

June 9, 1953

R. N. BENNETT

2,641,070

ENDLESS CONVEYER DITCHING MACHINE

Filed April 1, 1948

6 Sheets-Sheet 1

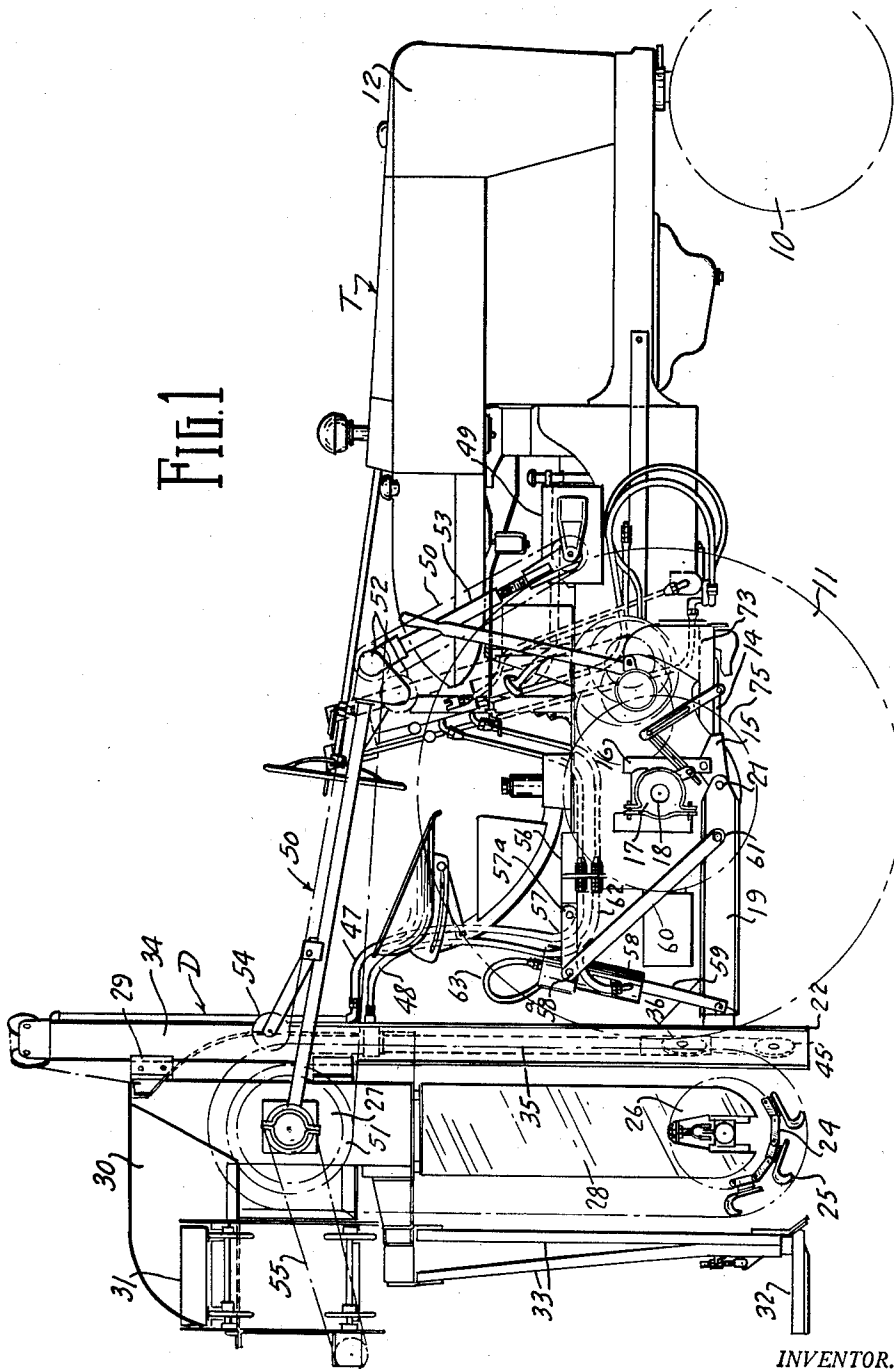


FIG. 1

INVENTOR.

