

Oct. 13, 1936.

F. O. DE MILLAR

2,057,089

HYDRAULIC ROAD GRADER

Filed Feb. 20, 1933

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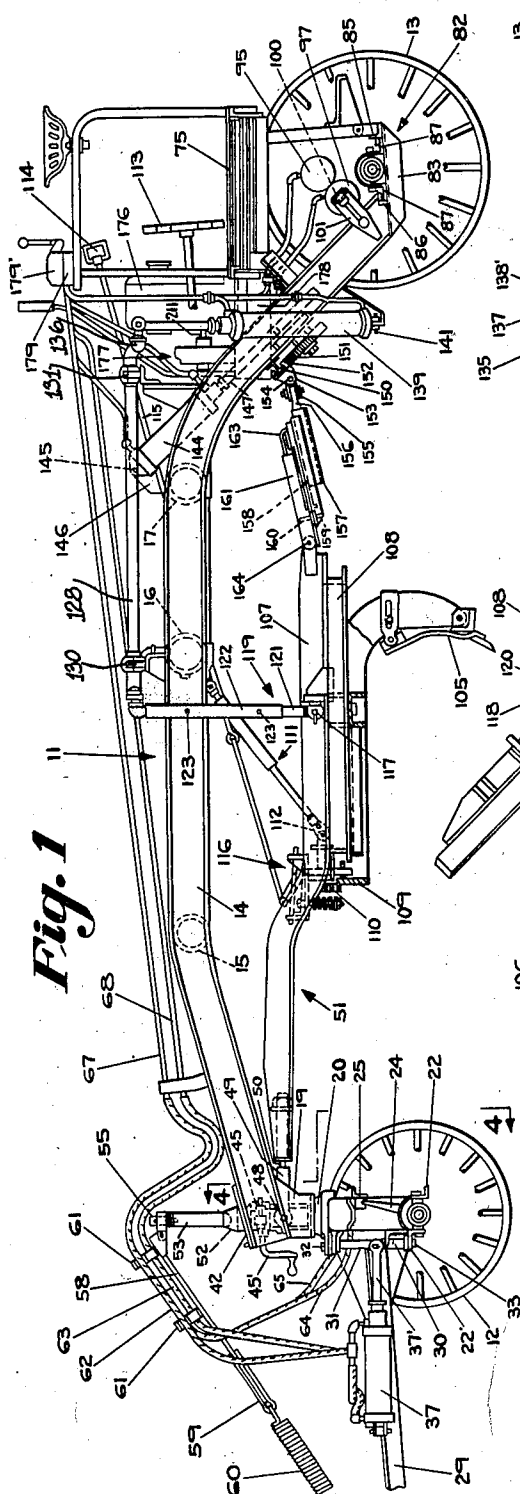


