June 24, 1941. F. E. ARNDT 2,247,007

ROAD GRADER

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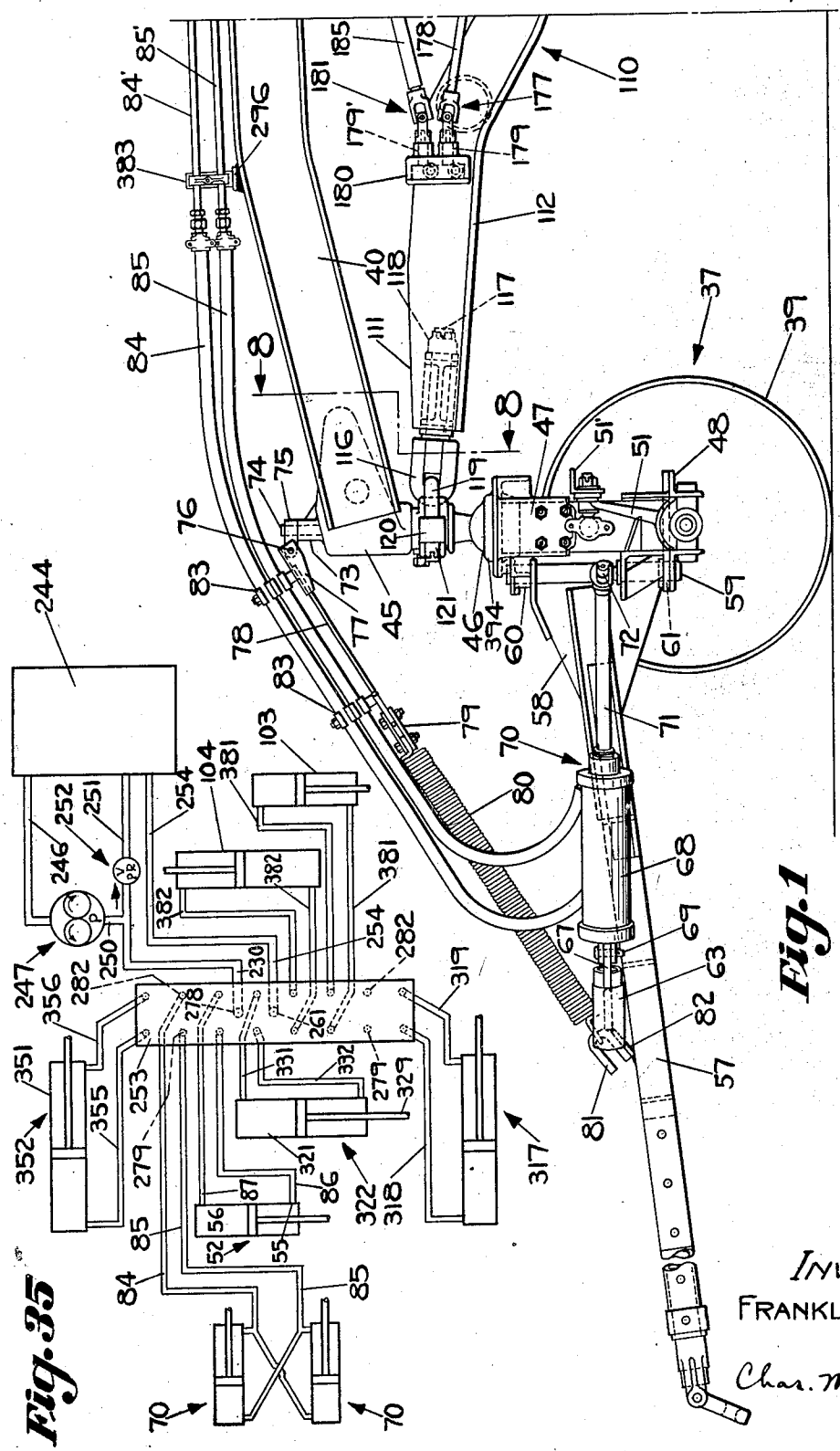


