

July 1, 1941.

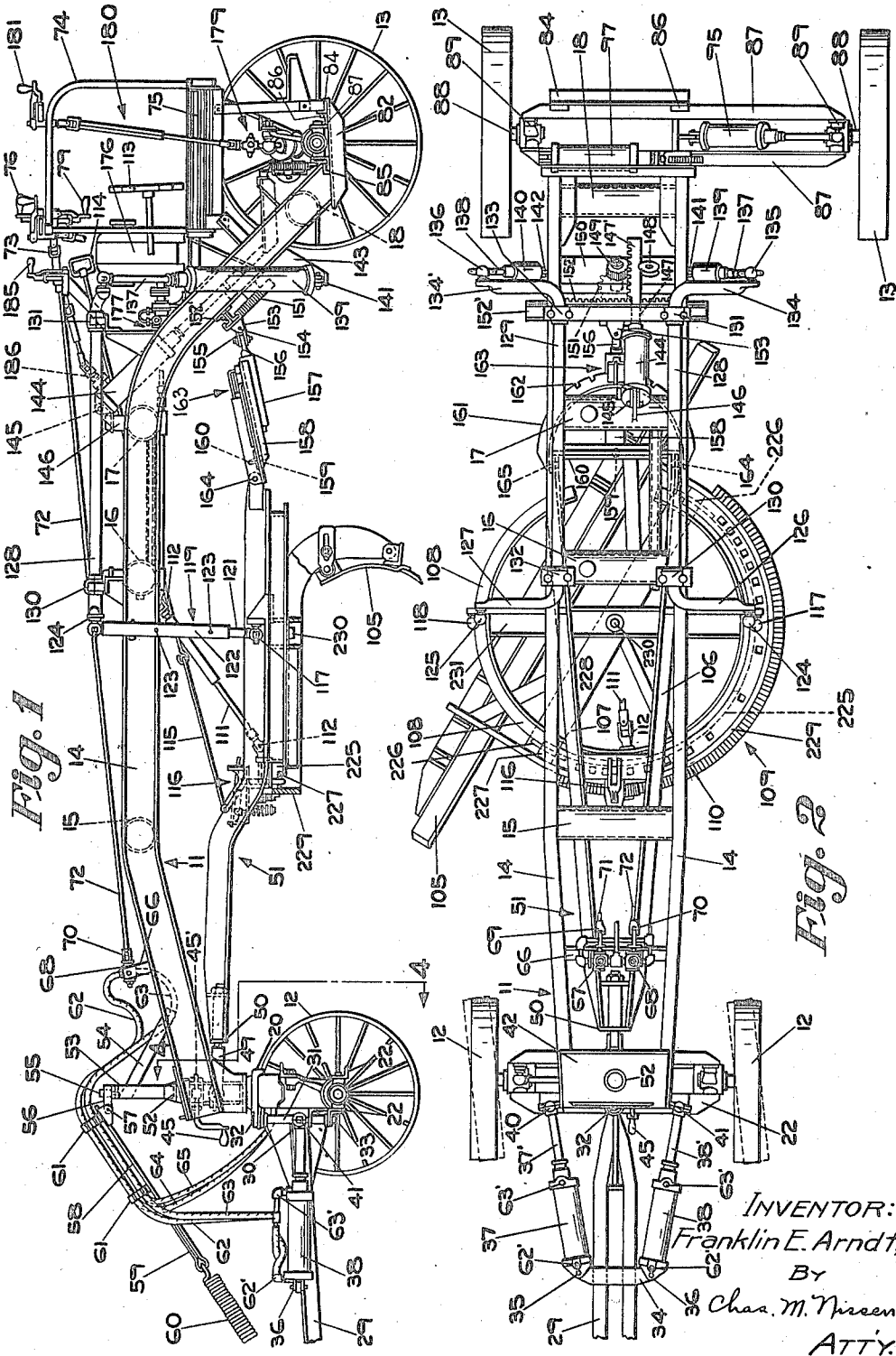
F. E. ARNDT

2,247,345

ROAD GRADER

Original Filed Feb. 2, 1933

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ROAD GRADER

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Fig. 3

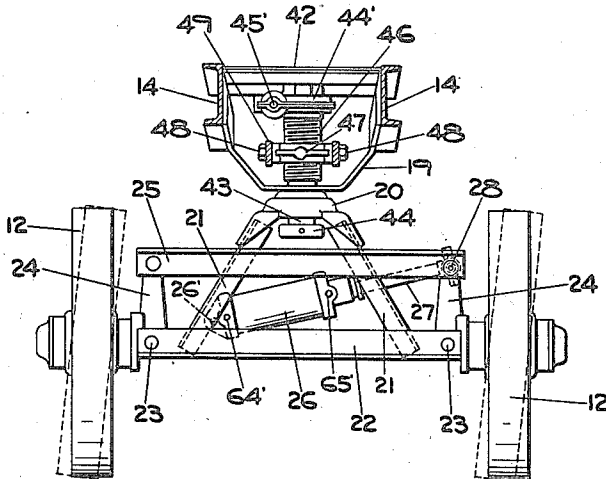
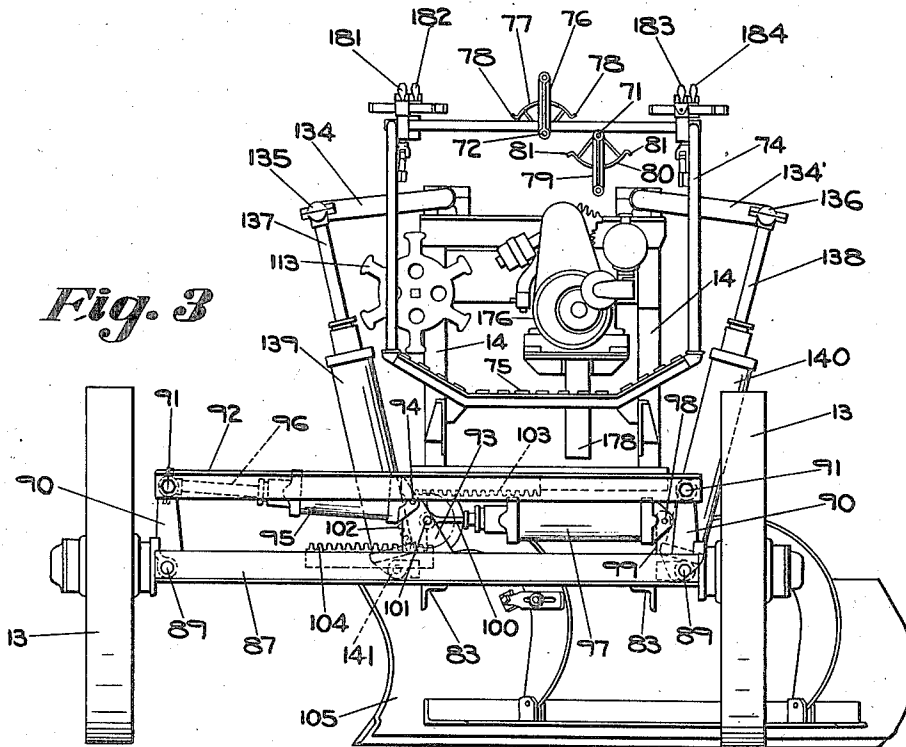


