Oct. 31, 1967 E. B. WAGNER 3,349,932

SIDE DUMP LOADER

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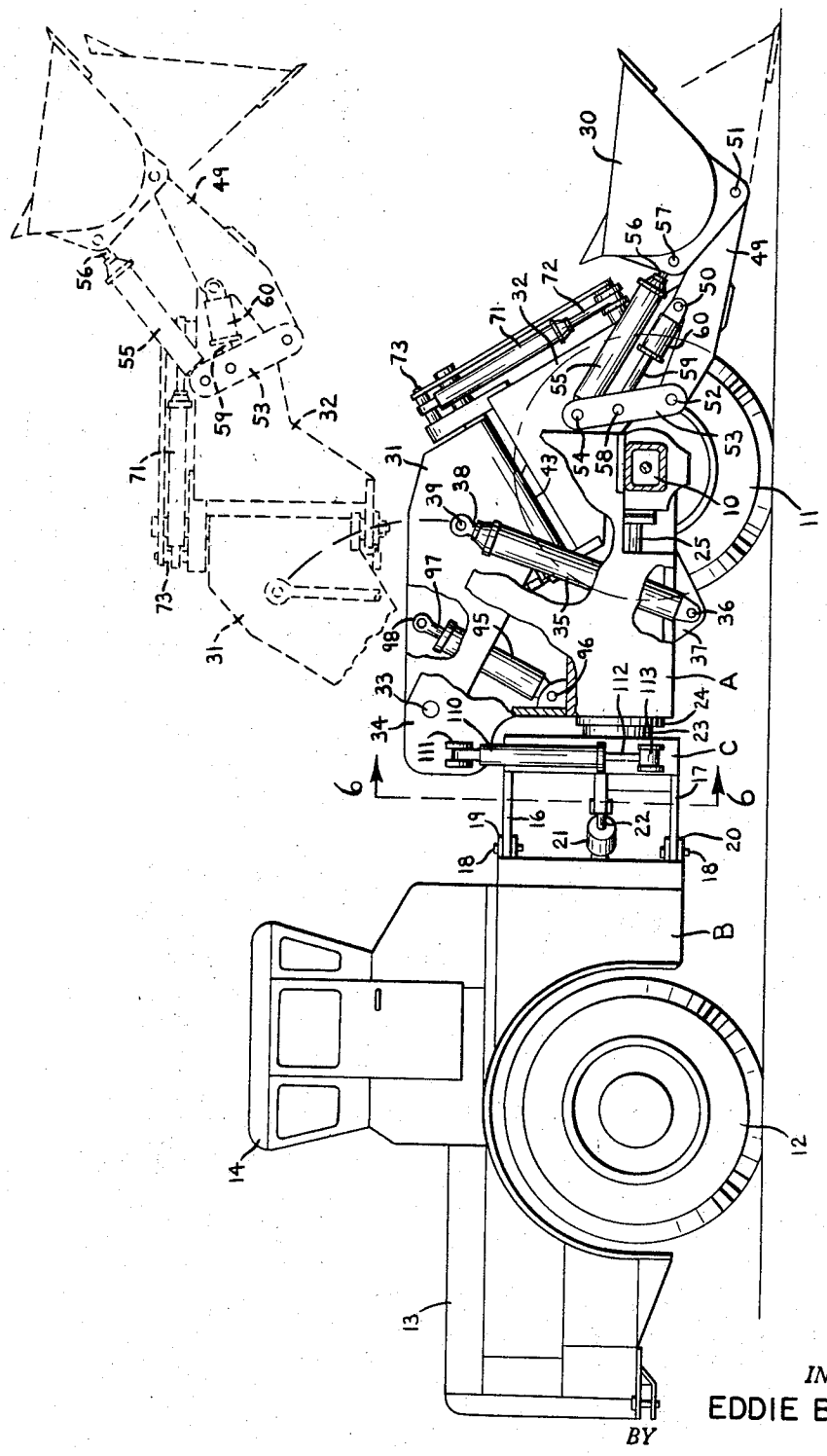

Fig. 1

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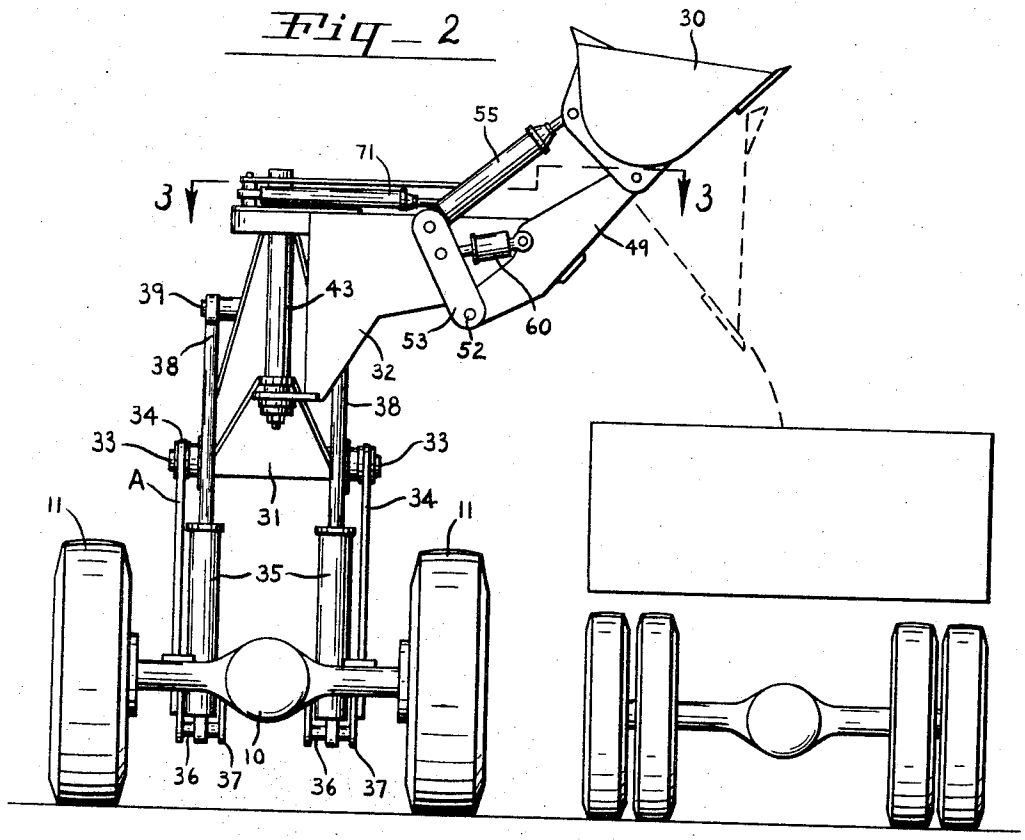
SIDE DUMP LOADER

