May 13, 1958 R. J. BRANT 2,834,125

TRENCH DIGGER

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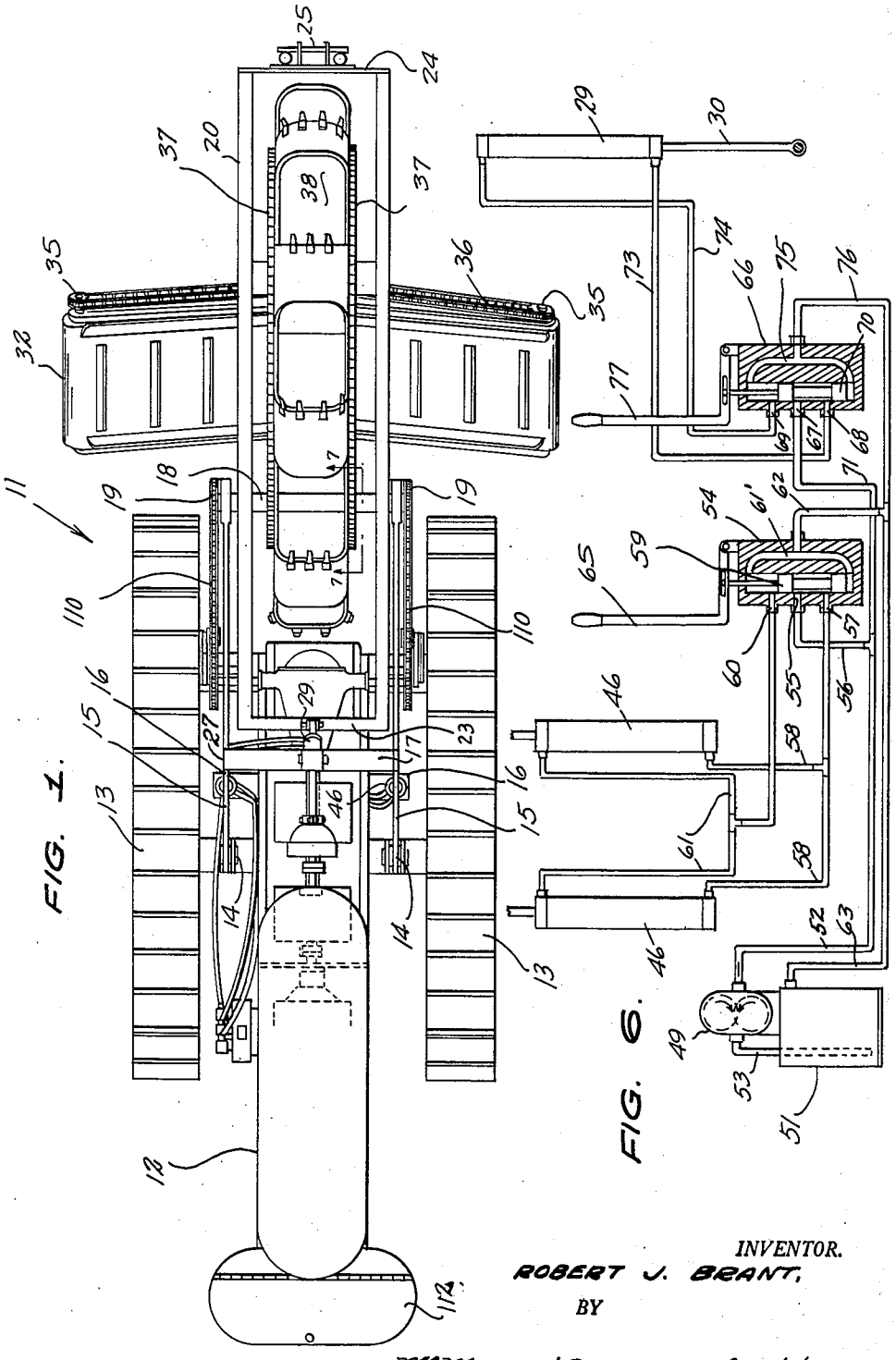


FIG. 1.

FIG. 6.

