

July 1, 1941.

F. E. ARNDT

2,247,464

ROAD GRADER

Filed Feb. 2, 1933

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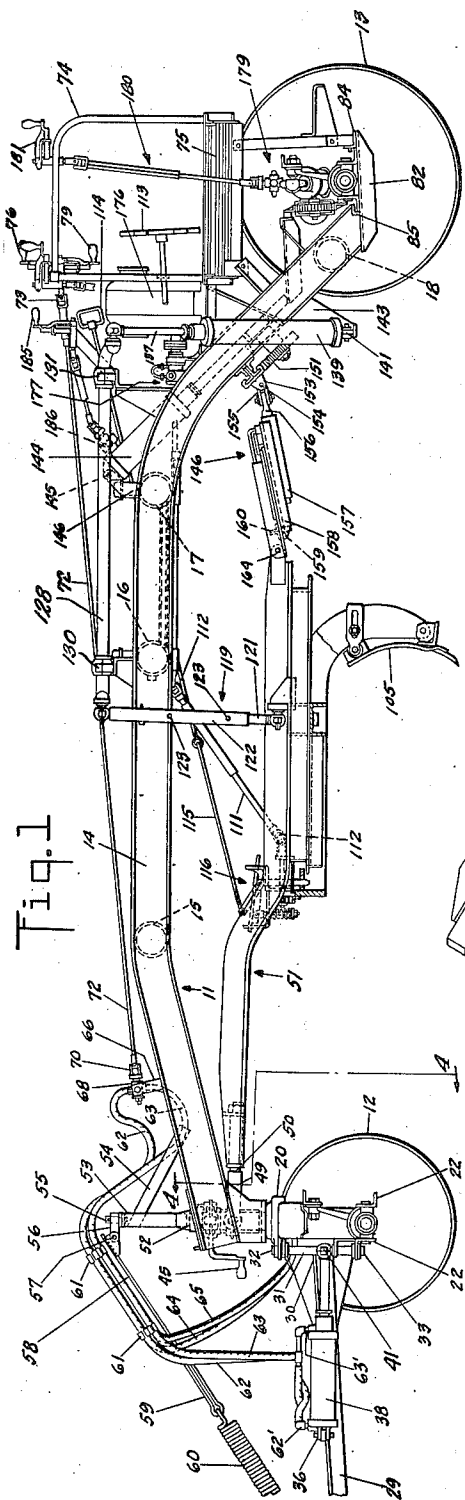