Filed Aug. 2, 1963 5 Sheets-Sheet 2

Fig. 2



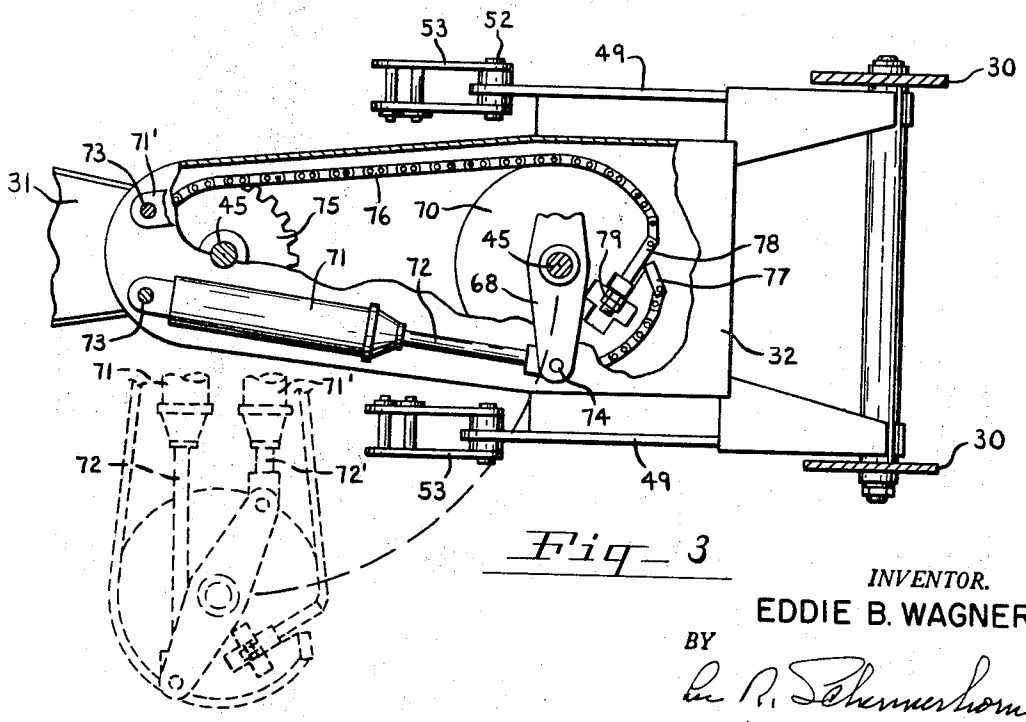


Fig. 3

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SIDE DUMP LOADER

Filed Aug. 2, 1963 5 Sheets-Sheet 3

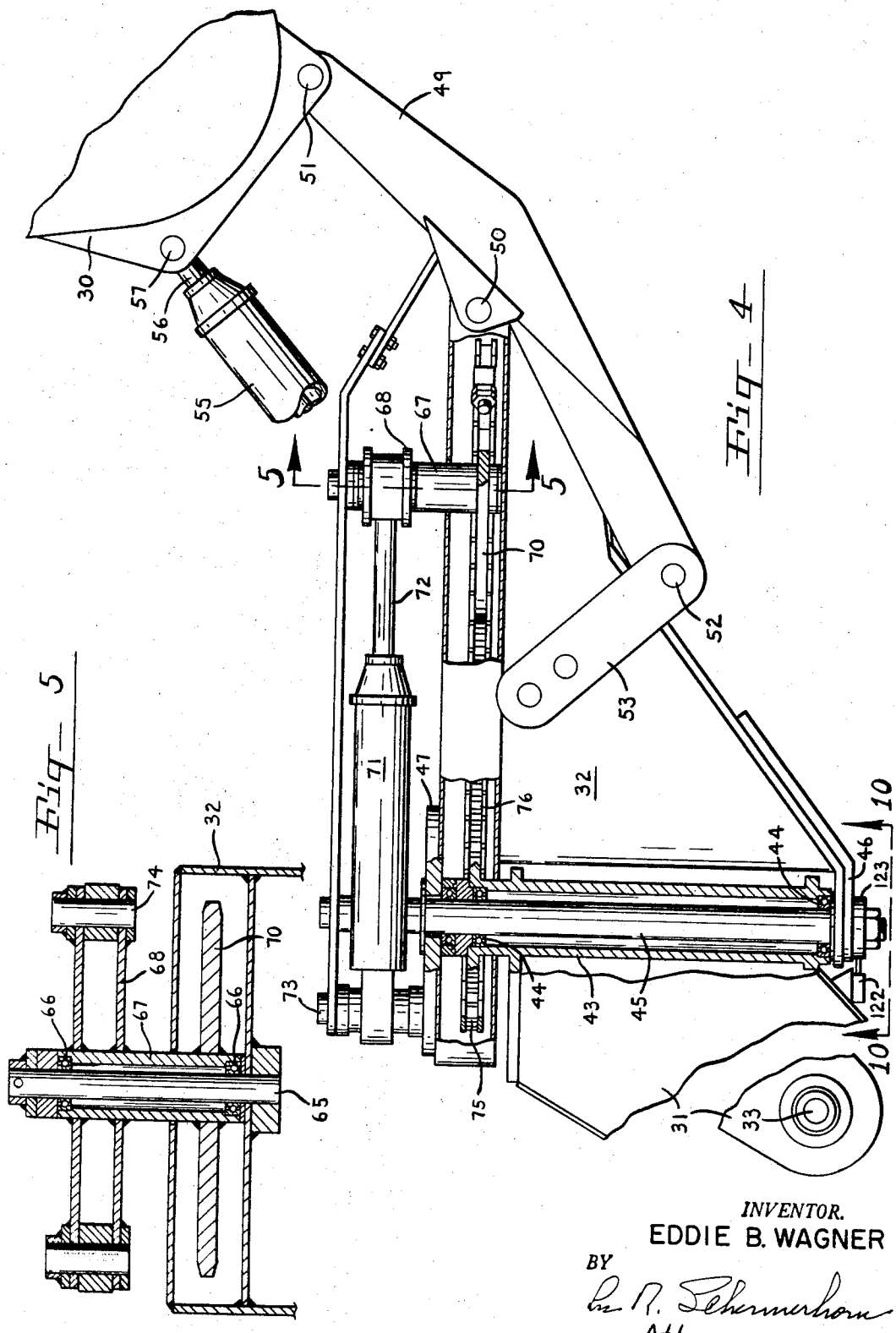

Fig. 4

Fig. 5

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SIDE DUMP LOADER

Filed Aug. 2, 1963 5 Sheets-Sheet 4

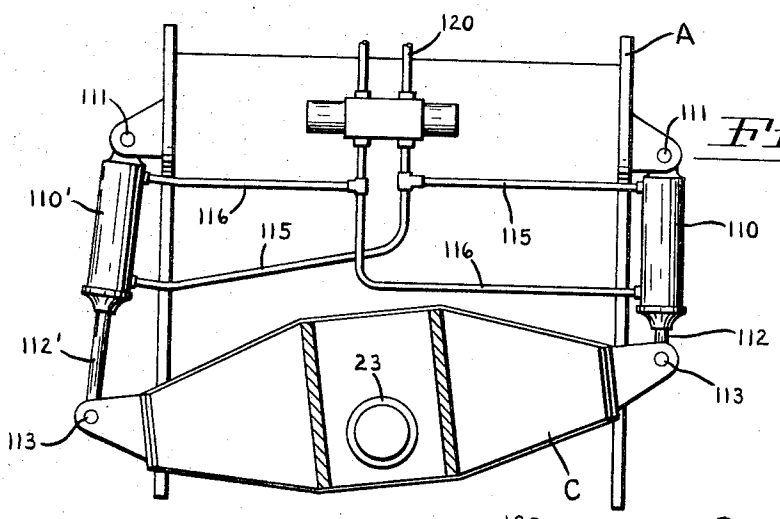

Fig_ 6

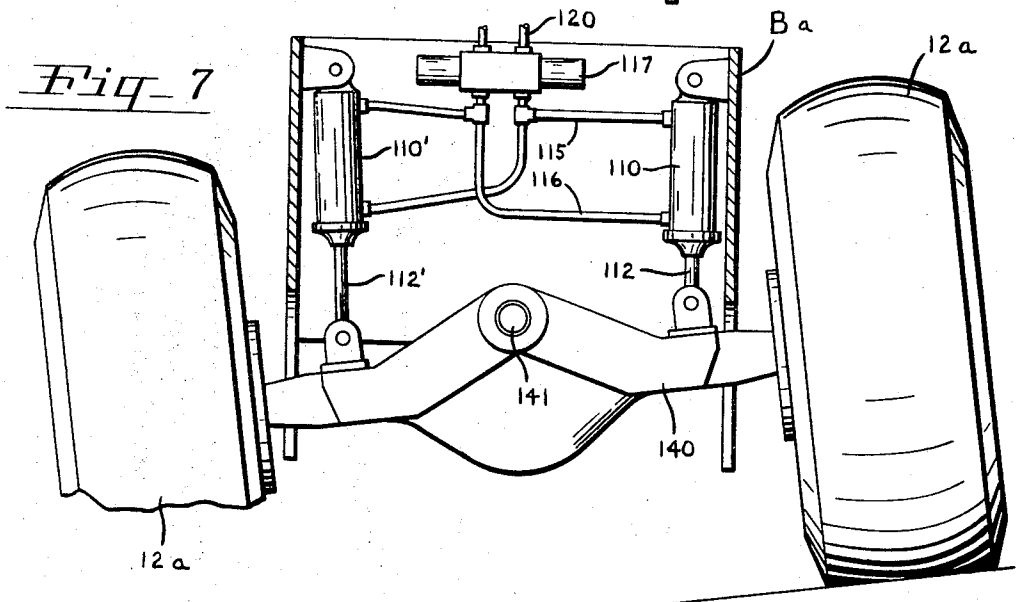

Fig_ 7

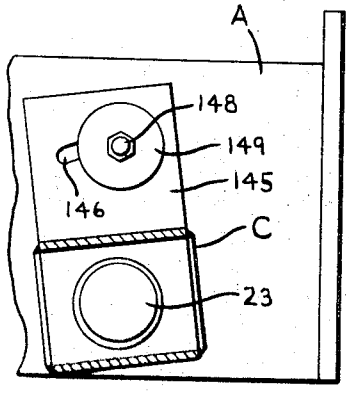

Fig_ 9

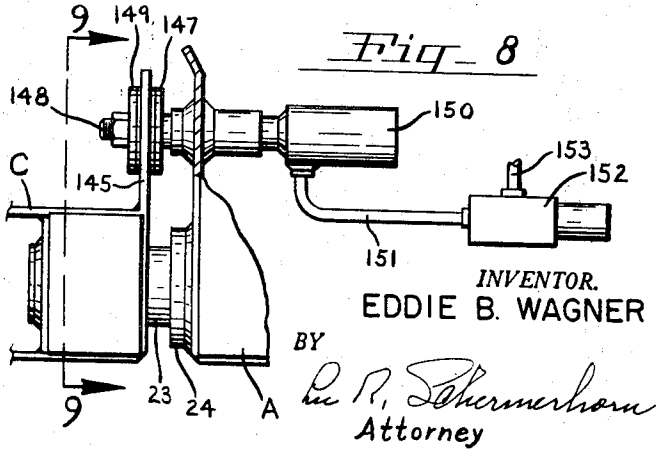

Fig_ 8

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SIDE DUMP LOADER