Fig. 1

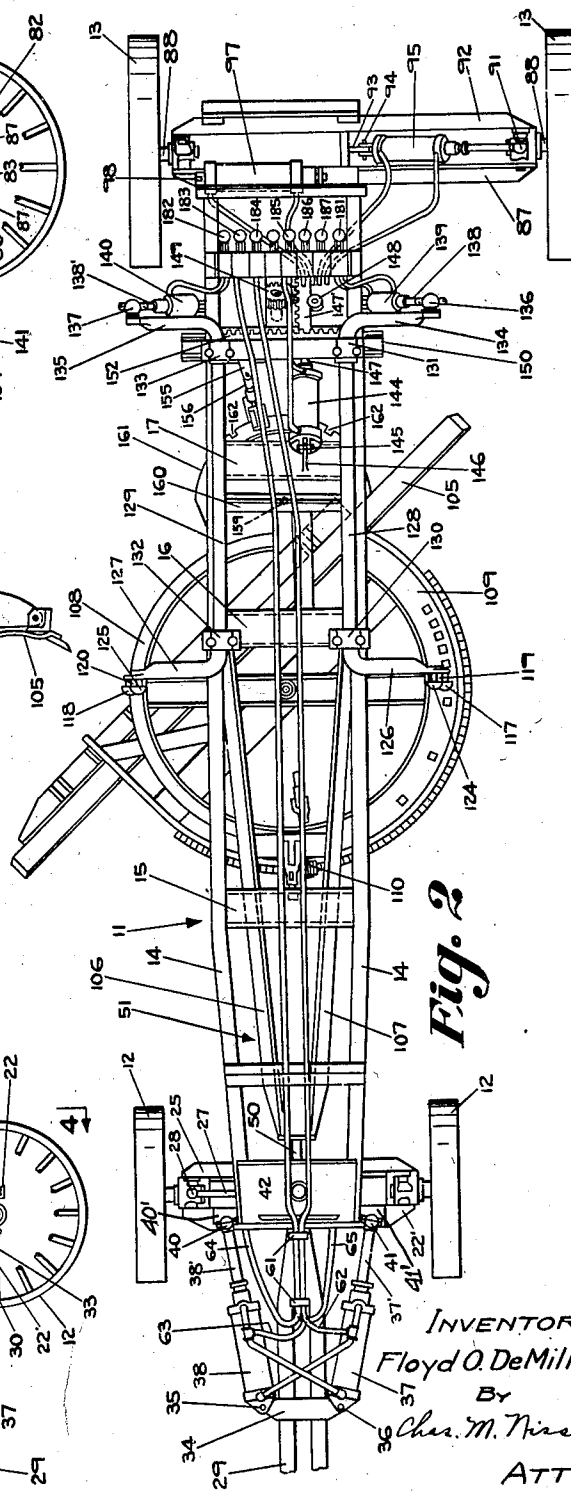


Fig. 2

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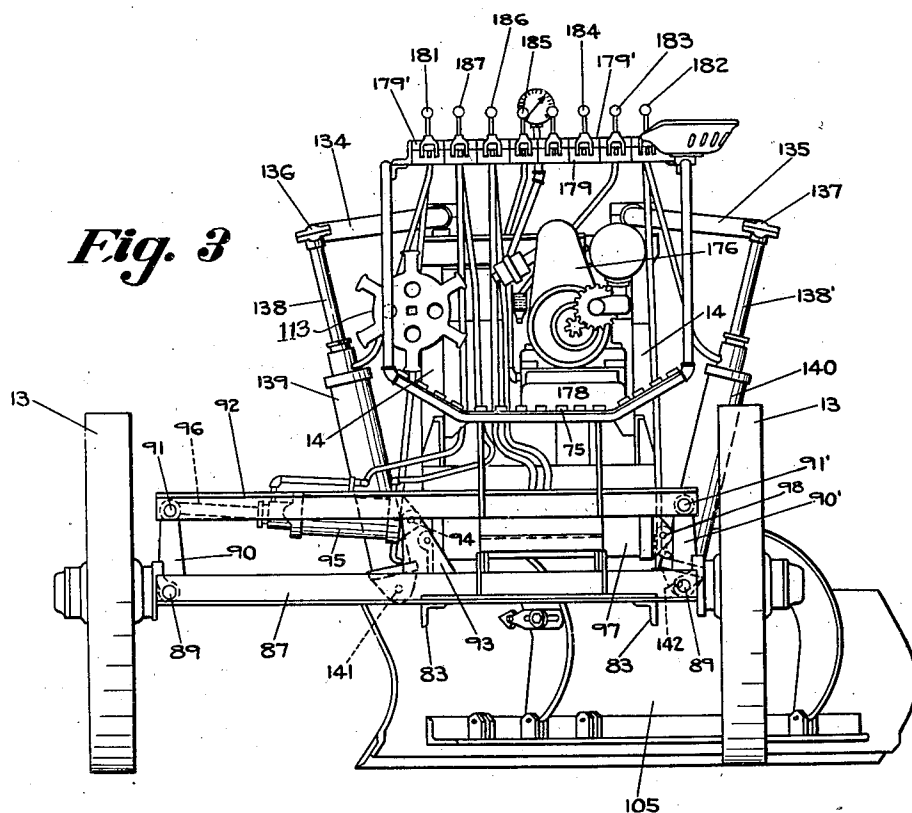
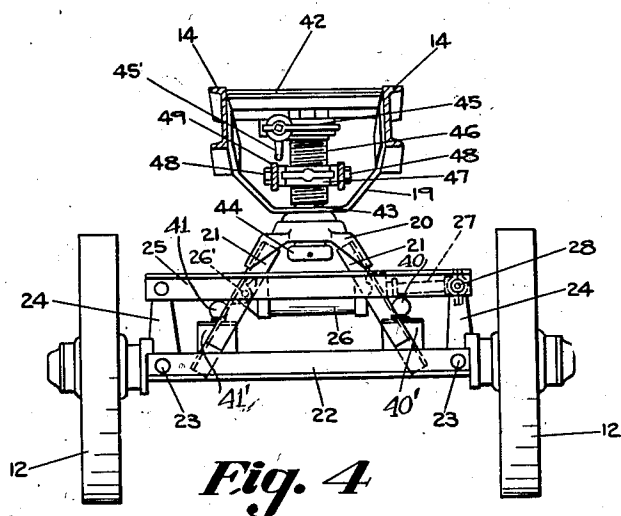
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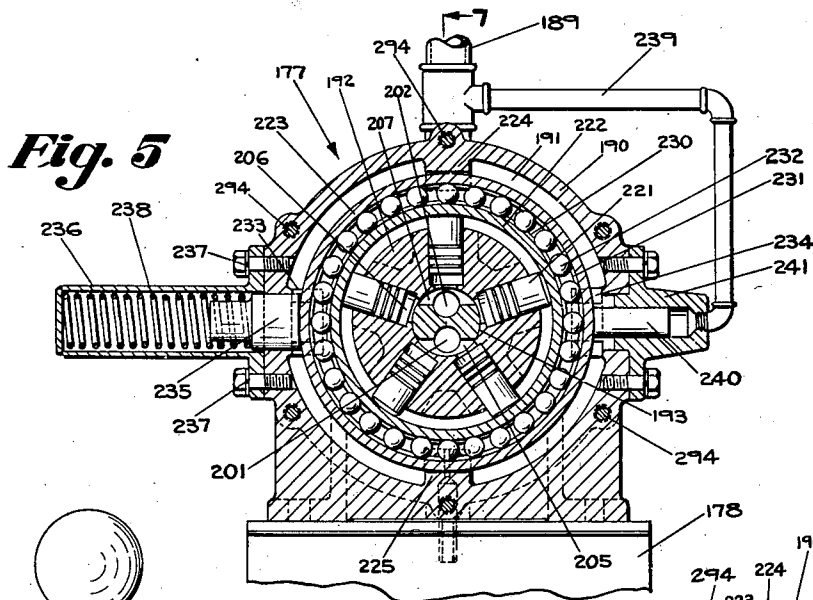
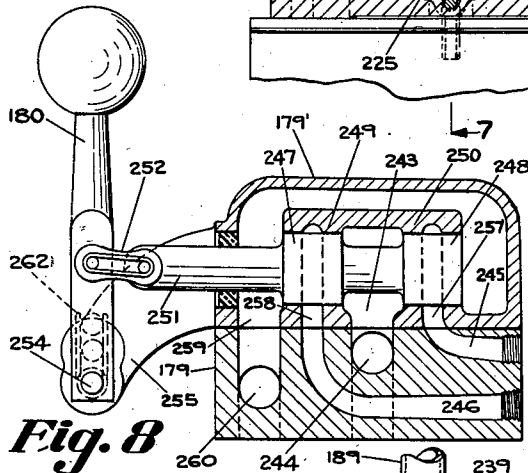
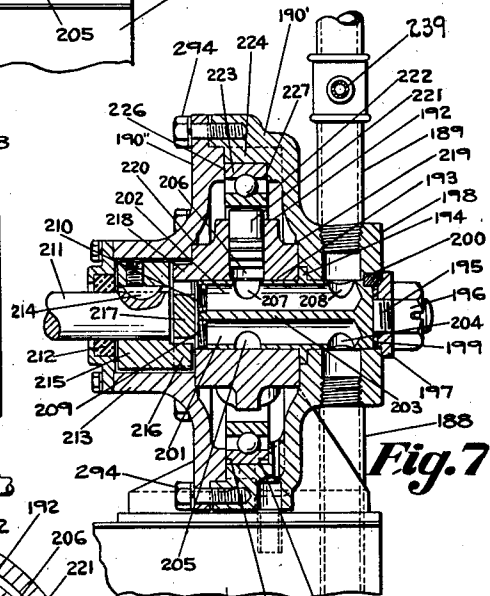
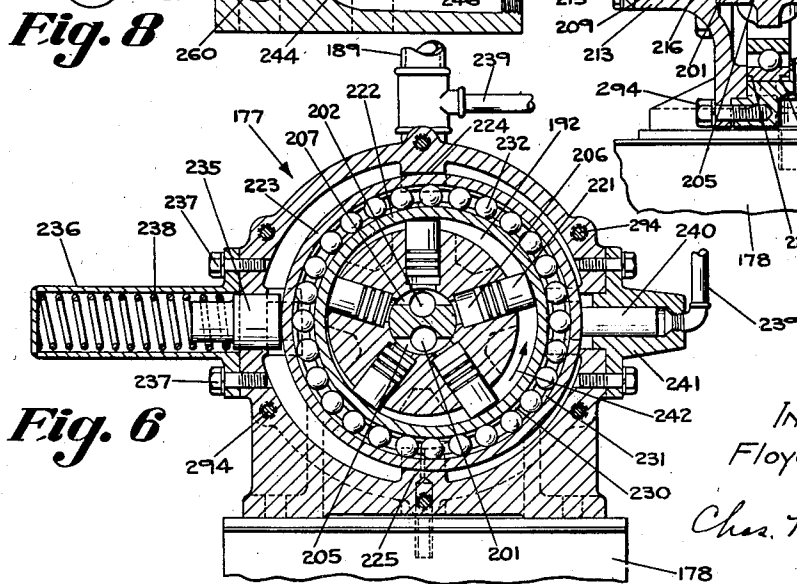
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4 Sheets-Sheet 3