Fig. 4

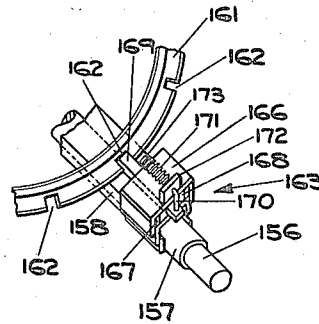


Fig. 2a

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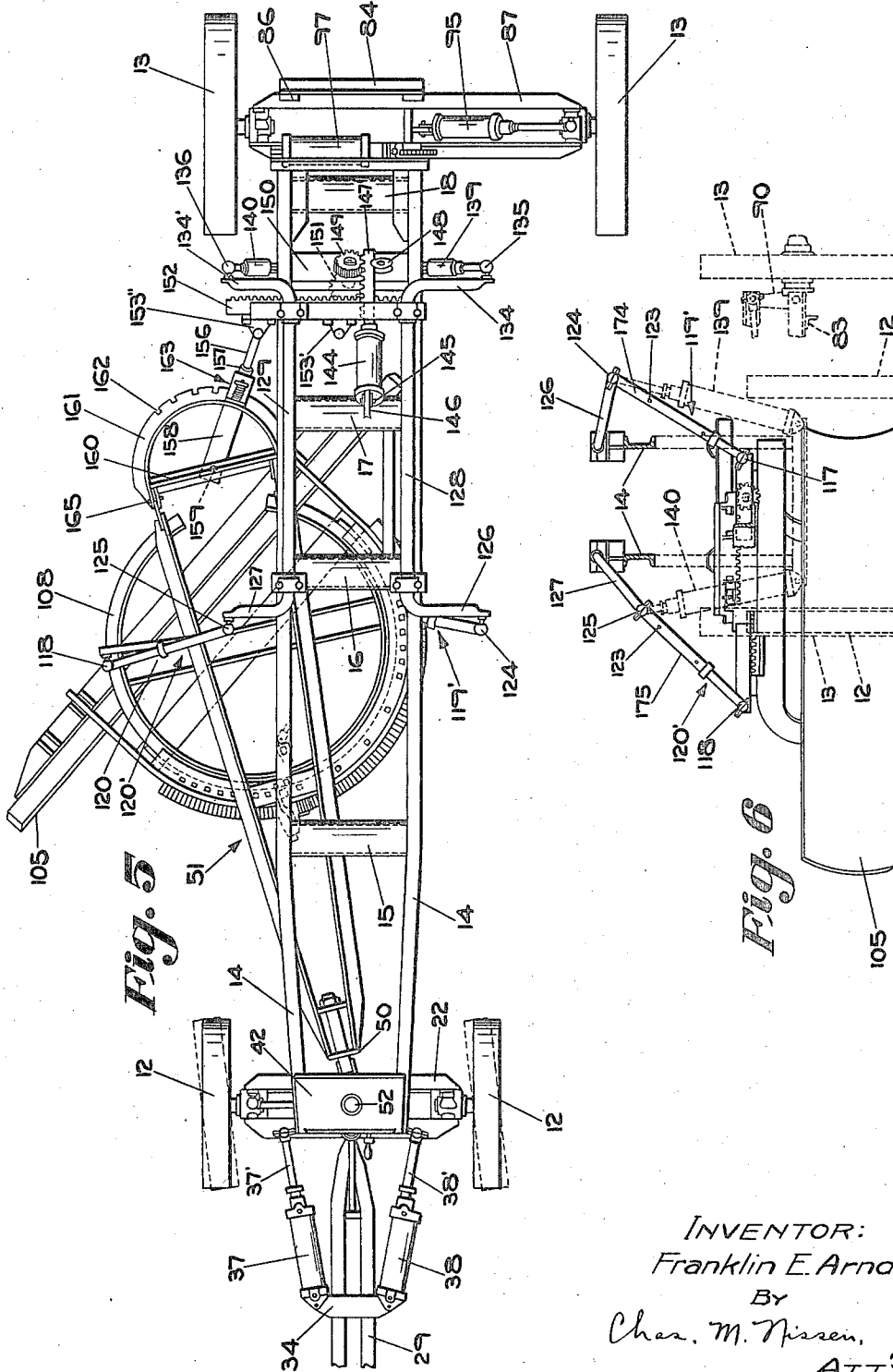
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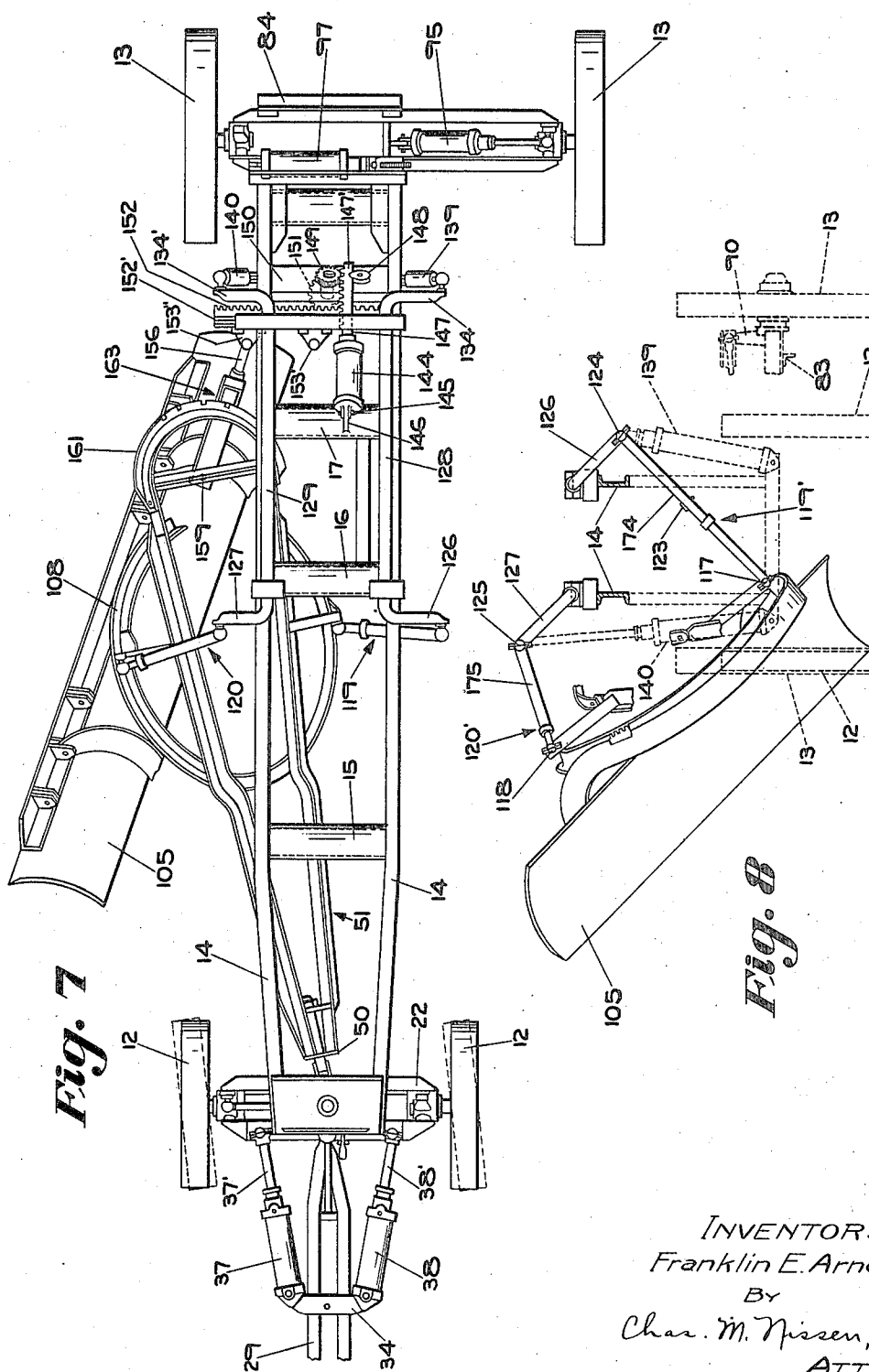
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ROAD GRADER

