July 9, 1963

A. R. BIEDESS

LOADING MACHINE

3,096,893

Filed Feb. 24, 1960

8 Sheets-Sheet 1

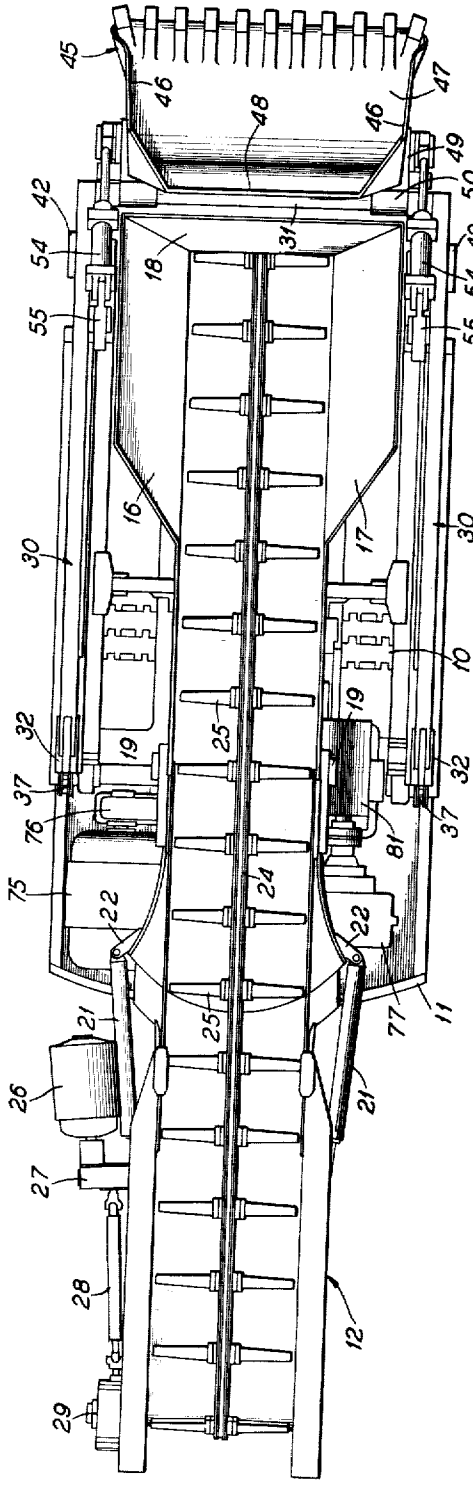

Fig. 1

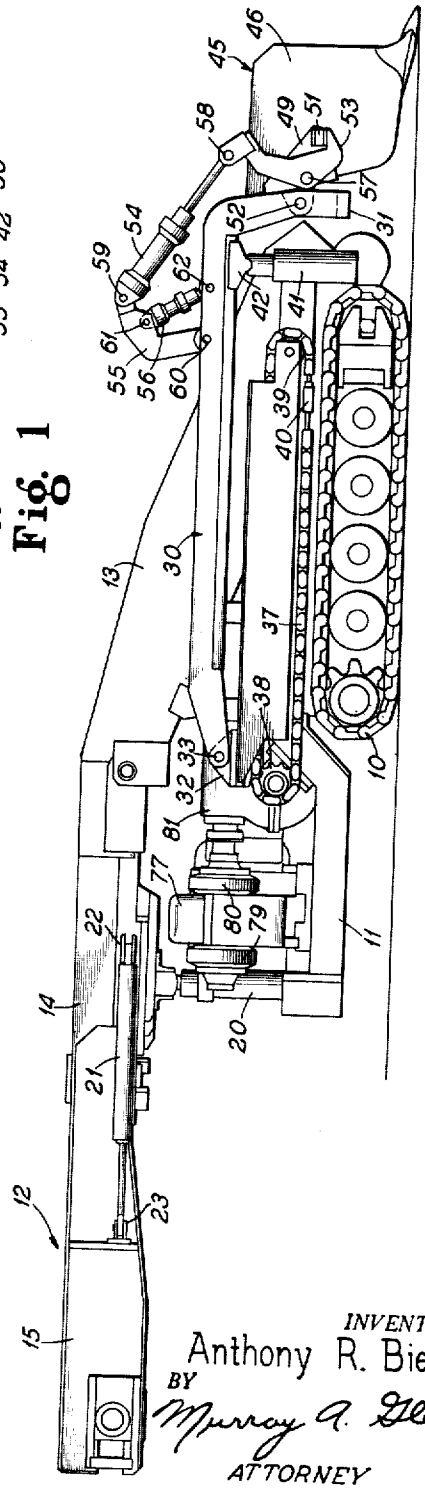

Fig. 2

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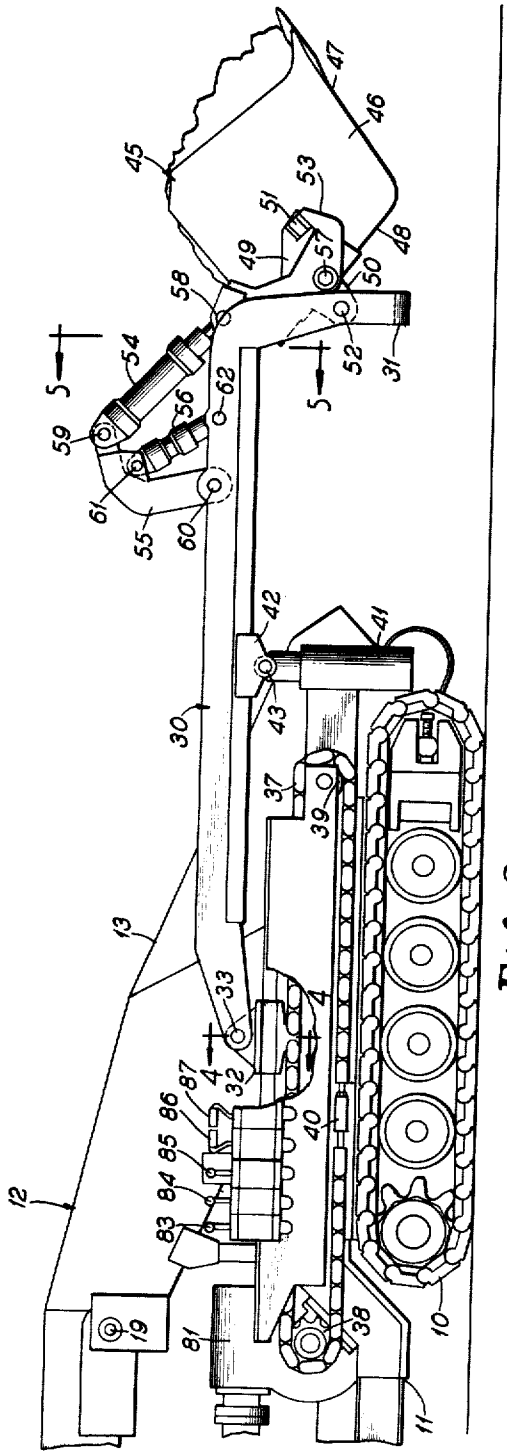

Fig. 3

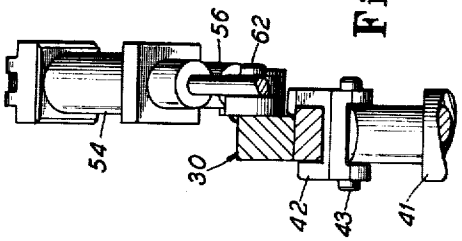

Fig. 5

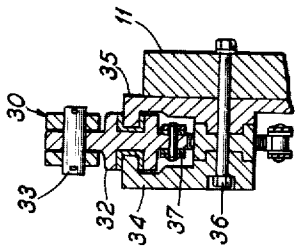

Fig. 4

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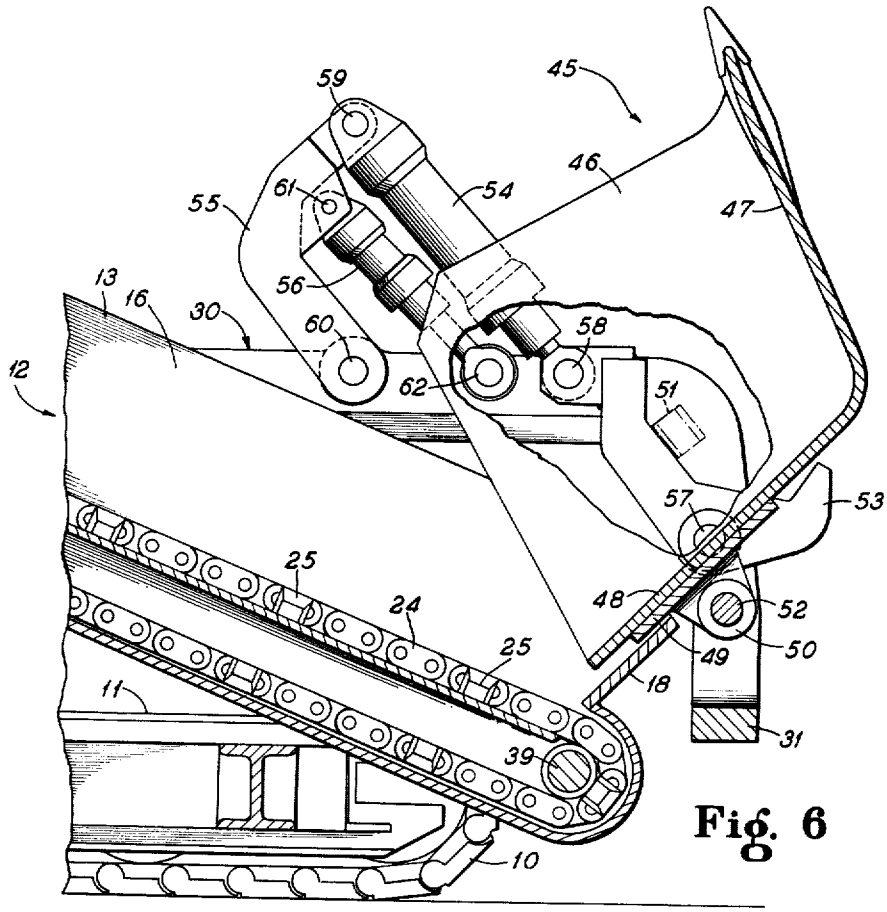