Filed Aug. 2, 1963 5 Sheets-Sheet 5

Fig_11

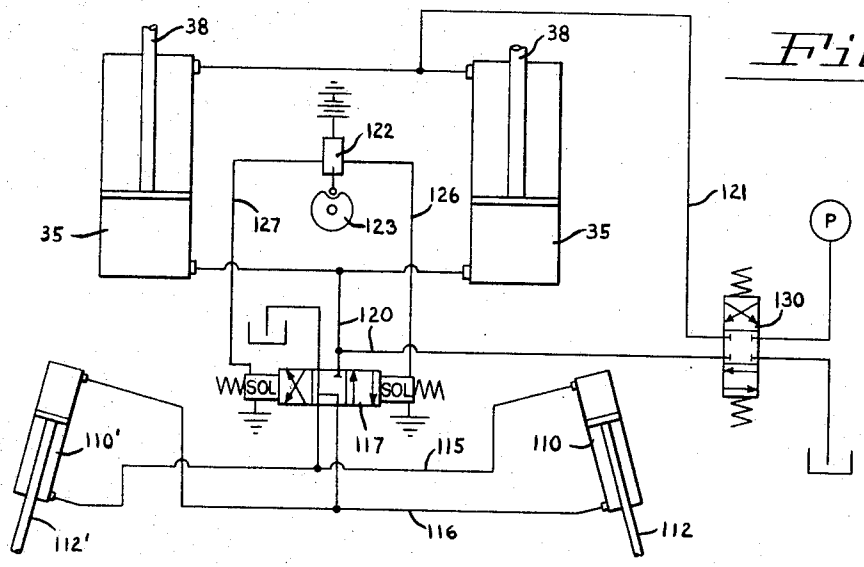


Fig_12

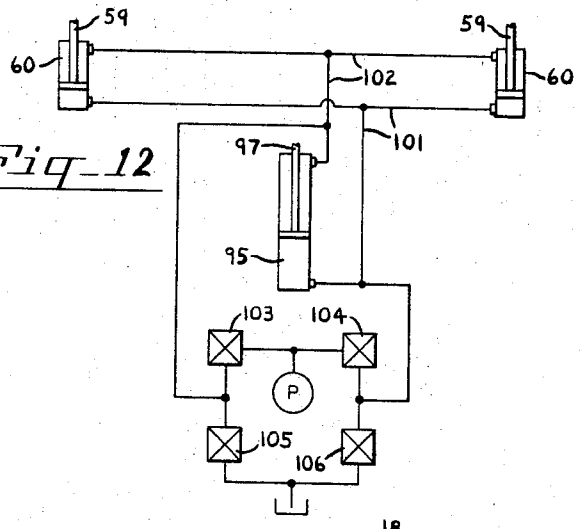


Fig_10

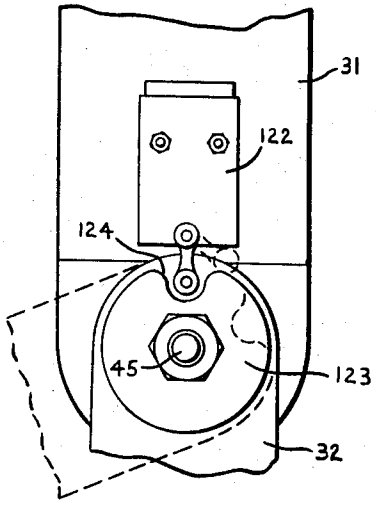


Fig_13

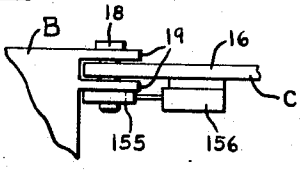
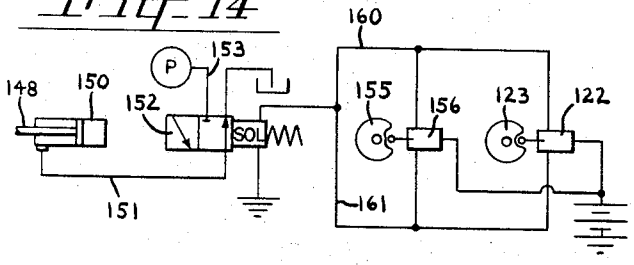


Fig_14



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United States Patent Office 3,349,932 Patented Oct. 31, 1967

3,349,932

SIDE DUMP LOADER

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Filed Aug. 2, 1963, Ser. No. 299,652
30 Claims. (Cl. 214—138)

This invention relates to loaders and has particular reference to improvements allowing a loader to dump to either side.