Fig. 1



Fig. 35

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ROAD GRADER

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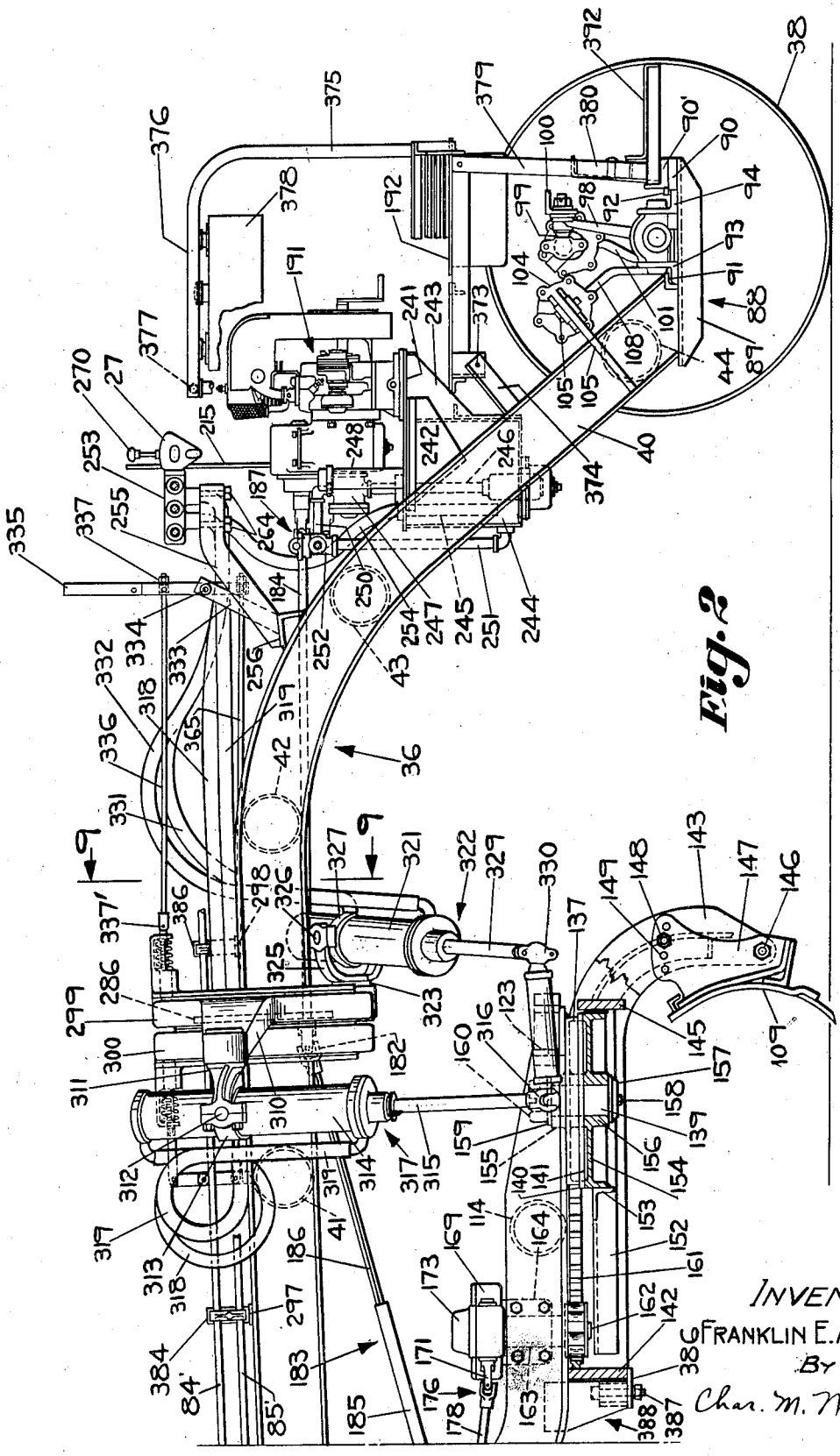


Fig. 2

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June 24, 1941. F. E. ARNDT 2,247,007