Fig. 1

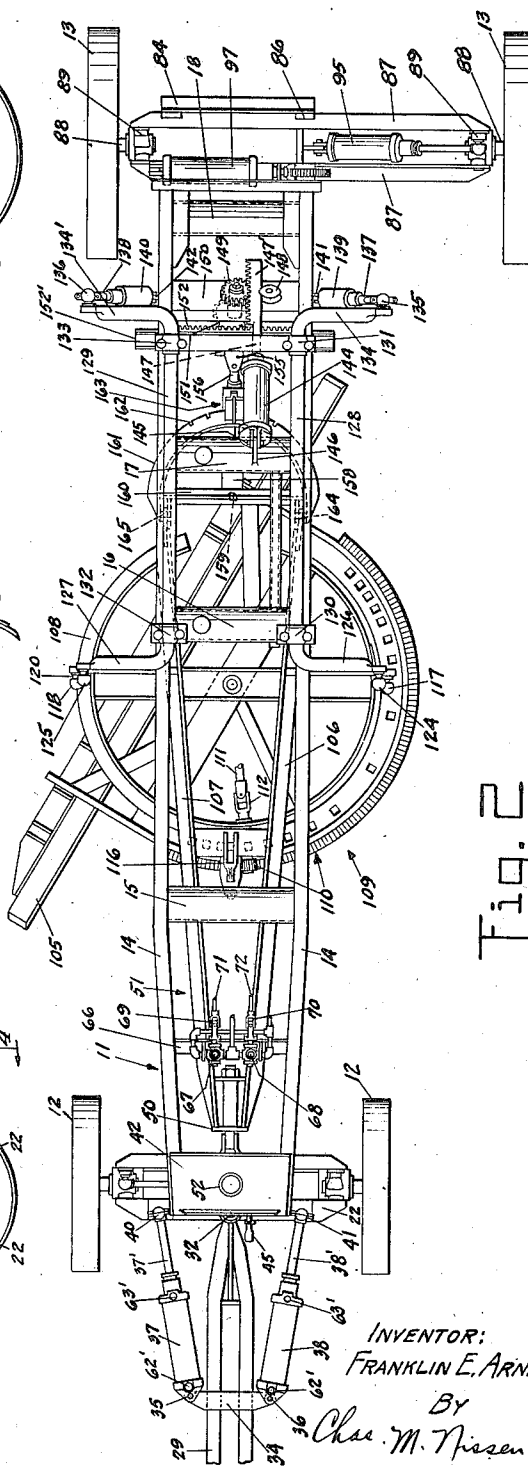


Fig. 2

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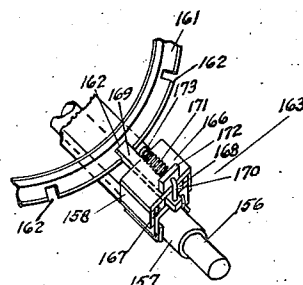
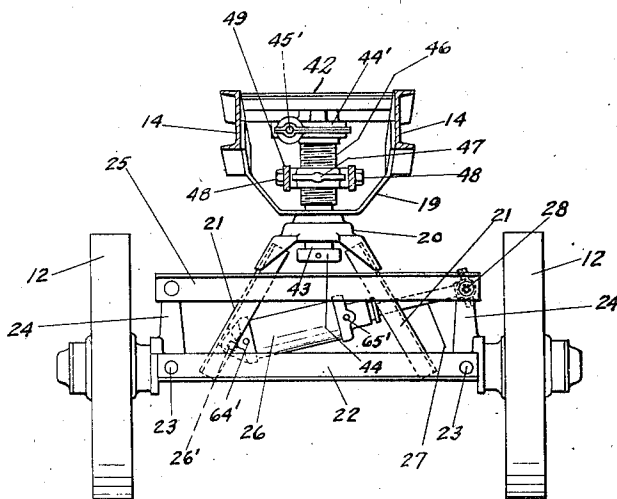
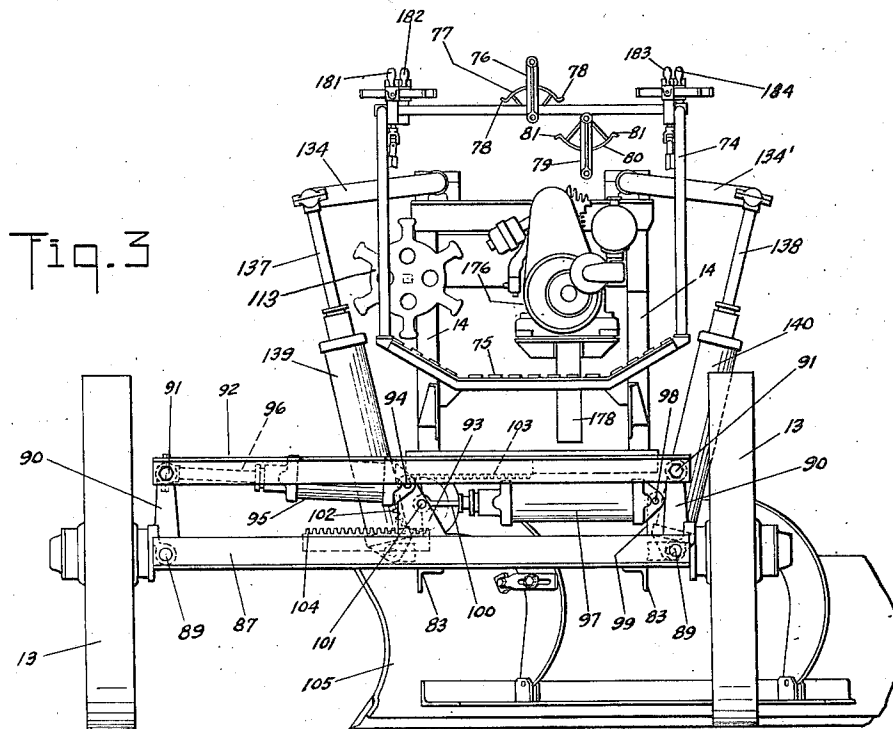
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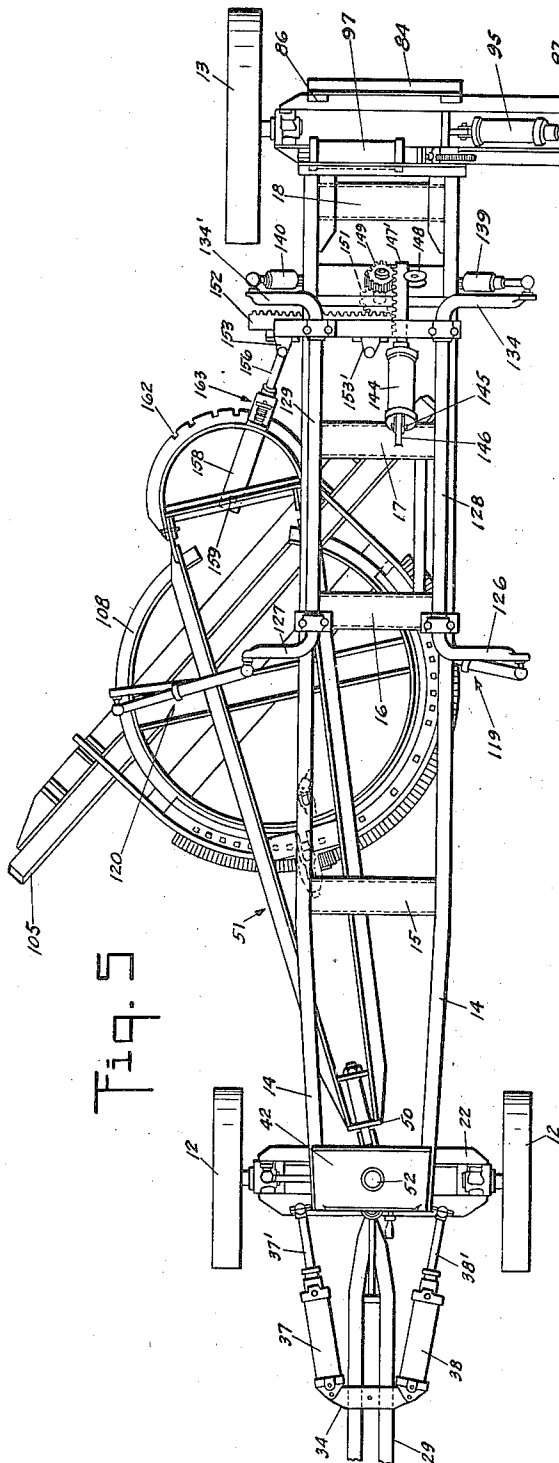


Fig. 5

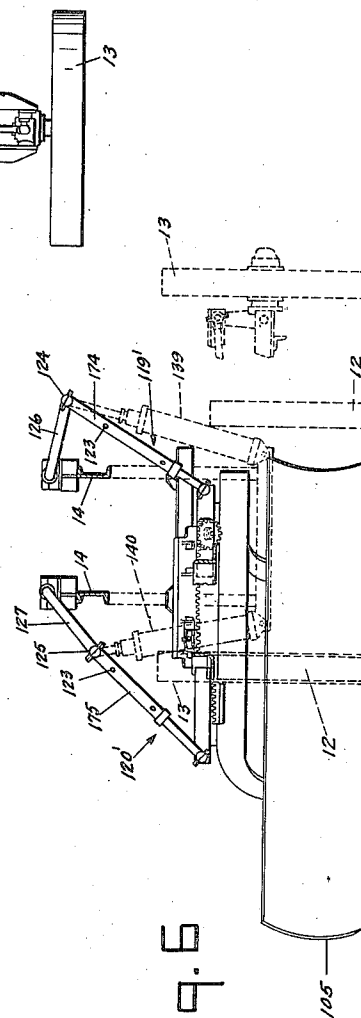


Fig. 6

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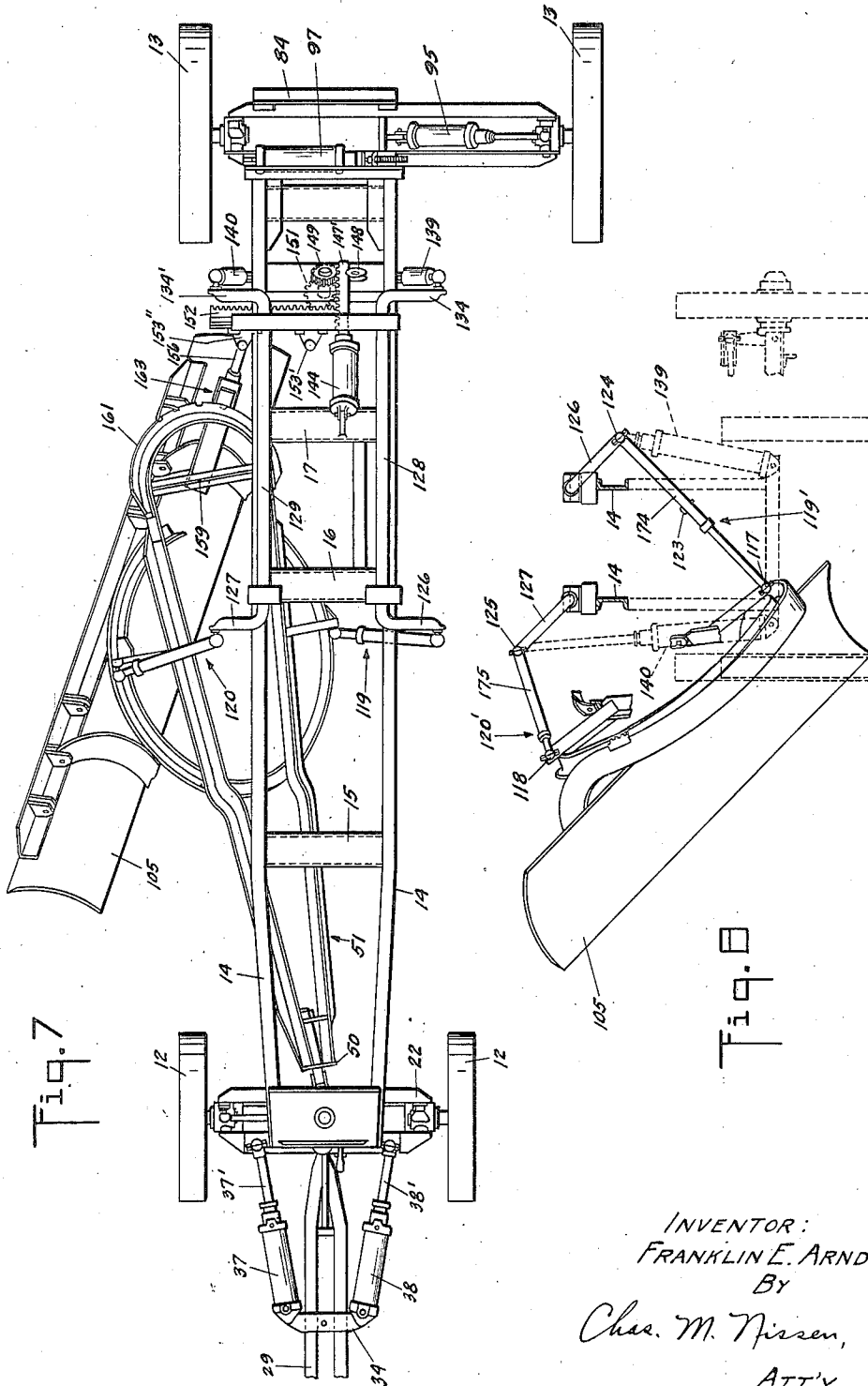
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ROAD GRADER

