Sept. 20, 1971 L. A. MOLBY 3,606,061

FRONT END LOADER TYPE VEHICLE

Filed June 23, 1969 2 Sheets-Sheet 1

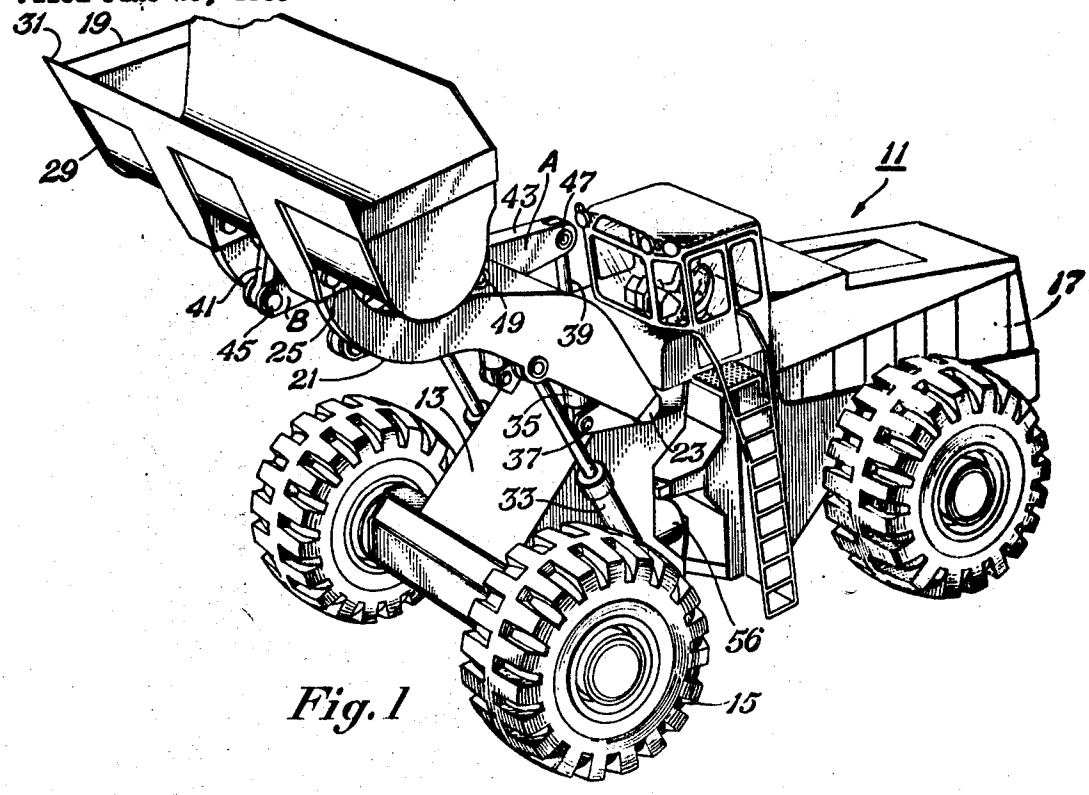


Fig. 1