ROAD GRADER

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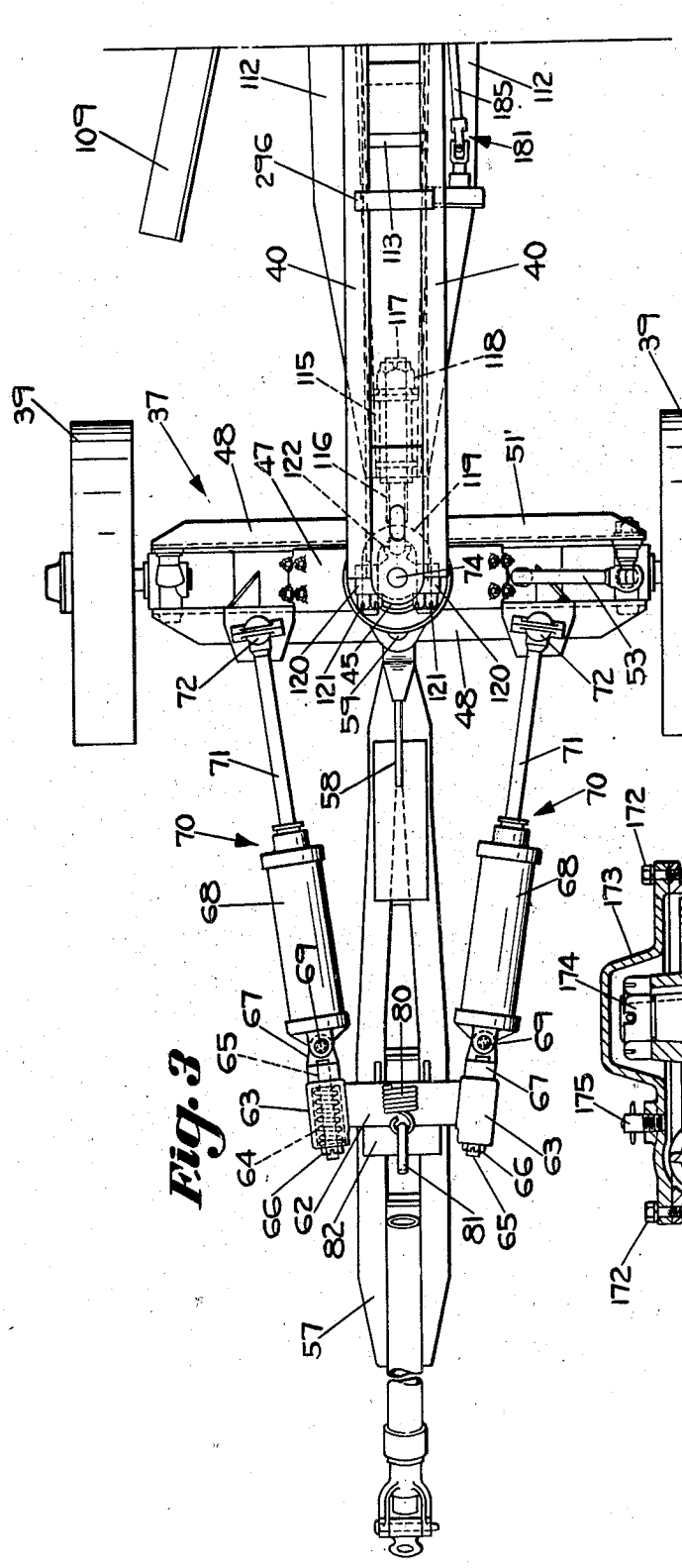