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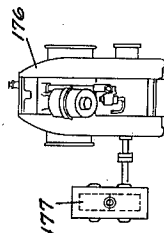
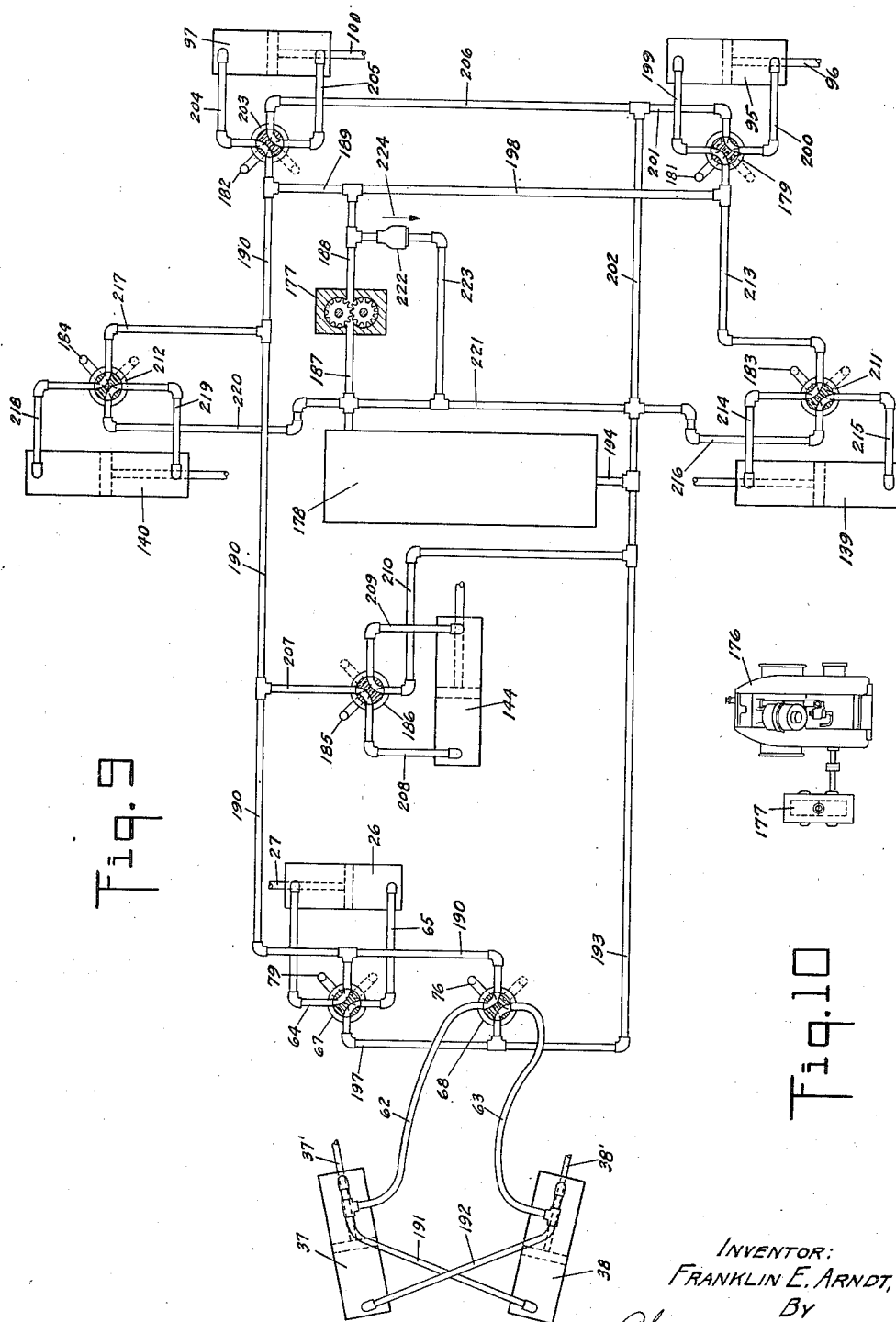
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ROAD GRADER

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5 Sheets-Sheet 5



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## UNITED STATES PATENT OFFICE

2,247,464

## ROAD GRADER

Franklin E. Arndt, Galion, Ohio, assignor to The Galion Iron Works and Manufacturing Company, a corporation of Ohio

Application February 2, 1933, Serial No. 654,901

20 Claims. (Cl. 37—156)

My invention relates to road building apparatus and one of its objects is the provision of improved and efficient fluid-pressure motor mechanism for effecting various adjustments in a road grading machine.

Another object of the invention is the provision of improved and efficient self-contained power-operated mechanism for moving a mold board in a road grading machine from a horizontal position to a high lift or bank sloping position.

A further object of the invention is the provision of improved adjustable connections between the rear end of the drawbar and the rear portion of the supporting framework in a road grading machine to enable the extent of lateral shift of the mold board to be increased.

Another object of the invention is the provision of improved connecting mechanism in a road grading machine between the drawbar and the supporting framework to strengthen the support of the mold board when operating in bank sloping position.

Another object of the invention is the provision of fluid-pressure operated mechanism for shifting a mold board laterally relatively to the supporting framework in a road grading machine.

A further object of the invention is the provision of improved fluid-pressure steering mechanism for a vehicle, particularly in a road grading machine.

Another object of the invention is the provision of improved supporting means for flexible fluid-pressure hose adjacent the steering post of the machine.

A further object of the invention is the provision of improved hydraulic mechanism for effecting the leaning of wheels in a road grading machine.

Another object of the invention is the provision of improved fluid-pressure operated mechanism for shifting the rear end of the frame of the road grader relatively to the rear wheels.

A further object of the invention is the provision of mechanism for controlling from a single station a plurality of fluid-pressure motors distributed about a road grading machine.

Another object of the invention is the provision of open framework combined with supporting and adjusting mechanism for a mold board in a road grading machine to enable the operator to view at all times the action of the mold board on the road surface.

A further object of the invention is the pro-

vision of means for varying the elevation of the front end of the drawbar in a road grading machine relative to the framework thereof to assist in adjusting the elevation of the mold board when in horizontal position and to afford ample clearance between the mold board and the framework when the mold board is moved to a bank sloping position.