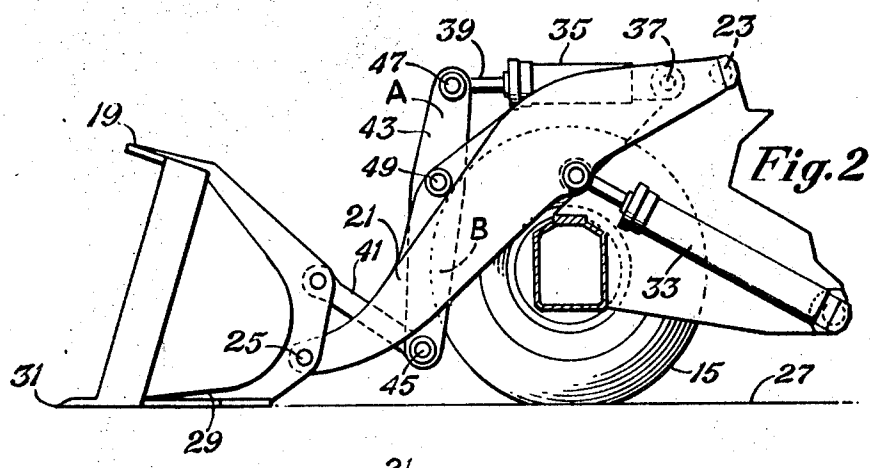


Fig. 2

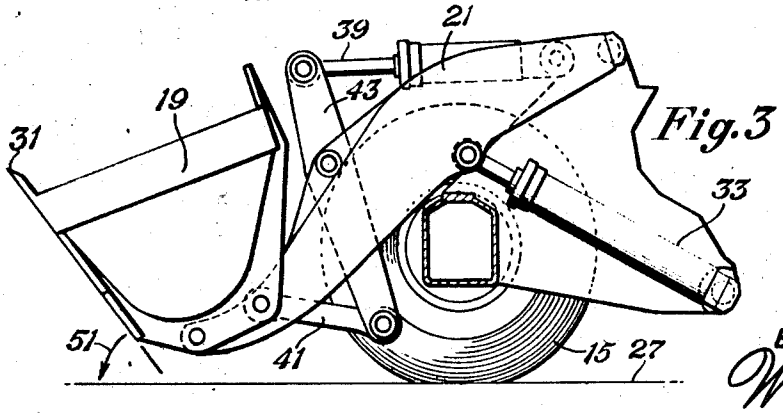


Fig. 3

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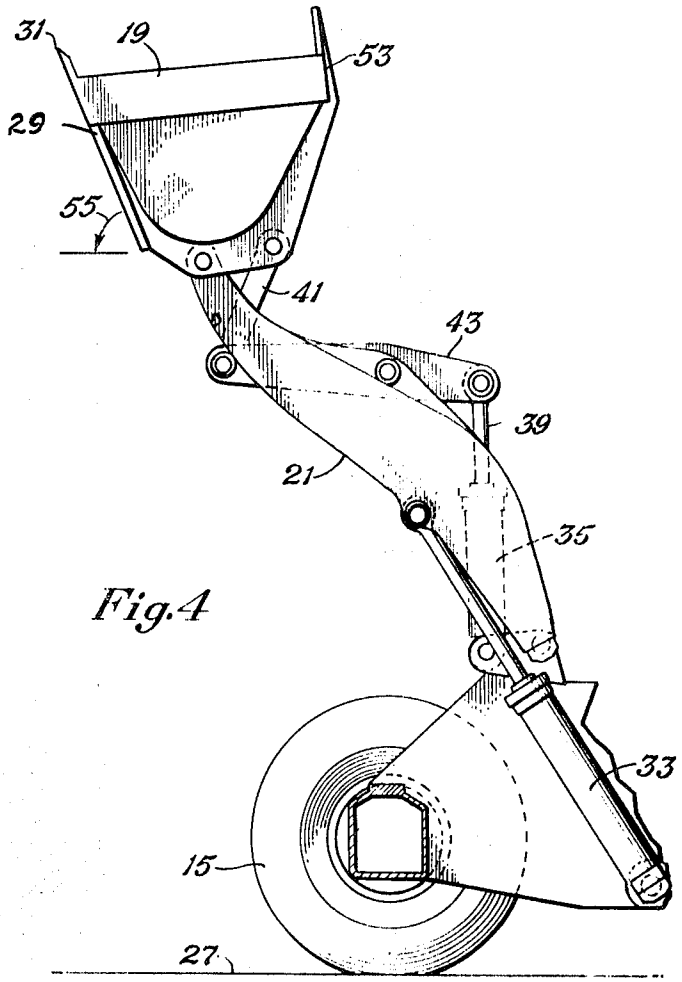