Fig. 6

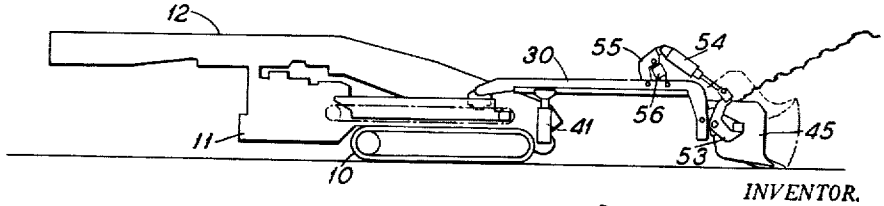

Fig. 7

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LOADING MACHINE

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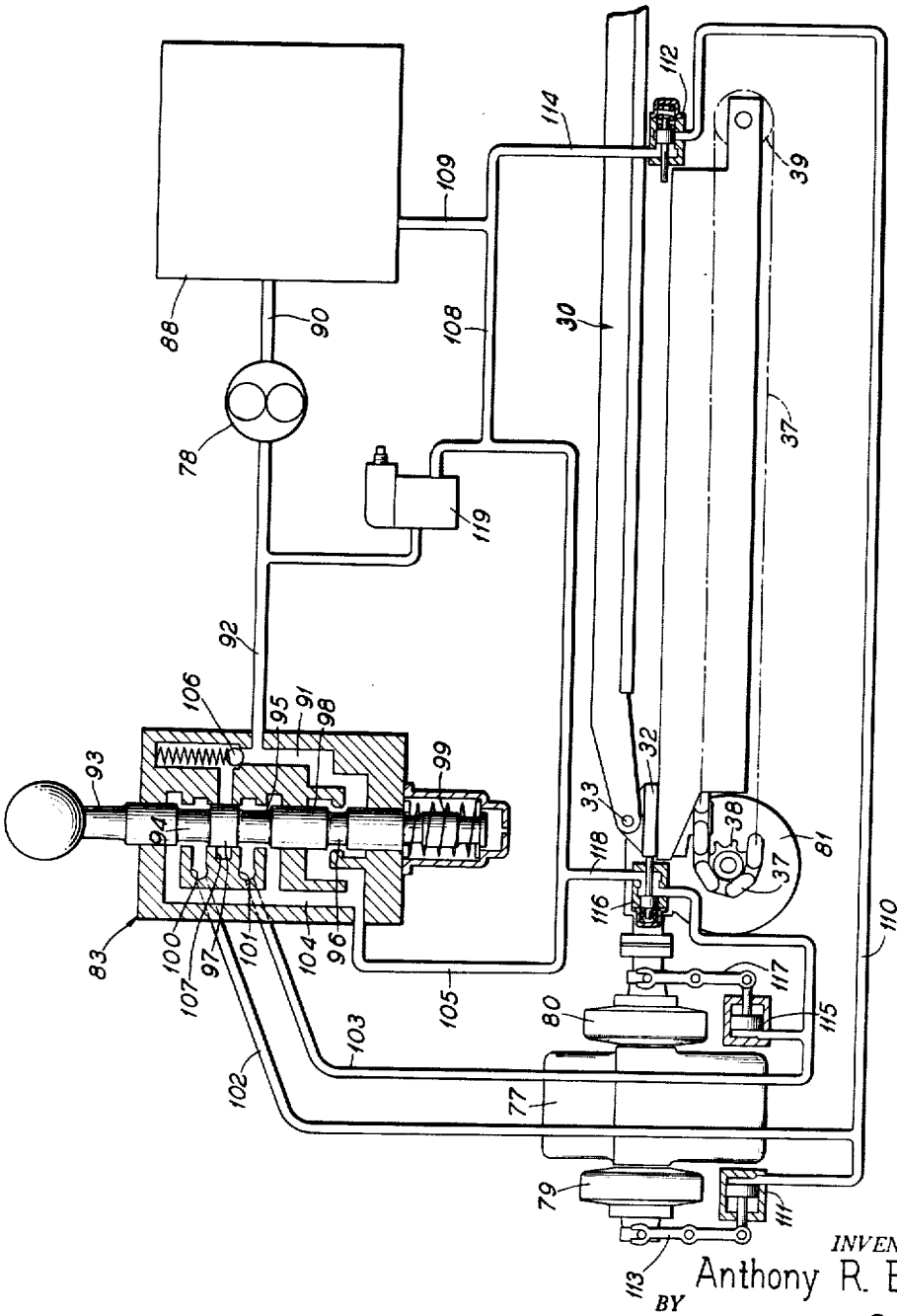