BY Robert N. Bennett

Phileas W. Prosser

ATTORNEY

June 9, 1953

R. N. BENNETT

2,641,070

ENDLESS CONVEYER DITCHING MACHINE

Filed April 1, 1948

6 Sheets-Sheet 2

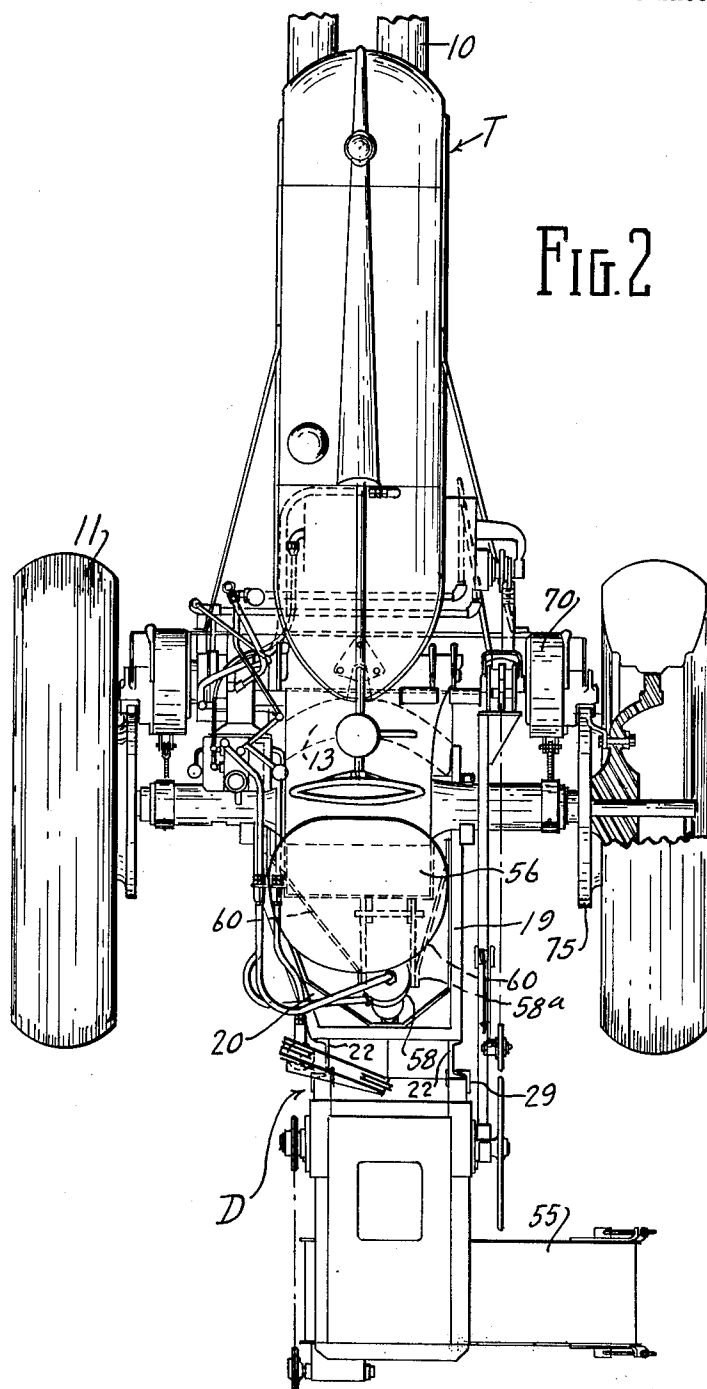


FIG. 2

INVENTOR.
Robert N. Bennett
BY
Deleah W. Preser

ATTORNEY

June 9, 1953

R. N. BENNETT

2,641,070

ENDLESS CONVEYER DITCHING MACHINE

Filed April 1, 1948

6 Sheets-Sheet 3

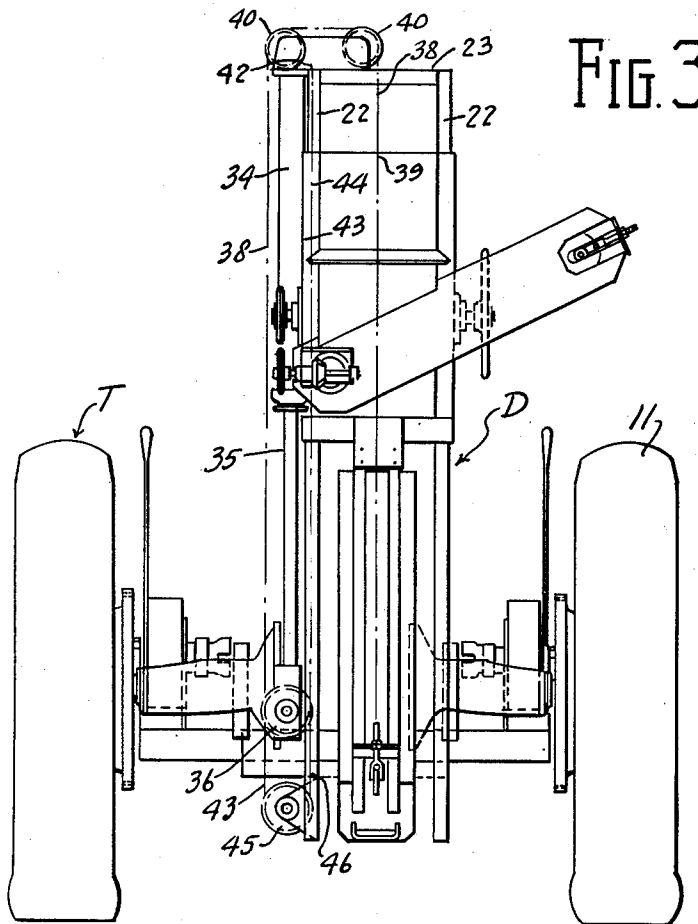


FIG. 3

INVENTOR.
Robert N. Bennett