Other objects of the invention will appear hereinafter, the novel features and combinations being set forth in the appended claims.

In the accompanying drawings, Fig. 1 is an elevation of a road grading machine embodying my improvements;

Fig. 2 is a plan view of the structure shown in Fig. 1;

Fig. 2<sup>a</sup> is a perspective view of the latch mechanism embodied in the connections between the rear end of the drawbar and the rear portion of the machine frame;

Fig. 3 is a rear elevation of the machine shown in Fig. 1;

Fig. 4 is an elevational view, partly in section, taken on the line 4—4 of Fig. 1 looking in the direction of the arrows;

Fig. 5 is a plan view of the machine shown in Fig. 1 with the mold board shifted to its maximum extent from one side of the machine;

Fig. 6 is a diagrammatic front elevational view of the mold board supporting mechanism shown in plan in Fig. 5;

Fig. 7 is a plan view of the road grading machine with the mold board adjusted to its bank sloping position;

Fig. 8 is a diagrammatic front elevational view of the supporting mechanism for the mold board when in bank sloping position;

Fig. 9 is a diagrammatic view of the pump and hydraulic motors and the piping therefor; and

Fig. 10 is a view representing the internal combustion engine connected to a hydraulic pump.

The machine shown in Figs. 1 and 2 comprises the vehicle frame 11 mounted on the front wheels 12, 12 and rear wheels 13, 13. The frame 11 comprises longitudinal spaced-apart beams 14, 14 which are rigidly connected by the tubular cross-pieces 15, 16, 17 and 18.

As shown in Fig. 4 the forward ends of the beams 14, 14 are connected by a U-shaped yoke 19 which rests upon a supporting frame 20 having depending channel irons 21, 21 secured at their lower ends to the axle-tree 22 on the ends of which are pivoted at 23, 23 the axles for the front wheels 12, 12. These axles are provided with vertical arms 24, 24 to the upper ends of

which is pivoted the cross-piece 25. Between one of the channel irons 21 and one of the arms 24 is pivotally connected a hydraulic motor comprising a cylinder 26 and a piston rod 27. The cylinder 26 is pivoted at 26' to one of the channel irons 21 and the piston rod 27 is pivoted at 28 to the remote vertical arm 24. As herein-after explained, the hydraulic motor comprising the cylinder 26 is double acting in that the liquid flows into and out of the cylinder on both sides of the piston therein and therefore when the leaning of the wheels 12 is adjusted, they may be locked in adjusted position by closing the valve controlling the flow of the liquid in the cylinder 26.

Figs. 1 and 2 illustrate a pull type grader having a vehicle tongue 29 secured at 30 to the vertical post 31, the upper end of which is journaled at 32 to the frame 20 and the lower end of which is journaled at 33 to the front axle-tree 22.

A cross-piece 34 secured to the tongue 29, as shown in Fig. 2, provides at its ends pivotal supports at 35, 36 for the cylinders 37, 38 of hydraulic motors comprising piston rods 37', 38', the rear ends of which are pivoted at 40, 41 to the front axle-tree 22. While in some instances one double acting hydraulic motor comprising a cylinder, a piston, and a piston rod may be employed, I prefer to use two hydraulic motors symmetrically arranged as shown in Fig. 2.

As shown in Figs. 1 and 2, a cross-plate 42 is secured to the upper sides of the forward ends of the side beams 14, 14 and secured to this plate 42 and depending therefrom is a vertical fixed bearing rod 43, the lower end of which is provided with a retaining cap 44 as shown in Fig. 4. When the hydraulic steering mechanism is operated the frame 20 turns on a vertical axis at the center of the bearing 43.

Secured to the bottom of the plate 42 concentric with the bearing rod 43 is a gear housing 44'. When the crank 45 is operated, worm gearing on shaft 45' and in the housing 44' turns the screw 46 in the nut 47 to which is pivoted at 48, 48 the yoke 49 which in turn is journaled at 50 to the front end of the drawbar 51. It will thus be seen that by turning the crank 45 the front end of the drawbar may be elevated or lowered relative to the front end of the main frame 11.

Secured to the top of the plate 42 is a socket 52 in which is mounted a vertical post 53 which may be held rigidly in vertical position by lateral braces one of which is shown at 54 in Fig. 1 secured to one of the beams 14.

To the top of the post 53 is swivelled at 55 a connecting member 56 the forward end of which is pivoted at 57 to a supporting plate 58. The forward end of the plate 58 is secured by means of the loop 59 to a spring 60 which is connected at its front end to the tongue 29. Clips 61, 61 are relied on to secure the four flexible conduits 62, 63 and 64, 65 to the plate 58. The conduits 62, 63 are connected to the ends of the cylinders 37 and 38 at 62', 62' and 63', 63'. The conduits 64 and 65 are connected to the ends of the cylinder 26 at 64', 65'.

Mounted on a cross-piece 66 on the forward portion of the frame 11 are two valves 67 and 68, the valve 67 controlling the flow of liquid in the conduits 64 and 65 and the valve 68 controlling the flow of liquid in the conduits 62 and 63. The valves 67 and 68 are connected by means of universal joints 69 and 70 to longitudinal rods 71 and 72 which extend to the rear

portion of the frame where they are connected by means of universal joints one of which is shown at 73 in Fig. 1, to operating cranks each movable along a gauge secured to the framework 74 at the operator's platform 75. The crank 76 may be connected to the rod 72 for actuating the valve 68 which controls the steering of the machine. As shown in Fig. 3 the crank 76 is associated with the gauge 77, the ends of which may be provided with limit stops 78, 78 which indicate wide open positions of the valve 68. In a similar manner the crank 79 may be connected to the rod 71 for actuating the valve 67 to control the leaning of the front wheels 12. The crank 79 may be associated with the gauge 80 which is provided with limit stops 81, 81 to indicate the wide-open positions of the valve 67.

It should be particularly understood that the leaning of the front wheels by means of the hydraulic motor mechanism shown in Fig. 4 may be taken advantage of to cooperate with the steering of the machine by means of the front wheels, to counteract the tendency of the mold-board during operation along the road surface to shift the front end of the machine sidewise. For instance, if the mold-board is in the position shown in plan in Fig. 2, the tendency will be during operation, for the front end of the machine to be shifted laterally to that side where the front end of the mold-board is located. By leaning the tops of the front wheels toward the right as viewed in Fig. 4, the lower edges of the rims of the front wheels will be in positions to dig or cut into the roadway and counteract the tendency of the mold-board to shift the front end of the machine sidewise. Furthermore, by means of the hydraulic motors 37, 38 the front wheels may be steered toward the left as viewed by the operator at the rear end of the machine and thus assist the leaning of the front wheels in counteracting the tendency of the mold-board to shift the front end of the machine sidewise. Moreover, the operator at his single station at the rear end of the machine has under his direct observation, the operation of the mold-board and the steering of the machine and the various adjustments may be made by the operator so as to effect locking of the various parts in adjusted positions including the front wheels, thereby greatly lessening the tendency of the front wheels as a unit to swerve sidewise on the vertical axis 32, the hydraulic motors 37, 38 being in very efficient positions to resist swerving of the front wheel unit on the axis 32 even when one wheel or the other rides over an obstruction or irregularity in the roadway.