Fig. 8

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8 Sheets-Sheet 5

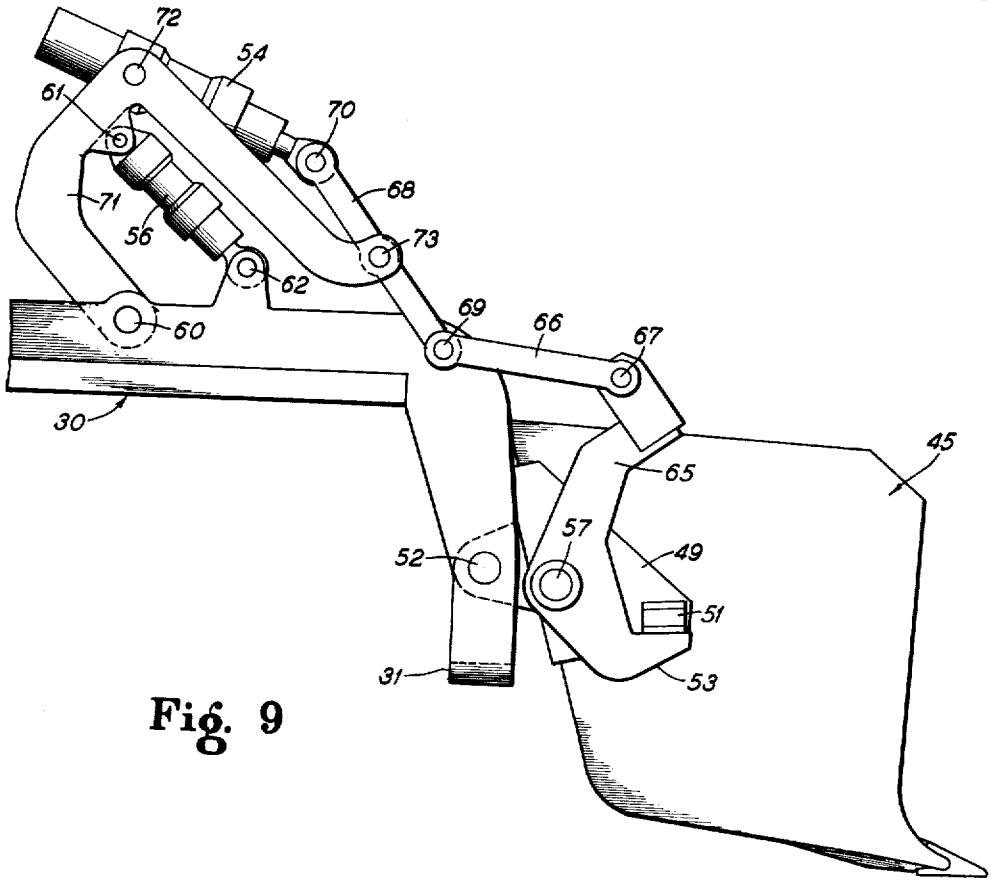

Fig. 9

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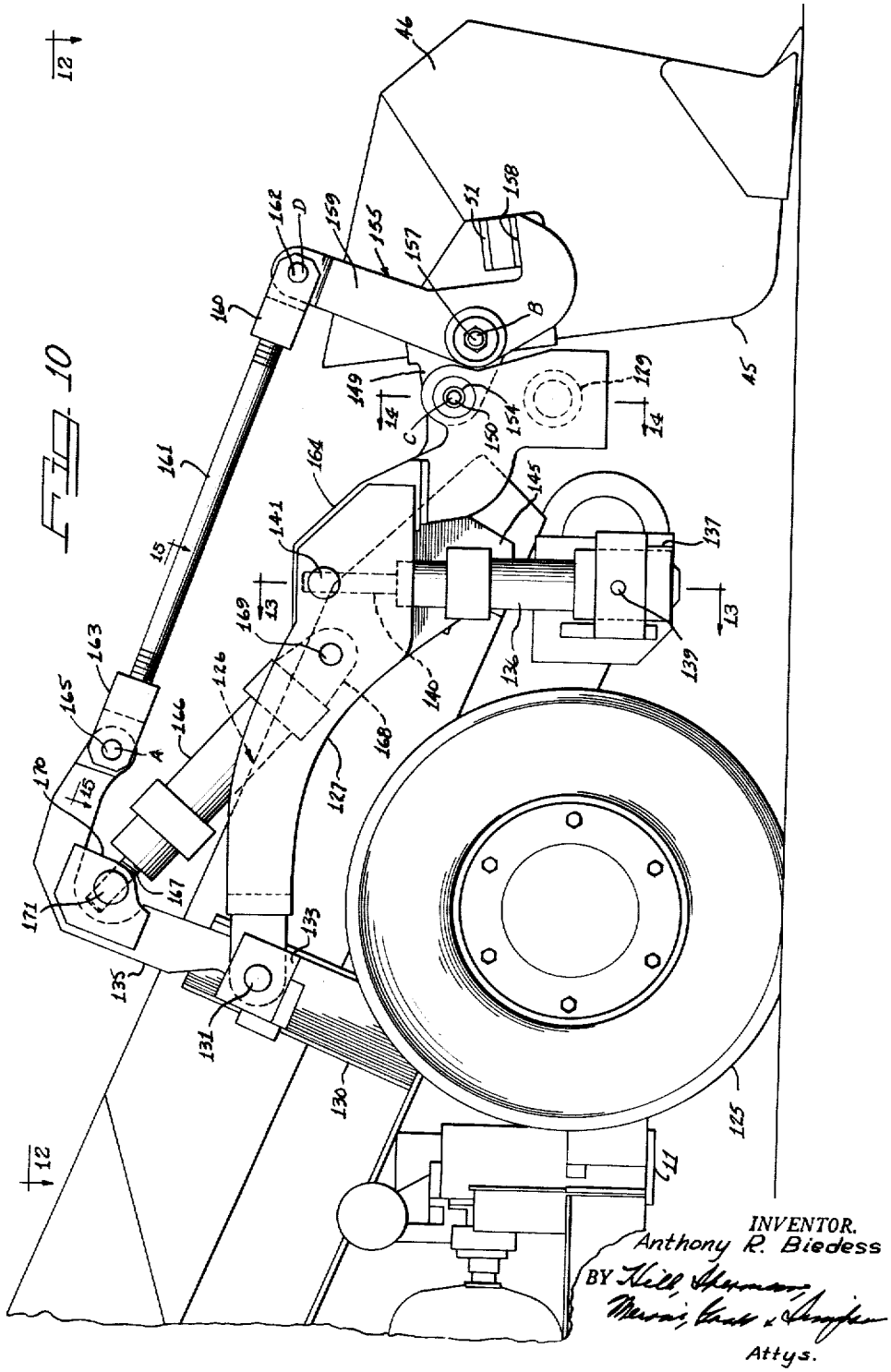

Fig. 10

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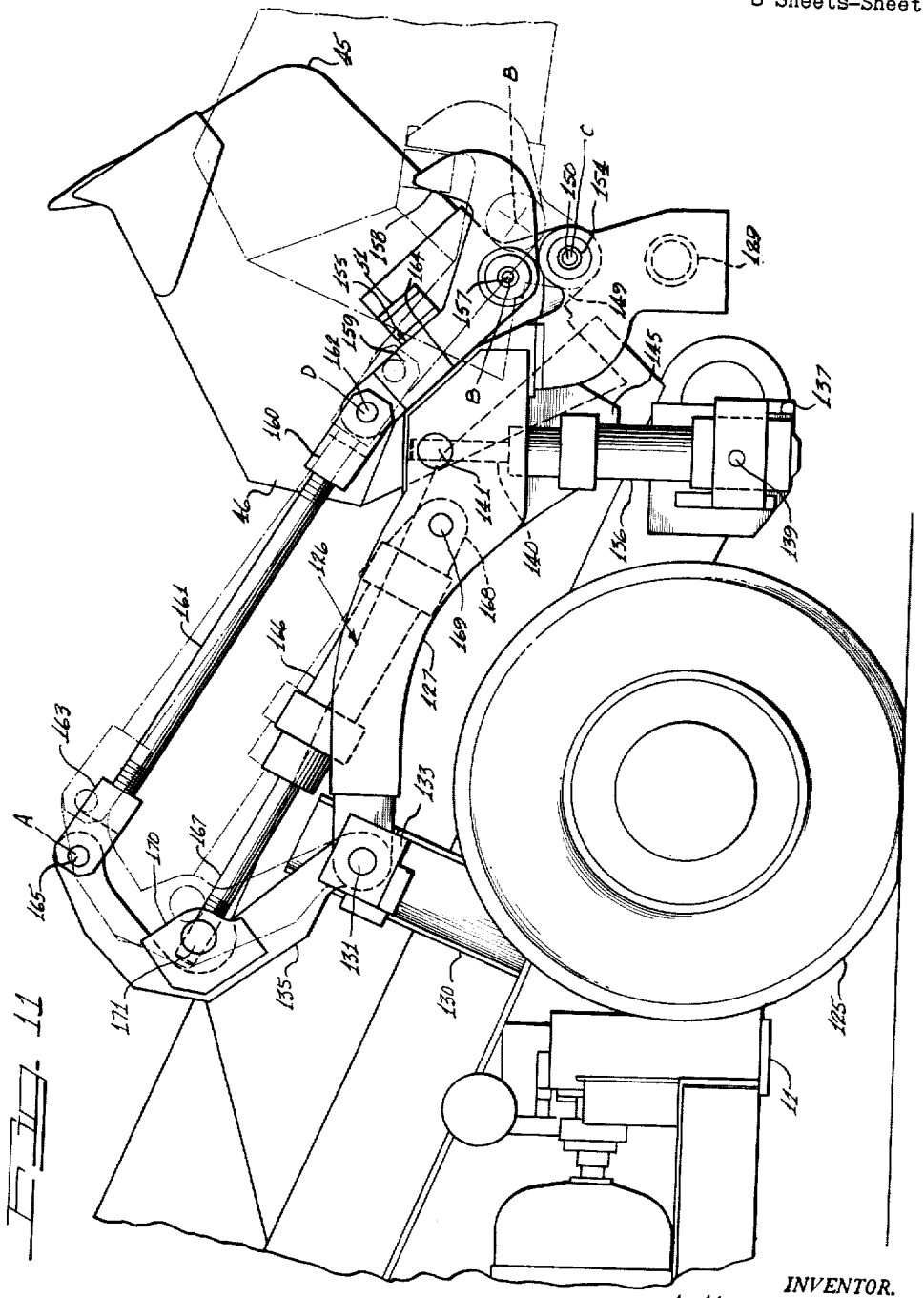