BY *Delbert W. Brown*
ATTORNEY

June 9, 1953

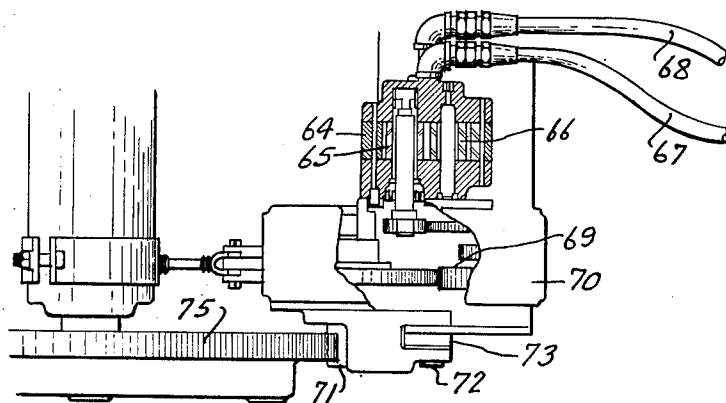
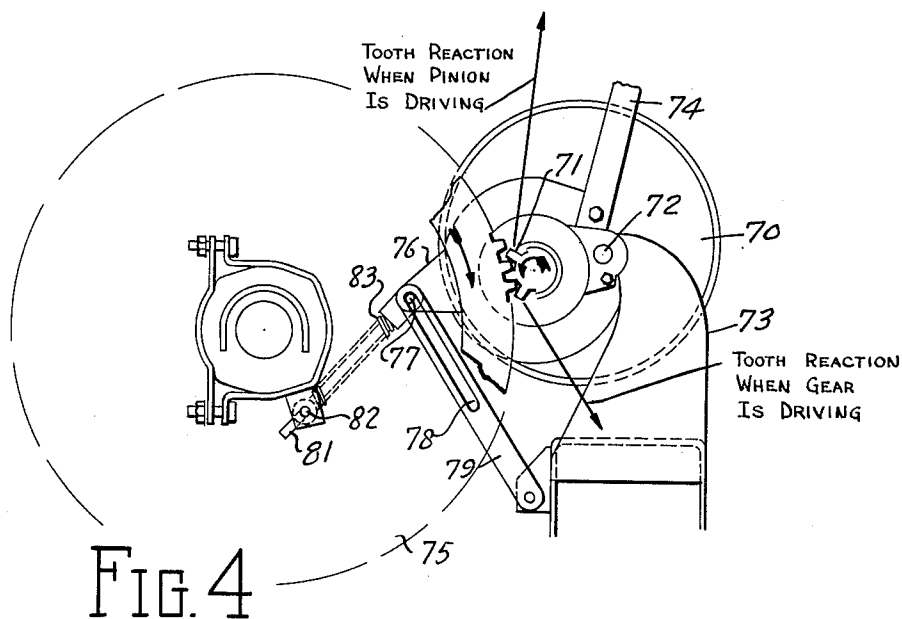
R. N. BENNETT

2,641,070

ENDLESS CONVEYER DITCHING MACHINE

Filed April 1, 1948

6 Sheets-Sheet 4



INVENTOR.

Robert N. Bennett

BY

Deborah W. Prater

ATTORNEY

June 9, 1953

R. N. BENNETT

2,641,070

ENDLESS CONVEYER DITCHING MACHINE

Filed April 1, 1948

6 Sheets-Sheet 5

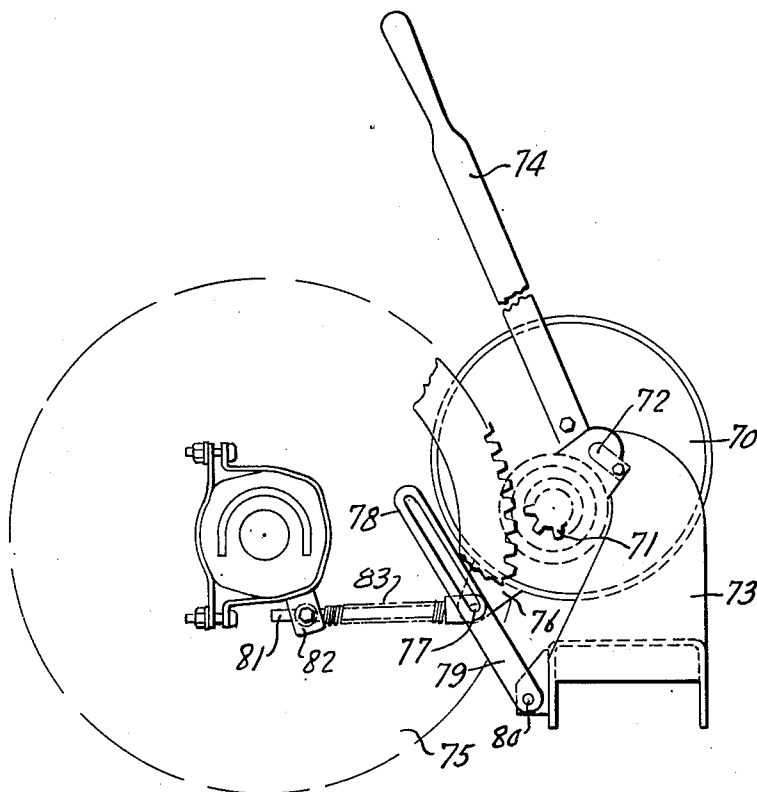


FIG. 6.