A loader is a self-propelled vehicle having a scoop-type bucket mounted on a forwardly extending boom. The bucket is filled by driving the vehicle forward with the bucket tilted forward and sliding on the ground so as to scoop up loose material on the ground, such as earth, rocks, sand or ore. Then the bucket is tilted back to retain the scooped up material and the boom is raised. With the bucket thus elevated, the vehicle may be maneuvered to position the bucket over some means of conveyance, such as a truck or conveyor belt. The load is discharged by tipping the bucket forward.

The utility of such loaders has heretofore been limited by the inability of the boom to swing from side to side whereby the load could only be dumped straight forward. In some working areas, as for example in a mine or tunnel, there is insufficient space to turn the vehicle in order to reach a conveyance close by. This has necessitated driving the loader in reverse for great distances, delaying excavation work and idling work crews and machine while awaiting return of the loader.

Previous attempts have been made to dump to one side but such machines have other objectionable limitations. For example, loaders have been developed which will raise one end of the bucket in order to discharge to one side of the vehicle. In such case the loader is usually limited to either right or left side dumping and the operator cannot dump on the opposite side when he might wish to do so. Even so, the end-tilted bucket will not cast its load appreciably beyond the side of the machine, which may be necessary in some cases. A more critical objection is that in mine or tunnel work there may not be sufficient overhead clearance to permit one end of a large bucket to be raised sufficiently high for side dumping.

A swinging boom has heretofore been considered impossible to achieve, especially in a vehicle which has articulated body sections for steering. Such vehicles, which have been widely adopted for large capacity loaders, have a longitudinal swivel axis or its equivalent for independent oscillation of the front and rear body sections or axles, creating inherent instability with an overhanging side load. A compactly constructed loader cannot resist overturning as does a swinging shovel-type machine which has a broad and rigid base and where the shovel load is small in relation to the size and weight of the whole machine. A distinguishing characteristic of a loader is the relatively large size and weight of its load in relation to the weight of the machine and the size of its base support. Hence, it has heretofore been considered necessary in a large capacity loader to keep the bucket in a forward position so that it could be counterbalanced by a weight on the rear end of the machine.

The general object of the present invention is, therefore, to provide a side dump loader which overcomes the disadvantages and shortcomings of prior machines as pointed out above.

More specifically, the object of the invention is to provide a side dump loader adapted to the lateral and overhead space limitations of a mine or tunnel, and particularly, to provide a stable swinging boom loader in a

vehicle having articulated body sections with a longitudinal swivel axis or oscillating axle.

Other objects are to provide a novel and improved swinging boom, to provide means to rigidify the body and axles as a boom base to resist overturning and to provide novel hydraulic levelling means for the bucket in a loader.

In the present loader the boom has a lower section which pivots up and down but does not swing. An upper boom section is arranged to swing about a pivotal axis on the lower section, which axis becomes vertical, or nearly vertical, when the lower section is raised to dumping position. This permits the bucket to turn parallel with the vehicle in overhanging position at a distance out from either the left or right side of the vehicle. Stabilizer or lock-up means are provided to resist overturning both in side dumping and in travelling with the loaded bucket elevated. These means are provided for vehicles having a longitudinal swivel axis between the body sections and also for vehicles having an oscillating rear axle, to form a semi-rigid boom base. Novel and improved hydraulic bucket levelling means are also provided.

Additional objects and advantages will become apparent and the invention will be better understood from the following detailed description of certain preferred embodiments illustrated in the accompanying drawings. Various changes may be made, however, in the details of construction and arrangement of parts and certain features may be used without others. All such modifications within the scope of the appended claims are included in the invention.

In the drawings:

FIGURE 1 is a side elevation view of a loader embodying the principles of the invention and showing the boom in raised position in broken lines;

FIGURE 2 is a front end view of the loader with the boom raised and swung to one side for dumping the bucket;

FIGURE 3 is a fragmentary view taken on the line 3—3 of FIGURE 2, showing the upper boom section in forward position in solid lines and in side position in broken lines;

FIGURE 4 is an enlarged side view of the boom with parts in section and parts broken away;

FIGURE 5 is a sectional view taken on the line 5—5 of FIGURE 4;

FIGURE 6 is a cross sectional view taken on the line 6—6 of FIGURE 1;

FIGURE 7 is a cross sectional view showing a stabilizer arrangement for a loader having an oscillating rear axle;

FIGURE 8 is a fragmentary side elevation view with parts in section, showing a lock-up device for stabilizing the vehicle;

FIGURE 9 is a view taken on the line 9—9 of FIGURE 8;

FIGURE 10 is a view taken on the line 10—10 of FIGURE 4;

FIGURE 11 is a schematic view of the hydraulic and electric systems for FIGURES 6 and 7;

FIGURE 12 is a schematic diagram of the hydraulic system involving the hydraulic compensating means for the bucket levelling cylinders;

FIGURE 13 is a fragmentary side elevation view of a switch arrangement for actuating the lock-up device of FIGURE 8 in response to turning the vehicle; and

FIGURE 14 is a schematic view of the electric and hydraulic system for FIGURE 8.

The loader vehicle comprises a front body unit or bogie A, a rear body unit or bogie B and an intermediate frame C. The front body unit A has a single axle 10 rigid with the frame of the unit carrying a pair of front wheels 11. The rear body unit B has a single axle rigid with the frame

of the unit carrying a pair of rear wheels **12**. This unit has an engine **13** arranged to drive all four wheels. The operator occupies a cab **14** for operating the bucket and driving the vehicle backward and forward.

The intermediate frame C has upper and lower rearwardly extending tongues **16** and **17** pivotally connected by vertical pins **18** with upper and lower ears **19** and **20** on the rear body unit. These pins define a pivotal axis of articulation between the front and rear body units for steering. Steering is accomplished by a pair of horizontal, obliquely disposed, double acting cylinders **21** which are pivotally connected to the front end of unit B. Piston rods **22** in these cylinders are pivotally connected at their divergent outer ends with opposite sides of the frame unit C. When one piston rod is extended and the other retracted, the two body units and their axles are forced into angular relationship, causing the vehicle to turn.

In order to provide flexibility for travel over uneven ground surfaces, there is a swivel connection on a longitudinal axis interconnecting the units A and C. This swivel connection comprises a cylindrical trunnion **23** extending forward from frame C and mounted for rotative oscillation in a cylindrical bearing **24** in body unit A. Thus, the intermediate frame C turns with the front body unit A about the vertical axis of pins **18** in steering and oscillates with the rear body unit B about the longitudinal axis of trunnion **23** in negotiating uneven ground. A drive shaft **25** for the front wheels extends through the center of trunnion **23**, with suitable universal joints, to a transmission associated with the engine in unit B.