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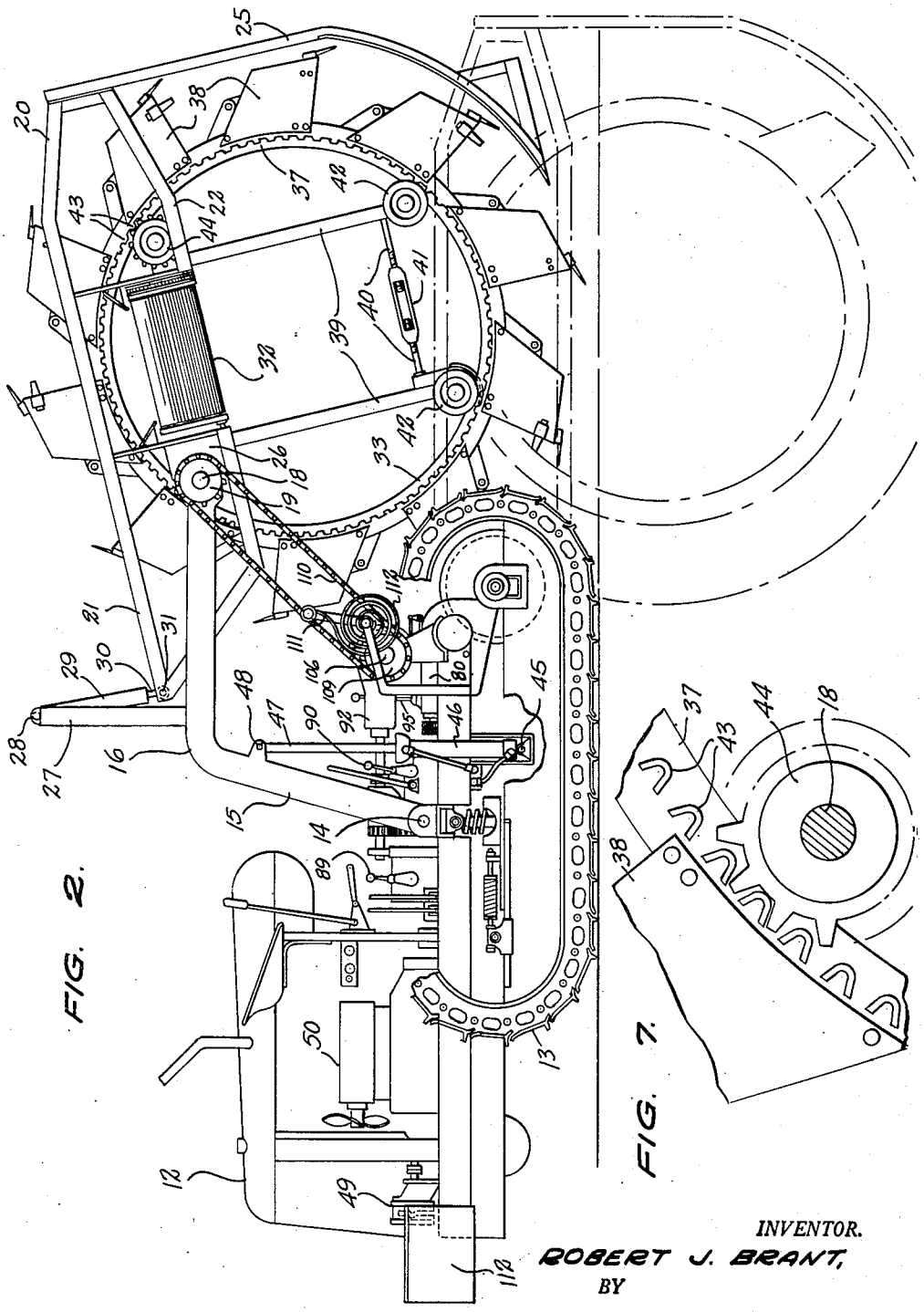


FIG. 2.

FIG. 7.

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FIG. 3.