INVENTOR.

BY *Robert N. Bennett*

Robert W. Packer

ATTORNEY

2,641,070

ENDLESS CONVEYER DITCHING MACHINE

Filed April 1, 1948

6 Sheets-Sheet 6

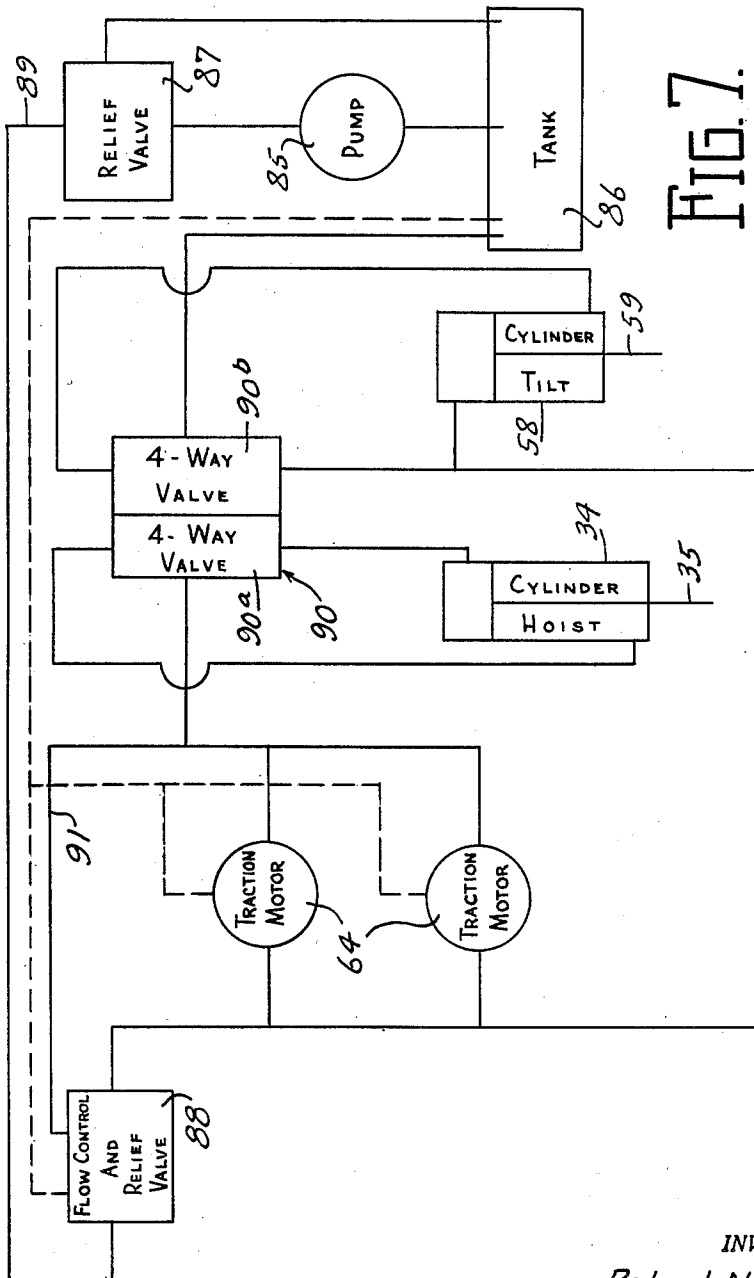


Fig. 7

INVENTOR.

Robert N. Bennett

BY *Richard W. Brown*

ATTORNEY

UNITED STATES PATENT OFFICE

2,641,070

ENDLESS CONVEYER DITCHING MACHINE

Robert N. Bennett, McComb, Ohio

Application April 1, 1948, Serial No. 18,411

8 Claims. (Cl. 37-90)

1

This invention relates to excavating machines, but more particularly to trenching machines of the boom type equipped with an endless series of digging buckets.

An object of this invention is to produce a simple and efficient excavating or trenching machine by equipping an ordinary wheel type tractor with excavating mechanism having the unique features of construction, arrangement and operation hereinafter described.

Another object is to produce a trenching machine of the boom type in which the boom and its associated parts are mounted on up-rights disposed at the rear of a tractor, the up-rights along with the associated parts being mounted on the tractor for movement between up and down positions and an inclined position in which the mechanism is positioned for roading or to enable the machine to be transported conveniently from place to place.

A further object is to produce a mechanism to automatically hold the digging mechanism into the cut in proportion to the power required to propel the machine.

A still further object is to provide a trenching machine of the above character with hoist mechanism operative not only to elevate the digging mechanism from digging position to roading position, but also to achieve positive control of the trench grade.

A still further object is to produce a trenching machine in which the digging mechanism can, as a unit, be hydraulically tilted from operative to inoperative positions, the same hydraulic mechanism being effective also to exert a force to retain the digging mechanism in the digging position, which force is proportional to the force required to propel or advance the machine.