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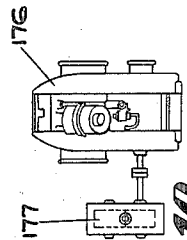
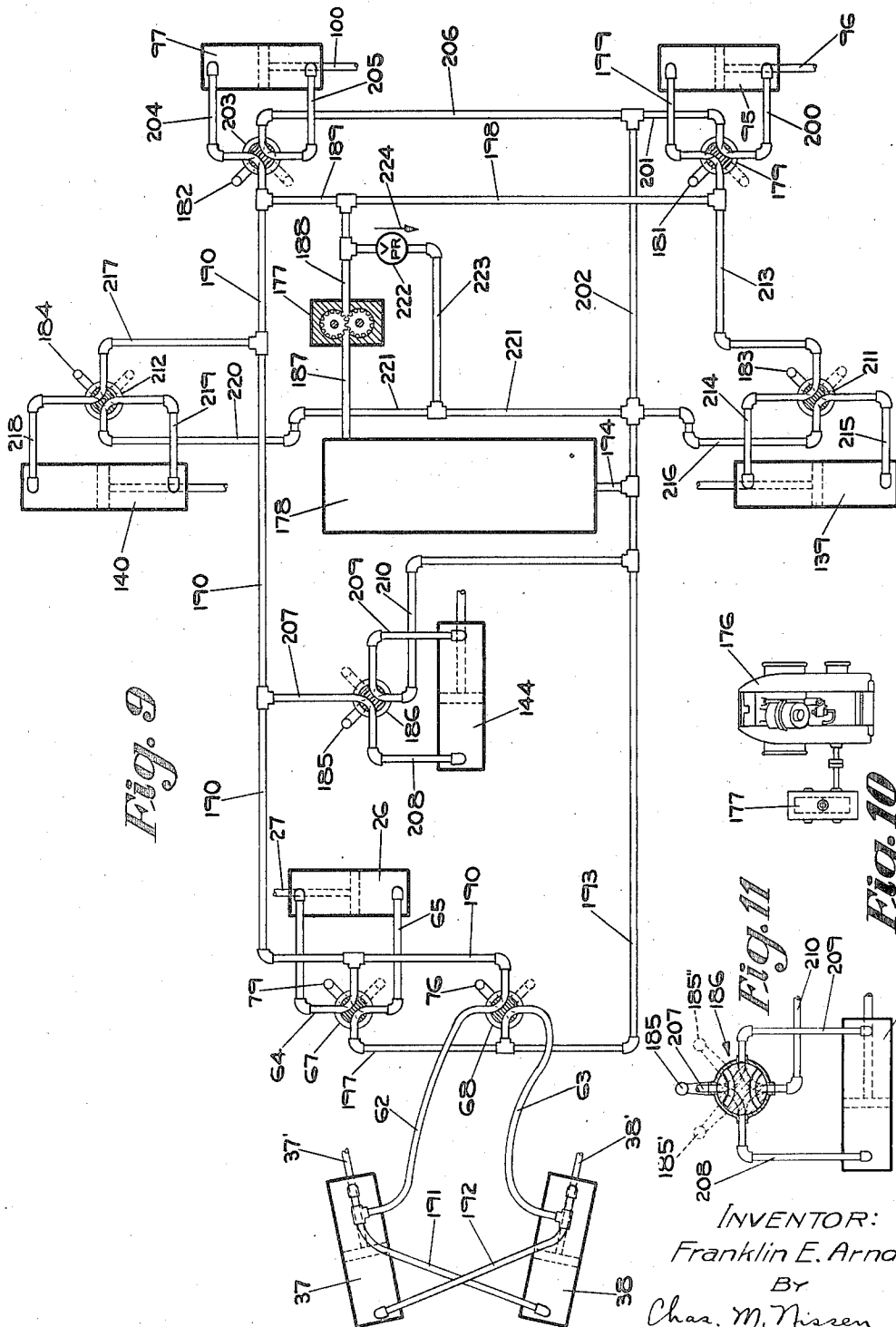
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UNITED STATES PATENT OFFICE

