the bucket tilt jacks returns to line 92 through line 94, branch line 95 and valve spool 86. Thus, if the bucket jacks are retracted to roll the bucket from a digging to a load-retaining position, and the positioning jacks are then retracted to cradle the load, the exhaust from the positioning jacks will be supplied to the bucket jacks to extend them a sufficient amount to roll the bucket slightly forwardly during the cradling action. This prevents the material from spilling rearwardly from the bucket.

If it is attempted to actuate the lift jacks 66 prior to retraction of the bucket tilt jacks to move the bucket from the digging position of Fig. 1 to the load-retaining position, it will be readily apparent that the stop 72 on the lift beams will strike the outboard cradle lever member 36 and, due to the relative positions of the pivotal connections of the lift beams and positioning linkages to the cradle lever mechanism, will tend to force the positioning jack pistons rearwardly within their cylinders. To prevent rupturing a hydraulic line in the system, a one-way pressure relief valve 104 is set to open at a pressure in excess of the normal pressure in line 80 and is positioned in parallel with the line 100 to permit circulation of fluid to the other side of the positioning jack piston.

The lift beam jacks are extended by suitable manipulation of valve spool 84 to supply pressure fluid to one side of the jack through the line 106, while exhaust fluid therefrom flows to the return line 92 through line 108. With the bucket disposed in the solid line high lift position of Figure 5, the valve 88 will be moved to supply fluid through line 96 to extend bucket tilt jacks 52 to dump the bucket as shown in dotted line in the same figure. Exhaust from jacks 52 is delivered, as before, through valve 88 to the return line. Although line 100 is connected to line 96 the positioning jacks will not be extended because exhaust from the latter cannot flow through line 98 with valve spool 86 in the hold position.

With respect to the foregoing description of the hydraulic system which has been presented to correspond to the jack action occurring in moving the bucket sequentially from the Fig. 1 position through the Fig. 4 position to the Fig. 5 position, it will be readily apparent that the flow of fluid in the individual jack systems is reversed in returning the bucket to the Fig. 1 position. In particular it should be noted that in moving the bucket from the Figure 4 cradled position to the low level load-retaining position aforementioned, the bucket must be automatically rolled rearwardly about pivot 44; that is, the opposite of its action in cradling. The circuitry shown in Figure 6 accomplishes this purpose. The valve spool 86 is moved in the proper direction, opposite to that required for cradling, to supply pressure fluid through branch line 95 and line 94 to retract the bucket tilt jacks 52. Exhaust from jacks 52 is delivered through lines 96 and 100 to the positioning jacks 62 thereby extending them. Exhaust from jacks 62 is then delivered to the return line through line 98 and a port in valve 82 controlled by spool 86.

Referring now to an operation of the loader structure itself, and with particular reference to Figs. 1, 4, 5 and 6, it may be assumed that the vehicle begins to dig with the bucket in the position shown in Fig. 1. After the load has been obtained in the bucket, the valve spool 90 is manipulated to supply fluid through the line 94 to retract the bucket tilt jacks and pivot the bucket to a low level load-retaining position about the pivotal connection 44 of the bucket to the outboard cradle lever.

The aforementioned load-retaining position is slightly to the rear of the digging position as shown in Fig. 1, with the bucket elevated a slight distance from the level of the ground. Thereafter, the valve spool 90 is released and the valve spool 86 is moved to supply fluid to the line 98 to retract the positioning jack 62. As the positioning jacks retract, they swing the cradle lever mechanism 34 about the pivotal connection 42 of the latter to the lift beams, thereby swinging the bucket upwardly and rearwardly to a position adjacent the front axle 22 of the vehicle and below the horizontal line of sight of the vehicle operator. It will be readily apparent that the bucket is thereby shifted a substantial distance toward the rear axle 24 and relative to the front fulcrum axle 22 of the vehicle. As a matter of fact, with the linkage constructed to the scale shown in the preferred embodiment, the cradle lever mechanism 34 will swing through an arc approximating 115 degrees.