Fig.4

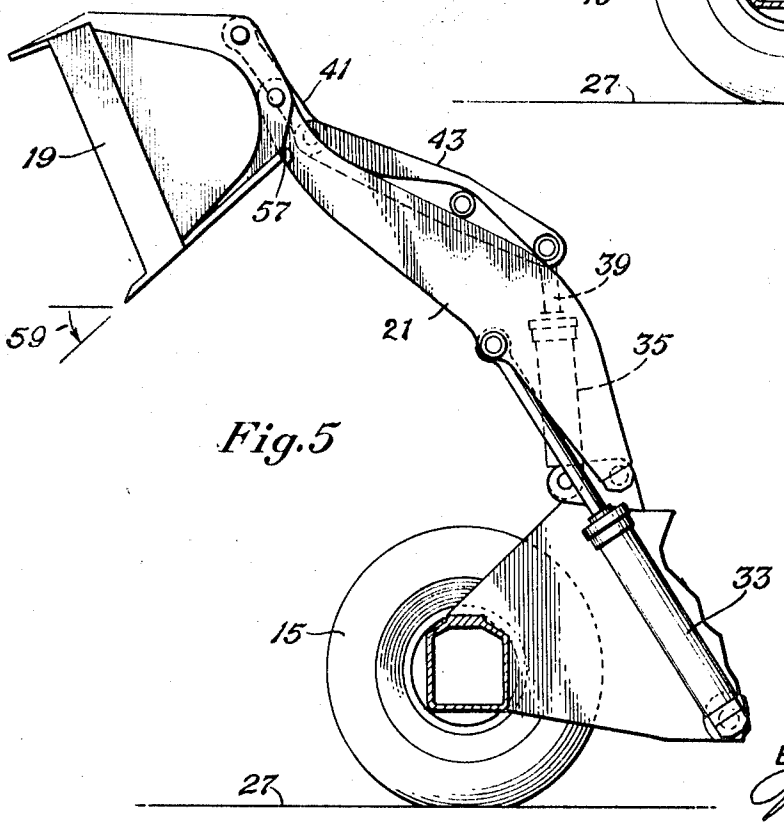


Fig.5

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3,606,061

FRONT END LOADER TYPE VEHICLE

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Filed June 23, 1969, Ser. No. 835,464
Int. Cl. E02f 3/80
U.S. Cl. 214—776 4 Claims

ABSTRACT OF THE DISCLOSURE

This specification discloses an improvement in a front end loader type vehicle characterized by a linkage arrangement between a tilting means and a bucket that inherently effects a normal ground level loading position of the bucket with the desired tilt attitude when the bucket is merely lowered from its full dump tilt at its top position. No skillful or time-consuming cooperative manipulation between the tilting means and an elevating means is required. To accomplish the above result without significant engineering sacrifices, there is employed, inter alia, a bell crank that has a ratio of lengths of a second lever arm, connected with the bucket, to a first lever arm, connected with the tilting means, of 1.4–2.0. The other components are selected to effect nearly optimum angles of tip back, carry and dump; and to enable elevating the loaded, tilted back bucket to the top without spilling the load by merely elevating the bucket, without adjusting the tilting means.

BACKGROUND OF THE INVENTION

This invention relates to so-called front end loader type machines and particularly to self-propelled wheeled type front end loaders having a bucket attached for powered pivotal movement to the outer end portion of a main beam, or boom, which in turn is attached at its inner end portion to the front end portion of the vehicle main frame and powered for pivoting elevational movement about a transverse horizontal axis.

In front end loaders of this type, material is normally scooped from a surface by a cutting edge carried on the forward portion of the scoop side of the bucket. Conventionally, linkage means supports the bucket in different pivotal positions relative to the end of the main beam. Thus, with a desired tilt attitude; ordinarily, with the scoop side of the bucket substantially horizontal; the vehicle is moved forward to load the bucket. Thereafter, the bucket is tipped backward to retain the load in the bucket and the main beam elevated to a top position. The load is then carried in this top position until over a dump receptacle, for example an earth mover hauler. The bucket is rapidly moved into the full dump position to dump the load into the receptacle. The operator then returns to pick up a second load and must, in the usual case, simultaneously lower the main beam and reposition the bucket to attain the desired tilt attitude at the ground level by operating both an elevating means connected between the main beam and the frame and a tilting means for tilting the bucket. It is readily apparent that the coordinated action of the elevating means and tilting means requisite to achieve the desired results is time consuming even for a skilled operator.