FIG. 11

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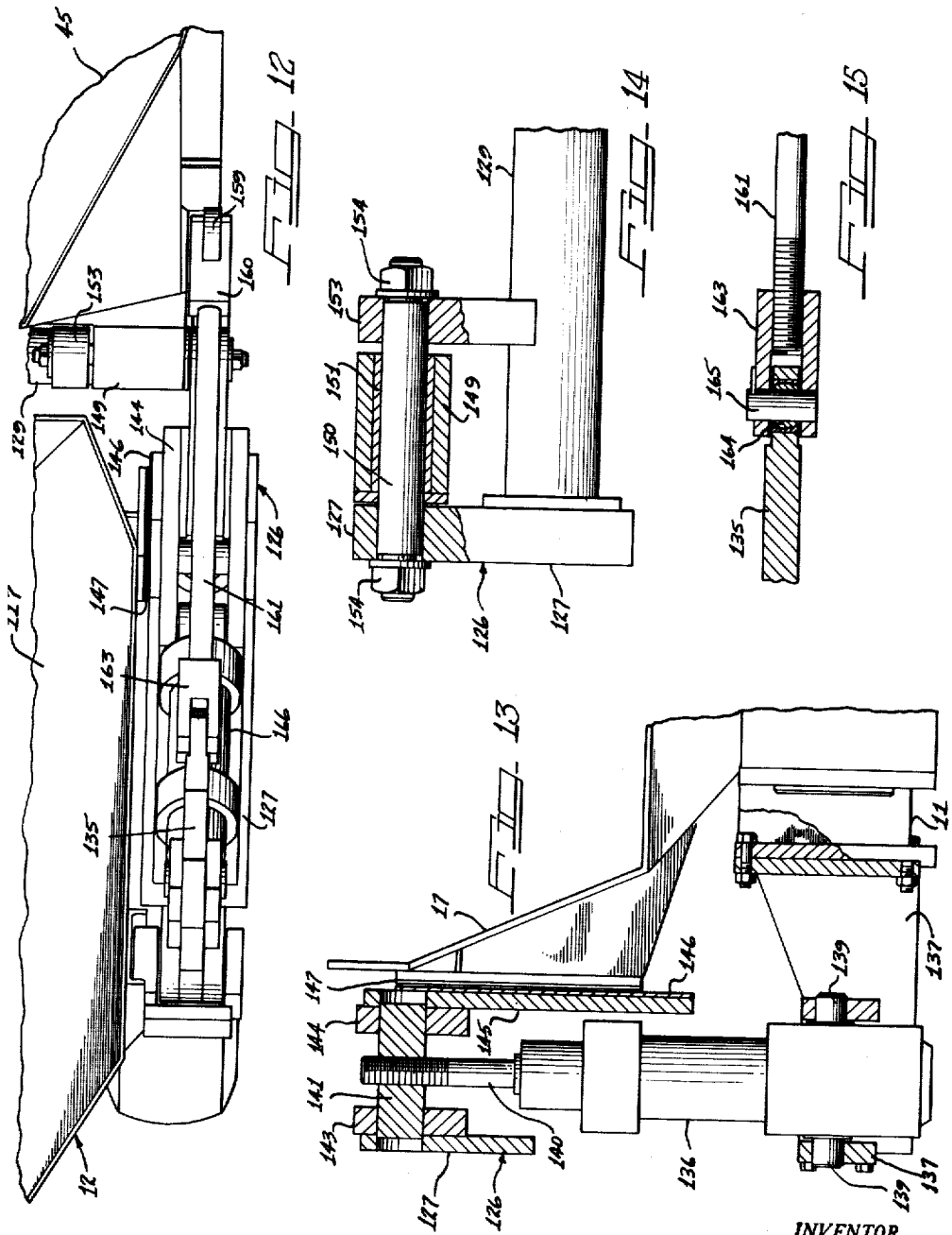

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United States Patent Office 3,096,893 Patented July 9, 1963

3,096,893

LOADING MACHINE

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Filed Feb. 24, 1960, Ser. No. 10,715
7 Claims. (Cl. 214—90)

This invention relates generally to mucking machines for loading rock and the like, operable in tunnels or mines underground where limited head room is available, and more particularly relates to improvements in the boom arrangement and bucket operating mechanism for such machines.

Mucking machines for loading rock and the like, as known in the art, generally comprise a main frame supported on traction means for propelling the main frame along the ground, which main frame has a conveyor mechanism extending rearwardly therealong from a position in advance thereof adjacent the ground and has a digging bucket disposed in advance of the forward end of the main frame, which is crowded into the mined loose material on the ground and lifts and discharges the loose material onto the conveyor.

The digging bucket usually has digging teeth extending in advance thereof and slidable along the ground and crowded into the mined material along the ground to fill the bucket therewith. The bucket is then lifted upwardly in an angular path toward the conveyor mechanism to dump its load on the conveyor mechanism, which carries the mined material along the machine beyond the rear end of the main frame for dumping into shuttle cars or other means for transporting the mined material from the working face.

A problem in the design of such machines is to so design the machine, that it will efficiently operate in places of low headroom and pick up the relatively heavy rock from the ground and raise and discharge the rock onto the conveyor mechanism in a substantially continuous operation with little or no delay, particularly in picking up the heavy rock from the ground.

It is also advantageous that the maneuvering of the machine and the conveyor mechanism during the crowding and loading operation be reduced to a minimum to facilitate the spotting of shuttle cars or other material transporting means at the discharge end of the conveyor mechanism and to provide as continuous a flow of mined material to the shuttle cars or other material carrying means as possible commensurate with loading and transporting conditions.

In order to efficiently pick up and load the material, it is essential that the digging bucket be carried in advance of the forward end of the machine and be so supported that it may readily slide over small obstructions on the ground encountered by the digging teeth at the leading edge of the bucket when crowded into the mined material, and that the mechanism for operating the bucket provide a relatively high tearing force for tearing the loaded bucket upwardly through the mined material on top of the bucket at a relatively slow rate of speed and then move the loaded bucket to its discharge position at a higher rate of speed.

It is, therefore, an object of the present invention to provide a mucking machine for loading rock and the like arranged with a view toward incorporating all of the foregoing advantageous features in the machine.

Another object of the invention is to provide an improved form of mucking machine so constructed and arranged as to operate in places of confined headroom and to efficiently tear the loaded digging bucket away from the mined material and quickly dump the mined material onto the material carrying conveyor of the machine.

Still another object of the invention is to provide a bucket operating mechanism for mucking machines of the rock loading type accommodating the bucket to readily follow on even ground and ride over obstructions on the ground as the bucket is being crowded into the loose material being loaded.

Still another object of the invention is to provide a bucket operating mechanism particularly adapted for mucking machines of the rock loading type, in which the leverage arrangement of the bucket operating mechanism is so arranged as to provide a high mechanical advantage for breaking away the loaded bucket from the loose material being loaded and to reduce the mechanical advantage and increase the speed of travel of the bucket as it moves to a discharge position after it has been torn away from the material being loaded.

Still another object of the invention is to provide an improved form of mucking machine of the rock loading type so arranged as to enable the discharge end portion of the conveyor mechanism to be maintained relatively stationary during the digging and loading of the mined material onto the receiving end of the conveyor mechanism.

A still further object of the invention is to provide an improved form of boom arrangement for a mucking machine of the rock loading type, wherein the boom, operatively carrying a digging and loading bucket at its forward end, may be operated to crowd the bucket into the loose material being loaded, while the mucking machine remains in a relatively stationary position on the ground.

This application is a continuation-in-part of my application Serial No. 737,048, filed May 22, 1958, and now abandoned.

These and other objects of the invention will appear from time to time as the following specification proceeds and with reference to the accompanying drawings wherein:

FIGURE 1 is a plan view of one embodiment of a mucking machine constructed according to the present invention;

FIGURE 2 is a side elevational view of the machine shown in FIGURE 1;

FIGURE 3 is a partial side elevational view of the embodiment shown in FIGURES 1 and 2 with the boom moved forwardly of the machine and with the bucket in a carrying position;

FIGURE 4 is an enlarged cross sectional view of a portion of the structure shown in FIGURE 3 and taken along the line 4—4 of FIGURE 3;

FIGURE 5 is an enlarged partial view of the structure shown in FIGURE 3 and taken along the line 5—5 of FIGURE 3;

FIGURE 6 is an enlarged side elevational view partially in cross section of a portion of the embodiment of the present invention shown in the previous figures and with the bucket in the dump position;

FIGURE 7 is a side elevational view showing the bucket moved into a pile of material to be removed;

FIGURE 8 is a circuit diagram showing the hydraulic controls for moving the boom longitudinally of the machine;

FIGURE 9 is a side elevational view showing another embodiment of the bucket operating mechanism;

FIGURE 10 is a fragmentary view in side elevation of the forward end portion of a modified form of mucking machine constructed in accordance with the present invention, in which the machine is mounted on rubber tire mounted traction wheels and the bucket is operated by a modified form of bucket operating mechanism;

FIGURE 11 is a fragmentary view in side elevation

similar to FIGURE 10, but showing the bucket in a discharge position;

FIGURE 12 is a fragmentary plan view looking substantially along line 12—12 of FIGURE 10;

FIGURE 13 is a fragmentary vertical sectional view taken substantially along line 13—13 of FIGURE 10;

FIGURE 14 is a fragmentary vertical sectional view taken substantially along line 14—14 of FIGURE 10; and

FIGURE 15 is a fragmentary horizontal sectional view looking substantially along line 15—15 of FIGURE 10.

In the embodiment of the invention illustrated in FIGURES 1 to 8 of the drawings, continuous traction tread devices or crawler track mechanisms **10** are shown as being provided to support and advance the machine during the loading operation and to propel the machine from working place to working place. A main frame **11** is suitably mounted on the crawler track mechanisms **10** and extends rearwardly therefrom a substantial distance, as shown in FIGURE 2. The rearward overhanging portion of the frame **11** is dropped a certain amount to accommodate a conveyor mechanism to extend along the main frame at a convenient height for efficient operation in places of limited head room.