It will be noted that the bucket tilt jacks 52 function primarily as latches for maintaining the bucket 48 in a desired disposition on the pivot axis 44 of the cradle levers. Moreover, it will be noted from a comparison of Figs. 1 and 4 that when the bucket is elevated in an arcuate path to the cradle position from the low level load-retaining position, in which latter position the bucket tilt jacks are slightly shorter than as shown in Fig. 1, that the point of pivotal connection 54 of the bucket tilt jacks to the cradle lever mechanism 34 swings through a very large arc as aforescribed. If the bucket tilt jacks remain in their substantially fully retracted positions, material would spill from the rear edge of the bucket when in the cradled position of Fig. 4. To maintain the bucket in a non-spilling attitude throughout its arcuate path to the cradled position, it is then necessary to extend the bucket tilt jacks 52 in relation to the degree of pivotal movement of the cradle lever mechanism about the pivot point 42 under control of the positioning jacks 62. To this end, as the positioning jacks are retracted to cradle the load as aforescribed, the exhaust fluid from these jacks is supplied through the line 100 to the line 96 and to the bucket jacks 52 to extend them automatically thereby rolling the bucket forwardly about its pivotal connection to the cradle lever mechanism. During this action, the exhaust pressure in line 100 is insufficient to open the pressure relief valve 104. In Fig. 4, it will be noted that the bucket jacks have been extended to a length approximately 75% greater than its length in the load-retaining position in which the jack would be slightly shorter than in the Fig. 1 digging position as aforescribed.

Although the invention shown is particularly adapted for use on a vehicle intended primarily to dig and itself transport loads, it will be apparent from Fig. 5 that this structure may also be used for loading other vehicles. Thus, with the load in the cradled position shown in Fig. 4, the valve spool 84 may be actuated to supply fluid through the line 106 to the lift jacks 66 to elevate the lift beam structure to the Fig. 5 position, exhaust fluid from the lift jacks returning through line 108. Thereafter, the valve spool 90 may be actuated to extend the bucket tilt jacks and dump the bucket as shown in dotted line in Fig. 5. With respect to Figs. 1, 4 and 5, and the actuation of the bucket tilt jacks to pivot the bucket among the various positions shown, it will be noted that the shape of the housings 58 formed in the rear wall of the bucket 48 are such as to permit sufficient clearance for pivoting action of the bucket tilt jacks about their pivotal connection 56 to the bucket.

Alternatively, when the vehicle is not to be employed as a loader but only for digging and transporting loads, the lift beams and the control therefor enclosed by the dotted line in Fig. 6 may be completely eliminated. The pivotal supports 42 of the rearmost ends of the outboard cradle levers 36 would then be carried by the forward frame section 4 at the position shown in the drawings.

In the interests of providing a more complete understanding of the significance of cradling a load as taught in this invention, let it be assumed that a basic vehicle constructed to the scale shown in Fig. 1 has a gross weight empty, including the bucket linkage, of 36,000 lbs. with the distribution of this weight of 23,000 lbs. on the rear axle and 13,000 lbs. on the front axle. Further, let it be assumed that this empty weight is sufficient to provide a counterweight for a cantilever-supported loader bucket for a small range of bucket sizes as is the usual case. Now let it be assumed that a relatively large bucket, that is, one outside the design range, is employed in digging a load which weighs 18,000 lbs., and the bucket is then elevated slightly from the ground into the low level load-retaining position. The gross vehicle weight loaded now becomes 54,000 lbs. with an approximate distribution of this load of 12,000 lbs. on the rear axle and 42,000 lbs. on the front axle. Thus, the moment of the 18,000 lb. bucket load about the front axle 22 has lifted the rear portion of the vehicle to reduce its rear axle load by 11,000 lbs. which has been transferred to the front axle. The fact that the bucket load has removed over 50% of the rear axle load is indicative of a condition of instability in the vehicle, particularly where the latter would be used in the load-retaining position to transport the load over relatively rough haul roads, for great distances, and at high speeds, as well as being subjected to inertia forces caused by side sway of the bucket and sway in a vertical longitudinal plane occasioned by braking the vehicle. In the interest of safety, a contractor faced with this situation would add a counterweight to the rear of the vehicle to stabilize it. As a result, the additional weight would cause the gross vehicle weight to exceed the upper design limit for the power plant.

In a loader constructed according to the teachings of this invention, the bucket could be cradled from the load-retaining position to the position shown in Fig. 4. If the load were cradled to this position, and again referring to the aforementioned approximate load figures, the 54,000 lb. load would then be distributed with approximately 21,000 lbs. on the rear axle and 33,000 lbs. on the front axle. By cradling the load, its moment arm about the front axle is reduced as is indicated by the transfer of 9,000 lbs. of the 11,000 lbs. previously shifted to the front axle back to the rear axle. In other words, the moment of the bucket load about the front axle is reduced to a marked degree as is shown by a comparison of rear axle loadings with the load uncradled and cradled. Thus, where the load is uncradled, its gravitational moment has the effect of reducing the original design empty weight rear axle loading to approximately 50% of its value. Conversely, when the load is cradled the rear axle load is approximately 90% of the original design figure for an empty vehicle.