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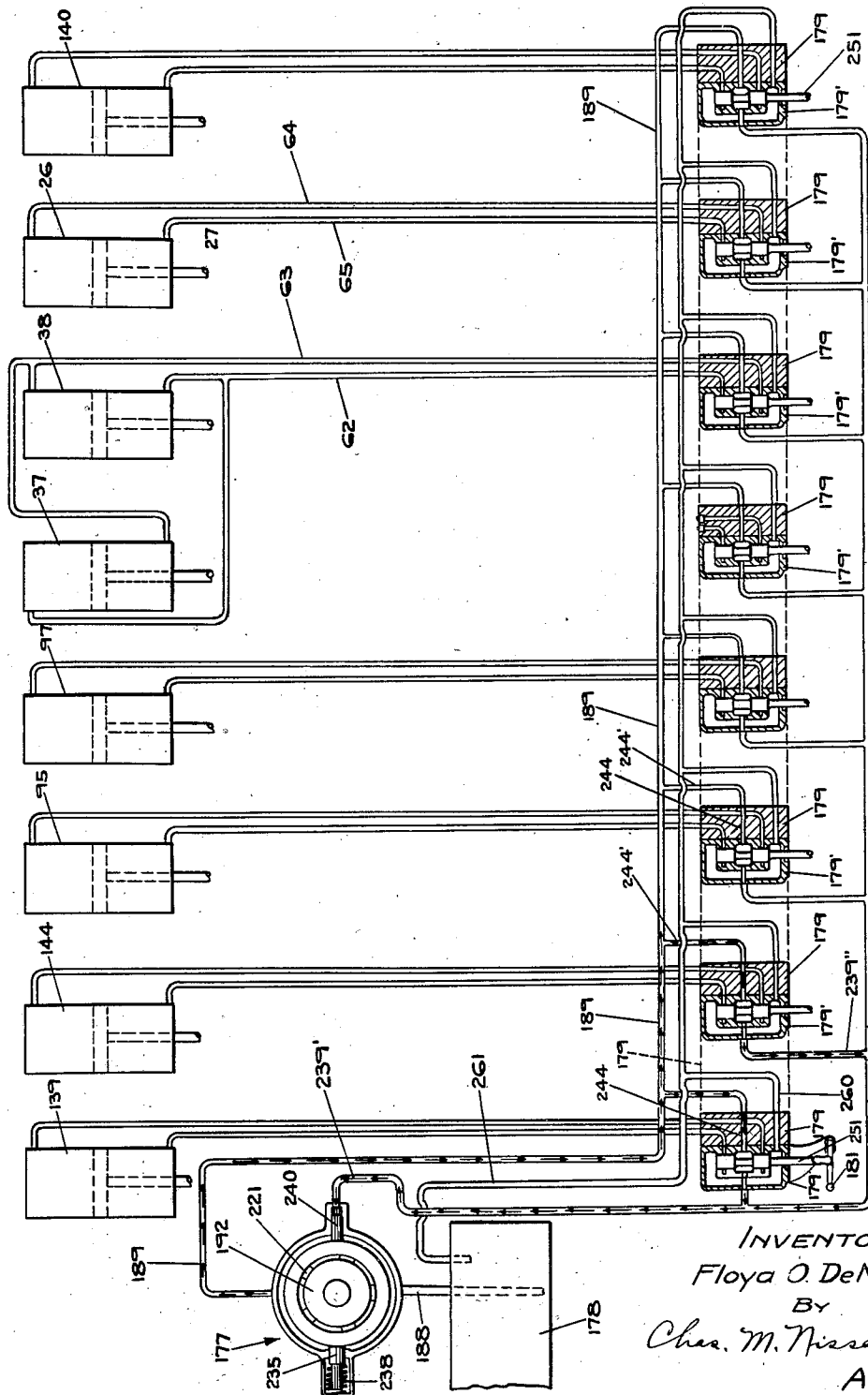
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2,057,089

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4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE

2,057,089

HYDRAULIC ROAD GRADER

Floyd O. De Millar, Granville, Ohio, assignor to
The Gallion Iron Works and Manufacturing
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Application February 20, 1933, Serial No. 657,666

34 Claims. (Cl. 37—156)

My invention relates to the adaptation of fluid-pressure motor-operated adjusting mechanism, particularly of the hydraulic type, to road working and road building machinery, and one of the objects of my invention is the provision of improved and efficient fluid-pressure controlling apparatus for adjusting various parts of such machinery by means of fluid-pressure motors and enabling a rotary fluid-pressure pump to operate continuously at substantially no volume and substantially no load when the motors are inactive.

Another object of the invention is the provision in road-working apparatus of means for controlling from a single operator's station a plurality of hydraulic motors distributed about the machine and automatically limiting the hydraulic pressure which may be exerted in any of the hydraulic motors.

Another object of the invention is the provision in a road grader of controlling apparatus for double acting hydraulic motors distributed about the machine, which controlling apparatus shall include a plurality of valves banked at the operator's station to enable the operator to actuate such valves at such station to effect desired adjustments of various parts of the machine.

Another object of the invention is the provision of hydraulic steering mechanism for a vehicle combined with valve mechanism located at the operator's station at the rear end of the machine for enabling a continuously operated rotary pump to supply pressure whenever desired to effect the steering operation.