An important objective of the present invention is to make possible the lowering of the bucket to the normal ground level loading position having the desired tilt attitude, with such result being rapidly and consistently achieved without the requirement for a high degree of operator skill and without loss of time.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic perspective view of a front end loader employing one embodiment of the invention.

FIGS. 2–5 are schematic fragmentary side elevational views, partially in section, illustrating an operative embodiment of the invention;

FIG. 2 showing the linkage arrangement with the scoop edge of the bucket in the horizontal position at the surface;

FIG. 3 showing the linkage arrangement of the bucket in full tilt back position at the surface;

FIG. 4 showing the linkage arrangement with the bucket in the carry position at the top before dumping; and

FIG. 5 showing the linkage arrangement with the bucket in the full dump position at the top.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

It is a particular feature of this invention to employ a linkage arrangement connecting a bucket to a front end loader type vehicle such that: (1) the bucket can be in the full dump position at the top in dumping its load and be properly positioned with its scoop side substantially parallel with the surface from which the material is to be scooped by simply lowering the main beam and (2) the bucket can be elevated from tilt back position at the surface to top position without spilling the load by simply elevating the main beam. Expressed otherwise, no adjustment of the tilting means is required to lower the bucket from its top dump position to effect proper positioning of the bucket for scooping another load, or to elevate a loaded, tilted back bucket from the surface to its top carry position without spilling the load. Thus, a faster loading operation may be effected. Moreover, less skilled operators are required, effecting further savings and lessening difficulties in obtaining competent personnel.

The invention can be clearly understood by referring to the figures. In FIG. 1, front end loader type vehicle **11** has its frame **13** mounted on wheels **15** and a prime mover **17** is mounted on the opposite end of vehicle **11** from bucket **19**. Prime mover **17** may be an internal combustion engine. It develops the power required for locomotion as well as to operate the various accessories, such as hydraulic pumps (not shown). A main beam **21** is pivotally attached at its inner end to a first point **23** on frame **13** for pivotal movement about a first transverse horizontal axis disposed at a first location. Bucket **19** is pivotally attached to outer end portion **25**, or other end, of main beam **21** and is adapted to scoop a load from a surface, to retain the load during elevation to a top position, and to dump the load above and in front of vehicle **11**. As can be seen from FIG. 2 bucket **19** is pivotally attached to the outer end portion **25** at some distance above smooth surface **27** when the scoop side **29** with cutting edge **31** is parallel with the surface, ordinarily substantially horizontal. In this way vehicle **11** can be moved forward to scoop material from surface **27** and fully load bucket **19** without imposing significant forces tending to tilt bucket **19** backwardly. By properly connecting outer end portion **25** to bucket **19**, scoop side **29** and cutting edge **31** operate substantially as an extension of main beam **21**.

Elevating means; such as, hydraulic cylinder **33**; is connected to main beam **21** and to frame **13** for elevating main beam **21**, consequently lifting the bucket and its contents.

Bucket tilting means, referred to as tilting means; such as, second hydraulic cylinder **35**; for tilting bucket **19** about outer end portion **25** of main beam **21**, is attached to frame **13** at a second point **37** for pivotal movement about a second transverse horizontal axis disposed at a

second location. Tilting means **35** includes a lineal extensible member; such as, piston shaft **39**.

Also, as part of the linkage arrangement to effect tilting of bucket **19**; linking means, such as lever **41**, is pivotally attached to bucket **19** and is ultimately connected via a bell crank **43** with tilting means **35** and is operable to tilt bucket **19** in either direction about the outer end portion **25** of main beam **21** in response to force from the tilting means.