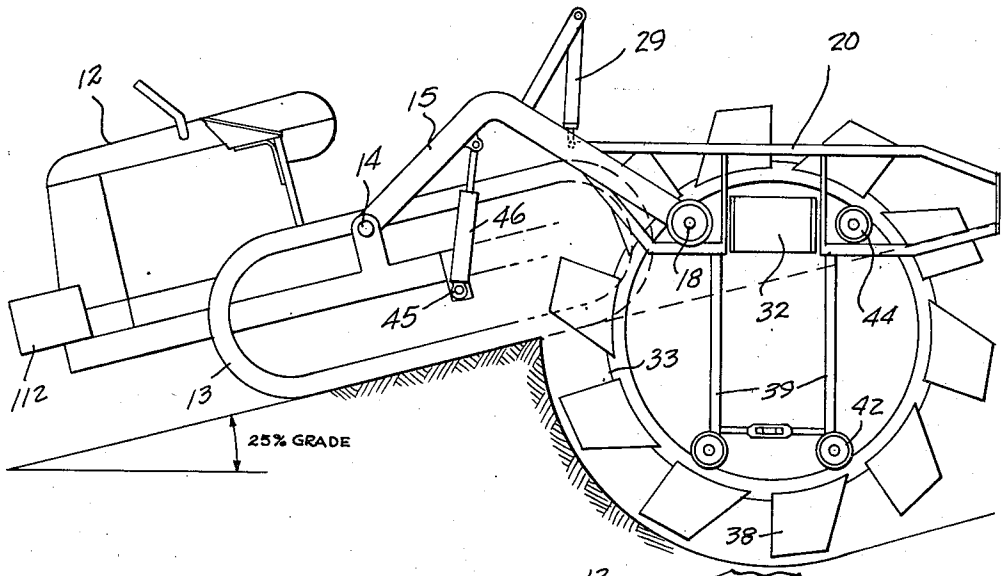
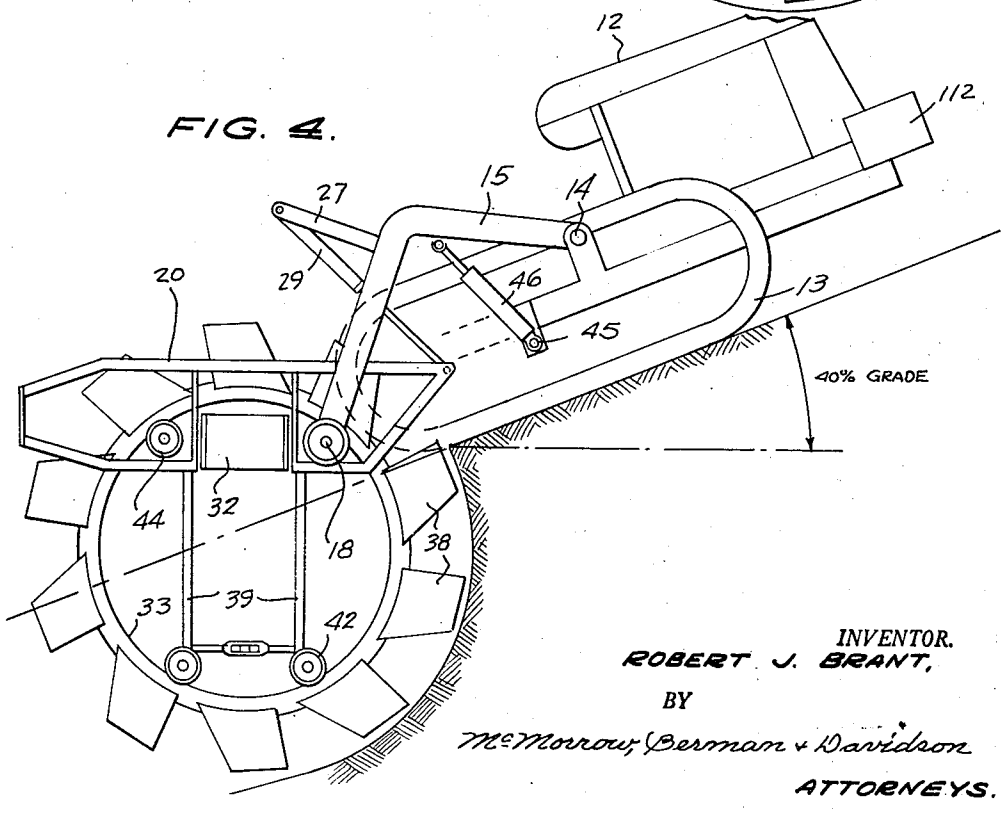


FIG. 4.