For purposes of illustration but not of limitation, an embodiment of the invention is shown in the accompanying drawings, in which:

Figure 1 is a side elevation of the trenching machine showing the boom in partly raised position;

Figure 2 is a top plan view of the trenching machine;

Figure 3 is a rear end elevation of the trenching machine;

Figure 4 is a fragmentary side elevation of the tractor drive, showing particularly the driving pinion in driving mesh with the gear connected to the traction wheel;

Figure 5 is a plan view partly in section of the traction wheel drive showing the torque motor and reduction gears;

2

Figure 6 is a side elevation showing the traction wheel drive somewhat similar to Figure 4, but showing the pinion disengaged from the driven gear; and

Figure 7 is a diagrammatic view showing the hydraulic operating means for the parts of the tractor.

The illustrated embodiment of the invention comprises a tractor T having front or steering wheels 10 and relatively large rear or traction wheels 11. The tractor T is the ordinary wheel type tractor powered by a gasoline engine contained within the hood 12 as will be readily understood, and attached to the tractor T is a trenching or digging unit generally indicated at D. As will more fully appear hereinafter, the trenching unit D which is adapted to excavate a trench in which drainage tile may be laid, is adapted to be attached to or detached from the tractor T in a relatively simple manner so that when desired, the tractor can be used for other purposes, but when it is desired to dig trenches for one purpose or another, the unit D may be attached to the tractor in a relatively short period of time.

Disposed on the under side of the tractor T is an arcuately shaped draw bar 13 (Figure 2), the ends 14 of which project to opposite sides of the tractor and have rigid therewith plates 15 which are suspended from a clamping bar 16 which is rigidly clamped to a housing 17 which supports the rear axle 18 of the tractor.

Forming part of the digging unit D is a horizontally disposed rigid U-shaped frame having arms 19 and 20 which are pivoted at their front ends at 21 to the plates 15 respectively. It will be observed that the pivot points 21 are in each instance beneath the rear axle 18 and close to the vertical center line thereof. It is desirable that these pivots 21 be arranged as close to the vertical center line of the rear axle as clearance conditions permit and as close to the road surface as possible, taking into consideration that the digging unit D when raised to roading or traveling position, must be sufficiently above the road surface as not to interfere with irregularities. As will hereinafter more fully appear, the entire digging unit D tilts or rocks about the pivots 21 either upwardly or downwardly.

The cross member of the U frame having the side arms 19 and 20, is rigid with a pair of laterally spaced uprights 22 which, as shown in Figure 3, are connected at their upper ends by a cross arm 23. The uprights 22 are of channel

form, U-shaped in cross section (Figure 2) and are disposed at substantially right angles to the arms 19. Figure 1 illustrates the position of the upright suitable for trenching operation, although in that figure, the digging unit is raised above the ground.

The digging mechanism consists of an endless chain 24 having a series of relatively small digger units 25 suitably fixed thereto. The chain 24 is trained about a lower sprocket 26 and an upper sprocket 27 mounted respectively on shafts carried by a boom 28. The boom 28 has two pairs of vertically spaced guide shoes 29 which are suitably clamped about the upright frame channels 22 so as to slide vertically thereon. As shown, the boom has a hood 30 which carries a suitable spoil conveyor 31 of any desired construction for conveying the dirt excavated by the diggers 25 and delivered thereto, to one side of the machine as will be readily understood by those skilled in this art. The boom also carries a shoe 32 suitably suspended by arms 33 to ride along the bottom of the trench as will be readily understood. When digging, the complete digging unit D is supported at two points, i. e. the shoe 32, which rides along the bottom of the finished trench, and the pivot points 21, about which the unit D is free to oscillate.

Carried by the uprights 22 at the upper end portion thereof is a hydraulic cylinder 34 in which reciprocates a suitable piston (not shown) to which is fixed a piston rod 35. Suitably fixed to the lower end of the piston rod 35 is a pair of sheaves 36. Fixed to the lower end of the adjacent upright 22 is a sheave 45. A cable 38 has one end anchored at 39 (Figure 3) to the upper end of the boom, the cable passing upwardly over sheaves 40 and 41 mounted on the top of the uprights 22. The cable 38 thence extends downwardly to one of the sheaves 36, and thence upwardly and dead ends at 42 at the upper end of an upright 22. It will be manifest that upon downward movement of the piston rod 35, the boom and its associated parts are forced upwardly of the uprights 22. Manifestly, upon the downward movement of the piston rod 35, the boom and associated parts are accordingly moved upwardly, thereby positively to raise the digging unit along the uprights 22.

In order forcibly to lower the boom along the uprights 22, a cable 43 is anchored at 44 on the boom (Figure 3) and extends downwardly to a sheave 45 which is fixed to the lower end of one of the frame uprights 22. The cable 43 then passes about the sheave 45 to the other of the sheaves 36, thence downwardly, and is dead ended at 46 to the adjacent upright 22 intermediate the sheaves 45 and 36. Tubes 47 and 48 lead to opposite ends of the hoist cylinder 34 for actuating the piston therein upwardly or downwardly to effect the desired movement of the boom.

The upper shaft on the boom, or the one carrying the sprocket 27, is driven from a transmission 49, deriving its power from the tractor engine, through a chain 50 which engages a sprocket 51 concentric with the sprocket 27, the chain passing over idlers 52 adjustably carried by a post 53 and a tightener sprocket 54 engaging the upper run of the chain 50 in the region of the sprocket wheel 51. This drive mechanism affords limited variation in the chain centers to enable the latter to become slack at certain points in its travel. Such variation of sprocket

center distances, and the tightening and slackening of the chain, is taken care of by the idler 54 which is preferably spring-loaded. A sprocket and chain drive 55 connects the main or head shaft with the conveyor 31 for concomitantly actuating the same.