Secured rigidly to the rear ends of the longitudinal beams 14 is a cross supporting structure 82 comprising angle irons 83, 83 as shown in Fig. 3 and the cross-piece 84 shown in Fig. 2. Guides are provided at 85, 86 for the transverse members 87, 87 of the rear wheel supporting frame. The axles 88, 88 for the rear wheels 13, 13 are pivoted at 89, 89 to the ends of the frame 87. Secured to the rear wheel axles are vertical crank arms 90, 90 the upper ends of which are pivoted at 91, 91 to the cross-piece 92.

A vertical bracket plate 93 is secured to the frame 87 and to its upper end at 94 is pivoted a cylinder 95 of a hydraulic motor comprising a piston rod 96 the outer end of which is pivoted at 91 to the upper end of the crank arm 90 at the left-hand side of the machine as viewed from the rear (Fig. 3). The hydraulic motor comprising the cylinder 95 is double acting in that the

liquid flows to and from the cylinder 95 on both sides of the piston therein and the controlling valve is such that when it is closed the crank arms 90, 90 will be locked in adjusted positions. The leaning of the rear wheels may therefore be adjusted by means of the hydraulic motor comprising the cylinder 95 and locked in adjusted position.

In order to shift the rear end of the frame 11 relatively to the rear wheels, a hydraulic motor comprising a cylinder 97 is pivoted at 98 to a bracket 99 which is secured to the frame 87. The piston rod 100 which is connected to the piston that moves in the cylinder 97, is pivoted at its outer end at 101 to a gear wheel 102 meshing with the rack bars 103 and 104. The upper rack bar 103 is secured to the machine frame and the lower rack bar 104 is secured to the frame 87. It can readily be seen that when the piston in the cylinder 97 is locked, the rack bars 103 and 104 are relatively stationary and therefore the gear wheel 102 is locked against rotation. The hydraulic motor comprising the cylinder 97 is double acting and controlled by valve mechanism so that when the piston rod 100 is moved relatively to the cylinder 97, the rear end of the main frame 11 will be shifted laterally relatively to the rear wheels 13, by the gear 102 rolling on the rack 104 and driving the rack 103. When the piston in the cylinder 97 is locked, the pivotal axis at 101 will be stationary relative to the cylinder 97. The rack bars 103 and 104 will not interfere at any time with the operation of the rear wheel leaning mechanism because when the vertical arms 90 are rocked in either direction the racks 103 and 104 will remain stationary.

Referring now to the road working implement comprising a mold board or scrapper 105 and the structure for supporting the same, it will be seen that the drawbar 51 comprises spaced-apart members 106 and 107 which diverge rearwardly and have secured to the rear portions thereof a supporting circular guide 108 for supporting and guiding the circle frame 109 on which the mold board 105 is mounted. By means of gearing 110 connected by shafts 111 and universal joints 112, to the wheel 113 at the operator's station, the circle 109 and the mold board 105 may be adjusted angularly relative to the path of travel of the road grading machine.

By means of the pull handle 114 connected by the rod 115 to the latch mechanism 116, the mold board may be releasably locked in adjusted angular position. The mechanism for swinging the mold board on a vertical axis to adjust the angularity thereof and the releasable latch mechanism 116, is of well-known construction but I have added thereto and combined therewith improved apparatus for shifting the mold board laterally and then upwardly to a bank sloping position or high lift position, which apparatus is self-contained and power-operated so that the actual work necessary to move the mold board to the desired adjusted positions is done by power-operated mechanism under the control of the operator.

It should be understood that the circular guide frame 108 is rigidly secured to the longitudinal members 106 and 107 of the drawbar 51 and therefore this circular frame 108 moves bodily with the drawbar and the mold board

105 moves bodily with the guide frame 108 and the drawbar 51.

To the diametrically opposite sides of the circular guide frame 108 are connected by means of universal joints 117 and 118 the lower ends of extensible hanger rods 119 and 120. Each hanger rod comprises a lower rod 121 telescoping into a pipe rod 122. Holes 123, 123 in the pipe 122 are adapted to register with the transverse hole in the rod 121 and a pin relied on to connect the rod 121 to the pipe 122 after the length of the hanger has been adjusted. While in Fig. 1 I have made provision for two different lengths of the hanger 119 it should be understood that there may be more than two holes 123 if desired.

The upper ends of the hangers 119 and 120 are connected by means of the universal joints 124 and 125 to the crank arms 126 and 127 which extend laterally from the longitudinal rockshafts 128 and 129. The rockshafts are mounted in suitable bearings 130, 131 and 132, 133 on the tops of the beams 14, 14 and spaced above the same a sufficient distance to afford ample clearance between the cranks 126 and 127 and the main frame 11 when such cranks are swung downwardly.

To the rear ends of the rockshafts 128 and 129 are connected the laterally extending crank arms 134', 134 which are connected at their outer ends by means of universal joints 135, 136 to the upper ends of the piston rods 137, 138 which extend downwardly into the cylinders 139 and 140 of hydraulic motors mounted on opposite sides of the rear portion of the frame 11 as shown in Fig. 2. The lower ends of the cylinders 139 and 140 are pivoted at 141, 142 to brackets 143 depending from the beams 14.

The hydraulic motors comprising the cylinders 139 and 140 are preferably double acting and provided with valves for controlling the flow of liquid to and from the cylinders on opposite sides of the pistons therein. Consequently when the mold board has been adjusted it may be locked in adjusted position to prevent undue vibration thereof during road working or bank cutting operations.

The mold board may be shifted laterally relatively to the frame 11 by means of the hydraulic motor comprising the cylinder 144 and the connections between the same and the rear end of the drawbar 51. The upper end of the cylinder 144 is pivoted at 145 to a bracket 146 mounted on the cross-tube 17 as shown in Figs. 1 and 2. The piston rod 147 is connected to a rack bar 147' which is guided by a roller 148 and which meshes with the pinion 149 secured to a shaft journaled in the cross-piece 150. The lower end of this shaft is secured to a gear 151 which meshes with the transverse rack bar 152. The rack bar 152 is supported by and guided along the transverse rail 152' secured to the lower sides of the beams 14 as shown in Fig. 1.

Between a pair of lugs 153 is pivoted at 154 on a horizontal axis, a clevis 155 and the latter is pivoted on an upright axis to a rod 156 which is adapted to slide in a longitudinal guide 157 on the bottom of the plate 158. The plate 158 is pivoted at 159 to the cross-piece 160 of a semi-circular frame, at the center of the arcuate member 161 thereof. This arcuate member is provided with four or more notches 162 for receiving the latch mechanism 163. The semi-circular frame comprising the cross-piece 160

and the arcuate member 161, is pivoted at 164, 165 to the rear ends of the members 196 and 107 of the drawbar 51.

The latch mechanism 163 is shown in perspective in Fig. 2<sup>a</sup>. On top of the rear end of the plate 158 is secured a guide frame 166 comprising fixed guide blocks 167, 168 along which is guided the latch 169 for movement into one of the notches 162. A handle 170 is secured to the rear end of the latch 169 and by grasping this handle and moving it rearwardly against the action of the spring 171 the latch 169 may be released from the notch 162. The handle 170 is connected to a rod which extends forwardly through the bracket 172 mounted on top of the frame 166, and a collar 173 on the outer end of the rod holds the spring 171 in the position shown in Fig. 2<sup>a</sup>.