2,247,345

ROAD GRADER

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

Original application February 2, 1933, Serial No. 654,901. Divided and this application April 26, 1935, Serial No. 18,409. Renewed January 12, 1939

24 Claims. (Cl. 280—80)

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

Another object of the invention is the provision of improved fluid-pressure motor-operated steering mechanism for a vehicle, such as that embodied in a road grading machine.

Another object of the invention is the provision of improved supporting means for flexible fluid-pressure hose of fluid-pressure motor-operated mechanism, adjacent the steering post of a road building machine.

A further object of the invention is the provision of improved fluid-pressure motor-operated mechanism for effecting the leaning of wheels in a road grading machine in co-operation with the steering thereof.

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 so as to co-operate with fluid-pressure operated mechanism for steering the machine during operation.

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

This application is a division of my co-pending application Serial No. 654,901, filed February 2, 1933, for an improvement in Road graders.

In the accompanying drawings,

Fig. 1 is an elevational view of the road grading machine embodying my improvements;

Fig. 2 is a plan view of the hydraulic road grading machine shown in Fig. 1;

Fig. 2^a 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 vehicle frame;

Fig. 3 is a rear elevation of the road grading 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;

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

Fig. 11 is a diagrammatic view illustrating the operation of the motor controlling valve of Fig. 9.

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 front and rear wheels are preferably of metal comprising radial spokes and circular rims having circular edges on opposite sides adapted to dig into the ground when leaned as hereinafter more fully described. 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 or bolster 20 having depending channel irons 21, 21 secured at their lower ends to the axle-tree 22 to 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 rear end of the cylinder 26 is pivoted at 26' to the left-hand inclined brace 21, and the outer end of the piston rod 27 is pivoted at 28 to the upper end of the upright arm 24.

As hereinafter 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, as indicated by the ports 64', 65' in Fig. 4, and therefore when the leaning of the wheels 12 is adjusted as indicated by the dotted lines in Fig. 4, they may be locked in adjusted position by closing the valve controlling the flow of the liquid through the ports 64' and 65' into and out of the cylinder 26.

Figs. 1 and 2 illustrate a pull type of 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 or bolster 20, and the

lower end of the post 31 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 35, 36 for the front ends of the cylinders 37, 38 of the hydraulic motors comprising the 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 used, I prefer to use two hydraulic motors symmetrically arranged as shown in Fig. 2.

A cross-piece 42 (Fig. 2) is secured to the upper sides of the forward ends of the side beams 14, 14 and secured to this plate 42 to depend therefrom is a fixed vertical bearing rod or king post, the lower end of which is provided with a retaining cap or collar 44, as shown in Fig. 4. When the hydraulic steering mechanism is operated, the bolster 20 turns on a vertical axis about the king post 43.

As shown in Figs. 1 and 2 the vertical post 31 is spaced in advance of the king post 43. This enables the tractor hitched to the front end of the tongue 29, to facilitate steering. This can readily be understood by considering the piston rods 37' and 38' disconnected at 40 and 41 from the axle-tree 22 and the tongue 29 moved by the tractor in an anti-clockwise direction as viewed in Fig. 2. The king-post 43 will then be out of alignment with the tongue 29 but continued pull by the tractor on the tongue 29 will, on account of the advanced position of the post 31, tend to swerve the latter in an anti-clockwise direction and thereby move the wheels 12, 12 to their dotted line positions shown in Fig. 2. It will thus be seen that the spacing arrangement of the posts 31 and 43 enables the pull of the tractor to aid the operation of the motors 37, 38 when the latter are connected at 40, 41 to the axle-tree 22.

Secured to the bottom of the plate 42 concentric with the vertical king post 43 is a gear housing 44' in which is journaled a worm wheel secured to the screw 46 to rotate with the latter. When the shaft 45' is rotated, a worm in the housing 44' rotates the worm wheel therein and thereby rotates the screw 46 in the nut 47. Pivoted to the nut 47 at 48, 48 is a 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 (Fig. 1), the front end of the drawbar may be adjusted in elevation relative to the front end of the frame 11.

Secured to the top of the plate 42 is a socket 52 (Fig. 1), with which is associated a vertical post 53 held rigidly in vertical position by lateral braces one of which is shown at 54 in Fig. 1, secured to the beams 14. The top of the post 53 is swiveled at 55 to 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 to effect a counterbalance of the latter.

Clips 61, 61 may be 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 cylinders 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 a 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 cranks 79 may be associated with a 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 co-operate with the steering of the machine by means of the hydraulic motors 37, 38 (Fig. 2), to counteract the tendency of the mold-board during operation along the roadway to shift the front end of the machine sidewise. For instance, if the mold-board is in the position shown 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, looking toward the front end of the machine, 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. The leaning of the wheels is indicated in dotted lines in Fig. 4 for counteracting the tendency of the mold-board to shift the machine sidewise when operating in the position shown in Fig. 2.

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. The steering of the wheels is shown in dotted lines in Fig. 2 to co-operate with the leaning of the front wheels as shown in dotted lines in Fig. 4, when the mold-board is operating in the position shown in Fig. 2.

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 (Fig. 1), comprising angle irons 83, 83 (Fig.