To complete the linkage arrangement and allow the invention to be effective, a bell crank **43** is interposed between and connected to lever **41** and to piston shaft **39**. Bell crank **43** is thus connected at third point **45** with lever **41**, for pivotal movement about a third traverse horizontal axis; and at fourth point **47** with piston shaft **39** for pivotal movement about a fourth transverse horizontal axis. Bell crank **43** is pivotally attached also to main beam **21** at an intermediate point **49** for pivotal movement about a fifth transverse horizontal axis. Bell crank **43** is thereby effectively divided into two lever arms, A and B. First lever arm A is formed between intermediate point **49** and fourth point **47** connected with piston shaft **39**. Second lever arm B is formed between intermediate point **49** and third point **45** connected with lever **41**. The ratio of the length of the second lever arm to the length of the first lever arm; i.e., B/A; must be at least 1.4. The length of second lever arm B is fairly well constrained since it must be pivotally attached to the main beam and yet not extend so low as to encounter surface **27**. It is readily apparent that from the point of view of economic feasibility, lever arm A cannot be shortened so short that tilting means must be uneconomically powerful to effect the tilting of bucket **19**. There is a practical maximum of about 2 for the ratio of the length of the second lever arm to the length of the first lever arm.

Employing this basic limitation on the bell crank and employing conventional empirical design techniques, the respective points and axes can be located, and the main beam, the linking means, the tilting means and the bell crank can be proportioned and pivotally connected to effect the following results:

(1) The scoop side of the bucket will be capable of forming angles, with respect to a reference plane that is horizontal when the vehicle is horizontal, within the following ranges: 45–49 degrees tip-back at the surface position; 51–60 degrees carry at the top position; 45–57 degrees below the reference plane maximum dump at the top position; and more than 45 degrees below the reference plane maximum dump at the surface position;

(2) The bucket can be moved from the maximum dump position at the top to the normal loading, or horizontal position at the surface position by only lowering the main beam and maintaining the lineal extensible member extended substantially the same distance from the second axis; and

(3) The loaded, tilted back bucket can be raised to the top without spilling the load by only raising the main beam.

The empirical design techniques are well known to those skilled in the art and need not be discussed in detail herein. They represent compromises between conflicting needs, and reflect the impracticality of theroetical design, because of the numerous possible combinations of variables.

While the design of the main beam, the linking means, the tilting means and the bell crank to effect the results enumerated hereinbefore can be performed empirically, the following guide lines facilitate placement of points and axes, proportioning of lengths, and location of pivotal connections to achieve the final result desired. Once the length of main beam **21** has been chosen to place bucket **19** ahead of front wheel **15** and long enough to allow as high a positioning at the top carry position as desired, the location of first point **23** and, hence, the location of the first transverse horizontal axis must be chosen. While it is desirable that first transverse horizontal axis be as near the center of gravity of the vehicle as possible from a point of view of aligning the forces, it is also desirable to be able to effect the top carry position without having an unduly long main beam. The main beam may be shaped to avoid protuberances of the vehicle; such as, the axle between the front wheels; without unnecessarily increasing its length. The remaining elements and the location of points and axes can be expressed as proportions of the length of the main beam. For example, a length X may be chosen as the straight line length between the ends of the main beam. On this basis the first transverse horizontal axis, or first point **23**, is located on the vehicle at a height of about 0.6X above the smooth surface when the vehicle is substantially horizontally supported by the surface. It has been observed on the designs which have worked that first point **23**, second point **37**, and fourth point **47** form a substantially straight line when bucket **19** is in position to scrape a load with its scoop side **29** substantially horizontal and contiguous with the surface **27** when surface is horizontal. Moreover, the arc described by the fifth transverse horizontal axis through intermediate point **49** on main beam **21** and the bell crank **43** substantially coincides with the arc described by the fourth transverse horizontal axis after maximum tilt back of the bucket during about the first ⅓ of the elevating of the bucket to the top carry position but falls outside during the last ⅓ in order to retain bucket in the carry position during elevating. A bell crank length of about 0.5X and divided into a first lever arm of about 0.2X and a second lever arm of about 0.3X to give a ratio of the second lever arm to the first lever arm of about 1.5 may be employed. The outer end portion of the main beam is connected to the bucket at a point about 0.09X above the surface when the scoop side of the bucket is contiguous with the horizontal surface. The fifth transverse horizontal axis passing through intermediate point **49** is located about 0.6X from the first transverse horizontal axis and about 0.1X from and normal to a straight line connecting the first transverse horizontal axis and the outer end portion of the main beam. The tilting means in the fully extended position effecting full tilt back of the bucket at the surface is about 0.5X and in the full dump position at the top is about 0.4X. The linking means is about 0.2X measured from the third point to its pivotal connection with the bucket. The bucket is connected to the linking means and the other end of the main beam at a distance along its bottom member separated by about 0.1X. The bucket in the full tilt back position at the surface clears the front wheels by about 0.1X. The elevating means is connected to the frame about 0.5X back of the center of the front wheels and to the main beam about 0.4X from the first point and raises the main beam through at least 75° from the surface position to obtain the necessary height of dump without having an unduly long main beam.