A further object of the invention is the provision in a road grader of a plurality of hydraulic motors for adjusting the height and lateral positions of a mold board combined with a plurality of valves at the operator's station at the rear end of the machine to accurately control said hydraulic motors and effect locking thereof in adjusted positions.

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 illustrating one of the adaptations of my improvements;

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

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 sectional elevation of my improved rotary pump in zero position;

Fig. 6 is a view similar to Fig. 5 but with the parts in operating position;

Fig. 7 is a sectional elevation on the line 7—7 of Fig. 5 looking in the direction of the arrows, the pipes being shown in elevation;

Fig. 8 is a sectional elevation of a manual controlling valve; and

Fig. 9 is a diagrammatic piping diagram for the rotary pump and hydraulic motors mounted on the road grader shown in Figs. 1 and 2.

The machine shown in Figs. 1 and 2 comprises a 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 and 17.

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 right-hand vertical arm 24 as viewed in Fig. 4. 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 and therefore when the leaning of the wheels 12 is adjusted they may be locked in adjusted positions 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 a vertical post 31, the upper end of which is pivoted at 32 to the frame 20 and the lower end of which is pivoted at 33 to the front angle 22' of the 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 outer ends of which are pivoted at 40, 41 to clips 40' and 41' secured to the front axle-tree 22 and to the channels 21. While in some instances one double acting hydraulic motor com-

prising 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 45. When the crank 45' is operated, worm-gearing in the housing 45 turns a screw 46 in the nut 47 to which is pivoted at 48, 48 the yoke 49 which in turn is pivoted 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 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 means of any desired construction. To the top of the post 53 is pivotally connected at 55 the inclined plate 58, the forward end of which is secured to the loop 59 and the latter connected to a spring 60 which is connected at its front end to the tongue 29.

Clips 61, 61 are relied on to secure four flexible conduits 62, 63 and 64, 65 to the plate 58. The conduits 62, 63 are connected to the steering motors 37 and 38 and the conduits 64, 65 are connected to the motor 26 for adjusting the leaning of the front wheels 12.

Mounted on a cross-piece 66 on the forward portion of the frame 11 are two metal pipes 67 and 68 which are respectively connected to the flexible conduits 62 and 63. The metal pipes 67 and 68 extend to the rear portion of the frame 11 where they are connected directly to the valve manifold as hereinafter more fully explained.

Secured rigidly to the rear ends of the longitudinal beams 14 is a guide frame 82 comprising angle irons 83, 83 as shown in Fig. 3. 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 at 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 as shown in 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' would be locked in adjusted positions. The leaning of the rear wheels may therefore be adjusted by means of the hydraulic motor 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 may be connected between the frame 11 and the frame 87. As shown in Fig. 2 the cylinder 97 may be pivoted at 98 to the frame 87 and its piston rod pivoted at 100 to the bracket 101 secured to the rear end of one of the beams 14, 14.

Referring now to the 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 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 links 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, are of well-known construction.

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 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 a 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 provision is made for two different length of the hanger 119 there may be more than two holes 123 if desired.

The upper ends of the hangers 119 and 120 are connected by 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 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, 135 which are connected at their outer ends by means of universal joints 136, 137 to the upper ends of the piston rods 138, 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 depending from the beams 14.

The hydraulic motors comprising the cylinders 139 and 140 are preferably double acting under control of valves located at the operator's station. Consequently, when the mold board has been adjusted it may be locked in adjusted position against both up and down movements.

The mold board may be shifted laterally relatively to the frame 11 by means of the hydraulic motor comprising the cylinder 144 and 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 75

147' which is guided by a roller 148 and which meshes with the pinion 149 secured to a shaft to the lower end of which is secured a gear 151 meshing with the transverse rack bar 152. The rack bar 152 is supported by and guided along a transverse rail 150 secured to the lower sides of the beams 14 as shown in Fig. 1.

Between a pair of lugs 153 is pivoted at 154 a clevis 155 and the latter is pivoted on an upright axis to a rod 156 which is adapted to slide in the 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 a plurality of notches 162 for receiving the latch mechanism 163.

A semi-circular frame comprising the cross-piece 160 and the arcuate member 161 is pivoted at 164 to the rear end of the drawbar 51. The latch mechanism may be released manually and the motor 144 operated to move the rack 152 along the guide 150 and thus snap the latch mechanism into another notch 162. Then upon reversing the motor 144, power may be applied to shift the mold board laterally relative to the machine frame 11.

It should be understood that the shifting of the mold board laterally and the adjustment thereof vertically may be effected by hydraulic motor mechanism entirely. The construction is such that the mold board may be moved by means of the hydraulic motor mechanism to high-lift or bank-sloping position on either side of the machine. Since the hydraulic motors are double acting they may be relied upon to lock the mold board at adjusted elevation whether occupying a horizontal position or occupying a high-lift or bank-sloping position.

The above described apparatus for adjusting the mold-board to various positions relative to the main frame, including the extensible hangers and the laterally shifting mechanism, is described and claimed in the application of Franklin E. Arndt, Serial No. 646,997, filed December 13, 1932, for an improvement in Road graders. In the application of Franklin E. Arndt, Serial No. 18,409, filed April 26, 1935 for an improvement in Road graders and as a division of Serial No. 654,901, filed February 2, 1933 for an improvement in Road graders, the hydraulic steering mechanism shown at the left hand ends of Figs. 1 and 2 of the accompanying drawings, is disclosed and claimed, but the claims hereto appended are directed to improvements not disclosed in any of said Arndt applications.

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 machine frame 11 as shown in Fig. 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 banked in a single position adjacent to the operator's station at the platform 75 which is located at the rear end of the machine. Inasmuch as the machine shown in Fig. 1 includes six adjusting hydraulic motors and one double steering hydraulic motor mechanism, I have shown seven controlling valves each having the construction shown in Fig. 8 and each comprising a valve housing 179' mounted on a manifold 179. Each valve may be manually operated by means of a lever 180. By referring to Figs. 2 and 9 it will be seen that the end knobs 181 and 182 may be con-

nected to levers 180 for operating valves to control the motors 139 and 140. The knob 183 may be connected to the front leaning wheel motor 28. The knob 184 may be connected to the valve for controlling the motors 37 and 38 to operate them in opposite directions so that whenever the piston rod 37' is moved in one direction, the other piston rod 38' may be moved in the opposite direction.

The knob 185 may be connected to the valve for controlling the motor 144. The knob 186 may be connected to the valve for controlling the rear shifting motor 97. The knob 187 may be connected to the valve for controlling the rear leaning wheel motor 95.