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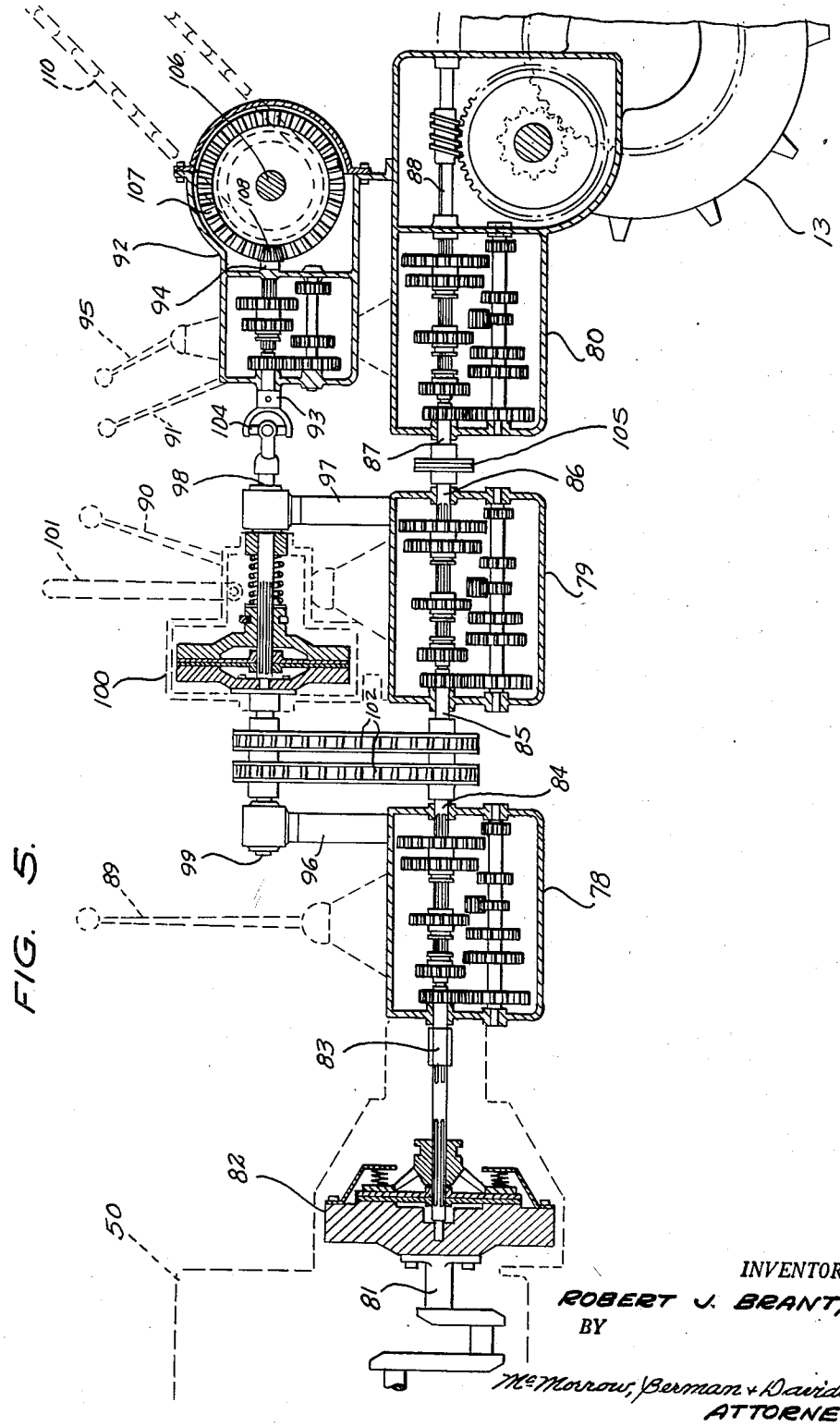


FIG. 5.

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TRENCH DIGGER

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Application January 5, 1954, Serial No. 402,255

3 Claims. (Cl. 37—97)

This invention relates to excavating machines, and more particularly to an improved tractor-mounted excavating machine for use in digging trenches, ditches, or the like.

The main object of the invention is to provide a novel and improved excavating machine which is relatively simple in construction, which is usable on relatively steep grades, as well as on level ground, and which operates with high efficiency in all types of soils.

A further object of the invention is to provide an improved digging wheel attachment for a tractor, whereby the tractor may be employed for excavating trenches, ditches, and the like, the attachment involving relatively inexpensive components, being rugged in construction, being easy to manipulate in accordance with the different operating conditions and in accordance with the desired depth of trench or ditch to be excavated, and being provided with speed regulating means for providing any one of a large number of different forward speeds of the tractor, as well as any one of a number of different speeds of the digging wheel.

A still further object of the invention is to provide an improved excavating machine which may be mounted on a conventional tractor with only a few alterations, the improved machine being arranged to provide selection of any one of a large number of different forward speeds of the tractor ranging from a speed of approximately 18 inches per minute to the top speed of the tractor, and the device being provided with means for regulating the speed of the digging wheel to afford a selection of four or more speeds in a high range and a selection of four or more speeds in a low range.

A still further object of the invention is to provide an improved digging machine adapted to be adjustably mounted on a tractor and being provided with hydraulic means for adjusting the machine in accordance with the steepness of the grade on which the machine is operating as well as in accordance with the direction of movement of the machine on the grade, the machine being provided with conveyor means for moving the excavated soil laterally so that it can be received in a truck or other vehicle, the machine including means for keeping the conveyor level regardless of the angle of the grade on which the machine is operating.