The loader bucket **30** is carried by a boom having a lower boom section **31** and an upper boom section or assembly **32**. Lower boom section **31** comprises a pair of arms which diverge from their upper ends to heel boom pin **33** in a pair of brackets **34** on opposite sides of the frame of front body unit A. The boom may be raised and lowered by a pair of double acting cylinders **35** having pivotal connections **36** at their lower ends with brackets **37** on the opposite sides of the frame. Piston rods **38** in the upper ends of these cylinders are pivotally connected at **39** with the outer portion of the lower boom section.

The upper end of lower boom section **31** carries a bearing tube **43** with bearings **44** for a pivot shaft **45**. This shaft is mounted at such an angle that when the lower boom section is fully raised, the shaft will be vertical as shown in FIGURE 4 and in broken lines in FIGURE 1. Upper boom section **32** has an ear **46** fixedly connected to the lower end of shaft **45**. Also connected with upper boom section **32** is an apertured plate **47** which surrounds and turns with the upper end of shaft **45**. Thus, when the boom is raised, the upper boom section may turn at right angles to the lower boom section for side dumping on either side of the loader as shown in FIGURE 2.

A pair of bucket carrying arms **49** are rigidly mounted on opposite sides of the outer end of the upper boom section. The outer ends of these arms are pivotally connected with the under side of the bucket at **51** while the inner ends are pivotally connected at **52** with a pair of arms **53** on opposite sides of the upper boom section. The upper ends of these arms are pivotally connected at **54** with the inner ends of double acting bucket tilting cylinders **55**. The cylinders **55** have piston rods **56** pivotally connected at **57** with the rear side of the bucket. Intermediate the ends of arms **53** are pivotal connections **58** for the piston rods **59** of double acting levelling cylinders **60**. The other ends of these cylinders are pivotally connected at **50** to the arms **49**.

The mechanism for swinging the upper boom section is shown in FIGURES 3, 4 and 5. Mounted on the upper boom section is a shaft **65** parallel with the shaft **45**. Mounted on bearings **66** on shaft **65** is a swivel tube **67** carrying a cross arm **68** and a disc **70** both integrally connected with the swivel tube. The cross arm and disc **70** may be rotated by a pair of double acting cylinders **71** and **71'** having piston rods **72** and **72'**. The rear ends of these cylinders are pivotally connected with upper boom section **32** by means of pins **73** in the plate **47**. The piston rods are pivotally connected at **74** with the opposite ends of cross arm **68**.

Bearing tube **43** on the lower boom section carries a stationary sprocket wheel **75** which is fixedly connected thereto. A chain **76** interconnects disc **70** and sprocket wheel **75**. One end of the chain is fixedly connected to the disc at **77** while the other end is connected to an adjustable bolt **78** on the disc which may be tightened by means of nuts **79**. Thus, when the piston rod **72** is extended, the upper boom section turns clockwise as shown in broken lines in FIGURE 3 and when the piston rod **72'** is extended, the upper boom section turns counterclockwise. The upper boom section will swing 90° right and left.

The hydraulic system for levelling cylinders **60** is shown in FIGURE 12. These cylinders are motor or slave cylinders which are controlled by a double acting pump or master cylinder **95** that is actuated by the raising and lowering of the boom. As shown in FIGURE 1, the lower end of cylinder **95** is pivotally connected at **96** to the frame of front body unit A. Its piston rod **97** is pivotally connected at **98** to lower boom section **31**. When the boom is lowered, hydraulic fluid is forced out of the lower end of cylinder **95** and this fluid is transmitted through line **101** to the inner ends of cylinders **60** causing their piston rods to be extended as shown in full lines in FIGURE 1. The hydraulic fluid displaced from the outer ends of cylinders **60** returns through line **102** to the upper end of cylinder **95**.

This is a closed hydraulic system which does not utilize an outside pressure source for its operation. When the boom is raised as shown in broken lines in FIGURE 1, hydraulic fluid is displaced from the upper end of cylinder **95** through line **102** to the outer ends of cylinders **60**. This causes the piston rods **59** to be retracted. The hydraulic fluid displaced from the inner ends of cylinders **60** then returns through line **101** to the lower end of cylinder **95**. The cylinder displacements and mechanical linkages are so proportioned that the resulting movements of arms **53** maintain the bucket level as the boom is raised and lowered.

During these levelling movements, of course, the tilting cylinders **55** operate as links of fixed length in a four bar linkage and cylinders **60** change the shape of the parallelogram by altering the angular relationship between arms **53** and arms **49**. When the bucket is dumped, one side of the linkage elongates by the extension of piston rods **56** from cylinders **55** with the angular relationship between arms **53** and **49** then remaining fixed. The hydraulic system and control valve for tilt cylinders **55** is conventional and is not illustrated.

In the event the piston rods **59** and **97** get out of synchronism because of leakage of hydraulic fluid out of the system and/or leakage of air into the system, they may be re-synchronized by means of valves **103** to **106**. For example, by opening manual valves **104** and **105**, pump pressure is admitted to the inner ends of all three cylinders, driving their piston rods out to their limits of movement. The piston rods are then synchronized and valves **104** and **105** are closed. The other two manual valves **103** and **106** permit synchronizing the piston rods by driving them all inwardly to their inner limits of movement in case the operator prefers to use this direction of movement for the purpose. The valves **103** to **106** remain closed during operation of the loader.

FIGURE 11 shows a hydraulic system for stabilizing the front body unit or bogie A. Included in this system is a pair of near vertical double acting hydraulic cylinders **110** and **110'** on opposite sides of the vehicle as shown in FIGURES 1 and 6. The upper ends of these cylinders are pivotally connected at **111** with brackets **34**. Piston rods **112** and **112'** in these cylinders are pivotally connected at **113** with brackets on opposite sides of intermediate frame

unit C. The upper and lower ends of these cylinders are cross connected by hydraulic lines **115**, **116** as shown and the lines are connected to a four-way, three position, spring centered, double solenoid valve **117**. When neither solenoid is energized, the valve is centered in mid position by spring action as shown, connecting the lines **115** and **116** together and to tank at atmospheric pressure. This permits free play of the piston rods **112** and **112'** up and down as the body units A and B swivel back and forth relative to each other on trunnion **23** in passing over uneven ground. This free swivel action is illustrated in FIGURE 6.

When one or the other of the solenoids is energized, one of the lines **115** or **116** is connected to a line **120** from the lower ends of boom lift cylinders **35**. Then the hydraulic pressure produced in the lower ends of cylinders **35** by the weight of the boom is transmitted to the upper end of one of the stabilizing cylinders **110**, **110'** and to the lower end of the other cylinder to resist tilting or overturning in the direction in which the upper boom section is swung. This operation is selectively controlled by boom direction switch **122**.

As shown in FIGURES 4 and 10, switch **122** is mounted on a bracket on lower boom section **31** near the end of boom pivot shaft **45**. It will be remembered that shaft **45** turns with the upper boom section **32**. Mounted on the lower end of shaft **45** is a switch actuating cam **123** having a single notch **124** therein. Switch **122** is a single pole, double throw switch having a mid position for deenergizing both solenoids of solenoid valve **117**. When the switch lever is actuated in one direction, it energizes a wire **126** to operate one solenoid and when the switch lever is actuated in the opposite direction, it energizes a wire **127** to operate the other solenoid.