Fig. 3

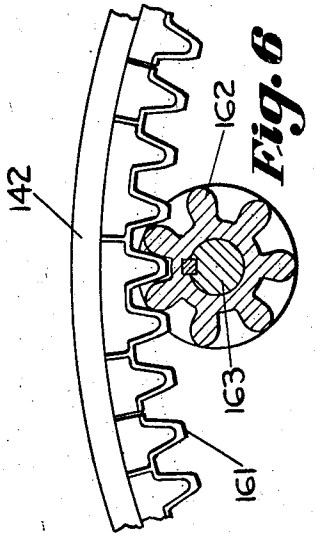


Fig. 6

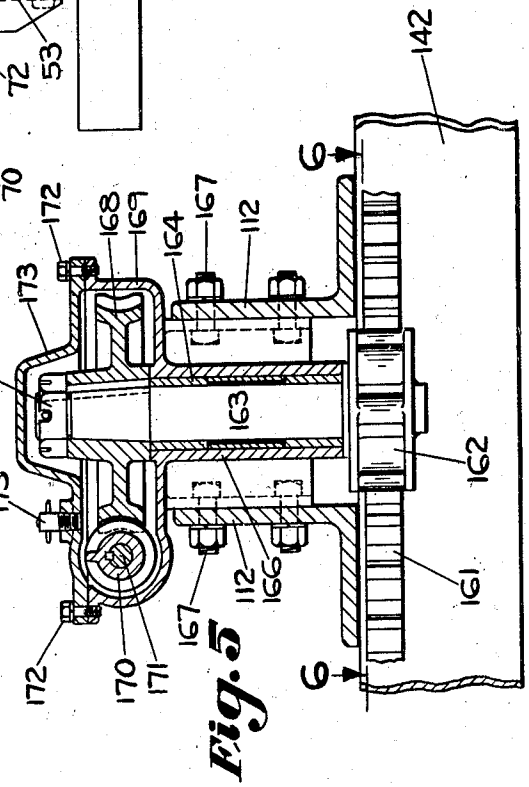


Fig. 5

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June 24, 1941. F. E. ARNDT 2,247,007

ROAD GRADER

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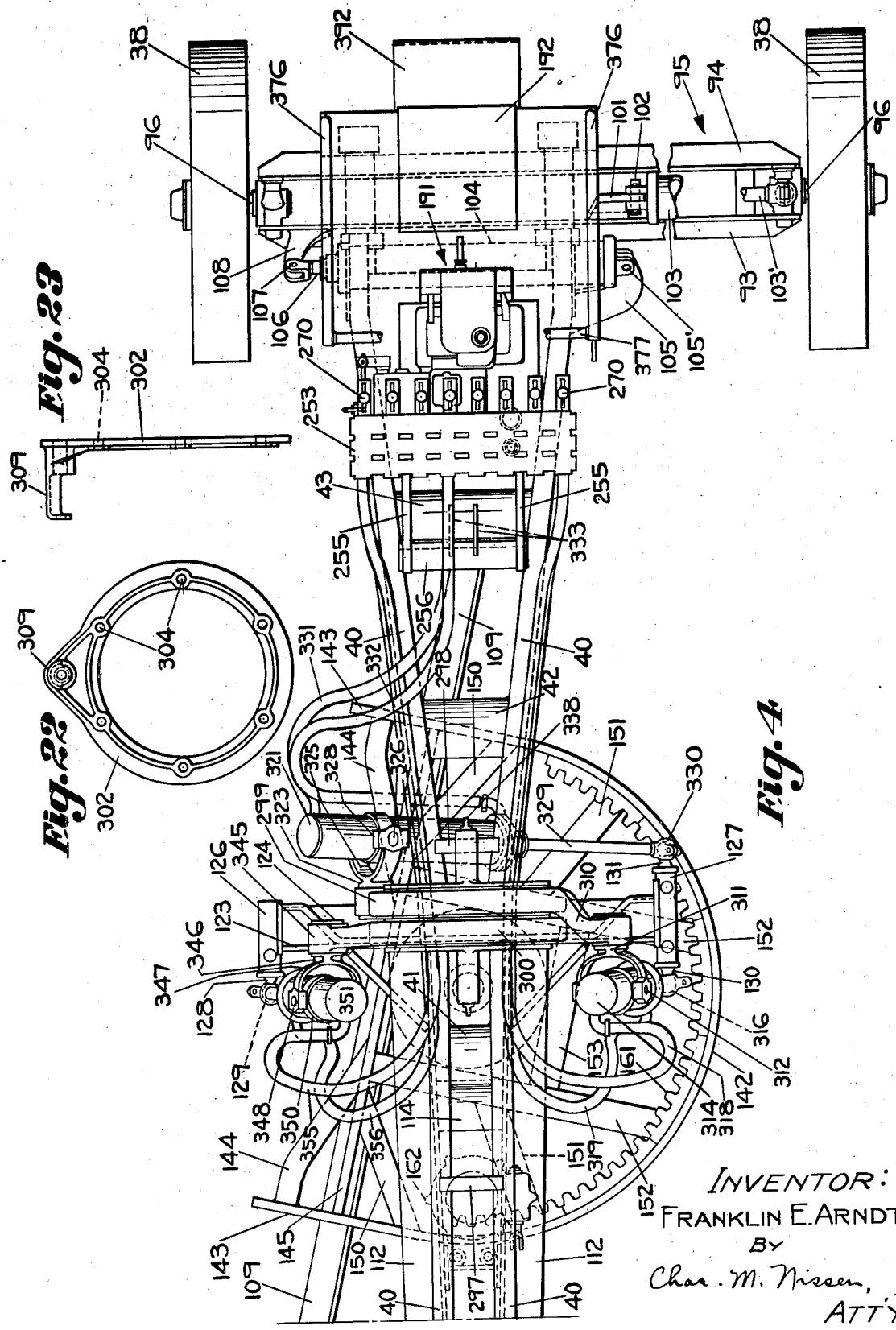