Suitably secured as by bolts to the rear end of the tractor frame, and extending transversely thereof, is an anchor bracket 56 to which are pivoted as at 57a rearwardly extending parallel links 57. Pivoted or trunnioned to the rear ends of the links 57 is a vertically disposed cylinder 58. Likewise pivoted at the points 58a is a pair of relatively long links 60, 60 which extend forwardly and downwardly in diverging relation and are pivotally connected at their lower ends at 61 to the frame arms 19 and 20 respectively. The pivots 61 are disposed as close to the pivots 21 for the forward ends of the arms 19 and 20 as clearance conditions will permit. Thus it will be apparent that the links 57 and 60, 60 form a triangular support in which the upper end portion of the cylinder 58 is trunnioned.

The piston rod 59 and cylinder 58 operate not only to tilt the digging unit D so that the uprights 22 are forwardly inclined (Figure 8) in the desired position for roading, but also exert pressure constantly to hold the digging unit in digging position (Figures 9 and 10) as will hereinafter be more fully described. Liquid is introduced to opposite ends of the tilt cylinder 58 through tubes 62 and 63 respectively.

During the digging operation, it is necessary to propel the machine into the cut at a much slower speed than ordinarily is afforded by the standard reduction gearing in the tractor. In this instance, mechanism is provided for driving each traction wheel 11 individually with a variable speed hydraulic torque motor operating through a set of reduction gears. The two torque motors are motivated from a common source of pressure fluid through a common variable flow control valve, thereby to transmit equal torque or tractive effort to each of the traction wheels. Thus the traction wheels can function the same as a standard mechanical differential unit because one traction wheel can turn faster than the other while the tractor is guided in a circle and still pull equally. If desired, standard steering brakes which are ordinarily furnished with a tractor of this type can be employed to facilitate turning in slippery ground when the front wheels tend to slide, by merely braking the inside wheel as will be readily understood. This will either stop it or slow it down, depending upon the braking pressure which is applied. This in turn slows down the torque motor and permits excess pressure fluid to flow through the opposite torque motor and increase the speed of the outside traction wheel.

A torque motor is indicated at 64 (Figure 5), and may be of any suitable or well-known construction. As shown, the motor is a gear type motor having gears 65 and 66. The admission of pressure fluid to the torque motor is controlled by tubes 67 and 68. The power from the torque motor 64 is transmitted through a train of reduction gears 69 which are contained within a housing 70 to a driving pinion 71. It will be manifest that each torque motor, its reduction gearing and driving pinion, are assembled as a unit and that unit is pivotally mounted in a trunnion bearing 72 on a rigid supporting bracket 73 suitably fixed to the tractor frame (Figure 1). A hand lever 74 is secured to this unit to

5

enable it to be rocked about the bearing 72. It will be observed that the torque motor and speed reduction unit is pivotally mounted on the trunnion bearings with the center line of these trunnions eccentric with the center line of the driving pinion 71.

The driving pinion 71 is engageable with a relatively large gear 75 which is suitably fixed to the adjacent traction wheel 11 for rotation therewith. The arrangement is such that the driving pinion 71 may be rocked into or out of mesh.

The housing 70 has a peripherally extending bracket 76 which carries at its outer end a pin 77 which is slidable in a longitudinally elongate slot 78 in an arm 79 pivoted at its lower end at 80 to a lower portion of the supporting bracket 73. The pin 77 is mounted on one end of a rod 81 which is slidable with respect to a bracket 82 rigid with the rear axle housing and interposed between the bracket 82 and shouldered on the opposite end portion of the rod 81 is a helical spring 83. It will be manifest that by rocking the lever 74, the driving pinion 71 may be moved into mesh with the gear 75 for driving the respective traction wheel 11. However, the driving pinion may also be rocked downwardly to the position indicated in Figure 6, in which the driving pinion 71 is out of mesh with the gear 75, the coil spring 83 retaining the pinion in this position.

It will be understood that the only time the slow speed travel of the tractor is required is when the machine is employed for digging, and this is required only in the forward movement. Consequently, the traction wheels 11 are required to rotate slowly only in a clockwise direction (Figure 1), and as a result, the driving pinion 71 is required to rotate only in a counterclockwise direction. The tooth reaction on the driving pinion is always in an upward direction during the digging operation, and this upward force tends to rotate the housing 70 (Figures 4 and 6) in a clockwise direction with relation to the supporting trunnion 72. This tendency of the housing to rotate is prevented at the point of full mesh by a positive stop of any suitable character. To disengage the driving pinion 71 from the gear 75, the lever 74 is rocked in a counterclockwise direction (Figure 4) until there is sufficient clearance between the driving pinion and the gear 75 so that the pinion is out of operative driving engagement. The coil spring 83 operates to hold the driving pinion either in engaged or disengaged position, but is only sufficient to overcome shock and vibration inasmuch as all the driving reaction imparted to the housing 70 is taken upward against the positive stop above mentioned.