A still further object of the invention is to provide an improved machine for excavating trenches and the like, the machine being arranged so that the digging action of its excavating member does not depend upon the weight of the excavating member, as in digging machines of the prior art, but is controlled by the force of the weight of the tractor transmitted to the digging element through hydraulic link means, said link means being also employed to regulate the depth of penetration of the digging element into the soil, whereby the over-all length of the machine is relatively small and whereby the machine is relatively light in weight relative to its digging capacity.

Further objects and advantages of the invention will become apparent from the following description and

claims, and from the accompanying drawings, wherein:

Figure 1 is a top plan view of an improved trench digging machine constructed in accordance with the present invention.

Figure 2 is a side elevational view, with parts broken away, of the machine illustrated in Figure 1.

Figure 3 is a side elevational view showing the machine operating downwardly along a twenty-five percent grade.

Figure 4 is a side elevational view of the machine, shown operating upwardly along a forty percent grade.

Figure 5 is a longitudinal vertical cross sectional view taken through the transmission unit of the excavating machine of Figures 1 and 2.

Figure 6 is a schematic view of the hydraulic system employed in the machine of Figures 1 and 2.

Figure 7 is an enlarged cross sectional detail view taken on the line 7—7 of Figure 1 and showing the engagement of one of the driving pinions with the gear teeth on a digging wheel element.

Referring to the drawings, **11** generally designates a trench digging machine according to the present invention. The machine comprises a tractor **12** which may be of any suitable type, for example, may be of the track-laying type having the endless flexible traction elements **13, 13**. Pivoted at **14, 14** to the opposite sides of the tractor frame and extending substantially longitudinally relative to the tractor are the arms **15, 15**, said arms being bent at **16**, as shown in Figure 2, and being connected together by the transverse bar element **17** adjacent the bends **16**, as shown in Figure 1.

Designated at **18** is a transverse shaft rotatably mounted in the ends of the arms **15** and having the respective sprocket wheels **19, 19** secured to the respective opposite ends thereof, outwardly adjacent the ends of the respective arms **15, 15**.

Designated generally at **20** is a frame which is rotatably mounted on the shaft **18** between the arms **15, 15**, said frame comprising a superstructure having the top longitudinal elements **21**, the lower longitudinal elements **22**, the forward transverse connecting member **23**, the rear transverse connecting member **24**, and the depending rear, furrow-engaging member **25**. Rigidly secured on the lower longitudinal members **22** are the vertical plate elements **26** through which the shaft **18** extends, the plate elements **26** being suitably journaled on the shaft **18** to support the frame **20**.

Rigidly secured on the transverse bar member **17** is the upstanding post element **27**. Pivoted at **28** to the top end of the post member **27** is the hydraulic cylinder **29** having the piston rod **30** which, in turn, is pivotally connected to the intermediate portion of the transverse bar member **23** of frame **20**, the pivotal connection being shown at **31**. The hydraulic cylinder **29** and its piston **30** define an adjustable link connecting the forward end of the frame **20** to the top end of the post member **27**, and hence to the side arms **15, 15**.

Designated at **32** is a belt conveyor mounted on the frame **20** and being located within a circular digging wheel structure **33** which is rotatably supported on said frame for rotation around a transverse axis, as will be presently described. As shown in Figure 1, the conveyor **32** extends laterally substantial distances on opposite sides of the frame **20** and is provided with suitable driving means, such as suitable hydraulic motors, not shown, mounted in the frame of the conveyor and drivingly connected to the drive shafts **35, 35** located at the opposite ends of the conveyor, the shafts **35, 35** being coupled together by a sprocket chain **36** so that the said shafts are synchronously driven. The hydraulic motors, or other driving means employed to operate the driving shafts **35, 35** are preferably independently controlled by conventional means, not shown, whereby the speed of the

belt conveyor 32 may be controlled independently of the speed of rotation of the digging wheel structure 33, so that the speed of movement of the conveyor belt may be regulated in accordance with the type of soil being excavated, the speed being greater for soft soil than for relatively hard soil, whereby the soil may be transported laterally from the digging wheel as rapidly as it is excavated thereby.

It will be understood that the soil conveyed by the belt conveyor 32 will be deposited in a truck or other vehicle disposed subjacent to the end of the conveyor.

The digging wheel structure 33 comprises the circular wheel members 37, 37 which are rigidly connected together by the spaced digging buckets 38 located on and rigidly secured to the peripheral portions of the wheel elements 37, 37 and projecting outwardly therefrom, as shown in Figure 2. The frame 20 includes the strut elements 39 which are adjustably connected together by the rods 40 and turnbuckles 41 connecting said rods, as shown in Figure 2, the struts 39 having the rollers 42 journaled to their lower ends, said rollers being peripherally grooved to receive the inner peripheries of the respective wheel elements 37, 37. The respective wheel elements 37, 37 are formed with the inwardly directed, regularly spaced gear teeth 43 which mesh with respective pinion gears 44 journalled to the frame 20 at opposite sides of the conveyor 32. A pair of such pinion gears 44 is rigidly secured on the shaft 18, thus coupling the wheel elements 37 to said shaft so that rotation of the shaft 18 drives the digging wheel structure 33. At the same time, the frame 20 is rotatable relative to the shaft 18, whereby the position of the conveyor belt 32 may be adjusted by means of the hydraulic cylinder 29 to maintain the conveyor belt level at all times.