The conveyor mechanism **12** may be a laterally flexible center strand chain and flight type of conveyor, such as is shown and described in the United States Patents Nos. 2,197,169; 2,388,885 and 2,642,982. The conveyor is suitably carried on the frame **11** and extends from a position in advance of the forward end thereof adjacent the ground rearwardly along said main frame in an inclined path and beyond the rear end of said main frame in a generally horizontal plane to overhang a shuttle car or other device being loaded. The conveyor mechanism **12**, as herein shown includes three interconnected trough shaped sections **13**, **14** and **15**. The forward section **13** forms a material receiving and inclined elevating section and may be fixedly mounted upon the main frame **11**. Opposite forward wall portions **16** and **17** of the forward section **13** are inclined outwardly toward the sides of the machine and with an upwardly extending forward inclined forward wall **18** define a hopper for receiving the material dumped thereonto. The center section **14** of the conveyor mechanism **12** is joined to the rearward end of the forward section **13** through pivotal mounting means **19**. Pivotal mounting means **19** permit pivotal movement of the center section **14** about a horizontal axis with respect to the forward section **13**. The rearward end of the center section **14** is connected to the forward end of the rearward section **15** for articulated movement therebetween about a vertical axis. A hydraulic cylinder **20** is mounted on the rearward end of the frame **11** to upstand therefrom and serves to adjustably support the center section **14** and the rearward section **15** of the conveyor mechanism **12**. Thus it may be seen that when the hydraulic cylinder **20** is extended the center section **14** and the rearward section **15** of the conveyor mechanism **12** are pivoted upwardly about the horizontal axis of pivotal mounting means **19**, and when the hydraulic cylinder **20** is retracted these sections **14** and **15** are pivoted downwardly about the same axis. The hydraulic cylinder **20** permits vertical adjustment of the rearward end of the conveyor mechanism **12** relative to a shuttle car or other conveyor system for efficient transfer of any load of material from the conveyor mechanism **12**. Hydraulic cylinders **21** are provided for adjustably maintaining the rearward section **15** in any angled position relative to the center section **14** in a horizontal plane. The head end of each of the hydraulic cylinders **21** is pivotally connected to a bracket **22** carried on the sidewalls of the center section **14**. The rod end of each of the hydraulic cylinders **21** is pivotally connected to the sidewalls of the rearward section **15** through pivotal mounting means **23**. Thus, it may be seen when one of the hydraulic cylinders **21** is extended, the rearward section **15** of the conveyor mechanism **12** is caused to pivot relative to the center section **14** in a horizontal plane, this pivoting causing retraction of the opposite hydraulic cylinder **21**.

The conveyor mechanism **12** further comprises a center strand endless chain **24** carrying a plurality of flights **25** in spaced apart relationship with respect to each other throughout the entire length of the chain **24** and connected thereto for movement about horizontal and vertical axes in a well known manner. The chain **24** extends over a suitable sprocket (not shown) rotatably carried at the rearward end of the rearward section **15**, and below the rearward section **15**, the center section **14** and the forward section **13** to the forward end of the forward section **13**. At the forward end of the conveyor mechanism **12**, the chain **24** is passed about a suitable idler (not shown) and further extends from the idler along the upper surface of the bottom walls of the forward section **13**, the center section **14** and the rearward section **15** of the conveyor mechanism **12**. The chain **24** of the conveyor mechanism **12** is driven by a suitable electric motor **26** through gearing **27**, shaft **28** and speed reducer **29**. The output shaft of the speed reducer **29** is drivingly connected to the sprocket (not shown) for the chain **24**. The electric motor **26** and the power train therefrom to the chain **24** are carried on one side of the rearward section **15** of the conveyor mechanism **12**.

Turning next to the means for loading the conveyor mechanism **12**, a boom **30** is provided and formed in duplicate portions disposed on each side of the machine, the portions being interconnected at the forward end thereof by a cross-member **31**. Each portion of the boom **30** is somewhat L-shaped with the relatively long leg thereof extending generally horizontally and with the relatively short leg thereof depending downwardly from the horizontal leg. The rearward end of each portion of the boom **30** is pivotally connected to a slide member **32**. As may be seen in FIGURES 3 and 4 each slide member **32** is formed to have an H-shaped center section and a pair of flanges, one formed to upstand from the H-shaped section and one formed to depend therefrom. The rearward end of each portion of the boom **30** is pivotally connected to the upstanding flange of one of the slide members **32** by means of a pin **33**. The H-shaped section of each slide member **32** engages a pair of opposed rails **34** and **35**. Each pair of rails **34** and **35** is secured to the frame **11** on one side of the machine by a plurality of bolts such as bolt **36** shown in FIGURE 4. The depending flange of each slide member **32** is connected with a chain **37** between one pair of the links thereof. Each chain **37** passes in opposite directions from the depending flange about a drive sprocket **38** and an idler **39**. The ends of the chain **37** are interconnected by a suitable turnbuckle or coupling **40**. Each sprocket **38** is rotatively mounted on one side of the frame **11** toward the rear thereof and each idler **39** is rotatively mounted on one side of the frame **11** toward the front thereof.

Each portion of the boom **30** is slidably supported at the forward end of the machine by an individual cylinder **41**. Each cylinder **41** is carried on one side of the frame **11** at the forward end thereof and immediately below one portion of the boom **30**. The piston rod of each cylinder **41** is provided with a shoe **42** pivotally connected thereto by means of a pin **43**. Each shoe **42** is positioned in cooperation with the underside of one portion of the boom **30**, the underside of each portion of the boom **30** having a rail configuration conforming to the shape of the shoes **42**.

From the foregoing description it may be seen that when the sprocket **38** is rotated clock-wise as viewed in the drawings, the chain **37** will be moved to in turn move the slide member **32**, which in turn will cause the boom **30** to be moved forwardly, for example, from a position such as shown in FIGURE 2 to a position such as shown in FIGURE 3. If the sprocket **38** is rotated in a counter-clockwise direction the boom **30** is moved rearwardly

relative to the machine. It may further be seen that when the hydraulic cylinders **41** are extended, the forward end of the boom **30** is pivoted upwardly about the axis of pins **33** and when the hydraulic cylinders **41** are retracted the forward end of the boom is lowered. The means for operating the sprockets **38** and the hydraulic cylinders **41** will be described below.

Turning next to a detailed description of the bucket arrangement for the first embodiment of the present invention, the bucket **45** comprises a pair of spaced-apart sidewalls **46** interconnected by a bottom wall **47** and a back wall **48**. The forward marginal edge of the bottom wall **47** is provided with suitable digging teeth. Each side wall **46** of the bucket **45** is provided with a member **49** having a rearwardly extending ear or flange **50** and an outwardly extending stop member **51**. The bucket **45** is pivotally carried on depending leg portions **44** of the boom **30** by means of a pair of pins **52**, each pin **52** being carried by one of the depending leg portions of the boom **30** and journalled through one of the ears **50** of the members **49**. The axis of pivoting of the bucket **45** about the pins **52** is such that when the bucket **45** is pivoted completely counter-clockwise as viewed in the drawings, the bucket **45** is moved into the forward section **13** of the conveyor mechanism **12** with the upper portions of the rear wall **48** and the side walls **46** positioned in the hopper defined by the side walls **16** and **17** and the forward wall **18** of the forward section **13** of the conveyor mechanism **12** as may easily be seen in FIGURE 6.

To pivot the bucket **45** to its various operative positions, a bell crank **53**, a hydraulic cylinder **54**, a lever **55** and a hydraulic cylinder **56** are provided for each side arm of the boom **30** and each side of the bucket **45**. Since these elements are formed in duplicate only those of one side arm of the boom and one side of the bucket **45** are here described. The bell crank **53** is pivotally carried on the member **49** by a pin **57**. The pivot axis of the pin **57** is located on the member **49** so that one leg or lever arm of the bell crank will engage the underside of the stop member **51** when the bell crank **53** is pivoted counterclockwise as viewed in FIGURE 2 of the drawings. The other leg or lever arm of the bell crank **53** is pivotally connected to the rod end of the hydraulic cylinder **54** by a pin **58**. The head end of the hydraulic cylinder **54** is pivotally connected to one end of the lever **55** by a pin **59**, and the other end of the lever **55** is pivotally carried on the horizontal portion of the boom **30** by a pin **60**. The head end of the hydraulic cylinder **56** is pivotally connected to the lever **55** intermediate the ends thereof by a pin **61**, and the rod end of the hydraulic cylinder **56** is pivotally connected to the horizontal portion of the boom **30** by a pin **62** located thereon forwardly of the pin **60**. The hydraulic cylinders **54** and **56** are of such a size, and the lever **55** and the bell crank **53** are of such a length, that when the hydraulic cylinder **56** is substantially completely retracted and the hydraulic cylinder **54** is substantially completely extended, the bucket **45** is positioned for digging at the ground level of the base of the crawler tractor mechanism **10** such as shown in FIGURE 2. These elements are further so formed and positioned that when the hydraulic cylinder **54** is retracted, the one lever arm bell crank **53** will engage the stop member **51** to pivot the bucket **45** rearwardly from the position shown in FIGURE 2 to that shown in FIGURE 3, and if the hydraulic cylinder **56** is then extended, the lever **55** will be moved counter-clockwise as viewed in the drawings to move the hydraulic cylinder **54** and the bucket **45** through the bell crank **53** and the stop member **51** from a position such as shown in FIGURE 3 to that shown in FIGURE 6 with the stop means **51** engaging the other lever arm of the bell crank **53**. It may be seen that when the bucket is pivoted rearwardly from the position shown in FIGURE 2 to that shown in FIGURE 3, the hydraulic cylinder **54** will act through a relatively long moment arm to exert an initially relatively powerful lifting or breakout force on the bucket **45**, and since thereafter in the further retraction of the hydraulic cylinder **54** the moment arm is decreased, the pivoting of the bucket **45** will occur at increasing speeds.