When upper boom section **32** is turned straight forward, the switch arm reposes in notch **124** whereby both solenoids of valve **117** are deenergized allowing the valve to be spring centered in mid position for free play of the piston rods **112** and **112'** up and down as previously mentioned. When upper boom section **32** turns to the right, the switch arm energizes wire **126** and the right solenoid to shift the valve to the right in FIGURE 11. This causes hydraulic pressure from the lower ends of boom lift cylinders **35** to be transmitted to line **115** while line **116** is connected to tank at atmospheric pressure. This pressure in line **115** acts in the upper end of cylinder **110** and in the lower end of cylinder **110'** tending to lift the right side of front body unit A and depress the left side relative to body unit B.

In this way body unit A is prevented from tilting or overturning by reaction against body unit B thereby utilizing the stabilizing force of the latter. The magnitude of this reaction force is proportional to the weight of the load in the bucket plus the weight of the boom itself since the force is derived solely from the hydraulic pressure in the lower ends of the boom lift cylinders. Hence, there is no possibility of over-compensation with light loads.

Some fluid is displaced from cylinders **35** to cylinders **110** and **110'**, tending to lower the boom but this is not of objectionable magnitude because the cylinders **110** and **110'** are considerably smaller than cylinders **35** and the necessary stabilizing force is developed by relatively small movements of piston rods **112** and **112'**.

When the boom swings to the left, the switch arm is actuated in the opposite direction to energize wire **127** and the left solenoid. This shifts the valve to the left, causing pressure line **120** to be connected with line **116** and causing line **115** to be connected to tank. The piston rods **112** and **112'** are thereby actuated in reverse directions, tending to lift the left side of the body unit A and depress the right side.

If desired, the stabilizing fluid pressure for cylinders **110** and **110'** may be obtained from pump pressure instead of boom lift cylinder pressure, in which case the stabilizing force exerted by piston rods **112** and **112'** is not automatically proportional to boom load.

The angle of boom swing at which the stabilizing system becomes effective is controlled by the width of notch **124** in cam plate **123**. By way of example, in the present vehicle this angle is preferably about 5° right and left from straight forward but it may be a larger or smaller angle.

The manual valve for raising and lowering the boom is a spring centered, three position, four-way valve **130** (FIGURE 11). When this valve is shifted downward, pump pressure is directed through line **120** to the lower ends of cylinders **35** to raise the boom. During the raising movement, fluid is displaced from the upper ends of the cylinders through line **121** to tank. When the boom has been raised, the valve is returned to its spring centered off position shown, closing the ends of both lines **120** and **121** to hydraulically lock the boom in raised position. The boom is lowered by shifting the valve to its upper position connecting line **121** with pressure and line **120** with tank. Since the boom is raised and lowered in its straight forward position, valve **117** remains at such times in its spring centered position shown wherein line **120** is not connected to either one of lines **115**, **116**.

The stabilizing system of FIGURE 11 may also be applied to loaders having an oscillating rear axle instead of the oscillating trunnion connection **23** between the front and rear body units. In such vehicles the intermediate frame unit C in FIGURE 1 is a fixed and integral part of front body unit A so that the body units A and B cannot oscillate relative to each other about a longitudinal axis. Provision is made for flexibility in travelling on an uneven ground surface by pivoting the rear axle beam **140** for oscillation on a central longitudinal trunnion **141** as shown in FIGURE 7. The rear body unit B_a corresponds to the rear body unit B in FIGURE 1 and the wheels 12_a correspond to the wheels **12** in FIGURE 1.

Piston rods **112** and **112'** are connected to the opposite ends of the axle **140** and react on rear body unit B_a to prevent both front and rear body units from tipping toward the side over which the boom is swinging, the same as in FIGURE 6. When the boom is straight forward, both piston rods **112** and **112'** are free to move up and down and allow the axle **140** to oscillate as illustrated in FIGURE 7.

FIGURES 8, 9, 13 and 14 show a different lock-up system for the oscillating trunnion vehicle of FIGURE 1. Intermediate unit C is provided with a radial outstanding plate **145** having an arcuate slot **146** concentric with trunnion **23**. A stationary frictional clamp plate **147** is mounted on body unit A in a position to loosely engage the front side of plate **145**. A piston rod **148** extends through slot **146** carrying a frictional movable clamp plate **149** on the rear side of plate **145**. These clamp plates are preferably faced with a friction material such as brake lining. The forward end of piston rod **148** is connected with a piston in a single acting cylinder **150** mounted on body unit A as shown. When fluid pressure from a line **151** is admitted to the rear side of the piston, the rear clamp plate **149** is pulled forward to clamp the plate **145** between the two plates **147** and **149** and prevent oscillation of body unit A relative to intermediate unit C and rear body unit B. A solenoid valve **152** controls the admission of pressure to line **151** from a supply line **153**.

It will be apparent that the clamp type lock-up shown in FIGURES 8 and 9 may also be applied in an obvious manner to the oscillating axle suspension of FIGURE 7 in lieu of the cylinders **110**, **110'**, if desired. This may be done by mounting plate **145** on the oscillating axle beam **140** and mounting the stationary friction plate **147** and cylinder **150** on the rear body unit B_a.

This axle or bogie lock-up may be made responsive to the turning of the vehicle as well as the swinging of the boom. In FIGURE 13 a notched cam plate **155** is mounted on an ear **19** of rear body unit B and a switch **156** is mounted on the tongue **16** of intermediate frame C for actuation thereby. Cam plate **155** is similar to cam

plate **123** except that it has a wider notch so that the switch will not be actuated until the front and rear body sections A and B are turned out of alignment by an amount exceeding a relatively large angle as, for example, 30° right or left. This angle may be made larger or smaller as desired.

The two switches **122** and **156** are connected in parallel to energize the solenoid of solenoid valve **152** as shown in FIGURE 14. In this case there is no differential operation so the right and left switch wires **160** and **161** are connected together so that the solenoid valve is actuated when the boom cam **123** turns either right or left and also when the steering cam **155** turns either right or left a sufficient amount. The solenoid is normally deenergized and the valve is spring actuated to the left as shown, connecting cylinder hydraulic line **151** to atmospheric pressure in the hydraulic fluid tank. This releases the clamping action on plate **145** and allows the two body units A and B to oscillate freely relative to each other the same as in FIGURE 6. Energization of the solenoid moves the valve to the right connecting pressure line **153** with cylinder line **151** to clamp the plate **145** and rigidify the swivel connection between body units A and B. In this way the weight of body unit B and its counterweight are made available to stabilize front body unit A in sharp turns as well as when the boom is swung to one side.

The present stabilizing and lock-up systems retain the free flexibility of a swivel trunnion connection between body units, or an oscillating axle suspension, for travel and at the same time provide stability equivalent to that of a rigid base crane for swinging the boom to either side. In this way a long side reach may be provided for the full and balanced loading of a large truck alongside as shown in FIGURE 2. Even with the truck at a distance from the loader the latter is able to cast its bucket load to the far side of the truck. No previous loader has been able to do this.

The hydraulic bucket levelling feature is advantageous for all loaders as it eliminates the conventional expensive and cumbersome mechanical linkage heretofore used for this purpose and substitutes a relatively simple and compact mechanism.

Having now described my invention and in what manner the same may be used, what I claim as new and desire to protect by Letters Patent is:

1. In a vehicle having a flexible suspension frame on its running gear and a boom on said frame having lateral swinging movements, means to rigidify said flexible suspension frame means responsive to lateral swinging movement of the boom to actuate said rigidifying means, and means utilizing the weight of the boom to provide an operative force for said rigidifying means proportional to the weight of the boom.

2. In a vehicle as defined in claim **1**, said flexible suspension comprising front and rear body units pivotally connected together for relative oscillation about a longitudinal axis, and said rigidifying means being operative on said pivotal connection.