The rotary pump 177 is connected by means of the suction pipe 188 to the supply tank 178. Since the pump 177 is operated continuously by the internal combustion engine the liquid is under pressure in the pipe 189. Inasmuch as it is desirable to operate the pump at substantially no volume and load when all of the motor controlling valves are closed, a branch pipe 239 is connected to the supply pipe 189 as shown in Fig. 5 for enabling the fluid-pressure in the pipe 189 to operate mechanism to hold the pump in zero position.

Assuming that the manually operated controlling valves on the manifold 179 at the operator's station are all closed, the rotary pump 177 will have all its moving parts concentrically arranged as shown in Fig. 5 and therefore the engine may continue to operate at very little or no load since the pump is in zero position. Consequently, the pump may be driven continuously with the consumption of a minimum amount of fuel during operation of the road grader with the various devices thereon locked and held in adjusted positions.

The pump 177 shown in Fig. 5 comprises a housing 190 mounted on the tank 178 which may be secured to the beams 14, 14 of the road grader. Within the chamber 191 in the housing 190 are mounted the rotating parts of the pump comprising a multiple cylinder block 192 journaled on the bearing 193. The pump housing 190 preferably consists of two sections 190' and 190'' secured together by means of the cap screws 294 as shown in Fig. 7.

The bearing 193 intermediate its ends is provided with a collar 194 adapted to fit into an annular seat at the inner center of the face of the section 190'. The right-hand end of the bearing 193 is provided with a screw-threaded rod 195 adapted to receive a nut 196. A circular clamping plate 197 engages at its peripheral edge the outer face of the circular support 198 and a washer 199 intervenes between the clamp plate 197 and the right-hand end of the bearing 193. By tightening the nut 196 the collar 194 is clamped to its seat and in order to prevent turning of the bearing 193 from its desired location a key 200 fits in ways in the upper central portion of the opening in the support 198 and in the upper side of the bearing 193 as shown in Fig. 7.

The bearing member 193 is provided with two longitudinal chambers 201 and 202 separated from each other by the horizontal partition 203. The lower chamber 201 is provided with an intake port 204 in communication with the suction pipe 188 and with a discharge port 205 adapted to communicate successively with the radial cylinders 206 in the rotary cylinder block 192. The upper chamber 202 is provided with an intake port 207 which is adapted to communicate successively with cylinders 206 and with a discharge port 208 which communicates with the discharge

pipe 189. The passageways or chambers 201 and 202 may be formed by boring the bearing 193 and closing the left-hand ends of the cylindrical recesses by means of the screw plugs 209, 210. The ports 204, 205 and 207, 208 may be formed by tangential milling.

The driving shaft 211 which is adapted to be connected to the continuously operating internal combustion engine 176 is journaled in a bearing 212 secured to the left-hand end of the cylindrical support 213 at the central portion of the pump housing section 190'. Secured to the inner end of the shaft 211 by means of a key 214 is a power transmitting coupling device 215 which is provided with an eccentric tooth 216 for engaging a flexible coupling 217 of leather or other suitable material. This coupling is provided with a plurality of spaced-apart radial arms and between two of such arms diametrically opposite the tooth 216 is an eccentric tooth 218 which projects from the rotary cylinder block 192. It will thus be seen that when the engine 176 rotates the shaft 211 the cylinder block 192 will be likewise rotated on the bearing 193 to move the lower cylinders into communication with the port 205 and the upper cylinders into communication with the port 207 as shown in Fig. 5. Accuracy of such communication is assured by the end peripheral edges of the cylinder block fitting annular bearing seats at 219 and 220 on the inner faces of the pump housing sections 190' and 190''.

Fitting in the cylinders 206 for reciprocation therein is a plurality of pistons 221 the outer ends of which bear against an abutment ring 222. Spaced from the ring 222 and concentric therewith is another ring 223 of larger diameter which is mounted between the top abutment 224 and the bottom abutment 225. As shown in Fig. 7 the outer ring 223 at its upper side is also confined against movement axially of the cylinder block 192 by the slide seats 226 and 227 at the upper inner sides of the pump housing sections 190' and 190''. The lower side of the outer ring 223 is also confined against axial movement relatively to the cylinder block 192 by the slide seats 228 and 229 at the lower inner sides of the pump housing sections 190' and 190''.

A ball bearing between the rings 222 and 223 is formed by the races 230, 231 in which travel the plurality of balls 232. This ball bearing serves to hold the inner ring 222 in adjusted position relative to the cylinders 221 and against axial movement relatively to the cylinder block 192. Such ball bearing also permits the outer ring to be held stationary while the inner ring rotates with the pistons 221. If desired, only one ring may be used in which event the outer ends of the pistons will slide along the inner surface of the ring but I prefer to employ the construction as shown to greatly minimize the wear between the outer ends of the pistons and the ring engaged thereby.

The outer ring 223 at its diametrically horizontal opposite sides fits between slide bearings 233 and 234 at the corresponding inner sides of the pump housing 190. While the ball bearing unit comprising the concentric rings 222 and 223 cannot move up or down relatively to the pump housing 190 it may move to a limited extent diametrically along the slide bearings 233 and 234.

Bearing against the left-hand side of the ball bearing unit as viewed in Figs. 5 and 6 is a plunger 235 slidable in an opening in the housing 190. A casing 236 secured at 237 to the housing

190 houses a spring 238 which acts on the plunger 235 to press it constantly against the outer ring 223.

Bearing against the right-hand side of the ball bearing unit as viewed in Figs. 5 and 6 is a plunger 240 slidable horizontally in the bearing 241. Hydraulic pressure in the branch pipe 239 is adapted to act on the right-hand end of the plunger 240 to force it to the left against the action of the spring-pressed plunger 235. Fig. 5 shows the position of the parts for zero operation of the pump since in this position the ball bearing unit is concentric with the axis of rotation of the cylinder block 192. Fig. 6 shows the position of the parts when the pressure in the pipe 239 has been sufficiently reduced to permit the spring 238 to act to move the ball bearing unit to its eccentric position where the inner ring 222 will act as an abutment to effect reciprocation of the pistons upon rotation of the cylinder block 192.