It should be understood that no labor need be exercised by the operator in shifting the mold board laterally. The latch 169 may be easily released manually by pulling the handle 170 rearwardly. Then by operating the hydraulic motor comprising the cylinder 144, the latch mechanism may be moved transversely of the frame of the machine until the latch 169 is snapped into the next notch by the spring 171. By again releasing the latch the rack bar 152 may be shifted by hydraulic power until the latch snaps into the last notch, whereupon the rear end of the drawbar will be rigidly connected to the rack bar 152. Then upon reversing the hydraulic motor comprising the cylinder 144, the latch mechanism will effect movement of the mold board laterally to its maximum extent when the piston in the cylinder 144 reaches the limit of its stroke. The hydraulic motor 144 being double acting, the shifting gearing will be locked in adjusted position when the valve connected to the cylinder 144 is closed. The connections between the rear end of the drawbar and the hydraulic motor 144 are such as to securely hold the mold board in adjusted lateral position. It should be understood that the mold board by reason of the plurality of the notches 162 may be adjusted to a corresponding plurality of lateral positions on either side of the frame of the machine.

Fig. 5 is a plan view of the road grader with the mold board adjusted to one of its extreme lateral positions while horizontal, as shown in Fig. 6, the latter being a diagrammatic front elevational view to show the relative positions of the front and rear wheels when adjusted as shown in Fig. 5 and the relative positions of the hangers and the front crank arms 126 and 127. As shown in Fig. 6 the tubular member 174 may be longer than the tubular member 175 so that the hangers 119' and 120' may be extended to different lengths to facilitate lateral shifting of the mold board while in horizontal position, as well as to facilitate movement of the mold board to bank cutting position as shown in Fig. 8.

In Figs. 5 and 7 I have shown two pairs of lugs 153' and 153'' secured to the rack bar 152 near the ends of the latter. When the mold board is about to be shifted to the right-hand side of the machine as shown in Fig. 5 the slide rod 156 is connected to the lugs 153'', whereas if the mold board is about to be shifted to the left-hand side of the machine, the slide rod 156 is connected to the lugs 153'. This adjustment may easily be made by releasing the latch 163 and swinging the plate 158 on its pivot 159, it being understood that all of the labor necessary

to shift the mold board laterally is performed by the hydraulic motor 144.

Inasmuch as it is desirable to use the shorter tube 175 on that side of the machine to which the mold board is shifted, and the longer tube 174 on the opposite side, as shown in Fig. 6, these tubes may be detachable at the universal joints 124 and 125 and therefore are interchangeable. For instance, the tubes 174 and 175 may be exchanged when the mold board is to be moved to the left-hand side of the machine and then up to bank sloping position.

After shifting the mold board to its extreme lateral position such as that shown in Fig. 5, the latch 163 is retained in position and the hydraulic motor 144 is locked. By releasing the pins in the tubes 174 and 175, the crank arms 126 and 127 may be adjusted by the hydraulic motors 139 and 140 until the hangers 119' and 120' are adjusted to the desired lengths and the pins 123 re-inserted to hold the hangers at the adjusted lengths. Then by operating the motors 139 and 140 in opposite directions the crank arms 126 and 127 may each be rotated in an anti-clockwise direction as viewed from the operator's station. Each motor is independently controlled so that the crank arm 126 may be moved through a small angle from the position shown in Fig. 6 to the position shown in Fig. 8 and the crank arm 127 may be moved through a larger angle from the position shown in Fig. 6 to the position shown in Fig. 8, whereupon the motors 139 and 140 may be locked to co-operate with the drawbar and the connections between the rear end of the drawbar and the machine or vehicle frame, to hold the mold board in rigid adjusted position relative to the machine frame. This position is preferably such as to direct the material that is cut from the bank, to the space between the paths of travel of the rear wheels, as shown in Fig. 8. However, the mold board may be shifted to a still higher position to direct the material outside of the path of the adjacent rear wheel.

The internal combustion engine 176 and the pump 177 to which it is connected, are mounted on suitable supporting framework at the rear end of the beams 14, 14, as shown in Figs. 1 and 3. The fluid-pressure medium such as oil is drawn from the supply tank 173 by the pump 177 and forced through the various pipes or conduits shown in Fig. 9. The valves for the respective hydraulic motors are each located adjacent the same and operated by connections extending to operating levers within reach of the operator on the platform 75 at the rear end of the machine. The rear leaning wheel motor 85 is provided with a valve 179 operable by the connections 180 to the actuating lever 181 (Fig. 1). In a similar manner the rear shifting motor 97 may be controlled by a valve 203 connected to the operating lever 182 (Fig. 3). The operating levers 183 and 184 are similarly connected to valves 211, 212 which control the mold board tilting motors 139 and 140. By means of the lever 185 and the connections between the same and the valve 186, the drawbar shifting motor 144 may be controlled.

The operation of the various adjustments by means of the hydraulic motors may best be understood by referring to the piping diagram in Fig. 9. When the vehicle tongue 29 is in its central position shown in Fig. 2 and it is desired to turn the front axle-tree 22, the motors 37 and 38 are operated in opposite directions. By means of the lever 76 (Fig. 3) the valve 68

may be moved to its full line position shown in Fig. 9.

The engine 176 is intended to be operated to continuously drive the pump 177. Liquid will be withdrawn from the supply tank 178 through the suction pipe 187 by the pump 177, and forced by the latter through the conduits 188, 189, 190, through the valve 68 into the pipe 62 and thence into the steering cylinder 37 back of the piston therein, and through the pipe 191 into the steering cylinder 38 ahead of the piston therein. When the pistons in the cylinders 37 and 38 move in opposite directions, liquid will be forced therefrom through the conduits 192 and 63 and thence through the valve 68 into the pipes 193, 194, back to the supply tank 178. When the valve 68 is closed the pistons in the cylinders 37 and 38 will be locked against movement in either direction. When the valve 68 is moved to its dotted line position the flow to and from the cylinders 37 and 38 will be reversed and consequently the front axle-tree 22 will be turned in the opposite direction.

By means of the lever 79 (Fig. 3) the valve 67 may be opened to the full line position shown in Fig. 9, whereupon liquid will be forced from the pipe 190 through the valve 67 into the pipe 64 and thence into the front wheel leaning cylinder 26 on that side of the piston therein to which the piston rod 27 is connected. The piston will move to draw inwardly the piston rod and the liquid will be forced out of the rear end of the cylinder 26 into the pipe 65 and through the valve 67 into the pipe 197 and thence through the pipes 193 and 194 back to the tank 178. By moving the valve 67 to its dotted line position the operation of the motor 26 may be reversed. By closing the valve 67 the piston rod 27 will be locked in adjusted position against movement in either direction. By means of the motor 26 the leaning of the front wheels 12 may be adjusted and locked in adjusted position.

The leaning of the rear wheels 13 is adjusted by means of the motor 95 which is controlled by the valve 179 to which the lever 181 (Figs. 1 and 3) is connected. When the valve 179 is in its full line position as shown in Fig. 9 liquid will be forced from the pump through the pipe 198 and valve 179 into the pipe 199 back of the piston in the cylinder 95. At the same time the liquid flows from the front end of the cylinder 95 through the pipe 200, valve 179 and pipes 201 and 202, back to the tank 178.

The motor 97 for shifting the rear end of the machine frame relatively to the rear wheels, is controlled by the valve 203 to which the lever 182 is connected. When the valve 203 is in its full line position as shown in Fig. 9 liquid will be forced through the valve into the pipe 204 and the cylinder 97, back of the piston therein. At the same time liquid flows from the cylinder into the pipe 205, valve 203 and pipes 206 and 202, back to the tank 178. Both of the valves 179 and 203 may be moved to their respective dotted line positions to reverse the motors controlled thereby and each motor may be locked in adjusted position by closing its controlling valve.