3) and the cross-piece 84 (Fig. 2). Guides are provided at 85, 86 for the transverse members 87, 87 (Figs. 1 and 2) for 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 (Fig. 3). 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, the 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 rectilinearly. When the piston in the cylinder 97 is locked, the pivotal axis 101 will be stationary relative to the cylinder 97. The rack bars 103, 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, 104 will remain stationary.

The leaning of the rear wheels will conform to the leaning of the front wheels as illustrated in dotted lines in Fig. 4. Therefore when the mold-board is in the position shown in Fig. 2, the leaning of the rear wheels co-operates with the leaning of the front wheels and the steering of the front wheels to counteract the tendency of the mold-board to shift the whole machine toward the right as viewed by the operator on his platform 75 looking forward. The shifting of the rear end of the frame relatively to the rear wheels enables the rear wheel at the operating side of the machine to be kept in alignment with the front wheel at the operating side of the machine, as illustrated in Fig. 5. As illustrated in Fig. 7, the lateral reach of the rear end of the drawbar 51 is at its maximum and such adjustment is facilitated by the lateral shifting of the rear end of the frame relatively to the rear wheels while maintaining the rear and front

wheels at the operating side of the machine in approximating the same path of travel. It will thus be seen that the shifting of the rear end of the frame relatively to the rear wheels, the leaning of the rear wheels, the leaning of the front wheels, and the steering of the front wheels, all co-operate to enable the machine to operate as illustrated in Figs. 5 and 6, Fig. 6 being a diagrammatic front elevational view of the mold-board supporting mechanism shown in plan in Fig. 5.

Referring now to road working implement comprising a mold-board or scraper 105 and the structure for supporting the same, it will be seen that the drawbar 51 comprises spaced-apart members 106, 107 which diverge rearwardly and have secured to the rear portions thereof a 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 a shaft comprising links 111 and universal joints 112, to the wheel 113 at the operator's station 75, 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 (Fig. 1) 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, may be of well known construction, but the circular guide 108 for supporting the circle 109 by means of a semi-circular groove 225 is believed to be novel and is disclosed and claimed in my co-pending application Serial No. 7,535, filed Feb. 21, 1935, for an Improvement in Road graders. Such semi-circular guiding groove comprises arcuate guide plates 226, 226 which engage the periphery of the circular guide 108, and the latch plate 227 which is spaced from the ends of the cross-piece 228 and secured to the semi-circular member 229, which is in reality the main portion of the circle 109. The cross-piece 228 is pivoted by means of the king bolt 230 to the cross-piece 231, to the ends of which are secured the angle iron circular guideway 108. It should be understood that the cross-piece 228 which is provided at its ends with a semi-circular groove comprising the latch plate 227, is pivoted to the king bolt 230 and moves with the circle and the mold-board, the latter being carried by the circle. The cross-piece 231 and the circular guide 108 are secured rigidly to the rear ends of the members 106, 107 of the drawbar frame 51. Consequently the circular guide 108 moves bodily with the drawbar, and the mold-board 105 moves bodily with the guide 108 and the drawbar 51.

To the diametrically opposite sides of the circular guide frame 108 are connected by means of universal joints 117, 118 the lower ends of extensible hangers 119 and 120. Each hanger comprises a lower rod 121 telescoping snugly into a pipe rod 122. Holes 123, 123 in the pipe 122 are adapted to register with one or more transverse holes in the rod 121 and a pin may be 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, and there may be a plurality of holes spaced apart along the rod 121.

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 rock shafts 128 and 129. The rock shafts 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 rock shafts 128, 129 are connected the laterally extending crank arms 134, 134' which are connected at their outer ends by means of the universal joints 135, 136 to the upper ends of the piston rods 137, 138 which extend downwardly into the cylinders 139, 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 (Figs. 1 and 2).

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 relative to the frame 11 by means of the hydraulic motors 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 tubular cross-piece 17, as shown in Figs. 1, 2 and 5. The piston rod 147 is connected to a rack bar 147' which is guided by a roller 148 into mesh 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 latter being supported by and guided along a transverse rail 152' secured to the lower sides of the beams 14 so as to extend transversely thereof in a position spaced rearwardly from the rear end of the drawbar 51.

Mounted on the front side of the rack bar 152 is a single central bracket 153 as shown in Fig. 2 or a pair of spaced-apart forwardly extending brackets 153', 153'', as shown in Figs. 5 and 7. To any one of these brackets may be pivoted on the horizontal axis 154 (Fig. 1) a clevis 155 which is pivoted at its forward end on an upright axis to the rear end of a rod 156 which is adapted to slide in a longitudinal guide 157 on the bottom of a 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 161 is provided with four or five 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 106, 107 of the drawbar 51.

The latch mechanism 163 is shown in perspective in Fig. 2a. 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 through a 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. 2a.

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 10 may be moved transversely of the machine until the latch 169 is snapped into the next notch by the spring 171. While the latch 169 is in one of the notches the motor 144 may be operated to shift the mold-board laterally but the extent may not be sufficient if the latch is in one of the intermediate notches. 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 25 144 reaches the limit of its stroke. Such maximum position is illustrated in Fig. 5.

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 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 bracket 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 looking forward, as shown in Fig. 5, the slide rod 156 is connected to the bracket 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 bracket lugs 153'. This adjustment may be easily 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 hangars 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. 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 frame, to hold the mold-board in rigid adjusted position relative to the vehicle frame. This position is preferably such as to direct the material that is cut from the bank, to the space between the path 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.

By referring to Fig. 8, it will be seen that the shifting of the rear end of the vehicle frame relatively to the rear wheels enables the mold-board to more effectively operate along a sloping bank while the adjacent front and rear wheels follow the same path of travel. The leaning of the front wheels and the leaning of the rear wheels may be such as to cause the rims of the wheels to dig into the road surface in such a manner as to resist the lateral working thrust during bank-cutting operations. Consequently the locking of the hydraulic motor 44, the locking of the frame shifting motor 97, the locking of the leaning wheel motors 26 and 95, and the locking of the motors 139 and 140, effect the holding of the mold-board rigidly in bank-sloping position while at the same time locking all of the adjustments to resist the lateral working thrust during bank-sloping operations. Furthermore, when a tractor is coupled to the tongue 29 to pull the machine along the roadway while the mold-board is operating on a sloping bank, the hydraulic steering motors 37, 38 may be set in certain positions and locked there with the assurance that the travel of the front wheels over rough ground and irregularities will not throw the setting of the steering mechanism out of adjustment.