Assuming the ball bearing unit is in its eccentric position and the cylinder block 192 rotating anti-clockwise as indicated by the arrow 242 centrifugal force tends to throw the pistons outwardly against the inner ring 222. The lower cylinders being in communication through the port 205, passageway 201 and port 204 with the suction pipe 188 liquid will be drawn into the lower cylinders as the pistons move outwardly. As each cylinder is cut off from communication with the port 205 it ceases to move outwardly and as soon as each cylinder communicates with the upper port 207 the corresponding piston is forced inwardly by the inner eccentric ring 222. When such inward movement occurs the liquid is forced into the port 207 along the passageway 202 and out through the port 208 into the supply pipe 189. It should be noted that when each piston is moving in or out while horizontal, the piston is in a neutral position, the inner end of the cylinder being closed.

When the pistons are moving upwardly the arc between their ends lengthens and therefore there is a small amount of sliding movement between the outer ends of the upwardly moving pistons and the inner ring 222. When the pistons move toward the left at the top such arc shortens and the frictional pressure on the outer ends of the pistons gradually increases. Consequently, the piston slides anti-clockwise relatively to the inner ring both when the arc lengthens and when it shortens thereby causing the ring 222 to lag slightly behind the cylinder block and pistons. The sliding of the outer ends of the pistons is very much smaller than when a stationary abutment ring is used.

Fig. 9 is a piping diagram showing a series of hand-operated valve devices mounted on the manifold 179 and each having the construction shown in Fig. 8. The valve housing 179' is provided with a port 243 which communicates with the supply passageway 244 which is common to all of the manual valve devices shown in Fig. 9. In this view I have shown the supply pipe 189 connected by the branch pipes 224' to the supply passages 244. Under each valve housing 179' is a pair of passageways 245, 246 which are adapted to be connected to a pair of pipes leading to a hydraulic motor. For instance, in Fig. 9 the pipes 62, 63 are connected to the motors 37, 38 and the pipes 64, 65 are connected to the motor 26.

The valve shown in Fig. 8 comprises connected pistons 247, 248 slidable in bearings 249, 250 and 75

provided with an actuating rod 251. The outer end of this rod is connected by means of the link 252 to a vertical lever 180, the lower end of which is pivoted at 254 to the bracket 255 secured to the housing 179'.

When the lever 180 is pushed to the right as viewed in Fig. 8 the supply passageway 244 is connected through the port 257 to the passageway 245 and thence to a hydraulic motor at one side of the piston therein. At the same time the other side of the piston is connected through the passageway 246 and the port 259 to the discharge passageway 260 which is connected to the pipe 261 leading back to the tank 178 as shown in Fig. 9.

The system illustrated in Fig. 9 shows a branch pipe 239' connected by the pipes 239'' to the valve housing 179' through a port 244 extending through the manifold 179. The manifold 179 is connected by a pipe 244' to the supply pipe 189, which leads to the pump 177. Fluid pressure from pipe 189 acts on the plunger 240 to move the rings 222 and 223 into neutral position, as previously described, when the valves are closed. Therefore when all of the levers 180 are released and the springs 262 hold the valves in closed position the plunger 240 is pushed to the left as shown in Fig. 5 and the rotary pump although continuing to rotate does not cause any flow of liquid.

With the system as illustrated in Fig. 9, the connection from supply pipe 189 to the plunger 240 will be through one of the non-operated hand valves, and the branch pipe 239 may be omitted. However, if said branch pipe 239 is employed, then branch pipes 239'' may be omitted.

When any hand valve shown in Fig. 9 is opened the relief of hydraulic pressure on the plunger 240 is sufficient to permit the spring 238 to move the ball bearing unit to the right as viewed in Fig. 6 and hold it there. The pump then operates to produce sufficient hydraulic pressure to operate the hydraulic motor to which the manual valve is connected. When the piston in the operating motor reaches the end of its stroke and its controlling valve is still open, assuming all of the other motors locked by closure of their valves, the hydraulic pressure in the branch pipes 239', 239'' will be sufficient to set the rotary pump automatically at zero. When this occurs the pressure in the branch pipes 239', 239'' will be confined so as to lock the pump in such zero position.

It will thus be seen that in providing the automatic mechanism for shifting the ball bearing unit to its concentric position the engine may continue to rotate the pump with very little power and this automatic mechanism protects the motors as well as the pump without the use of any check valves or pressure regulators.

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 road working apparatus, the combination with a portable frame, of a plurality of adjustable devices carried thereby, a plurality of hydraulic motors respectively connected to said adjustable devices, a plurality of valves one for each of said hydraulic motors, a rotary pump,

means for continuously operating said pump, and means adapted always to act directly on the pump to set it to rotate at substantially no load when said motors are not operating.

2. In a road grader, the combination with a portable frame, of a road working implement carried thereby, means comprising two hydraulic motors for adjusting said road working implement and locking the same in adjusted position, valves for controlling said motors, mechanism for supporting said valves at a single operator's station, a rotary pump, an internal combustion engine connected to said pump to continuously operate the same, and mechanism acting on the pump to set the same to operate at substantially no load when both of said valves are closed and the road working implement is locked in adjusted position and to set the same to operate to produce sufficient hydraulic pressure to cause either motor to respond to its valve when the latter is actuated.

3. In a road grader, the combination with a vehicle, of a plurality of adjustable devices mounted thereon including an adjustable road working implement, a plurality of double acting hydraulic motors connected to said devices to adjust the same, a plurality of valves one for each of said motors, means comprising a manifold to bank said valves in one position adjacent to the operator's station, a rotary pump connected through said valves to said motors, and means acting on said pump to set the same at zero when said valves are closed and to automatically produce sufficient fluid-pressure to operate any motor when its valve is opened.

4. In a road working machine, the combination with a vehicle, of adjustable mechanism carried thereby, a fluid-pressure motor connected to said mechanism to adjust the same, a valve for controlling said fluid-pressure motor, a fluid-pressure pump, means for continuously driving said pump, and means adapted to move an element of said pump always to enable said pump to be driven with substantially no load thereon whenever said valve is closed.

5. In a road working machine, the combination with a vehicle, of adjustable mechanism carried thereby, a hydraulic motor connected to said mechanism to adjust the same, a valve for controlling said motor, a rotary pump, a continuous pressure conduit completely filled with liquid connecting said valve and pump, an engine for continuously driving said pump, and means responsive to hydraulic pressure for controlling said pump always to operate with substantially no load thereon whenever said motor is inactive.

6. In a road machine, the combination with a vehicle, of means comprising a hydraulic motor to steer the same, a valve for controlling said motor, a pump, an engine connected to said pump to continually drive the same, and means responsive to hydraulic pressure to enable said pump to operate at substantially no load when said motor is inactive.