As can be seen in FIG. 1, the preferred embodiment employs pairs of elements described hereinbefore. That is, a pair of main beams **21** are employed, as are pairs of cylinders for each of elevating means and of tilting means, and bell cranks.

The linkage arrangement and operation is best illustrated in FIGS. 2–5. The operation in which scoop side **29** of bucket **19** is scooped along surface **27** by forward motion of vehicle **11**, as illustrated in FIG. 2, has been described hereinbefore and will not be repeated.

Once bucket **19** is loaded with the material scooped from surface **27**, it is tilted back as illustrated in FIG. 3. Tilt back is effected by extension of piston shaft **39**, rotating bell crank **43**, pulling lever **41** to tilt back bucket **19**. The angle **51** of tilt back is within the range 45–49°.

The loaded bucket may be carried in this position but has the obvious disadvantage of encountering low obstructions in advance of the front wheels **15**. Therefore, it is,

ordinarily, advantageous to elevate the loaded bucket to the top before it is carried since this also improves visibility of the area immediately in front of the wheels and since the loaded bucket must be lifted before it can be dumped into a carrying vehicle.

An advantage of this invention is that the loaded, tilted back bucket; i.e., the loaded bucket in the tilted back position; can be elevated from the surface position to the top carry position without adjustment of piston shaft **39**. All that is required is operation of hydraulic cylinder **33** to elevate main beam **21** as shown in FIG. 4. Piston shaft **39** is retained with the same length of protrusion; yet, by linkage arrangement, through bell crank **43** and lever **41**, loaded bucket **19** is retained in the carry position with the proper tip back to prevent spilling of the load either from cutting edge **31** in one direction or top **53** in the other direction. In fact, at the top carry position, scoop side **29** of bucket **19** forms an angle **55** of carry at the top position within the optimum range of 51–60° with respect to a reference plane parallel with surface **27**. In the top carry position illustrated in FIG. 4 the front end loader may be positioned near a dump receptacle to receive the load since the operator has good visibility and can steer vehicle **17** at its mid-point by steering means **56** (FIG. 1). Such mid-point steering is not critical to the operation of the invention since any other method of steering the front end loader type vehicle can be employed. The mid-point steering is well known and need not be described herein.