In the second embodiment of the means for pivoting the bucket **45** as illustrated in FIGURE 9, members identical to those of the first embodiment are designated by the same numerals. As shown in FIGURE 9, the bucket **45** is pivotally carried on the depending portions of the boom **30** by pins **52** and members **49**. Since the bucket pivoting arrangement is formed in duplicate for each portion of the boom **30** and on each side of the bucket **45**, again, only those members on one side thereof will be described. The bell crank **53** is pivotally carried on the member **49** by a pin **57**. One leg or lever arm of the bell crank **53** is positioned to engage the stop **51** as in the previously described embodiment. The other lever arm **65** of the bell crank **53** which is relatively longer than the first mentioned lever arm or leg is pivotally connected to a link **66** by a pin **67**. The other end of the link **66** is pivotally connected to one end of a lever **68** by a pin **69**. The other end of the lever **68** is pivotally connected to the rod end of the hydraulic cylinder **54** by a pin **70**. The head end of the hydraulic cylinder **54** is pivotally connected to a lever **71** intermediate its ends by a pin **72**. One end of the lever **71** is pivotally connected to the lever **68** intermediate the ends thereof by a pin **73**. The other end of the lever **71** is pivotally carried on one portion of the boom **30** by a pin **60**. The head end of the hydraulic cylinder **56** is pivotally connected to the lever **71** by a pin **61** which is located on the lever **71** between the pins **60** and **72**. The rod end of the hydraulic cylinder **56** is pivotally carried on one portion of the boom **30** by a pin **62** which is located on that portion of the boom **30** forwardly of the pin **60**.

The various described members of the second embodiment of the bucket pivoting arrangement are so formed and positioned that when the hydraulic cylinders **54** and **56** are substantially completely retracted, the bucket **45** is positioned in the digging position at ground level as shown in FIGURE 9. If the hydraulic cylinder **54** is then extended, the lever **68** will be pivoted in a clockwise direction as viewed in FIGURE 9 to pivot the bell crank **53** through the link **66** in a counter-clockwise direction from the position shown in FIGURE 9 to one wherein the bucket is pivotally positioned such as shown, for example, in FIGURE 3. If the hydraulic cylinder **56** is then extended, the lever **71** will be pivoted in a counter-clockwise direction as shown in FIGURE 9 to further pivot the bucket **45** through the lever **68**, the link **66**, and the bell crank **53**, to the dump position such as shown, for example, in FIGURE 6. The second embodiment of the bucket pivoting arrangement differs from the first in that the large end of the piston of the hydraulic cylinder **54** is used in the break-out and initial dumping action of the bucket **45**, and further in that the force and speed of the bucket in pivoting may be varied by different relative locations of the pins **69**, **73** and **70** on the lever **68**.

Turning next to the means for operating the various elements of the machine, the crawler mechanism **10**, the hydraulic cylinders **20** and **21** of the conveyor mechanism **12**, and the hydraulic cylinders **41**, **54** and **56** are operated by any suitable power means (not shown). The main motor **75** which may be seen in FIGURE 1 supplies power for the sprockets **38**. The motor **75** is mounted upon the frame **11** and its output shaft delivers power to a transmission **76**. The output of the transmission **76** is connected in parallel to a speed-reducer **77** and to the hydraulic fluid pump **78** shown in FIGURE 8. Two clutches **79** and **80** are associated with the output shaft of the speed-reducer **77** and will drive the output shaft in either direction depending upon which clutch is operated. The output shaft of the speed-reducer **77** is further connected to a worm-type speed reducer **81**. The speed reducer **81**, which as shown in FIGURES 1 and 2 is

mounted on the frame **11** with its output shaft extending transversely of the machine and connected in driving relationship to the sprockets **38** on each side of the machine. It may thus be seen that when one of the clutches **79** or **80** is energized, the speed reducer **81** is operated to drive the sprockets **38** in one direction; and when the other of the clutches **79** or **80** is operated, the speed reducer **81** is operated to drive the sprockets **38** in an opposite direction.

Referring to FIGURES 3 and 8, five control assemblies **83**, **84**, **85**, **86** and **87** are employed. The first assembly **83** is shown in FIGURE 8 as a hydraulic valve. Assembly **84** is another hydraulic valve similar to valve **83** and is provided for operation of the hydraulic cylinders **56**. The hydraulic valve **84** is connected by suitable conduits to a pressure source (not shown), a reservoir (not shown), and to the hydraulic cylinders **56**. The assembly **85** is also a hydraulic control valve and is provided for operation of the hydraulic cylinders **54**. The hydraulic control valve **85** is connected by suitable conduits to a hydraulic fluid pump and reservoir (not shown), and to the hydraulic cylinders **54**. The control assemblies **86** and **87** are provided for controlling the operation of the crawler track mechanism **10**. These control assemblies **86** and **87** may be connected by any suitable means (not shown) to the driving elements of the crawler track mechanism **10**. Any suitable means known in the art (not shown) may be provided for controlling the operation of the hydraulic cylinders **20**, **21** and **41**.

As shown in FIGURE 8, the low pressure side of the hydraulic fluid pump **78** is connected to the reservoir **88** by conduit **90**. The high pressure side of the hydraulic fluid pump **78** is connected to passageway **91** in valve **83** by conduit **92**. The valve spool **93** of valve **83** is provided with three annular grooves **94**, **95** and **96** separated by two annular lands **97** and **98** and is biased to the neutral position shown in FIGURE 8 by the spring assembly **99**. In addition to the passageway **91**, the valve body is provided with two annular grooves **100** and **101** respectively connected to the conduits **102** and **103**, a passageway **104** connected to a conduit **105**, and a check valve **106** formed in passageway **91** between the connection of conduit **92** thereto and an annular groove **107**. The check valve **106** will permit hydraulic fluid flow from passageway **91** to annular groove **107**, but will prevent any hydraulic fluid flow in the reverse direction. When the valve **83** is in the neutral position shown in FIGURE 8, hydraulic fluid from conduit **92** will flow through passageway **91** about the annular groove **96** of the valve spool **93**, through passageway **104** to conduit **105**. From conduit **105** the hydraulic fluid will flow through conduits **108** and **109** to reservoir **88**. In the neutral position, land **97** of the valve spool **93** will seal hydraulic fluid from the annular grooves **100** and **101** of the valve body, and hydraulic fluid conduits **102** and **103** are vented to the reservoir **88** through annular grooves **100** and **101** of the valve body, annular grooves **94** and **95** of the valve spool **93**, and passageway **104** to and through conduits **105**, **108** and **109**. When the valve spool **93** is moved inwardly of the valve body, land **98** of the valve spool **93** will block passageway **91** from passageway **104**. High pressure hydraulic fluid will then flow through the check valve **106**, annular groove **107** of the valve body, annular groove **94** of the valve spool **93**, annular groove **100** of the valve body and through conduit **102**. Conduit **103** will remain vented to the reservoir **88**. When the valve spool **93** is moved outwardly of the valve body, passageway **91** is again blocked from fluid communication with passageway **104** by a land on the inner end of the valve spool **93**. High pressure hydraulic fluid will then flow from passageway **91** through check valve **106**, through annular groove **107** of the valve body, through annular groove **95** of the valve spool **93**, through annular groove **101** of the valve body and through conduit **103**. The conduit **102** will be vented over the circuit previously described. Thus, it may be seen that when valve spool **93** is in the neutral position fluid flows through the valve **83** to reservoir **88** and conduits **102** and **103** are vented. When spool **93** is moved in and out respectively, high pressure fluid flows to conduit **102** while conduit **103** is vented; and fluid flows to conduit **103** and conduit **102** is vented.

Conduit **102** is connected to conduit **110** which is connected to a cylinder **111**. Conduit **110** is connected to a valve **112**. Cylinder **111** is connected by a lever **113** to clutch **79** of speed reducer **77** so that when the cylinder **111** is extended, clutch **79** is operated. Valve **112** has a spool spring-biased to block conduit **110** from the outlet port connected to conduit **114**. Conduit **114** also connects to conduit **109**. Valve **112** is carried on the frame **11** and is positioned at the forward end of the chain **37** with the valve spool aligned so the slide member **32**, carrying the rear end of the boom **30**, will engage the spool of the valve **112** when the slide member **32** is moved to its forwardmost position by the chain **37**. The slide member **32** will then operate the valve **112** to provide free fluid flow from conduit **110** to conduit **114**.

Similarly to conduit **102**, conduit **103** is connected in parallel to a cylinder **115** and a valve **116**. The cylinder **115** is connected to operate the clutch **80** of the speed reducer **77** through a lever arrangement **117**. The outlet port of the valve **116**, which is identical in construction to valve **112**, is connected to conduit **105** by means of conduit **118**. The valve **116** is on one side of the machine at a position where the valve spool thereof can interconnect conduits **103** and **118** when the slide member **32** is moved to its rearwardmost position by the chain **37**. The system for the boom **30** further includes a pressure relief valve **119** which is connected between conduits **92** and **108** and which will operate to by-pass fluid from the high pressure side of the pump **78** to the reservoir **88** whenever the pressure in conduit **92** exceeds a certain predetermined amount.