The internal combustion engine 176 and the pump 177 (Fig. 10) 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 178 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 hydraulic motor 95 is provided with a valve 179 operable by the connections 180 (Fig. 1) to the actuating lever 181.

In a similar manner the rear shifting hydraulic motor 97 may be controlled by a valve 203 connected to the operating lever 182 (Fig. 9). The operating levers 183 and 184 are similarly connected to the valves 211, 212 which control the 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, 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 to the cylinder 37 back of the piston therein, and through the pipe 191 into the 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 axle tree 22 will be turned in the opposite direction.

By means of the lever 79, 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 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 down to 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 may be adjusted and locked in adjusted position.

The leaning of the rear wheels 13 is adjusted by means of the hydraulic motor 95 which is controlled by the valve 179 to which the lever 181 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, 202, back to the tank 178.

The hydraulic motor 97 for shifting the rear end of the vehicle 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 97 into the pipe 205, valve 203, and pipes 206, 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 hydraulic motors 95 and 97 controlled thereby and each motor may be locked in adjusted position by closing its controlling valve. That is to say, after the rear end of the vehicle frame has been shifted laterally to bring into alignment the front and rear wheels on the operating side of the machine, the adjustment may be locked and so also the adjustment of the leaning of the rear wheels may be locked with the assurance that the metal rims of the metal-spoked wheels will dig into the road surface to resist lateral thrusts during operation of the mold-board.

The motor 144 for shifting the rear end of the drawbar, is controlled by the valve 186 to which the actuating lever 185 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 ahead of the piston therein. At the same time liquid will be forced from the other end of the cylinder 144 into the pipe 209, through the valve 186 into the pipe 210, and thence back to the tank 178. Operation of the motor 144 may be reversed by moving the valve 186 to its dotted line position shown in Fig. 9, and by closing the valve 186 the motor 144 may be locked in adjusted position, and when such locking is effected the tendency of the rear end of the drawbar to move laterally relatively to the vehicle frame, during operation of the mold-board, will be effectually resisted.

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, as shown in Fig. 9. 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 above the piston therein. At the same time liquid will be forced out of the lower 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 below the piston therein. At the same time liquid flows from the cylinder 140 on top of the piston therein, into the pipe 219 and through the valve 212 into the pipe 220 which is connected to the return pipe 202. 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 may be locked. The locking of the motors 139 and 140 will effectively lock the crank arms 126, 127 and hangers 174, 175 in their adjusted positions, for instance, such as those shown in Fig. 8.

In Fig. 11 is illustrated the various positions for the valve 186 for control of the hydraulic reciprocating motor 144. When the valve lever 185 is in its full line position, the supply pipe 207 and the return pipe 210 are entirely cut off from the pipes 208, 209 which are connected to the opposite ends of the cylinder and therefore when the lever 185 is in its full line position, the piston in the cylinder 144 is locked in its adjusted position and can not move in either direction.

When the lever 185 is moved to its dotted line position 185', the supply pipe 207 will be connected to the pipe 208, and the pipe 209 will be connected to the return flow pipe 210, as indicated by the curved dotted lines in the valve 186 shown in Fig. 11. When the lever 185 is in its dotted line position indicated at 185'', the supply pipe 207 will be connected to the pipe 209 and the pipe 208 will be connected to the return flow pipe 210. When the lever is in its dotted line position 185', the piston in the cylinder 144 will be moved toward the right, whereas when the lever 185 is in its dotted line position 185'', the piston in the cylinder 144 will be moved to the left. Each of the other controlling valves shown in Fig. 9 is arranged to operate as illustrated in Fig. 11.

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 181. The pump 177 therefore draws liquid directly from 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 hydraulic motors at the same time. For instance, he may control the leaning of the front wheels and the leaning of the rear wheels at the same time by means of the hydraulic motors 26 and 95. Furthermore, he may in adjusting the mold-board to a high lift or steep 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 will be sufficient to divert the liquid from the tank 178, but if a plurality of motors are being operated 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 177. This by-pass pipe is connected by the pipe 221 to the return pipe 202 and therefore all pipes on the supply side of the pump are always 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. By referring to Figs. 1 and 2, it will be seen that the hydraulic motor controlling valves are located on the machine in positions adjacent to the hydraulic motors so that when these valves are opened the distance of water flow will be reduced to a minimum and consequently no appreciable time will be necessary for the building up of pressure in the piping connections. It is evident by referring to Fig. 9 that the continuous operation of the pump 177 keeps the main pressure pipes 190 and 198 constantly under full pressure and therefore when one of the controlling valves is opened, the distance from the valve to the cylinder being short, the necessary working pressure will be built up immediately. The presence of the pipe 221 in no

way interferes with the main pressure supply pipes because the only connection between the latter and the pipe 221 is through the relief valve 222 and this valve does not open until the pressure in the main supply pipes reaches a predetermined maximum.

When the mold-board is operating in bank-cutting position, there is a tendency at certain times for it to move outwardly from the machine frame when it meets an obstruction or unusually hard material in the bank. The tubular guide 157 therefore tends to slide off the slide rod 156. When the bracket lugs 153 are midway between the ends of the rack bar 152, as shown in Fig. 2, the latch 163 may be placed in the last notch 162, whereas when the bracket lugs 153' and 153'' are located near the ends of the rack bar 152, the latch 163 may be located in a notch 162 near 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 (Fig. 5) and the center line of the plate 158 extending through the same center 159, may be made greater when the end bracket lugs 153' and 153'' are used, and consequently for a given high lift or steep bank-cutting position of the mold-board harder work may be performed in bank-sloping position while maintaining all of the parts of the machine 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 rear traction wheels, in which event the pump 177 may be operatively connected to such power plant.

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 therefore wish 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 vehicle, the combination with a frame, of an axle-tree pivoted to the front end thereof, a tongue pivoted to said axle-tree, a pair of hydraulic motors pivotally connected at their ends to said tongue and to said axle-tree, and means supported on said frame for operating said motors under control of the operator at a station at the rear end of said frame to effect steering of the vehicle.