Fig. 23

Fig. 22

Fig. 4

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ROAD GRADER

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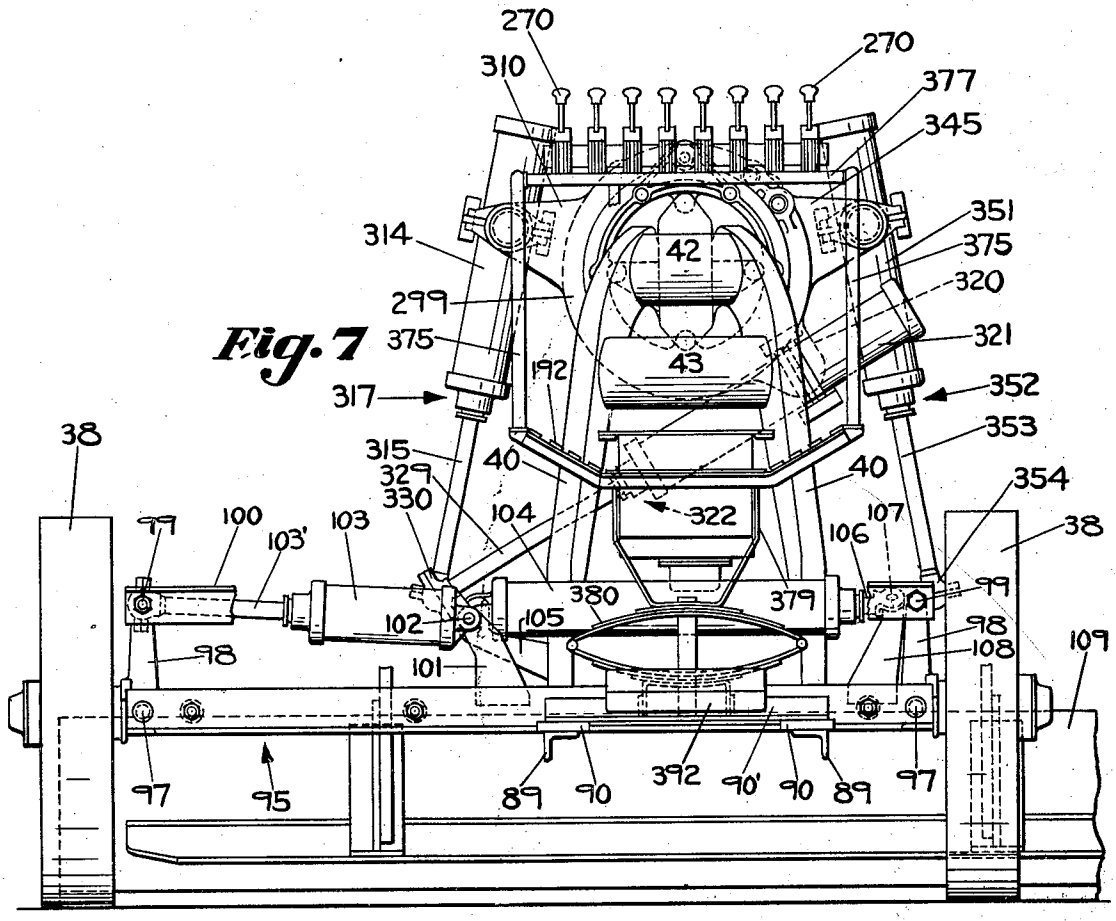