Since the loader construction contributes a relatively small percentage of the gross vehicle weight empty, it may be considered to be substantially the same for a great range of bucket sizes. Therefore, an extremely large range of bucket sizes and associated support linkage therefor may be mounted on a basic vehicle, and cradling of the loaded bucket will result in an extremely significant reduction in its moment arm about the vehicle front axle thereby maintaining substantially the original vehicle stability.

It should also be noted that the cradled bucket is carried at a relatively low height adjacent the front axle or fulcrum point, thereby further reducing vehicle instability by substantially minimizing the effect of inertia when the vehicle is braked, steered or subjected to side swaying of the bucket as compared to conventional structures in which the bucket is carried at a relatively great distance forward of or forward and above the front axle. Moreover, reference to the approximate load figures above will demonstrate that more equal weight dis-

tribution may be achieved in vehicles equipped with this invention than with conventional structures, a matter of particular significance where a four-wheel drive is employed.

From an examination of the foregoing description taken in conjunction with the drawings, it will be appreciated that this invention provides a relatively simple and versatile means for reducing the moment of bucket loads about a vehicle fulcrum point, thereby eliminating the need for an additional counterweight for the vehicle when the latter is to be used for digging and transporting loads over rough roads for large distances and at relatively high speeds. However, at the same time, the structure of this invention retains all the principal features and advantages of conventional loaders when used merely to load other vehicles. In this regard, it should be noted that the specific embodiment shown is intended for illustrative purposes only, and in no manner is intended to limit the invention which is defined by the claims which follow.

What is claimed is:

1. A vehicle comprising front and rear ground-engaging means, a material handling bucket disposable in a digging position longitudinally outwardly beyond one of said ground-engaging means; a cradle mechanism for said bucket comprising cradle lever means having an inner portion operatively pivotally connected to said vehicle for pivotal movement relative thereto about a horizontal transverse axis immediately longitudinally outwardly beyond said one ground-engaging means with said bucket in the digging position, an outer portion of said lever means connected to said bucket, said lever means extending longitudinally outwardly beyond said axis with said bucket disposed in said digging position, means connected to and controlling the position of said bucket on said lever means; and adjustable linkage means operatively pivotally connected between said vehicle and cradle lever means, said linkage means being adjustable to pivot said cradle lever means about said axis to a substantially upright position to swing said bucket upwardly and longitudinally toward said one ground-engaging means from said digging position to a cradled position immediately over said one ground-engaging means and substantially below the horizontal line of sight of the vehicle operator.

2. A vehicle comprising front and rear ground-engaging means, a material handling bucket disposable in a digging position longitudinally outwardly beyond one of said ground-engaging means; a cradle mechanism for said bucket comprising cradle lever means having an inner portion operatively pivotally connected to said vehicle for pivotal movement relative thereto about a horizontal transverse axis immediately longitudinally outwardly beyond said one ground-engaging means with said bucket in the digging position, an outer portion of said lever means connected to said bucket, said lever means extending longitudinally outwardly beyond said axis with said bucket disposed in said digging position, latch means connected between said cradle lever means and bucket to support the latter on said cradle lever means; and adjustable linkage means operatively pivotally connected between said vehicle and cradle lever means, said linkage means being adjustable to pivot said cradle lever means about said axis to a substantially upright position to swing said bucket upwardly and longitudinally toward said one ground-engaging means from said low-level load-retaining position to a cradled position immediately over said one ground-engaging means and substantially below the horizontal line of sight of the vehicle operator.