3. In a vehicle as defined in claim **1**, said flexible suspension comprising an oscillating axle and said rigidifying means being operative on said axle.

4. In a vehicle as defined in claim **1**, said last means comprising a boom lift cylinder, a cylinder and piston rod unit interconnecting relatively movable parts of said flexible suspension and a hydraulic line interconnecting said cylinders, and said actuating means comprising a valve in said line.

5. In a vehicle having a flexible suspension frame on its running gear and a boom on said frame having lateral swinging movements, means to rigidify said flexible suspension frame, means responsive to lateral swinging movement of the boom to actuate said rigidifying means, said vehicle having front and rear body units pivotally interconnected for steering, and means responsive to the turning of said units out of alignment with each other to actuate said rigidifying means.

6. In a loader, a boom having lower and upper boom sections, means for raising and lowering said lower boom section, a pivotal connection between said boom sections arranged to become vertical when the boom is raised, a bucket on the outer end of said upper boom section, means to swing said upper boom section laterally on said pivotal connection, a flexible suspension system in the running gear of the loader, means to rigidify said suspension system, and means on said boom pivot responsive to swinging movements of said upper boom section to actuate said rigidifying means.

7. In a vehicle having a flexible suspension frame on its running gear and a swinging boom on said frame having a swing pivot, hydraulic cylinder means arranged to rigidify said suspension system so as to resist tilting of the vehicle when said boom swings to the side, a solenoid valve arranged to connect said cylinder means with a source of hydraulic pressure, and a circuit having a switch on said boom pivot arranged to energize said solenoid when the boom swings toward the side.

8. In a vehicle as defined in claim **7**, said cylinder means being arranged to clamp two relatively movable parts of said suspension system rigidly together.

9. In a vehicle as defined in claim **8**, said vehicle having front and rear body units pivotally connected together for steering, and a switch in said circuit arranged to energize said solenoid when said body units turn out of alignment with each other.

10. In a vehicle as defined in claim **7**, said hydraulic cylinder means comprising a pair of cylinder and piston rod units connected between relatively movable parts of the suspension system on opposite sides of the vehicle and arranged to lift one side of the vehicle and depress the opposite side, a boom lift cylinder furnishing said source of hydraulic pressure, said solenoid valve having a pair of solenoids for shifting the valve in opposite directions to control the application of said boom lift cylinder pressure to said cylinder and piston rod units so as to lift selectively one side or the other of the vehicle, said switch being arranged to energize one or the other of said solenoids in accordance with the direction of boom swing.

11. In a vehicle as defined in claim **10**, said flexible suspension system comprising front and read body units pivotally connected together for relative oscillation about a longitudinal axis, said boom being on one of said units, and said cylinder and piston rod units being arranged to oppose tilting of said one body unit by reaction against the other body unit.

12. In a vehicle as defined in claim **10**, said flexible suspension system comprising an oscillating axle, and said cylinder and piston rod units being connected between said frame and opposite ends of said axle.

13. A side dump loader comprising a vehicle having a flexible suspension with relatively movable parts allowing the vehicle to tilt, a boom on the vehicle carrying a loader bucket in vertical and lateral swinging movements, stabilizing hydraulic cylinder and piston units connected between said parts to resist tilting, a boom lift cylinder, conduits for transmitting hydraulic pressure from said boom lift cylinder to said stabilizing units, a valve in said conduits, and means responsive to boom swing for actuating said valve.

14. A side dump loader comprising a vehicle having an oscillating axle, a boom on the vehicle carrying a loader bucket in vertical and lateral swinging movements, a boom lift cylinder, stabilizing cylinders connected with the opposite ends of said axle, conduits for transmitting hydraulic pressure from said boom lift cylinder to said stabilizing cylinders, a valve in said conduits, and means responsive to boom swing for actuating said valve.

15. A side dump loader vehicle comprising front and rear body units swivel connected together for relative

oscillation about a longitudinal axis, a boom on one of said units carrying a loader bucket in vertical and lateral swinging movements, a boom lift cylinder, stabilizing cylinders on opposite sides of said one body unit arranged to react against the other body unit to resist said relative oscillation, conduits for transmitting hydraulic pressure from said boom lift cylinder to said stabilizing cylinders, a valve in said conduits, and means responsive to boom swing for actuating said valve.

16. In a vehicle having a flexible suspension frame on its running gear and a boom on said frame having lateral swinging movements, separate extensible and contractible means on opposite sides of the vehicle interconnecting relatively movable parts of said flexible suspension for vertical pushing and pulling movements, and means responsive to said swinging movements of the boom to actuate said extensible and contractible means in opposite differential relation depending upon the direction of boom swing so as to push up on the side of the boom supporting frame toward which the boom is swung and pull down on the opposite side.

17. In a loader vehicle, a boom having lower and upper boom sections, means for raising said lower boom section, a pivotal connection between said boom sections arranged to become vertical when the boom is raised, a bucket on the outer end of said upper boom section, means to swing said upper boom section laterally on said pivotal connection, a flexible suspension system in the running gear of the vehicle having parts which move relative to each other when the vehicle tilts on the running gear, hydraulic cylinder means arranged in interconnecting relation with said relatively movable parts to rigidify said suspension system and resist tilting when said cylinder means is supplied with hydraulic fluid under pressure, said suspension system being flexible when said cylinder means is not pressurized from an external source of hydraulic pressure, a source of hydraulic pressure external to said cylinder means, a valve arranged to connect said external source to said cylinder means, and means on said pivotal connection operated by swinging movements of said upper boom section to actuate said valve.

18. In an articulated vehicle, a first wheeled section having a pair of laterally spaced wheels, a second wheeled section having a pair of laterally spaced wheels, vertical pivot means connected to the first wheeled section to permit pivotal movement of the first wheeled section only about a substantially vertical pivot axis, horizontal pivot means connecting the second wheeled section to the vertical pivot means to permit limited pivotal movement about a horizontal pivot axis of the second wheeled section relative to the vertical pivot means, load-carrying means on one of the sections for supporting a load counterbalanced by the other section, and restraining means interconnecting the first and second wheeled sections and applying a sustained force opposing such pivotal movement about the horizontal pivot axis so as to make the full weight of said other section effective in accordance with the magnitude of said force in counterbalancing when the sections have been turned about the vertical pivot means to an angular relationship to each other.

19. In an articulated vehicle, a first wheeled section having a pair of laterally spaced wheels, a second wheeled section having a pair of laterally spaced wheels, vertical pivot means connected to the first wheeled section to permit pivotal movement of the first wheeled section only about a substantially vertical axis, horizontal pivot means connecting the second wheeled section to the vertical pivot means to permit limited pivotal movement only about a horizontal pivot axis of the second wheeled section relative to the vertical pivot means, outboard load means on one of the sections, and coupling means interconnecting the first and second wheeled sections for resisting such pivotal movement about the horizontal axis with a sustained force so as to make the full weight of the other section effective in accordance with the magnitude of said force in counterbalancing when the sections have been turned about the vertical pivot means to an angular relationship to each other.

20. In an articulated vehicle, a first wheeled section, a second wheeled section, vertical pivot means connected to the first wheeled section to permit pivotal movement of the first wheeled section only about a substantially vertical pivot axis, horizontal pivot means connecting the second wheeled section to the vertical pivot means to permit limited pivotal movement only about a horizontal pivot axis of the second wheeled section relative to the vertical pivot means, support means on one of the sections for supporting a load, and means interconnecting the first and second wheeled sections and responsive to the magnitude of a load supported by the support means for resisting such pivotal movement about the horizontal pivot axis with a sustained force proportional to the magnitude of the load.