Considering the operation of the hydraulic system for the boom **30** and assuming the spool **93** is moved inwardly of the body of valve **83**, the high pressure fluid in conduit **102** will operate cylinder **111** which in turn operates clutch **79** of speed reducer **77**. This causes the speed reducer **77** to rotate sprockets **38** in a clockwise direction as viewed in FIGURE 8. This moves the chain **37** which in turn moves the slide members **32** forwardly. As the slide members **32** move forwardly, the boom **30** will be carried forwardly as previously described, and if the valve spool **93** is held inwardly until the slide member **32** reaches its forwardmost position, the valve **112** will be operated to permit the high pressure fluid in conduit **110** to flow through conduits **114** and **109** to the reservoir **88**. This venting of fluid from conduit **110** will permit the clutch **79** to be disengaged thereby stopping the drive to the sprockets **38**. If the valve spool **93** is moved outwardly of the valve body of the valve **83**, the high pressure hydraulic fluid then directed through conduit **103** will operate the hydraulic cylinder **115** to in turn cause an operation of the clutch **80** which will in turn cause power to be delivered to the sprockets **38** to rotate the sprockets **38** in a counter-clockwise direction as viewed in FIGURE 8 to move the boom rearwardly relative to the machine. When the slide member **32** and the boom **30** reach their rearwardmost position, the slide member **32** will operate the hydraulic valve **116** to vent high pressure hydraulic fluid from the hydraulic cylinder **115** through conduits **118**, **105**, **108** and **109** to the reservoir **88**. With the high pressure hydraulic fluid vented from hydraulic cylinder **115**, clutch **80** will be disengaged and the drive to the sprockets **38** will be disconnected. It is, of course, not necessary that the slide member **32** be moved only from one extreme position to the other since by operating the valve spool **93** of the valve **83** to the neutral position any high pressure hydraulic fluid in the conduits **102** and **103** is vented to the reservoir **88** to thereby cause disengagement of either

of the clutches **79** or **80** and stopping the boom **30** in any selected intermediate position.

Turning next to a brief description of the operation of the instant invention in order that the construction thereof may be more readily understood, reference is again made to FIGURES 2, 3, 6, 7 and 9 of the drawings. With the hydraulic cylinders **54** and **56** of either embodiment of the present invention operated so that the bucket **45** is positioned such as shown in FIGURE 2, the crawler track mechanism **10** may be operated to position the bucket **45** immediately before a pile of material to be removed. With the crawler track mechanism then stopped, and with the conveyor mechanism **12** then operating and having its rearward end disposed over a shuttle car or some other conveyor means, the hydraulic system previously described may be operated to slide the boom forward. The bucket **45** and the digging teeth or edge thereof will then be projected into the pile of material to be removed (FIGURE 7). Because one leg of the bell crank **53** engages the underside of the stop **51**, the bucket in moving forwardly may easily slide over any obstructions at ground lever. When the bucket **45** is substantially filled with the material to be removed, the hydraulic cylinders **54** are operated to cause the loaded bucket **45** to break away the material in the bucket **45** from that remaining in the pile and further fill the bucket in a scooping action. Operation of the hydraulic cylinders **56** will then cause the load in the bucket to be dumped therefrom over the rear wall **48** of the bucket **45** onto the forward section **13** of the conveyor mechanism **12**. The conveyor mechanism **12** will then carry that material rearwardly of the machine. As the pile immediately in front of the machine is removed, the boom **30** may be gradually moved forwardly without moving the machine itself until the bucket is working the face of the pile such as shown in FIGURE 7. Only when the face of the pile has been moved beyond the forwardmost reach of the boom **30** and the bucket **45** need the crawler track mechanism **10** again be operated to move the machine in close proximity to the pile. The described digging operations need not be performed only at the ground level of the machine. By suitable extensions of the hydraulic cylinders **41**, the bucket **45** may be caused to dig at higher levels.

In the modification of the invention illustrated in FIGURES 10 to 15 inclusive, the same part numbers will be applied to the same parts as in the first and second forms of the invention.

In FIGURES 10 and 11, the main frame **11** is shown as being mounted on rubber tire mounted traction wheels **25** instead of the continuous crawler track mechanisms **10**. The traction wheels **125** serve to propel the machine along the ground and to crowd the digger bucket **45** into the material to be loaded and are driven in a manner similar to that shown and described in my application Serial No. 9,501, filed February 18, 1960 and entitled "Rock Loading Machine." The four traction wheels and drive to said traction wheels, therefore, need not herein be shown or described further.

The bucket **45** is directly connected to the main frame **11** for vertical and angular movement with respect thereto, to be crowded into the mined material by movement of said main frame toward the mined material by the tractive effort of the traction wheels **125**, on a boom structure **126**. The boom structure **126** includes boom arms **127** extending along each side of the forward wall portions **16** and **17** of the conveyor mechanism **12** and beyond the forward ends thereof and connected together at their forward ends by a cross tube **129**. The boom arms **127** are pivotally mounted at their rear ends on the outsides of the wall portions **16** and **17** on support structures **130**, on pivot pins **131** mounted at their outer ends on blocks **133**, welded or otherwise secured to said support structures. The pivot pins **131** also form pivotal mountings for actuating levers **135** for the bucket **45**.

Each boom arm **127** is adjustably supported adjacent the forward end of the conveyor mechanism **12** on a hydraulic cylinder **136** trunnioned adjacent its lower end in a support **137** extending laterally from the main frame **11**, on trunnion pins **139**. The hydraulic cylinder **137** has a piston rod **140** extensible therefrom, shown in FIGURE 12 as being threaded through a transverse pin **141** pivotally mounted at its ends in parallel spaced arm portions **143** and **144** of the boom arm **127**. The inner arm portion **144** of the boom arm **127** has a depending leg portion **145** extending inwardly of the hydraulic cylinder **136** in a downward direction for a portion of the length of said hydraulic cylinder and having a bearing plate **146** on the side thereof adjacent the conveyor mechanism **12**, having slidable bearing engagement with a bearing plate **147** extending vertically of the conveyor mechanism **12** and shown in FIGURE 12 as being secured thereto. The bearing plates **146** and **147** have sliding contact with each other and serve to limit lateral displacement of the boom structure **126** during operation of the digger bucket **45** and to provide slidable engaging surfaces for the boom structure during vertical adjustment thereof by operation of the hydraulic cylinders **136**.

The digger bucket **45** is transversely pivoted to the forward end portion of the boom structure **126** on laterally spaced ears **149** extending rearwardly from the side walls **46** of said digger bucket. As shown in FIGURE 13, the ears **149** are pivotally mounted on transverse pivot pins **150** on bearings **151**. Each pivot pin **150** is mounted at one end on the arm portion **127** of the boom structure **126** and at its opposite end on a lug **153** extending upwardly from the tube **129** inwardly of the boom arm portion **127** and welded or otherwise secured to the transverse tube **129**. Nuts and washers **154** are threaded on opposite ends of the pivot pin **150** to retain said pin in position.

A bell crank **155**, similar to the bell crank **53** is pivotally mounted on each side wall **46** of the bucket **45** on a pivot pin **157**. The bell crank **155** has a depending arm or leg having an engaging end portion **158** engageable with the stop member **51** extending outwardly from the side wall **46** of the bucket **45** when the bell crank is pivoted in a counter clockwise direction to pivot the bucket **45** upwardly about the axis of the pivot pin **150**. It will be noted from FIGURE 10 that the operative connection from the bell crank **155** to the bucket **45** is such that the bucket may pivot upwardly relative to the engaging face **158** when being crowded into the loose material during the loading operation, to accommodate the bucket to ride along uneven ground and over high spots on the ground free from the bell crank **155**.

The bell crank **155** also has an upwardly extending leg or lever arm **159** having a clevis **160** of an adjustable link **161**, pivotally connected to its upper end on a pivot pin **162** extending through said clevis and lever arm. The opposite end of the link **161** has a clevis **163** threaded thereon and extending along opposite sides of the actuating lever **135** and pivotally connected therewith on a ball **164** mounted on a pivot pin **165** mounted in said clevis at its ends (FIGURES 10 and 15).

The actuating lever **135** is actuated by a hydraulic cylinder **166** having a piston rod **167** extensible therefrom. The hydraulic cylinder **166** has a connector **168** extending from the head end thereof between the arm portions **143** and **144** of the boom arm **127** and pivotally connected thereto on a pivot pin **169**.

The piston rod **167** extends between connector plates **170** welded or otherwise secured to opposite sides of the actuator lever **135** intermediate the ends thereof, and is pivotally connected to said actuator plates by pivot pin **171**.

In describing the operation of the mechanism of FIGURES 10 and 11, the mechanism on only one side of the machine will herein be referred to, for the purpose of simplicity. In these figures, the axis of connection

of the link **161** to the actuator **135** is designated by A. The axis of the pivot pin **157** is designated by B and the axis of connection of the ear **149** to the boom **127** on the pivot pin **150** is designated by C. The axis of connection of the link **161** to the lever arm **159** of the bellcrank **155** is designated by D.