2. In a vehicle, the combination with a supporting frame, of a cross-bar, front wheels mounted for adjustment of the leaning thereof at the ends of said cross-bar, a fluid-pressure motor for adjusting such leaning, means for effecting the operation of said motor, and fluid-pressure motor mechanism for effecting steering by means of said front wheels.

3. In a vehicle, the combination with a supporting frame, of a cross-bar, axles pivoted to the ends of said cross-bar on axes extending longitudinally of said frame, parallel motion mechanism for maintaining said axles in alignment or in parallelism, wheels journaled on said axles, means comprising a fluid-pressure motor for actuating said parallel motion mechanism to vary the leaning of said wheels, and fluid-pres-

sure motor mechanism for effecting steering by means of said wheels.

4. In a vehicle, the combination with fluid-pressure operated steering mechanism, of flexible hose for conducting the fluid-pressure medium to said steering mechanism, and means for supporting the hose forwardly of the steering axis to confine the bending of said hose during operation of said steering mechanism to a position approximately at such axis.

5. In a vehicle, the combination with a portable frame, of traction wheels supporting the frame, a vehicle tongue operatively connected to the wheels, hydraulic mechanism intermediate the tongue and wheels for shifting the wheels relative to the tongue for facilitating steering of the machine, flexible conduits for supplying pressure fluid to the said hydraulic mechanism, and yieldable supporting means for the conduits for maintaining the conduits unobstructed in all relative positions of tongue and wheels.

6. In a vehicle, the combination with a portable frame, of traction wheels supporting the frame, a vehicle tongue operatively connected to the wheels, hydraulic mechanism associated with the tongue and wheels for adjusting the wheels relative to the tongue for facilitating steering of the machine, flexible conduits for supplying pressure fluid to the hydraulic mechanism, and supporting means for the conduits including a standard, a connecting member swivelly mounted on the standard, a supporting plate for supporting the conduits pivoted to the connecting member, and a spring intermediate the plate and tongue and connected thereto.

7. In a vehicle, the combination with a portable frame, of traction wheels supporting the frame, a vehicle tongue operatively connected to the wheels, hydraulic mechanism associated with the tongue and wheels for adjusting the wheels relative to the tongue for facilitating steering of the machine, flexible conduits for supplying pressure fluid to the hydraulic mechanism, and supporting means for the conduits including a standard, a connecting member swivelly mounted on the standard, a supporting plate for supporting the conduits pivoted to the connecting member, and a spring intermediate the plate and tongue and connected thereto, the said supporting means maintaining the conduits unobstructed in all relative positions of tongue and wheels, valve means for controlling supply of fluid to the conduits, and mechanism operable from an operator's position for operating the valve means.

8. In a road-working machine, the combination with an implement carrying vehicle frame, of means comprising front wheels for supporting said frame, fluid-pressure motor mechanism for adjusting the leaning of the front wheels, and fluid-pressure motor mechanism for effecting steering with the front wheels.

9. In a device of the class described, the combination with a vehicle frame, of a front axle-tree pivoted to said frame, steering wheels connected to said axle-tree, a tongue pivotally connected to said axle-tree, a pair of spaced hydraulic motors pivotally connected at their forward ends to said tongue and at their rear ends to said axle-tree, and means for controlling said motors to adjust said axle-tree and said wheels relative to said frame and locking the axle-tree in rigid connection to said tongue.

10. In a road vehicle, the combination with a frame, of an axle-tree pivoted to the front end

thereof, a tongue pivoted to said axle-tree, a hydraulic motor pivotally connected at its forward end to said tongue in spaced-apart relation to the pivot between the tongue and said axle-tree, a pivotal connection between the rear end of said hydraulic motor and said axle-tree in spaced-apart relation to the pivot between said tongue and said axle-tree, steering wheels connected to the outer ends of said axle-tree, and means for controlling said hydraulic motor to effect steering of the vehicle and to lock said hydraulic motor in adjusted position to enable the same to distribute the pull on the pivot between the tongue and the axle-tree and the pivot between the rear end of the hydraulic motor and said axle-tree.

11. In a vehicle, the combination with a supporting frame, of a front cross-bar, wheels mounted for adjustment of the leaning thereof at the ends of said cross-bar, mechanism comprising a fluid pressure motor mounted on said cross-bar to move bodily therewith on its pivot relative to said frame, means operated by said fluid pressure motor for adjusting the leaning of said wheels, a hauling tongue pivotally connected to said cross-bar, fluid pressure motor mechanism between said tongue and said cross-bar for adjusting the latter together with said wheels on the pivot between said tongue and said cross-bar, and means for controlling at will the operation of the aforesaid fluid pressure motor and the operation of said fluid pressure motor mechanism to secure co-operation of the leaned wheels with the steering thereof.

12. In a road vehicle, the combination with a frame, of an axle-tree pivoted to the front end of said frame, a pulling tongue pivoted to said axle-tree midway between the ends thereof, a cross-piece mounted on said tongue and spaced forwardly from the rear end of said tongue, a pair of reciprocating hydraulic motors pivotally connected at their outer ends to the outer ends of said cross-piece and pivotally connected at their rear ends to said axle-tree at points spaced laterally from the rear end of said tongue, and means for effecting reverse operation of said motors to swing the axle-tree together with said wheels relatively to said frame and relatively to said tongue and for effecting locking of said motors in adjusted positions to rigidly connect said axle-tree to said tongue in adjusted position relative thereto.

13. In a vehicle, the combination with a supporting frame, of a cross-bar pivoted to the front end thereof on an upright axis, axles pivoted to the ends of said cross-bar on axes extending longitudinally of the frame, parallel motion mechanism for maintaining said axles in alignment or in parallelism, a hydraulic motor pivotally connected at one end to said cross-bar and at the other end to said parallel motion mechanism, wheels journaled on said axles, hydraulic motor mechanism for effecting steering by means of said wheels, and means for at will controlling the operation of said hydraulic motor and the operation of said hydraulic motor mechanism to secure co-operation in the leaning of the wheels and the steering thereof.

14. In steering mechanism for a vehicle, the combination with an axle-tree, of a tongue pivoted thereto, hydraulic motor mechanism pivotally connected at one end to said tongue and at its other end to said axle-tree in spaced relation with the pivot between the tongue and the axle-tree, and means for effecting operation

of said hydraulic motor mechanism to effect steering of the vehicle while the hauling pull between the tongue and the axle-tree is distributed by reason of the aforesaid spaced relation between the pivots at the axle-tree.