21. In an articulated vehicle, first axle means, a pair of wheels mounted on the first axle means, a first frame carried by the first axle means, second axle means, a pair of wheels mounted on the second axle means, a second frame carried by the second axle means, outboard load means carried by the second frame, a pivot connection means connecting the frames together for pivotal movement therebetween about a generally vertical pivot axis and also connecting the frames together for pivotal movement therebetween about a horizontal pivot axis generally transverse to the first axle means, and hydraulic stabilizer means for resisting with a sustained force pivotal movement between the frames about said horizontal pivot axis so as to make the full weight of the first frame, the first axle means and the wheels on the first axle means effective in accordance with the magnitude of said force in counterbalancing when the frames have been turned about the vertical pivot axis to an angular relationship to each other.

22. In an articulated vehicle, first axle means, a first frame carried by the first axle means, second axle means, a second frame carried by the second axle means, pivot connection means connecting the frames together for pivotal movement therebetween about a generally vertical pivot axis and also connecting the frames together for pivotal movement therebetween about a generally horizontal pivot axis extending longitudinally of the first frame, a first fluid pressure cylinder device connected to the first frame and to the second frame at one side of said horizontal pivot axis, a second fluid pressure cylinder device connected to the first frame and to the second frame at the opposite side of said horizontal pivot axis, movable load-carrying means on said first frame, means for driving the movable load-carrying means, and means responsive to the magnitude of a load on the movable load-carrying means for supplying fluid under a sustained pressure to the fluid pressure cylinder devices.

23. In an articulated vehicle, a first wheeled section having a pair of laterally spaced wheels, a second wheeled section having a pair of laterally spaced wheels, outboard load means on one of the sections, first swivel means having a pair of ends pivotal relative to another about a vertical pivot axis, one end of the first swivel means being connected rigidly to the first wheeled section, second swivel means having a pair of ends pivotal relative to one another about a horizontal pivot axis, one end of the second swivel means being connected rigidly to the second wheeled section and the other end of the second swivel means being connected rigidly to the other end of the first swivel means, whereby the wheeled sections are connected together for pivotal movement about said vertical pivot axis and also are connected together for pivotal movement about said horizontal pivot axis, and fluid pressure means resisting with a sustaining force relative turning movement between the ends of the second swivel means so as to make the full weight of the other section in accordance with the magnitude of said

force effective in counterbalancing when the sections have been turned about the vertical pivot axis to an angular relationship to each other.

24. The articulated vehicle of claim 23 including means for varying the pressure of fluid in the cylinder means.

25. In an articulated vehicle, a first wheeled section having a pair of laterally spaced wheels, a second wheeled section having a pair of laterally spaced wheels, outboard load means on one of the sections, first swivel means having a pair of ends pivotal relative to one another about a vertical pivot axis, one end of the first swivel means being connected rigidly to the first wheeled section, second swivel means having a pair of ends pivotal relative to one another about a horizontal pivot axis, one end of the second swivel means being connected rigidly to the second wheeled section and the other end of the second swivel means being connected rigidly to the other end of the first swivel means, whereby the wheeled sections are connected together for pivotal movement about said vertical pivot axis and also are connected together for pivotal movement about said horizontal pivot axis, extensible cylinder means having fluid under pressure therein and resisting relative turning movement between the ends of the second swivel means in accordance with pressure of the hydraulic liquid, and means for varying the pressure of the hydraulic liquid and sustaining said pressure so as to make the full weight of the other section effective in accordance with the magnitude of said pressure in counterbalancing when the sections have been turned about said vertical pivot axis to an angular relationship to each other.

26. In an articulated vehicle, a first wheeled section having a pair of laterally spaced wheels, a second wheeled section having a pair of laterally spaced wheels, first swivel means having a pair of ends pivotal relative to one another about a vertical pivot axis, one end of the first swivel means being connected rigidly to the first wheeled section, second swivel means having a pair of ends pivotal relative to one another about a horizontal pivot axis, one end of the second swivel means being connected rigidly to the second wheeled section and the other end of the second swivel means being connected rigidly to the other end of the first swivel means, whereby the wheeled sections are connected together for pivotal movement about said vertical pivot axis and also are connected together for pivotal movement about said horizontal pivot axis, hydraulic means having hydraulic liquid therein and resisting relative turning movement of the ends of the second swivel means in accordance with the pressure of the hydraulic liquid, a hydraulic hoist device on one of the wheeled sections for lifting a load at the end of the last-mentioned wheeled section remote from the other wheeled section, and means for supplying hydraulic liquid to the hoist device and the hydraulic means with a sustained pressure in accordance with the magnitude of a load carried by the hoist device.

27. In an articulated vehicle, a first wheeled section having a pair of laterally spaced wheels, a second wheeled section having a pair of laterally spaced wheels, pivot means connecting the first wheeled section to the second wheeled section for pivotal movement about a vertical pivot axis and a single horizontal pivot axis extending longitudinally of one of the wheeled sections, a load carrying means on the first wheeled section for carrying a load positioned beyond the end of the first wheeled section remote from the swivel means, and variable hydraulic means interconnecting the wheeled sections for resisting with a sustained force relative pivotal movement of the wheeled sections about said horizontal axis so as to make the full weight of the second wheeled section effective in accordance with the magnitude of said force in counterbalancing when the sections have been turned about said vertical pivot axis to an angular relationship to each other.

28. In an articulated vehicle, a first wheeled section having a pair of laterally spaced wheels, a second wheeled section having a pair of laterally spaced wheels, swivel means connecting the first wheeled section to the second wheeled section for pivotal movement about a vertical pivot axis and a single horizontal pivot axis extending longitudinally of one of the wheeled sections, a load carrying means on the first wheeled section for carrying a load positioned beyond the end of the first wheeled section remote from the swivel means, variable hydraulic means interconnecting the wheeled sections for resisting with a sustained force relative pivotal movement of the wheeled sections about said horizontal axis, and means responsive to the magnitude of a load on the load carrying means for adjusting the variable hydraulic means.

29. In an articulated vehicle, a first wheeled section having a pair of laterally spaced wheels, a second wheeled section having a pair of laterally spaced wheels, connection means connecting the wheeled sections together for turning movement relative to one another about a vertical pivot axis and for pivotal movement relative to one another about a horizontal pivot axis extending generally longitudinally relative to one of the wheeled sections, outboard load-carrying means on the second wheeled section, fluid pressure means for raising the load-carrying means relative to the ground, and means interconnecting the first and second wheeled sections and responsive to the magnitude of a load carried by the load-carrying means for resisting such pivotal movement about the horizontal pivot axis with a sustained force proportional to the magnitude of the load.

30. In an articulated vehicle, first axle means, a pair of wheels on the first axle means, a first frame member supported by the first axle means, second axle means, a pair of wheels on the second axle means, a second frame member supported by the second axle means, means connecting the frame members and axle means for pivotal movement of the first axle means and the first frame member relative to the second axle means and the second frame member about a vertical axis and for relative pivotal movement between the axle means about a horizontal axis extending perpendicularly to one of the axle means, outboard load-carrying means carried by one of the frame members, and means restricting said relative pivotal movement about said horizontal axis with a sustained force varying in accordance with the magnitude of a load carried by the outboard load-carrying means.

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