7. In a road machine, the combination with a vehicle, of means comprising a double acting hydraulic motor to steer the same, a valve to control said motor, a manual lever to operate said valve to open positions, automatic means for moving said valve to closed position when released, a pump, an engine to continually drive said pump, and hydraulic pressure responsive mechanism to enable said pump to be driven by said engine with substantially no load on said

pump when said valve is closed and said hydraulic motor is locked in inactive position.

8. In a road working machine, the combination with a vehicle, of adjustable mechanism carried thereby, a plurality of double acting hydraulic motors connected to said mechanism to adjust the same, a plurality of valves one for each of said motors, a pump, an engine for continuously driving said pump, piping connections between the pump and the valves and between the latter and said motors, said piping connections being constantly fully filled with liquid, and hydraulic pressure responsive mechanism to enable said pump to be driven with substantially no load thereon when said valves are closed but causing said pump to operate any one of said motors immediately after its valve is opened.

9. In a road working machine, the combination with a vehicle, of adjustable mechanism carried thereby, a double acting hydraulic motor connected to said mechanism to adjust the same in opposite directions, a valve for controlling said motor, a pump, means to continuously drive said pump, hydraulic pressure responsive mechanism for controlling said pump to rotate with substantially no load thereon when said valve is closed and to produce hydraulic pressure to operate said motor in either direction when said valve is open in either of two positions, and piping connections between the pump and the valve and between the valve and the motor kept constantly filled with liquid to secure quick response of said motor to the opening of said valve.

10. In a road working machine, the combination with a vehicle, of adjustable mechanism thereon, a hydraulic motor connected to said mechanism to adjust the same, a valve at the operator's station and connected to said motor to control the same, a lever at the operator's station to enable the operator to fully open the valve accurately at any time, automatic means for completely closing the valve accurately when said lever is released, a pump, means for continuously driving said pump, hydraulic pressure responsive mechanism for controlling said pump to operate with substantially no load thereon when said valve is closed, and piping connections maintained completely filled with liquid at all times to secure quick response of said motor and said pump to the operation of said valve.

11. In a road working machine, the combination with a vehicle, of adjustable mechanism carried thereby, a fluid-pressure motor for adjusting said mechanism, said motor comprising a cylinder and a piston, a valve for controlling said motor, a pump, means for continuously driving said pump, and fluid-pressure responsive mechanism acting on said pump automatically to set the same for continued operation at substantially no load while maximum pressure in said cylinder is maintained after the piston reaches the limit of its stroke.

12. In a road grading machine, the combination with a wheel supported frame, of a road working implement, adjusting mechanism therefor comprising two double acting hydraulic motors, valve mechanism for controlling said hydraulic motors, an hydraulic pump, means for continuously driving said pump, and hydraulic pressure responsive mechanism for automatically relieving the load on said pump when said road working implement meets an obstruction in its adjusting movement.

13. In a road grader, the combination with a vehicle, of a mold board adjustably mounted

thereon, means comprising a plurality of double acting hydraulic motors for adjusting the height of the lateral position of said mold board relative to said vehicle, valve mechanism for controlling said motors, a hydraulic pump, means for driving said pump continuously, and hydraulic pressure responsive mechanism for limiting the hydraulic pressure on any of said motors when said mold board meets an obstruction or when such motor reaches the limit of its stroke and for enabling said pump to be driven at substantially no load when said valve mechanism is closed and said motors are locked to hold the mold board in adjusted position.

14. In a road grader, the combination with a vehicle, of a mold board adjustably mounted thereon, a plurality of motors connected to said mold board to adjust the latter and lock the same in adjusted position, valve mechanism for controlling said motors, a hydraulic pump, means to continuously operate said pump, and automatic hydraulic pressure responsive mechanism acting on said pump to limit the pressure on any motor when it reaches the limit of its stroke but holding the motor at its limit until said valve mechanism is closed whereupon such motor will be locked at such limit.

15. In a road grader, the combination with a vehicle, of means comprising a hydraulic motor for steering said vehicle, a road working implement, means comprising hydraulic motor mechanism for adjusting said road working implement relative to said vehicle, valve mechanism for controlling said hydraulic motor and said hydraulic motor mechanism, a pump, means for continuously driving said pump, and automatic hydraulic pressure mechanism for limiting the hydraulic pressures exerted on said hydraulic motor and in said hydraulic motor mechanism and to enable said pump to be driven with substantially no load thereon when said valve mechanism is closed.

16. In a road grader, the combination with a vehicle, of a mold board adjustably mounted thereon, two hydraulic motors each comprising a cylinder and a piston connected to said mold board to adjust the elevation and inclination thereof relative to said vehicle, a plurality of valves one for each of said motors and connected to the latter to lock the same in stationary position when said valves are closed, a hydraulic pump, means for continuously driving said pump, and automatic hydraulic pressure responsive mechanism acting directly on said pump to limit the hydraulic pressure in said motor when said mold board meets an obstruction in its adjusting movement and to materially reduce the load on the pump when said valves are closed to lock the mold board in adjusted position.

17. In a road grader, the combination with a vehicle comprising a supporting frame and a pair of front wheels and a pair of rear wheels, of means comprising hydraulic motors for adjusting the leaning of the front wheels and for adjusting the leaning of the rear wheels, means comprising a hydraulic motor for shifting the rear end of said frame laterally relative to said rear wheels, a mold board, means comprising a hydraulic motor for shifting the mold board laterally, means comprising a pair of hydraulic motors for adjusting the elevation of said mold board, a plurality of controlling valves for said motors, means for banking said valves in one position adjacent to the operator's station, manual mechanism for operating said valves individually at said station, a hydraulic pump, and hydraulic pressure respon-

sive mechanism for controlling said pump to limit the pressure exerted thereby in any of said motors and to enable said pump to be driven with substantially no load thereon when all of said valves are in their closed positions.

18. In road working apparatus, the combination with a portable frame, of a plurality of adjustable devices carried thereby, a plurality of hydraulic motors respectively connected to the said adjustable devices, a plurality of valves one for each of the hydraulic motors, a rotary pump, means for continuously operating the pump, and means operable responsively to hydraulic pressure set up by closing the said valves for acting directly on the pump to set it always to rotate at substantially no load when the motors are not operating.