It will be understood that in the event the tractor T were driven at high road speeds with the driving pinion 71 in mesh with the gear 75, the reduction gearing associated with the torque motors would be driven at such a high speed that they would soon become badly damaged. This difficulty is overcome because in such an event, the driving gear is automatically moved out of engagement with the adjacent gear 75. This affords a safety feature and militates against damage which may occur in the event the operator inadvertently throws the tractor T into high gear with the driving pinions 71 engaging with the respective gears 75. The reducing gears will be driven and the driving pinions 71 will be automatically swung away from the adjacent gears 75, the reactions being reversed to that above

6

described causing the housing 70 to rock in a counterclockwise direction.

It will be understood that the driving mechanism which includes drive pinion 71, constitutes an auxiliary driving system for the tractor T equipped also with a conventional driving or transmission system. Such auxiliary driving mechanism thus operates when the tractor is driven slowly forwardly for trenching purposes, the driving pinion 71 being retained in operative driving relation. However, when the tractor is operated by the conventional driving or transmission system, the pinion 71 as above explained, is automatically moved away from operative position.

Figure 7 illustrates the hydraulic circuit and in that figure, 35 designates a suitable pump connected to be driven by the power plant of the tractor T in any suitable or well-known manner. The pump communicates with a tank or reservoir 86 containing the liquid for use in connection with the system. Associated with the pump is a relief valve 87 which is adapted to return liquid to the reservoir at a pressure approximately double the pressure setting of the relief valve forming a part of a flow control unit 88. It will be understood that liquid such as oil under pressure from the pump 35 passes through a line 89 to the flow control valve 88 of any suitable construction, and which serves to regulate the speed of the torque motors 64, one being provided as above explained, for each of the traction wheels 11. Assuming for purposes of description that the relief valve which forms a part of the flow control valve is set for four hundred pounds per square inch which is approximately one-half the pressure setting on the relief valve 87, the maximum differential pressure across the torque motor 64 will be limited to four hundred pounds per square inch, whether or not the hoist control cylinder 34 is being operated simultaneously with the torque motors. The flow control valve 88 may be manually adjustable for controlling the speed of the torque motors up to the capacity of the pump 35 and when the adjustment of the valve 88 is turned to closed position, the torque motors will be stopped.

The oil passes through the torque motors 64, and flows to a valve unit 90 which is designed to control the hoist cylinder 34 and the tilt cylinder 58. Also it will be apparent that any oil which is by-passed around the torque motor 64 by the flow control valve 88 may return to the reservoir through the line 91. Thus oil which flows from the flow control valve 88 either through the torque motor 64 or through the by-pass line 91, is still available for use in the hoist cylinder 34 and tilt cylinder 58, and may be used to actuate the pistons within these cylinders whether the torque motors 64 are operative or inoperative. The valve unit 90 is divided into portions 90a and 90b. The valve portion 90a operates as a conventional four-way valve in that when in neutral position, oil may by-pass freely to the reservoir 86 with both ports of the ends of the cylinder 34. When such valve is shifted to hoisting position for operating the hoist cylinder 34, the valve mechanism diverts the complete flow of oil to the hoisting end of the cylinder and opens the opposite end to the reservoir 86. On the other hand, when in the lowering position, such valve mechanism diverts the full flow of oil to the lowering end of the cylinder

34 and opens the hoist end of the cylinder to the reservoir 86.

The other valve portion 90b in the multiple valve unit 90 operates the tilt cylinder 53. In the neutral position, the valve of this portion allows the oil to flow freely to the reservoir 86 and blocks the ports to both ends of the tilt cylinder 53. This is the position in which the excavating boom is held in its elevated or roading position (Figure 8). In the raising position, the valve of the portion 90b diverts the oil to the lower end of the tilt cylinder 53 and opens the opposite end of the cylinder to the reservoir 86. This position is used in tilting the up-rights 22 to the roading or traveling position. In the lowered and operating position, this valve allows the oil to flow freely through it to the reservoir 86, opens the lower end of the cylinder 53 to the reservoir, and blocks the upper end of the tilt cylinder. This permits the oil from the pressure side of the torque motor 64 to exert a force on the upper end of the piston in the tilt cylinder 53, proportional to the tractive effort of the machine. Since the lower end of the tilt cylinder 53 is open to the reservoir 86, the piston within the tilt cylinder is allowed to float up and down as the angular relation between the up-rights 22 and the tractor T changes, and still maintain a downward pressure on the tilt cylinder piston.

Forming a part of the flow control valve 88 is a relief valve to enable unloading of the pump 85 through the flow control valve when the latter is in its closed position. Detail illustration and description of the valve mechanism above referred to is not considered necessary since such detail construction forms no part of the present invention and further for the reason that such mechanism to accomplish the desired results is well-known in the art. However, the manner in which these valve mechanisms are employed in this connection is regarded as being of particular importance for achieving the desired results in the operation of the tractor and digging unit.

It is to be understood that numerous changes in details of construction, arrangement and operation may be effected without departing from the spirit of the invention especially as defined in the appended claims.