Pivoted to the respective sides of the tractor frame at 45 are respective hydraulic jack cylinders 46, said cylinders having the piston rods 47 which are pivotally connected at their top ends to the respective arms 15, as shown at 48, whereby the arms 15 may be raised or lowered by means of the hydraulic jack cylinders 46, as will be presently described. Thus, the elevation of shaft 18 and the digging wheel structure 33 rotatably supported on and drivingly coupled to said shaft may be controlled by means of the hydraulic jack cylinders 46.

Designated at 49 is a hydraulic pump which is drivingly coupled to the tractor engine 50, the pump 49 being in communication with a reservoir 51 containing oil or other suitable hydraulic fluid. Designated at 52 is the outlet conduit of said pump and designated at 53 is the return conduit thereof. Mounted on the tractor is a three-way control valve 54 having an inlet port 55 which is connected to the conduit 52 by a conduit 56, as shown in Figure 6. The valve 54 has a lower outlet port 57 which is connected to the lower ends of the cylinders 46, 46 by respective conduits 58, 58 and which may be placed in communication with the fluid inlet port 55 when the valve element 59 is in its lowered position, such as shown in Figure 6. The valve 54 has the upper outlet port 60 which is connected by conduits 61, 61 to the top ends of the cylinders 46, 46. When the valve member 59 is in its lowered position, shown in Figure 6, the port 60 is in communication with a return passage 61' in the valve 54, said return passage being connected by a conduit 62 to the fluid return conduit 63 leading to the reservoir 51. Thus, with the valve element 59 in the lowered position shown in Figure 6, fluid under pressure will be admitted to the lower ends of the cylinders 46, 46, causing the pistons 47 to be elevated, whereby the arms 15 and the digging wheel structure 33 will be elevated. Conversely, when the valve element 59 is raised, as by rotating the valve operating handle 65 clockwise from the position shown in Figure 6, the upper port 60 will be placed in communication with the fluid inlet port 55 and the lower port 57 will be placed in communication with the fluid return passage 61'. This will cause hydraulic fluid under pressure to be admitted into the top ends of the cylinders 46, 46 and will allow hydraulic fluid to discharge from the lower ends of said cylinders, causing the piston rods 47 to be lowered, and thus causing the arms 15 and the digging wheel structure 33 to be similarly lowered.

Designated at 66 is a second three-way valve having the fluid inlet port 67, the lower port 68 and the upper port 69. When the movable valve element 70 is in its lowered position, shown in Figure 6, the fluid port 68 is connected to the port 67. Port 67 is connected by a conduit 71 to the conduit 52. Port 68 is connected by a conduit 73 to the lower end of the cylinder 29. Port 69 is connected by a conduit 74 to the upper end of the cylinder 29. Valve 66 is provided with the return passage 75 which is connected by a conduit 76 to the return conduit 63. When the valve element 70 is in its lowered position, shown in Figure 6, hydraulic fluid under pressure will be delivered from the port 67, through the port 68 and the conduit 73, to the lower end of the cylinder 29. Hydraulic fluid will discharge from the upper end of said cylinder through the conduit 74, the port 69, the return passage 75 and the conduit 76 to the return conduit 63, whereby the return fluid is delivered to the reservoir 51. This causes the piston rod 30 to be elevated, whereby the frame 20 will be rotated clockwise, as viewed in Figure 2. To rotate the frame counterclockwise, as viewed in Figure 2, the valve operating handle 77, linked to the valve element 70, is rotated clockwise, as viewed in Figure 6, to elevate the valve element 70, reversing the direction of the hydraulic fluid in the conduits 73 and 74, and causing hydraulic fluid under pressure to enter the conduit 74, and thus to enter the top end of the cylinder 29, while at the same time hydraulic fluid is discharged from the lower end of the cylinder 29 into the return passage 75, and thence to the return conduits 76 and 63. When the piston rod 30 is lowered, the frame 20 is rotated counterclockwise, as viewed in Figure 2.