15. In a road vehicle, the combination with a frame, of an axle-tree pivoted to the front end thereof, a tongue pivoted to said axle-tree, a pair of reciprocating hydraulic motors each of the piston and cylinder type one pivotally connected at its ends to said tongue and said axle-tree on one side of said tongue and the other pivotally connected to said tongue and said axle-tree on the other side of said tongue, the pivotal connections to said axle-tree and the tongue being spaced from the pivotal connection between the tongue and the axle-tree, and a hydraulic system operable from a single station to secure simultaneous operation of said motors in opposite directions to effect steering of the vehicle and to effect locking of the hydraulic motors in adjusted positions to rigidly connect the axle-tree to said tongue in adjusted fixed relation thereto.

16. In a vehicle, the combination with a portable frame, of means comprising a front steering wheel unit for supporting said frame, hydraulic motor mechanism for operating said steering wheel unit to effect steering of the vehicle, flexible conduits extending from said portable frame to the hydraulic motor mechanism on the steering wheel unit, supporting means for the conduits including a standard on the front end of said portable frame and a conduit support pivotally connected to said standard, and means on the portable frame for controlling the flow of the pressure liquid in said conduits to thereby effect operation of said hydraulic motor mechanism and the operation of said steering wheel unit.

17. In a vehicle, the combination with a portable frame, of means comprising a front steering wheel unit for supporting said frame, hydraulic motor mechanism mounted on said steering wheel unit to operate the same, flexible conduits connected to said hydraulic motor mechanism, means on the portable frame for controlling the flow of the pressure liquid in said conduit to effect operation of said hydraulic motor mechanism and the operation of said steering wheel unit, and mechanism pivotally mounted on the said frame for supporting said conduits for turning on an upright axis located in vertical alignment with the pivot between the steering wheel unit and said frame.

18. In a road vehicle, the combination with a frame, of a front axle-tree, steering wheels at the ends of said axle-tree, mechanism comprising a bolster for pivotally supporting the front end of said frame on said axle-tree, a tongue, mechanism independent of the pivot between said frame and said front axle-tree for pivotally connecting said tongue to said axle-tree, hydraulic motors on opposite sides of the tongue pivotally connected at their rear ends to said axle-tree in spaced relation to the pivot of the tongue, mechanism for pivotally connecting the forward ends of said motors to opposite sides of said tongue, and means for controlling said motors to secure simultaneous reverse operation thereof to effect steering of the vehicle by the turning of said bolster on its pivot relatively to the front end of said frame.

19. In a machine of the class described, the combination with a vehicle frame, of a steering wheel unit comprising an axle-tree pivotally con-

connected to said frame, a pair of spaced-apart supporting wheels, axles for said wheels pivotally connected to the ends of said axle-tree on spaced-apart longitudinal horizontal parallel axes, upright arms one connected to each of said axles, a cross-rod pivotally connected at its ends to the upper ends of said arms, a fluid-pressure motor between one of said arms and said axle-tree for adjusting the leaning of said wheels, and means comprising an additional fluid-pressure motor connected to said axle-tree for oscillating said steering wheel unit on its pivotal connection to said vehicle frame.

20. In a machine of the class described, the combination with a vehicle frame, of a steering wheel unit comprising an axle-tree connected to said frame, a pair of spaced-apart supporting wheels, axles for said wheels pivotally connected to the ends of said axle-tree on spaced-apart parallel longitudinal axes, upright actuating arms one connected to each of said axles, a cross-rod pivotally connected at its ends to the free ends of said actuating arms, fluid pressure motor mechanism for effecting leaning of the wheels by movement of said arms on said longitudinal axes, and means comprising additional fluid-pressure motor mechanism for effecting steering of the machine by said steering wheel unit.

21. Steering wheel mechanism for vehicles, comprising an axle tree, a pair of spaced-apart supporting wheels, axles for said wheels pivotally connected to the ends of said axle tree on spaced-apart parallel axes, an actuating arm secured to one of said axles, an additional arm attached to the other axle, a cross-rod pivotally connected to both of said arms, a tongue pivotally connected to said axle tree, means comprising a fluid-pressure motor for effecting actuation of said arms and said cross-rod to in turn adjust said wheel axles on said parallel axes, and means comprising a fluid pressure motor connected between said tongue and said axle tree to effect steering by swinging the axle tree on an upright axis relatively to said tongue.

22. Steering wheel mechanism for vehicles, comprising the combination with an axle tree, of a pair of spaced-apart supporting wheels, axles

for said wheels pivotally connected to the ends of said axle tree on spaced-apart parallel axes, actuating arms one connected to each of said axles, a cross-rod pivotally connected at its ends to the free ends of said actuating arms, a tongue pivotally connected to said axle tree, a fluid-pressure motor connected between said axle tree and one of said arms, means comprising a fluid-pressure motor connected between said tongue and said axle tree for effecting swinging of said axle tree on an upright axis relatively to said tongue, and means for effecting control of said first-named fluid-pressure motor to effect leaning of the wheels and for effecting control of the second-named fluid-pressure motor to effect steering of the vehicle.

23. In a machine of the class described, the combination with a vehicle frame, of steering wheel unit comprising an axle tree, a tongue pivotally connected to said axle tree, a pair of hydraulic motors pivotally connected at their ends to said tongue and to said axle tree, and means on said frame and connected to said motors for controlling the operation of the latter from an operator's station on said frame to effect steering of the machine.

24. In a machine of the class described, the combination with a vehicle frame, of a steering wheel unit pivotally connected to the front end of said frame and comprising an axle tree, a tongue pivotally connected to said axle tree, longitudinally extending hydraulic motor mechanism pivotally connected at its forward end to said tongue and connected at its rear end to said axle tree to afford a rigid connection between the tongue and the axle tree when the hydraulic motor mechanism is locked in adjusted position, and means on the vehicle frame connected by flexible hose to said hydraulic motor mechanism to control the operation of the latter and said locking thereof, the construction and arrangement being such that the hauling pull is distributed between the connections of the tongue and the hydraulic motor mechanism to said axle tree.

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