What I claim is:

1. A trenching machine comprising a power driven tractor, an excavating unit of the boom type disposed in rear of said tractor, said unit including a vertically disposed supporting frame and a vertical reciprocable digging boom carried by said frame, a mounting connection between said excavating unit and tractor whereby the excavating unit may be rocked upwardly and forwardly for roading purposes, said mounting including pivotal supporting means for said unit, and power means for effecting such rocking movement, said power means being also operable to exert pressure to hold the digging boom in digging position.

2. A trenching machine comprising a power driven tractor having a rear axle, support means for the tractor including front supporting elements and rear tractive means, said axle constituting the point of oscillation of the tractor about the rear tractive means in passing over surface irregularities, a digging unit in rear of said tractor and including an upright supporting frame, a boom carried by and vertically reciprocable within said frame, a series of endless excavating buckets carried by said boom, and a

pivotal connection between said excavating unit and said tractor juxtaposed to the vertical center line of said rear axle enabling pivotal movement of the excavating unit relative to the tractor about a horizontal axis.

3. A trenching machine comprising a tractor having traction wheels, hydraulic torque motors for driving said traction wheels respectively, a boom type excavating unit in rear of said tractor, a connection between said unit and tractor enabling pivoting of the unit about a horizontal axis relative to said tractor, a hydraulic piston and cylinder assembly between said tractor and said unit operative to effect a tilting movement of the unit relative to the tractor, a hydraulic pump on said tractor, and operative connections between said pump, torque motors and piston and cylinder assembly for imparting hydraulic pressure downwardly on the excavating unit through said piston and cylinder assembly proportional to the pressure imparted to said torque motors.

4. A trenching machine comprising a power driven tractor having rear traction wheels, and an excavator unit including a rigid frame, an excavator boom shiftable vertically in said frame to and from digging position, arms rigid with said frame extending forwardly thereof, a pivotal mounting for the forward end of said arms in the region of the vertical center line of said traction wheels, means for tilting said excavator unit about said pivotal mountings, said tilting means comprising a hydraulic piston and cylinder assembly providing a connection between the tractor and said frame and operative to tilt the excavator unit to roading position and also to hold the boom into digging position, torque motors individual to each traction wheel, and hydraulic means for delivering liquid under pressure to said torque motors and liquid under pressure proportionately to said piston and cylinder assembly.

5. A trenching machine comprising a power driven tractor having rear traction wheels, and an excavator unit including a rigid frame, an excavator boom shiftable vertically in said frame to and from digging position, arms rigid with said frame extending forwardly thereof, a pivotal mounting for the forward end of said arms in the region of the vertical center line of said traction wheels, means for tilting said excavator unit about said pivotal mountings, said tilting means comprising a hydraulic piston and cylinder assembly providing a connection between the tractor and said frame and operative to tilt the excavator unit to roading position and also to hold the boom into digging position, torque motors individual to each traction wheel, and drive means associated with the torque motors, including a drive pinion shiftable automatically out of driving relation upon rotation of the tractor wheels at a speed in excess of a predetermined maximum.

6. A trenching machine comprising a tractor having traction wheels, hydraulic torque motors for driving said traction wheels respectively, a boom type excavating unit in rear of said tractor, a connection between said unit and tractor enabling pivoting of the unit about a horizontal axis relative to said tractor, a hydraulic piston and cylinder assembly between said tractor and said unit operative to effect a tilting movement of the unit relative to the tractor, and a hydraulic pump on said tractor for said torque motors and said piston and cylinder assembly.

7. A trenching machine comprising a tractor

9

having traction units, an excavating unit pivotally connected to said tractor, a hydraulic torque motor for each traction unit, a tilt cylinder and piston assembly interposed between said excavating unit and tractor, a hydraulic pump on the tractor, a flow control and relief valve assembly, a four-way valve assembly, and conduits connecting said pump, torque motors, cylinder and piston assembly, and said valve assemblies in such manner that the excavating unit is forcibly held in excavating position in proportion to the propelling effort exerted by the torque motors.

8. A trenching machine comprising a tractor having traction units, an excavating unit pivotally connected to said tractor, a hydraulic torque motor for each traction unit, a tilt cylinder and piston assembly interposed between said excavating unit and tractor, a hydraulic pump on the tractor, a flow control and relief valve assembly, a four-way valve assembly, conduits connecting said pump, torque motors, cylinder and piston assembly, and said valve assemblies in such man-

10

ner that the excavating unit is forcibly held in excavating position in proportion to the propelling effort exerted by the torque motors, an additional four-way valve assembly, a hoist cylinder and piston assembly on said excavating unit, and conduit connections between said valve assembly, said pump and said hoist cylinder and piston assembly for effecting operation of the latter.

ROBERT N. BENNETT.

References Cited in the file of this patent
UNITED STATES PATENTS

Number	Name	Date
1,038,915	Lyback	Sept. 17, 1912
1,762,568	Barber	June 10, 1930
1,892,881	Fuller et al.	Jan. 3, 1933
2,231,983	Zuckerman	Feb. 18, 1941
2,393,324	Joy	Jan. 22, 1946
2,446,242	Orshansky	Aug. 3, 1948
2,519,077	Schmidt	Aug. 15, 1950
2,524,206	Orendorff	Oct. 3, 1950