3. A vehicle comprising front and rear ground-engaging means, a material handling bucket disposable in a digging position longitudinally outwardly beyond one of said ground-engaging means; a cradle mechanism for said bucket comprising cradle lever means having an inner portion operatively pivotally connected to said vehicle for pivotal movement relative thereto about a hori-

zontal transverse axis immediately longitudinally outwardly beyond said one ground-engaging means with said bucket in the digging position, an outer portion of said lever means pivotally connected to said bucket, said lever means extending longitudinally outwardly beyond said axis with said bucket disposed in said digging position, a fluid pressure-operated tilt jack operatively pivotally connected between said cradle lever means and bucket, said tilt jack being operable to control pivotal movement of said bucket about its connection to said cradle lever means between said digging position and a low-level load-retaining position longitudinally outwardly beyond said one ground-engaging means; and positioning linkage means including a fluid pressure-operated positioning jack operatively pivotally connected between said vehicle and cradle lever means, said linkage means being operable to pivot said cradle lever means about said axis to a substantially upright position to swing said bucket upwardly and longitudinally toward said one ground-engaging means from said low-level load-retaining position to a cradled position immediately over said one ground-engaging means and substantially below the horizontal line of sight of the vehicle operator.

4. A vehicle comprising front and rear axles and ground-engaging means mounted thereon, a material handling bucket disposable in a digging position longitudinally outwardly beyond said front axle; a cradle mechanism for said bucket comprising cradle lever means having an inner portion operatively pivotally connected to said vehicle for pivotal movement relative thereto about a horizontal transverse axis immediately longitudinally outwardly beyond said front axle with said bucket in the digging position, an outer portion of said lever means pivotally connected to said bucket, said lever means extending longitudinally outwardly beyond said axis with said bucket disposed in said digging position, a fluid pressure-operated tilt jack operatively pivotally connected between said cradle lever means and bucket, said tilt jack being operable to control pivotal movement of said bucket about its connection to said cradle lever means between said digging position and a low-level load-retaining position longitudinally outwardly beyond said front axle; and positioning linkage means including a fluid pressure-operated positioning jack operatively pivotally connected between said vehicle and cradle lever means, said linkage means being operable to pivot said cradle lever means about said axis to a substantially upright position to swing said bucket upwardly and longitudinally rearwardly from said low-level load-retaining position to a cradled position immediately over said front axle and substantially below the horizontal line of sight of the vehicle operator.

5. A vehicle comprising front and rear axles and ground-engaging means mounted thereon, a material handling bucket disposable in a digging position longitudinally outwardly beyond said front axle; a cradle mechanism for said bucket comprising cradle lever means having an inner portion operatively pivotally connected to said vehicle for pivotal movement relative thereto about a horizontal transverse axis immediately below and longitudinally outwardly beyond said front axle with said bucket in the digging position, an outer portion of said lever means pivotally connected to said bucket, said lever means extending longitudinally outwardly beyond said axis with said bucket disposed in said digging position, a fluid pressure-operated tilt jack operatively pivotally connected between said cradle lever means and bucket, said tilt jack being operable to control pivotal movement of said bucket about its connection to said cradle lever means between said digging position and a low-level load-retaining position longitudinally outwardly beyond said front axle; and positioning linkage means including a fluid pressure-operated positioning jack operatively pivotally connected between said vehicle and cradle lever means, said linkage means being operable to pivot said cradle lever means about said axis

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to a substantially upright position to swing said bucket upwardly and longitudinally rearwardly from said low-level load-retaining position to a cradled position immediately over said front axle and substantially below the horizontal line of sight of the vehicle operator.

6. A vehicle comprising front and rear axles and ground-engaging means mounted thereon, a material handling bucket disposable in a digging position longitudinally outwardly beyond said front axle; a cradle mechanism for said bucket comprising cradle lever means having an inner portion operatively pivotally connected to said vehicle for pivotal movement relative thereto about a horizontal transverse axis immediately longitudinally outwardly beyond said front axle with said bucket in the digging position, an outer portion of said lever means pivotally connected to said bucket, said lever means extending longitudinally outwardly beyond said axis with said bucket disposed in said digging position, a fluid pressure-operated tilt jack operatively pivotally connected between said cradle lever means and bucket, said tilt jack being operable to control pivotal movement of said bucket about its connection to said cradle lever means between said digging position and a low-level load-retaining position longitudinally outwardly beyond said front axle; positioning

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linkage means including a fluid pressure-operated positioning jack operatively pivotally connected between said vehicle and cradle lever means, said linkage means being operable to pivot said cradle lever means about said axis to a substantially upright position to swing said bucket upwardly nad longitudinally rearwardly from said low-level load-retaining position to a cradled position immediately over said front axle and substantially below the horizontal line of sight of the vehicle operator; and fluid circuit means interconnecting said positioning jack and tilt jack whereby exhaust from the former is supplied to the latter to pivot said bucket automatically relative to said cradle lever means as the latter pivots toward said upright position to maintain said bucket in a non-spilling attitude.

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