19. In road working apparatus, the combination with a portable frame, of a plurality of adjustable devices carried thereby, a plurality of hydraulic motors respectively connected to the said adjustable devices, a plurality of valves one for each of the hydraulic motors, a rotary pump, a plunger operable responsively to hydraulic pressure set up by closing the said valves for acting on the pump to set it to rotate at substantially no load when the motors are not operating, the plunger being released upon relief of the hydraulic pressure upon opening of any one of the valves to enable the pump to move to operative position, and resilient means acting in opposition to the plunger to automatically set the pump in operative position upon release of the plunger to thereby pump fluid under pressure to the motors when any of the valves are open.

20. In road working apparatus, the combination with a portable frame, of a plurality of adjustable devices carried thereby, a plurality of hydraulic motors respectively connected to the said adjustable devices, a plurality of valves one for each of the hydraulic motors, a rotary pump, a plunger operable responsively to hydraulic pressure set up by closing the said valves for acting on the pump to set it to rotate at substantially no load when the motors are not operating, the plunger being released upon relief of the hydraulic pressure upon opening of any one of the valves to enable the pump to move to operative position, and a spring acting on the pump in opposition to the plunger to automatically set the pump in operative position upon release of the plunger, to thereby pump fluid under pressure to the motors when any of the valves are open.

21. A road working machine comprising, the combination with a wheeled supporting frame including a steering wheel, of means for operating said steering wheel to a desired steering position and maintaining it in said position, said means comprising a hydraulic system including a continuously operating pump, and hydraulic pressure responsive means acting on said pump to operate the latter at substantially no load when no useful work is being performed thereby.

22. A road working machine comprising, the combination with a wheeled supporting frame including a steering wheel, of means for operating said steering wheel to a desired steering position and maintaining it in said position, said means comprising a hydraulic motor system including means for trapping hydraulic fluid in both the intake and outlet of the motor thereof, a continuously operating pump, and means for adjusting an element of said pump thereby reducing the fluid output of said pump to substantially zero when said motor is in a fixed position.

23. A road working machine comprising, the combination with a wheeled supporting frame, of a hydraulic motor system for adjusting a wheel to a desired position and maintaining it in said position, said system comprising means for trapping hydraulic fluid in both the intake and outlet of the hydraulic motor, a constantly running pump, and means for adjusting an element of said pump thereby reducing the fluid output of said pump to substantially zero when said motor is in a fixed position.

24. A road working machine comprising, the combination with a wheeled supporting frame, of means for adjusting said wheel to a desired position and maintaining it in said position, said means comprising a hydraulic motor system including a pump and a hydraulic motor, means for continuously driving said pump, and means for adjusting an element of said pump to reduce the fluid output of said pump to substantially zero when said motor is in a fixed position.

25. A road working machine comprising, the combination with a supporting frame including a pair of rear supporting wheels adapted for lateral adjustment, of means for adjusting said wheels to a desired lateral position and maintaining them in said position, said means comprising a hydraulic motor system including a pump and a hydraulic motor, means for continuously driving said pump, and means to reduce the fluid output of said pump to substantially zero when said motor is in a fixed position.

26. A road working machine comprising, the combination with a wheeled supporting frame including a pair of rear supporting wheels adapted for lateral adjustment, of a hydraulic motor system for adjusting said wheels laterally to a desired position and maintaining them in said position, said system comprising means for trapping hydraulic fluid in both the intake and outlet of the hydraulic motor, a constantly running pump, and means for reducing the fluid output of said pump to substantially zero when said motor is in a fixed position.

27. A road working machine comprising, the combination with a supporting frame including a pair of supporting wheels adapted for tilting adjustment, of means for adjusting said wheels to a desired tilted position and maintaining them in said position, said means comprising a hydraulic motor system including a pump and a hydraulic motor, means for continuously driving said pump, and means to reduce the fluid output of said pump to substantially zero when said motor is in a fixed position.

28. A road working machine comprising, the combination with a wheeled supporting frame including a pair of supporting wheels adapted for tilting adjustment, of a hydraulic motor system for adjusting said wheels to a desired tilted position and maintaining them in said position, said system comprising means for trapping hydraulic fluid in both the intake and outlet of the hydraulic motor, a constantly running pump, and means for reducing the fluid output of said pump to substantially zero when said motor is in a fixed position.

29. A road working machine comprising, the combination with a supporting frame including a pair of rear supporting wheels adapted for adjustment, of means for adjusting said wheels to a desired position and maintaining them in said position, said means comprising a hydraulic motor system including a pump and a hydraulic motor, means for continuously driving said pump,

and means to reduce the fluid output of said pump to substantially zero when said motor is in a fixed position.

30. A road working machine comprising, the combination with a wheeled supporting frame including a pair of rear supporting wheels adapted for adjustment, of a hydraulic motor system for adjusting said wheels to a desired position and maintaining them in said position, said system comprising means for trapping hydraulic fluid in both the intake and outlet of the hydraulic motor, a constantly running pump, and means for reducing the fluid output of said pump to substantially zero when said motor is in a fixed position.
31. A road working machine comprising the combination with a supporting frame including a pair of rear supporting wheels adapted for lateral adjustment, of means for adjusting said wheels to a desired lateral position and maintaining them in said position, said means comprising a hydraulic motor system including a continuously operating pump, a hydraulic motor, and a control valve therefor; and means responsive to hydraulic pressure to enable said pump to operate at substantially no load when said motor is inactive.

32. A road working machine comprising the combination with a supporting frame including a pair of rear supporting wheels adapted for tilting adjustment, of means for adjusting said wheels to a desired tilted position and maintaining them in said position, said means comprising a hydraulic motor system including a continuously operating pump, a hydraulic motor and a

control valve therefor; and means responsive to hydraulic pressure to enable said pump to operate at substantially no load when said motor is inactive.

33. A road working machine comprising the combination with a supporting frame, of means requiring adjustment during the operation of said machine to perform a road working operation, a hydraulic motor for operating said means and holding it fixed in adjusted position, a pump connected to said motor, means for effecting the operation of said pump on said motor including a high pressure conduit completely filled with liquid connecting them together, and means responsive to hydraulic pressure to cause said pump always to operate at substantially no load whenever said motor is not in the act of effecting the aforesaid adjustment.

34. A road working machine comprising the combination with a supporting frame, of means requiring adjustment during the operation of said machine to perform a road working operation, a hydraulic motor connected to a supply pipe for operating said means, a pump connected to said supply pipe, said supply pipe being completely filled with liquid between said motor and said pump, means for controlling the operation of said motor by effecting control of the flow into said supply pipe from said pump, and means responsive to hydraulic pressure in said supply pipe to cause said pump always to operate at substantially no load whenever said motor is not in the act of effecting the aforesaid adjustment.

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