From the above it will be seen that the operating levers 65 and 77, associated with the valves 54 and 66 mounted on the tractor provide a means whereby the operator of the tractor may regulate the raising and lowering of the digging wheel structure 33, and at the same time the angle of elevation of the conveyor 32.

Thus, the raising and lowering of the digging wheel structure 33 is controlled by the valve operating handle 65, whereby the digging wheel structure 33 may be moved to a desired position. In order to level the conveyor 32 the valve operating handle 77 may be manipulated to properly adjust the position of frame 20 to adjust the conveyor to a horizontal position.

Referring now to Figure 5, it will be seen that the tractor is provided with three serially arranged, conventional multiple-ratio transmission sections, shown at 78, 79 and 80, for example, each having four forward speed ratios. The crankshaft 81 of the engine 50 is connected through the conventional clutch 82 to the input shaft 83 of the first transmission section 78. The output shaft 84 of the first section is directly coupled to the input shaft 85 of the second section 79, and the output shaft 86 of the second section 79 is directly coupled to the input shaft 87 of the third section 80. The output shaft of the third section 80 is connected directly to the differential input shaft 88 which is conventionally coupled to the traction means 13 of the tractor. Each of the multiple-ratio transmission sections 78, 79 and 80 is provided with the usual gear shift lever, the levers being shown at 89, 90 and 91 in dotted view in Figure 5, whereby the speed of the tractor may be controlled over a wide range of different values, depending upon the positions of the gear shift levers 89, 90 and 91. The combinations of different ratios provided by the three serially arranged transmission units 78, 79 and 80 thus provide a selection of tractor speeds ranging from a low speed of the order of 18 inches per minute to the top speed of the tractor.

Mounted on the tractor frame is an additional multiple-

ratio transmission unit **92** for example, a unit having four forward speed ratios, said unit having the input shaft **93** and the output shaft **94**, the selection of speed ratios being controlled by the operation of the transmission gear shift lever **95**, shown in dotted view in Figure 5. Suitably journaled in the top portions of upstanding supports **96** and **97** secured on the transmission units **78** and **79** are respective shaft elements **99** and **98** which are coupled together by a conventional clutch **100**, said clutch being controlled by the clutch handle **101**. The shaft **99** is drivingly coupled to the transmission shafts **84** and **85** between the first and second transmission units **78** and **79**, as by sprocket chains **102** engaging sprocket wheels on the shafts **84—85**, as illustrated in Figure 5, whereby the shaft **99** is driven by the intermediate transmission shafts **84** and **85** between the first transmission section **78** and the second transmission section **79**. The shaft **98** is connected to the input shaft **93** of the auxiliary transmission unit **92** by a universal joint **104**, as shown in Figure 5, thus allowing relative movement between the transmission unit **92** and the transmission units **78** and **79**. It will be also observed from Figure 5 that the output shaft **86** of transmission unit **79** is coupled to the input shaft **87** of the transmission unit **80** by a flexible coupling **105** which allows small relative angular movements of the shafts **86** and **87**.

The auxiliary transmission unit **92** includes a differential comprising respective transverse shafts **106** each having a large beveled gear **107** secured thereon which is in mesh with a pinion gear **108** carried on the shaft **94**, whereby the shafts **106** are driven by the output shaft **94** of the transmission unit **92**. Secured on each shaft **106** externally of the housing of the transmission unit **92** is a sprocket wheel **109** which is coupled to a respective sprocket wheel **19** by a sprocket chain **110**.

As shown in Figure 2, each sprocket chain **110** is tensioned by a tension arm **111** pivoted to the tractor frame in any suitable manner and biased upwardly by a spiral spring **112** having its outer end connected to the end of the tensioning arm **111** and having its inner end anchored to the tractor frame, the end of the tensioning arm bearing against the upper portion of the sprocket chain **110** and exerting tensioning force on said chain, as will be readily apparent from Figure 2.

In operation, the traction element **13** of the machine is driven at a selected rate of speed from the engine **50** through the serially arranged multiple-ratio transmission units **78**, **79**, and **80**. At the same time the sprocket chains **110** are driven at a selected speed through the multiple-ratio transmission units **78** and **92**, assuming the clutch **100** to be in engaged position whereby torque is transmitted from shaft **99** to shaft **98**. This rotates the shaft **18**, causing the digging wheel structure **33** to be rotated clockwise, as viewed in Figure 2, whereby the digging buckets **38** penetrate into the soil to an increasing depth as the digging action continues, assuming the digging wheel **33** to be lowered to ground-engaging position, and whereby the excavated soil is elevated by the buckets **38** and is deposited on the moving belt of the conveyor **32** continuously. The excavated soil is moved laterally on the moving conveyor belt and is deposited into a truck or other vehicle disposed subjacent the end of the conveyor belt, as above described.