Once positioned over the dump receptable to receive the load, the piston shaft **39** is retracted part way to effect a full dump position, illustrated in FIG. 5. A mechanical stop **57** is employed in conjunction with bucket **19** and main beam **21** to facilitate effecting a full dump position without careful positioning of piston shaft **39** by the operator. The operator can simply pull the lever to the retract position and partially retract piston shaft **39**. When bucket **19** hits the mechanical stop, a relief valve is opened to bypass hydraulic fluid around hydraulic cylinder **35**; whereupon the operator releases the retract lever which closes off valves to the hydraulic cylinder and holds this position of piston shaft **39** by liquid lock. As can be seen from FIG. 5, bell crank **43** does not quite align with lever **41** such that there is a moment arm to rotate bucket **19**. Dump angle **59**, which the scoop side of bucket **19** makes with the surface **27**, is within an optimum range of 45–57°, measured below a reference plane parallel with the surface. A minus sign (—) is sometimes employed simply to designate that the angle is measured opposite from the others, or below the reference plane.

As indicated hereinbefore, a primary advantage of this invention is that elevating means **33** can be retracted to lower main beam **21** and angle **59** returns to 0 as the bucket reaches the surface. Thus, the loader is ready to scoop an additional load from surface **27** without requiring any adjustment of tilting means **35** by the operator. Specifically, the operator can change the position illustrated in FIG. 5 to that illustrated in FIG. 2 simply by moving the lever effecting retraction of piston in hydraulic cylinder **33**.

The cycle; of scooping a load, tilting the bucket into the carry position, lifting the bucket to the top carry position and positioning it over and dumping into a dump receptacle and returning to scoop another load; is repeated as necessary.

One vehicle having the approximate proportions and location of points and axes listed in the table has been found to be particularly attractive in effecting the results of the invention. The listed empirical design criteria are within the general set outlined hereinbefore and those design criteria that have been employed without change in effecting the results of the invention are not again listed in the table.

TABLE

Element or location:	Proportion
Main beam **21**	X
Bell crank **43**	0.514X
First lever arm A	0.20X
Second lever arm B	0.322X
B/A	1.56
Distance of first point **23** above horizontal surface	0.65X
Distance from horizontal surface to other end **25** of main beam mounted to bucket with scoop side on the surface	0.094X
Intermediate point **49**:	
Distance from first point **23**	0.618X
Distance normal to straight line connecting first point and other end of main beam	0.128X
Tilting means:	
Fully extended	0.526X
In the full dump position at the top	0.444X
Fully retracted effecting full dump at the surface	0.378X
Linking means, between pivotal connections	0.234X
Bucket:	
Distance between pivotal connections	0.144X
Distance bucket clears front wheel in full tilt back position at the surface	0.10X
Elevating means connection:	
Distance from connection on frame to the center of the front wheels	0.475X
Distance from connection on main beam to the first transverse horizontal axis	0.35X
Angle through which main beam is raised from surface to top	81–83°

Although the invention has been described with a high degree of particularity, it is understood that the present disclosure has been made only by way of example and that numerous changes in the details of construction and the combination and arrangement of parts may be resorted to without departing from the spirit and the scope of the invention.

What is claimed is:

1. In a front end loader type vehicle having a frame mounted on wheels and having a prime mover, the improvement comprising:

(a) a main beam attached at an inner end portion to a first point on said frame for pivotal movement about a first transverse horizontal axis disposed thereat;

(b) a bucket pivotally attached to said main beam at an outer end portion thereof and adapted to scoop a load from a surface, to retain said load during lifting, and to dump said load above and in front of said vehicle;

(c) elevating means connected to said main beam and to said frame for elevating said outer end portion of said main beam;

(d) bucket tilting means attached to said frame at a second point for pivotal movement about a second transverse horizontal axis disposed thereat and including a lineal extensible member; and