The mold board shifting motor 144 is controlled by the valve 186 to which the actuating lever 185 (Fig. 1) is connected. When this valve is in its full line position liquid will be forced from the pipe 190 into the pipe 207, the valve 186 and the pipe 208, into the cylinder 144, back of the piston therein. At the same time the liquid will be forced from the other end of the cyl-

inder 144 into the pipe 209, through the valve 186 into the pipe 210, and thence back to the tank 178.

The lifting hangers are operated by the motors 139 and 140 to which are connected the controlling valves 211 and 212 respectively actuated by the levers 183 and 184. When the valve 211 is in its full line position liquid will be forced from the pipe 198 into the pipe 213 and through the valve 211 into the pipe 214 and thence into the cylinder 139 ahead of the piston therein. At the same time liquid will be forced out of the rear end of the cylinder 139 into the pipe 215 and through the valve 211 into the pipe 216 back to the tank 178.

In a similar manner when the valve 212 is in its full line position liquid will flow from the pipe 190 into the pipe 217 and through the valve 212 into the pipe 218, and into the cylinder 140 back of the piston therein. At the same time the liquid flows from the piston 140 into the pipe 219 and through the valve 212 into the pipe 220 which is connected to the suction pipe 187. When the valves 211 and 212 are moved to their dotted line positions the motors 139 and 140 may be reversed and when these valves are closed both motors are locked.

It should be particularly noted that the supply side of the pump 177 is connected directly to each of the hydraulic motors. With respect to the pump 177 the motors 26, 95, 97, 139, 140 and 144 are connected in parallel to each other. The motors 37 and 38 considered as a pair or group are also connected across the pump 177 in parallel with the other motors but the pistons of the motors 37 and 38 always operate in reverse directions so as to properly effect steering as indicated in Figs. 2, 5 and 7.

A pipe 221 connects the pipe 220 to the suction pipe 187. The pump 177 may therefore draw liquid from the return flow pipe 202 or from both return pipe 202 and the tank 178. It is desirable to keep all of the pipes completely filled with liquid at all times and the pipes are therefore preferably so arranged that there will be no drainage by gravity into the tank 178 from any of the return pipes.

The capacity of the pump 177 is preferably such as to enable the operator to effect the operation of a plurality of motors at the same time. For instance, he may control the leaning of the front and rear wheels at the same time by means of the motors 26 and 95. Furthermore, he may in adjusting the mold board to a high lift or bank cutting position, operate the motors 139, 140 and 144 at the same time. If one motor alone is being operated the return pipe 221 may be sufficient to divert the liquid from the tank 178 but if a plurality of motors are operating simultaneously some of the liquid will flow back into the tank 178.

When all of the valves are closed and the pump 177 continues to operate, the check valve 222 in the by-pass pipe 223 will be opened in the direction of the arrow 224 to prevent stalling of the pump. This by-pass pipe is connected by the pipe 221 to the return pipe 202 and therefore all pipes on both sides of the pump are maintained filled with liquid so that as soon as any valve is opened there will be an immediate response in the operation of the motor to which it is connected, the controlling valves being adjacent to the motors, as shown in Figs. 1 and 2.

When the mold board is operating in bank cutting position there is a tendency for the mold

board when it meets with an obstruction or unusually hard material to move outwardly away from the machine frame while at the same time it is being thrust rearwardly. The tubular guide 157 therefore tends to slide off the slide rod 156. When the lugs 153 are midway between the ends of the rack bar 152, as shown in Fig. 2, the latch may have to be placed in the last notch 162, whereas when the lugs 153' and 153'' are located near the ends of the rack bar 152, the latch 163 may be located in a notch 162 nearer the center line of the drawbar 51. It will thus be seen that the angle between the center line of the drawbar extending through the pivot 159 and the center line of the plate 158 extending through the same center, may be made greater when the end lugs 153' and 153'' are used, and consequently for a given high lift position of the mold board harder work may be performed in bank sloping position while maintaining all of the parts of the apparatus properly connected and without subjecting them to undue strain.

While I have shown a pull type grader, it should be understood that my improvements are also applicable to a road grader of the self-propelled type embodying an internal combustion engine as the power plant connected to the rear traction wheels.

Obviously those skilled in the art may make various changes in the details and arrangement of parts without departing from the spirit and scope of the invention as defined by the claims hereto appended, and I wish therefore not to be restricted to the precise construction herein disclosed.

Having thus described and shown an embodiment of my invention, what I desire to secure by Letters Patent of the United States is:

1. In a road grader, the combination with a wheel supported frame, of spaced-apart longitudinal rock shafts, a drawbar flexibly connected at its forward end to said frame, a road-working implement carried by said drawbar, radial crank arms extending laterally from said rock shafts, spaced-apart hangers pivotally connected at their ends to said crank arms and said drawbar, means between said frame and said drawbar for shifting the road-working implement laterally relative to said frame, spaced-apart hydraulic motors pivotally connected at their lower ends to said frame, operating connections between the upper ends of said hydraulic motors and said rock shafts, and means for effecting operation of said hydraulic motors to actuate the hangers for co-operation with said shifting means to adjust the position of the road-working implement relative to the frame and the road surface.

2. In a road grader, the combination with a wheel supported frame, of longitudinal rock shafts journaled to said frame to occupy spaced-apart positions, crank arms extending radially and laterally from the front ends of said rock shafts, a road-working implement, a drawbar flexibly connected at its forward end to said frame and carrying said road-working implement, spaced-apart upright hangers pivotally connected at their upper ends to said crank arms and pivotally connected at their lower ends to said drawbar, two hydraulic motors one connected between the frame and one of said rock shafts and the other connected between said frame and the other rock shaft, and means for controlling the operation of said hydraulic motors to operate said hangers individually to effect

adjustment of the road-working implement and lock the same in adjusted position.

3. In a road grader, the combination with a wheel supported frame, of longitudinal rock shafts journaled to the sides of said frame and having radial arms extending laterally from the ends thereof, a road-working implement, extensible hangers connected by universal joints at their ends to the forward crank arms and to said road-working implement, separate hydraulic motors connected at their upper ends by universal joints to the rear crank arms and connected at their lower ends by pivots to said frame, and means for effecting the operation of said hydraulic motors individually and the locking thereof in adjusted positions.

4. In a road grader, the combination with a wheel supported frame, of a drawbar having its front end pivotally connected to said frame, a road-working implement carried by said drawbar, and means comprising spaced apart rack bars connected by a gear for shifting laterally the rear end of the frame together with said road working implement relatively to the rear wheels of the machine.

5. A road working machine comprising the combination with a supporting frame, of a road-working implement, a drawbar pivotally connected at its forward end to said frame, a hydraulic motor mounted on said frame longitudinally thereof and comprising a reciprocating piston, and mechanism connected between said motor and the rear end of said drawbar to enable rectilinear movement of said piston to effect shifting of said rear end laterally and thereby move the road-working implement laterally of said frame.

6. A road working machine comprising a supporting frame having spaced-apart longitudinal beams connected by a tubular cross-brace, of a drawbar pivotally connected at its front end to said frame, a road-working implement carried by said drawbar, a transverse rack-bar connected to the rear end of said drawbar and mounted on said frame to slide laterally relatively thereto, a hydraulic motor comprising a piston in a cylinder pivotally connected at one end to said tubular cross-brace, a rack bar connected to said piston to reciprocate bodily therewith at right angles to said first-named rack-bar, and gearing between said reciprocating rack-bar and said transverse rack bar to effect lateral shifting of the road-working implement.