As fluid under pressure is admitted to the head end of the cylinder **166** to extend the piston rod **167** therefrom, the bellcrank **155** will initially pivot upwardly about axis B and engage the engaging end portion **158** of said bellcrank **155** with the stop **51** and then pivot the bucket **45** upwardly. During initial upward pivotal movement of the bucket **45**, the moment arm supplying the force to raise the bucket and tear the bucket from rock piled thereon will be from D to C, the weight of the bucket and rock thereon will hold the link **161** and lever arm **159** in angularly disposed relation with respect to each other. The bellcrank **155**, stop **51** and bucket **46** will then move upwardly as a unit. As the pull on the lever arm **159** causes **161** and **159** to approach a straightened condition, however, **161** and **159** will then act as a pulling link and the bucket will continue its upward movement about point C. The moment arm will then be reduced to the distance from B to C. As the bucket is pivoted upwardly about the shorter moment arm the lever arm **159** will engage a camming face **164** on the boom arm **127**, preventing the link **161** and lever arm **159** from straightening out or moving past a dead center position. The bucket **45** will then pivot relatively to the bellcrank **155** and the stop **51** will move away from the engaging end portion **158** of said bellcrank.

During movement of the bucket from the broken line position shown in FIGURE 11 to the solid line discharge position shown, the speed of travel of the bucket moving about the shortened moment arm will materially increase and the bucket will move upwardly to its discharge position at a relatively high rate of speed until the stop **51** engages the lever arm **159** of the bellcrank **155**, stopping movement of the bucket and jarring the loose material therein to fall onto the conveyor **24**.

During lowering of the bucket, fluid under pressure is admitted to the piston rod end of the cylinder **166**, pivoting the bucket in a downward direction about the moment arm D—C. The link **161** and lever arm **159** will then move angularly with respect to each other until gravity takes over and the stop **51** comes into engagement with the engaging end portion **158** of the bellcrank **155**. Continued lowering movement of the bucket into the gathering position shown in FIGURE 10 will then be under the control of the cylinder **166** and piston rod **167**.

It will also be noted that the stop **51**, while accommodating relatively free upward movement of the digger bucket during the operation of crowding said digger bucket in the material being loaded, may also be positively engaged with the arm **159** of the bell crank **155** as the digger bucket is moved to its discharge position and serves to jar moist material from the digger bucket, the link **161** and lever arm **159** holding the digger bucket in its discharge position until the piston rod **167** is retractibly moved with respect to the hydraulic cylinder **166**, to move the digger bucket to a loading position.

The free connection between the bell crank **155** and the digger bucket **45**, thus besides accommodating the digger bucket to freely ride along rises on the ground without affecting the operating mechanism for the bucket, also serves as a stop for the digger bucket when in its discharge position and engages the arm **159** with a jarring action, to jar any moist material in the bucket to flow downwardly therealong onto the receiving end portion of the conveyor mechanism **12**.

While I have herein shown and described various forms in which my invention may be embodied, it should be understood that various other variations and modifications in the invention may be attained without departing from the spirit and scope of the novel concepts thereof as defined by the claims appended hereto.

I claim as my invention:

1. In a loading machine, a mobile frame, a conveyor extending along said frame from a position adjacent the ground at the forward end thereof and fixed from vertical movement with respect to said frame at its forward end, a boom transversely pivoted to said frame rearwardly of the forward end thereof and extending in advance of said frame, hydraulic cylinder and piston means supporting the forward end of said boom on said frame and vertically adjusting said boom about its axis of pivotal connection to said frame, a digger bucket transversely pivoted to the forward end of said boom and extending in advance thereof for slidable engagement with the ground, a bellcrank pivotally connected to one side of said digger bucket intermediate its ends and having depending and upwardly extending lever arms, a stop projecting outwardly from the side of said bucket between said arms of said bellcrank for engagement therewith, a pivoted actuating lever having two angularly extending arms, means pivotally mounting said actuating lever on said frame at the end of one arm thereof, hydraulic cylinder and piston means pivotally connected between said boom and said actuating lever adjacent the juncture of said arms, whereby an upper of said arms extends generally along said hydraulic cylinder and piston means, and linkage means connecting the free end of the upper of said arms with the upwardly extending arm of said bellcrank, to pivot said bellcrank to engage said stop and swing said bucket upwardly from a loading to a dumping position.

2. A loading machine in accordance with claim 1, wherein the actuating lever is pivoted to the frame coaxially with the axis of pivotal connection of the boom to the frame and wherein the linkage means is extensible and retractible to vary the angular relation of the digger bucket with respect to the ground.

3. In a loading machine, a mobile frame, a conveyor extending along said frame and having a forward receiving end at a fixed elevation with respect to the ground, a boom transversely pivoted to said frame rearwardly of the forward end thereof and extending in advance of said frame, a digger bucket transversely pivoted to the forward end of said boom and depending from said boom into engagement with the ground, means for holding said boom in position and vertically adjustably moving said boom with respect to the ground, a bellcrank transversely pivoted to one side of said digger bucket for movement about an axis spaced beneath and forwardly of the axis of pivotal connection of said digger bucket to said boom when said digger bucket is in engagement with the ground, a stop projecting laterally of said digger bucket, said bellcrank having a lever arm depending from its axis of connection to said digger bucket and extending underneath said stop when said digger bucket is in engagement with the ground and having a second upright lever arm extending upwardly of the axis of connection of said bellcrank to said digger bucket, an actuating lever transversely pivoted to said frame and extending upwardly of its axis of pivotal connection to said frame, an extensible and retractible operating member transversely pivoted to said boom and pivotally connected with said actuating lever intermediate the ends of said actuating lever, a rigid link, a transverse pivot pin connecting one end of said link to the free end of said actuating lever, a second transverse pivot pin connecting the opposite end of said link with the upright arm of said bellcrank, the relationship between the axis of connection of said bucket to said boom, said bellcrank to said bucket and the axes of said pivot pins being such that when said bucket is in depending relation with respect to said boom, the weight of said bucket and the rock loaded thereon will engage said stop with said depending arm of said bellcrank and effect initial upward movement of said bucket about a lever arm equal to the distance between the axis of connection of said bucket to said boom and the axis of said pivot pin connecting said link to the upright arm

of said bellcrank, and as said bucket moves toward a discharge position, said link and the upright arm of said bellcrank will move into aligned relation with each other and pivot said bucket to a discharge position about a shorter moment arm equal to the distance between the axis of connection of said bucket to said boom and said bellcrank to said bucket and move said stop away from said depending lever arm of said bucket.

4. A loading machine in accordance with claim 3, wherein said boom has a camming face thereon engageable with said upright arm of said bellcrank and retaining said link and upright arm from moving past dead center positions with respect to each other as said bucket moves to its discharge position.

5. In a loading machine, a mobile frame, a conveyor extending along said frame and having a forward receiving end in fixed relation with respect to said frame, a boom transversely pivoted to said frame rearwardly of the forward end thereof and extending in advance of said frame, means for retaining said boom in position and vertically moving said boom with respect to said frame, a digger bucket transversely pivoted to the forward end of said boom and extending in advance thereof for slidable engagement with the ground, an extensible and retractible operating member pivotally connected to said boom, an actuating lever transversely pivoted to said frame, an operative connection between said operating member and said actuating lever, linkage means connecting the free end of said actuating lever with said digger bucket to effect upward movement of said digger bucket from a digging to a discharge position, bearing plates extending vertically along the outer sides of said conveyor, other bearing plates extending vertically along the inner sides of said boom and having slidable engagement with said first mentioned bearing plates to retain said boom from lateral shifting movement in all positions of elevation thereof with respect to the ground.

6. A loading machine in accordance with claim 5, wherein the boom includes two parallel spaced boom arms extending along opposite sides of the conveyor and connected together in advance of the forward end of the conveyor, wherein the boom arms are adjustably supported adjacent their forward ends on hydraulic cylinders and pistons operative to raise and lower said boom

arms about their axes of pivotal connection to said frame, and wherein the bearing plates extending vertically along the inner sides of the boom, are mounted on the boom arms adjacent the forward ends thereof, and the bearing plates extending vertically along opposite sides of the conveyor are adjacent the forward end of the conveyor.

7. In a loading machine, a mobile frame, a conveyor extending along said frame and having a forward receiving end portion fixed with respect to said frame, a boom transversely pivoted to said frame rearwardly of the forward end thereof and extending in advance of said frame, hydraulic cylinder and piston means supporting the forward end of said boom on said frame and vertically adjusting said boom about its axis of pivotal connection to said frame, a digger bucket transversely pivoted to the forward end of said boom and extending in advance thereof for slidable engagement with the ground, a bellcrank pivotally connected to one side of said digger bucket intermediate its ends and having depending and upwardly extending lever arms, a stop projecting outwardly from the side of said digger bucket between said arms of said bellcrank, an actuating lever pivoted to said frame coaxial with the axis of pivotal connection of said boom to said frame, said actuating lever having two angularly extending arms extending vertically of the axis of said actuating lever to said frame, hydraulic cylinder and piston means pivotally connected between said boom and said actuating lever adjacent the juncture of said arms, whereby an upper of said arms extends generally along said hydraulic cylinder and piston means, and a rigid link connecting the free end of the upper of said arms with the upwardly extending arm of said bellcrank for actuating said bellcrank upon operation of said actuating lever to swing said bucket upwardly from a loading to a dumping position.

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