(e) linking means pivotally attached to said bucket, and a bell crank pivotally connected to said linking means and to said tilting means, operable to tilt said bucket in either direction about said other end of said main beam in response to force from said tilting means; said bell crank being connected to said linking means at a third point for pivotal movement about a third transverse horizontal axis and to said tilting means at a fourth point for pivotal movement about a fourth transverse horizontal axis and pivotally attached to said main beam at an intermediate point

for pivotal movement about a fifth transverse horizontal axis, forming a first lever arm between said intermediate point and said fourth point and a second lever arm between said intermediate point and said third point, such that the ratio of the length of said second lever arm to the length of said first lever arm is at least 1.4 and no greater than 2; said first and second transverse horizontal axes being located such that, and said main beam, said linking means, said bucket tilting means, and said bell crank being proportioned and pivotally connected such that the scoop side of said bucket will be capable of forming angles, with respect to a reference plane parallel to a horizontal surface supporting said vehicle, within the following ranges: 45–49° tip back at the surface position; 51–60° carry at the top position, 45–57° below the reference plane maximum dump at the top position, and more than 45° below the reference plane maximum dump at the surface position, and such that said bucket can be moved from the maximum dump position at the top to a normal loading position wherein the scoop side of said bucket is in a horizontal scoop position at said horizontal surface by only lowering said outer end portion of said main beam and maintaining said lineal extensible member extended substantially the same distance from said second point, and such that the loaded, tilted back bucket can be elevated to the top without spilling the load by only elevating said outer end portion of said main beam.

2. The vehicle of claim 1 wherein said first point, said second point, and said fourth point form a substantially straight line when said bucket is in said normal loading position.

3. The vehicle of claim 1 wherein said first point, said second point, and said fourth point form a substantially straight line when said bucket is in said normal loading position, wherein the arc described by said fifth transverse horizontal axis through said intermediate point on said main beam and said bell crank substantially coincides with the arc described by said fourth transverse horizontal axis through said fourth point after maximum tilt back of said bucket during about the first ⅓ of said elevating to said top position and falls outside thereof during the last ⅓, and wherein said elements are proportioned as follows: said main beam is X in length; said bell crank is about 0.5X, has a first lever arm of about 0.2X and a second lever arm of about 0.3X to give a ratio of said second lever arm to said first lever arm of about 1.5; said first transverse horizontal axis through said first point is located about 0.6X above said surface; said outer end portion of said main beam is connected to said bucket at a point about 0.09X above said surface when said scoop side of said bucket is substantially contiguous with said surface; said intermediate point is located on said main beam about 0.6X from said first point and at a distance, normal to a straight line connecting said first point and said outer end portion of said main beam, of about 0.1X; said tilting means in the fully extended position effecting full tilt back of said bucket at said surface is about 0.5X and in the full dump position at the top is about 0.4X; said linking means is about 0.2X measured from said third point to its pivotal connection to said bucket; said bucket is connected to said linking means and to said outer end portion of said main beam at pivotal connections separated by about 0.1X; said bucket in the full tilt back position at said surface clears said front wheel by about 0.1X; and said elevating means is connected to said frame about 0.5X back of the center line axis of the front wheels and to said main beam about 0.4X from said first point and raises said main beam through at least 75° from said surface position to its top position.

4. The vehicle of claim 3 wherein said elements are proportioned as follows: said main beam is X in length, said bell crank is about 0.514X, has a first lever arm of about 0.20X, and a second lever arm of about 0.322X, forming a ratio of said second lever arm to said first lever arm of about 1.56; said first transverse horizontal axis through said first point is about 0.65X above said surface; said outer end portion of said main beam is connected to said bucket at a point about 0.094X above said surface when said scoop side of said bucket is substantially contiguous with said surface; said intermediate point is located on said main beam about 0.618X from said first point and at a distance, normal to the straight line connecting said first point and said outer end portion of said main beam, of about 0.128X; said tilting means in said fully extended position is about 0.526X, in said full dump position at the top is about 0.444X, and in a fully retracted position effecting full dump at the surface is about 0.378X; said linking means is about 0.234X measured from said third point to its pivotal connection to said bucket; said bucket is connected to said linking means and to said outer end portion of said main beam at pivotal connections separated by about 0.144X; said bucket clears said front wheel in full tilt back position at said surface by about 0.10X; said elevating means is connected to said frame about 0.475X back of the center line axis of said front wheels and to said main beam about 0.35X from said first point and raises said main beam through 81–83° from said surface position to its top position.

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