As shown in Figure 3, the machine may be employed on a downward grade, the machine moving downwardly along the grade, whereby the trench is excavated in a downward direction. Similarly, the machine may be employed to excavate along an upward grade, as shown in Figure 4.

The tractor may be suitably counter-weighted to counter-balance the weight of the digging wheel structure **33** and the other elements associated with the digging attachment, as by the provision of a receptacle **112** on the end of the tractor opposite the digging attachment, said receptacle being employed to receive suitable weights, tools, or other heavy items.

From the above it will be apparent that the digging wheel structure may be raised and lowered by hydraulic jack cylinders **46**, which are in turn controlled by the valve operating lever **65**. It will also be apparent that the cylinders **46** govern the digging pressure and may be employed to force the digging wheel bucket elements **38** into the ground with a maximum pressure equal to that which can be developed by the weight of the tractor. It is apparent that the maximum grades which can be worked by the machine can be increased by suitably increasing the length of the hydraulic cylinders **46**, whereby the range of angular movement of the arms **15**, **15** may be accordingly increased.

The digging wheel elements **37**, **37** are preferably solid castings, eliminating the necessity for welding separate segments together, reducing irregularities, minimizing wear, and obtaining smoother operation than has been heretofore obtained with welded digging wheel elements.

The hydraulic motors, not shown, which drive the conveyor shaft **35** are of conventional construction and are preferably operated by the tractor engine **50**, through suitable hydraulic pump means. As above explained, the speed of the conveyor belt can be thus adjusted to the needs of the digging operation. For example, in soft soil, the speed of the belt may be accelerated to handle the increased amount of soil deposited on the conveyor belt by the digging buckets **38**.

While a specific embodiment of an improved excavating machine has been disclosed in the foregoing description, it will be understood that various modifications within the spirit of the invention may occur to those skilled in the art. Therefore, it is intended that no limitations be placed on the invention except as defined by the scope of the appended claims.

What is claimed is:

1. In combination, a tractor, a pair of arms pivoted at their ends to opposite sides of the tractor and extending upwardly and longitudinally thereof, a transverse shaft mounted in the opposite ends of said arms, upstanding means rigidly connecting the intermediate portions of said arms, a frame rotatably mounted on said shaft between said arms and having an end portion extending subjacent the top of said upstanding means, link means connecting said frame portion to the top of said upstanding means, a digging wheel rotatably supported on the intermediate portion of said frame for rotation around a transverse axis, said wheel being provided with digging buckets on its periphery, a belt conveyor mounted on said frame within and transverse to said wheel, jack means connected between the tractor and said arms for raising and lowering said arms, and means on the tractor drivingly coupled to said digging wheel and arranged to rotate said digging wheel.

2. In combination, a tractor, a pair of arms pivoted at their ends to opposite sides of the tractor and extending upwardly and longitudinally thereof, a transverse shaft rotatably mounted on the opposite ends of said arms, upstanding means rigidly connecting the intermediate portions of said arms, a frame rotatably mounted on said shaft between said arms and having an end portion extending subjacent the top of said upstanding means, adjustable link means connecting said frame portion to the top of said upstanding means and arranged to vary the angular relation between said frame and said arms, a digging wheel rotatably supported on the intermediate portion of said frame for rotation around a transverse axis, said wheel being provided with digging buckets on its periphery, a belt conveyor mounted on said frame within and transverse to said wheel, jack means connected between the tractor and the portions of said arms adjacent the tractor for raising and lowering said arms, means gearingly coupling said shaft to said wheel, and means

on the tractor drivingly coupled to said shaft and arranged to rotate said shaft.

3. In combination, a tractor, a pair of arms pivoted at their ends to opposite sides of the tractor and extending upwardly and longitudinally thereof, a transverse shaft rotatably mounted on the opposite ends of said arms, upstanding means rigidly connecting the intermediate portions of said arms, a frame rotatably mounted on said shaft between said arms and having an end portion extending subjacent the top of said upstanding means, a hydraulic link connecting said frame portion to the top of said upstanding means and arranged to vary the angular relation between said frame and said arms, a digging wheel rotatably supported on the intermediate portion of said frame for rotation around a transverse axis, said wheel being provided with digging buckets on its periphery, a belt conveyor mounted on said frame within and transverse to said wheel, said conveyor extending substantial distances laterally on opposite sides of the tractor, respective hydraulic jacks connected between the tractor and the portions of said arms adjacent the tractor for

raising and lowering said arms, means gearingly coupling said shaft to said wheel, and means on the tractor drivingly coupled to said shaft and arranged to rotate said shaft.

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