7. In a road working machine, the combination with a wheel supported frame, of a drawbar pivotally connected at its forward end to said frame, a road-working implement carried by said drawbar, a transverse rack bar connected to the rear end of said drawbar and mounted on said frame to move laterally thereof, and means comprising an additional rack bar connected to said transverse rack bar to shift the same together with the rear end of said drawbar laterally of said frame and thereby secure lateral adjustment of said road-working implement relative to said frame.

8. A road grading machine comprising a vehicle frame, a drawbar pivotally connected at its front end to said vehicle, a road-working implement carried by said drawbar, a rack bar, guides for supporting said rack bar for sliding movement transversely of said vehicle frame, mechanism comprising another rack bar extending longitudinally of said frame and connected to said transverse rack bar to effect shifting

thereof in said guides and relatively to said frame, and a connection between said transverse rack bar and the rear end of said drawbar to transmit movement of said rack bar to said road-working implement to effect adjustment of the latter relative to said frame.

9. A road working machine comprising the combination with a frame, of a road-working implement mounted on said frame, a laterally shifting connection between the frame and said road-working implement and comprising gearing, and a hydraulic reciprocating motor mounted on said frame and connected to said gearing to actuate the same and thereby effect lateral shifting of the road-working implement relatively to said frame.

10. A road working machine comprising the combination with a vehicle having a supporting frame, of a road-working implement carried by said frame for adjustment laterally of the vehicle, and means comprising a reciprocating hydraulic motor connected at one end to said frame and at the other end to gearing connected to said road-working implement to shift the latter laterally of said frame and hold the same in adjusted position while said motor acts as a strut to resist back pressure during operation of said road-working implement.

11. In a road grader, the combination with a wheel supported frame, of longitudinal shafts journaled to the sides of said frame and having arms extending radially from the ends thereof, a drawbar connected to said frame, a road-working implement mounted on said drawbar, extensible hangers connected pivotally to said drawbar and also connected pivotally to two of the said arms on opposite sides of said frame, separate reciprocating hydraulic motors connected between said frame and the other two arms on opposite sides of said frame, and means for effecting operation of said hydraulic motors individually and the locking thereof in adjusted positions.

12. In a road grader, the combination with a wheel supported frame, of a drawbar flexibly connected at its forward end to said frame, a moldboard carried by said drawbar, spaced-apart hangers connected to said drawbar, spaced-apart longitudinal rock shafts connected to said hangers, upright reciprocating fluid-pressure motors connected to said rock shafts, laterally shifting mechanism connected to said drawbar, a reciprocating fluid pressure motor connected to said laterally shifting mechanism to actuate the same, and means for controlling said motors to effect lateral shifting of said moldboard and adjustment thereof in elevation and inclination relative to the vertical.

13. In a road working machine, the combination with a vehicle, of a road working implement, a drawbar for carrying said road working implement, spaced-apart extensible hangers at the sides of said frame and connected at their lower ends to said drawbar, spaced rock shafts at the sides of said frame and connected to the upper ends of said hangers, two reciprocating hydraulic motors one connected to one of said rock shafts and the other connected to the other rock shaft, means for controlling said motors individually, a laterally shiftable device at the rear portion of said frame and spaced rearwardly from the rear end of said drawbar, an extensible connection extending rearwardly from said drawbar to said laterally shiftable device, said connection being pivoted to the rear end

of said drawbar on a horizontal axis, and means for actuating said laterally shiftable device in co-operation with said motors connected to hangers of adjusted lengths to secure adjustment of the road working implement in elevation and inclination relative to the road surface.

14. In a road grader, the combination with a vehicle frame, of a drawbar flexibly connected at its forward end to said frame, spaced extensible hangers at the sides of said frame and connected at their lower ends to the free end portion of said drawbar, a moldboard mounted on said drawbar, rock shafts mounted on said frame and connected to said hangers, fluid pressure motors connected to said rock shafts for individual actuation thereof, a laterally shiftable device mounted on said frame, flexible connections extending rearwardly from said drawbar to said laterally shiftable device, a pump mounted on said frame, an engine mounted on said frame and connected to said pump to operate the same, means for shifting said device laterally relative to said frame to effect lateral shifting of said moldboard, and operator-controlled means for connecting the pump to either fluid pressure motor to effect adjustment of the moldboard in elevation and in inclination transversely of the roadway.

15. In a road working machine, the combination with a vehicle frame, of a drawbar flexibly connected at its forward end to said frame, spaced-apart hangers pivoted at their lower ends to the free end portion of said drawbar, spaced-apart rock shafts mounted on said frames and each having laterally extending arms at their ends, the arms at the forward ends of said rock shafts being pivoted to the upper ends of said hangers, reciprocating fluid pressure motors pivotally connected at their lower ends to said frame and pivotally connected at their upper ends to the arms at the rear ends of said shafts, a moldboard carried by said drawbar, and means for controlling said motors to effect lifting and lowering of said hangers individually to adjust the elevation and inclination of the moldboard relative to the roadway.

16. In a road grader, the combination with a wheel supported frame, of spaced-apart longitudinal rock shafts mounted thereon, a drawbar flexibly connected at its forward end to said frame, a road-working implement carried by said drawbar, crank arms extending radially from said rock shafts, spaced-apart hangers pivotally connected at their ends to said crank arms and said drawbar, means between the said frame and the rear end of said drawbar for shifting the road-working implement laterally relative to said frame, reciprocating hydraulic motors pivotally connected to said frame and to said crank arms, and means for effecting operation of said hydraulic motors to actuate the hangers for co-operation with said laterally shifting means to adjust the position of the road-working implement relative to the frame and the road surface.

17. In a road grader, the combination with a wheel supported frame, of longitudinal rock shafts journaled to said frame to occupy spaced-apart positions, crank arms extending radially from the said rock shafts, a road-working implement, a drawbar flexibly connected at its forward end to said frame and carrying said road-working implement, spaced-apart upright hangers pivotally connected at their lower ends to said drawbar and pivotally connected at their

upper ends to two of said crank arms one on one rock shaft and the other on the other rock shaft, two reciprocating hydraulic motors connected between the said frame and the other two crank arms, and means for controlling the operation of said hydraulic motors individually to effect adjustment of the road-working implement and the locking of the same in adjusted position.

18. A road-working machine comprising a supporting frame, of a road-working implement adjustably mounted thereon, a rack bar mounted on said frame and connected to said road-working implement, an additional rack bar, a fluid-pressure motor connected between said frame and said additional rack bar, and gearing between said rack bars to effect upon operation of the motor the adjustment of the road-working implement relative to said frame by shifting said first-named rack bar relatively to said frame.

19. In a road-working machine the combination with a vehicle of a road-working implement adjustably mounted thereon a laterally

shiftable device mounted on said frame and connected to said road-working implement a reciprocating motor operable in a direction transversely of said laterally shiftable device, and operating connections between said motor and said device for effecting shifting of the latter laterally of the frame upon operation of said motor to adjust said road-working implement relative to said frame.

20. In a device of the class described, the combination with a vehicle, of an adjustable member carried by said vehicle, a rack bar, guides for supporting the rack bar for sliding movement transversely of said vehicle, mechanism comprising another rack bar extending longitudinally of the vehicle and connected to said transverse rack bar to effect shifting thereof in said guides and relatively to said vehicle, and a connection between said transverse rack bar and said adjustable member to effect adjustment of the latter relative to said vehicle.

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