Fig. 7

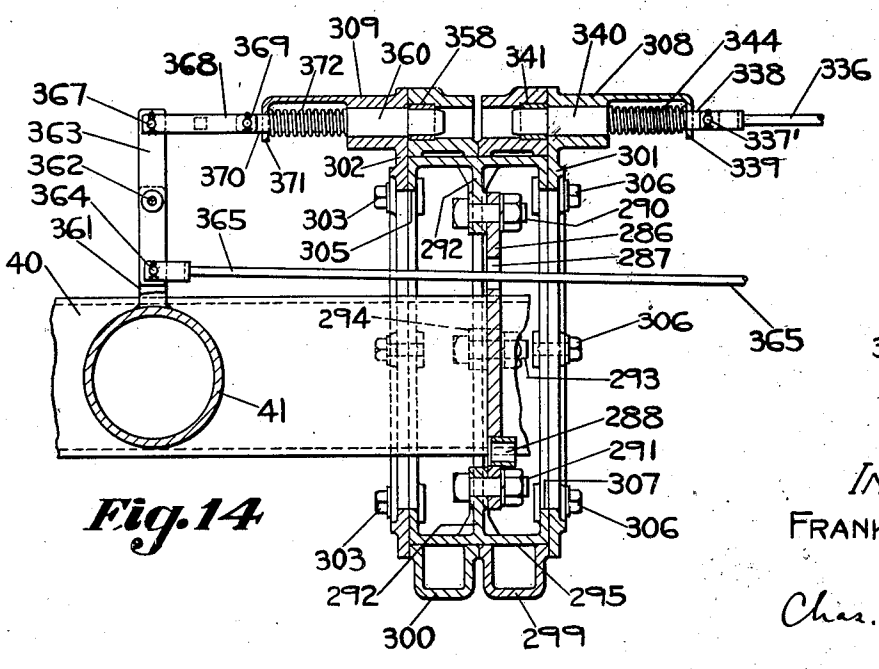



Fig. 14

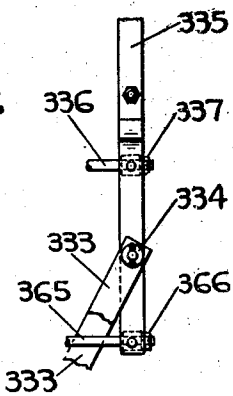



Fig. 15

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June 24, 1941. F. E. ARNDT 2,247,007

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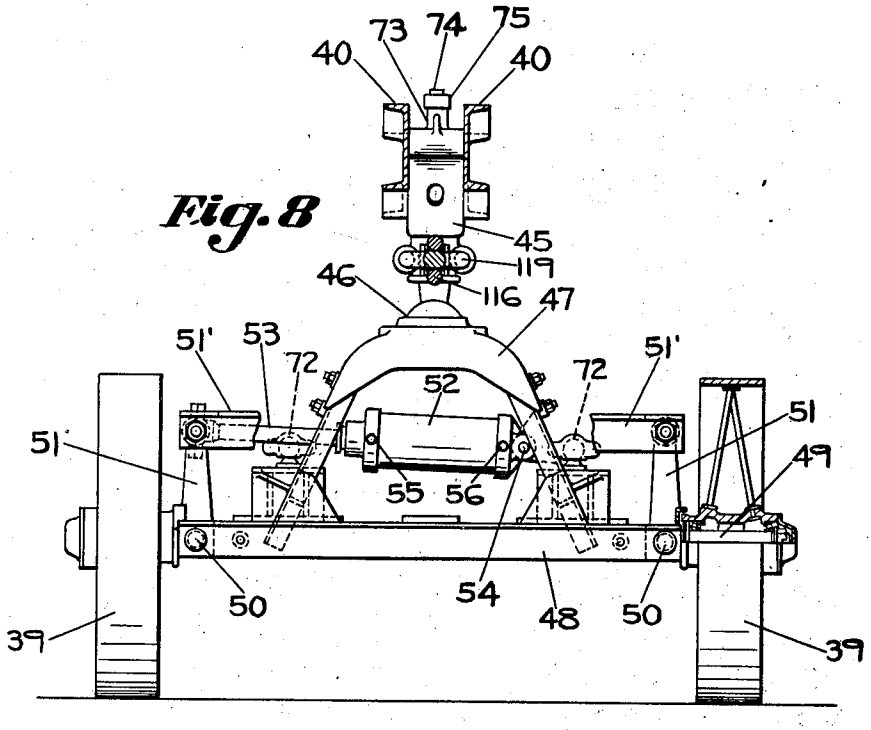



Fig. 8

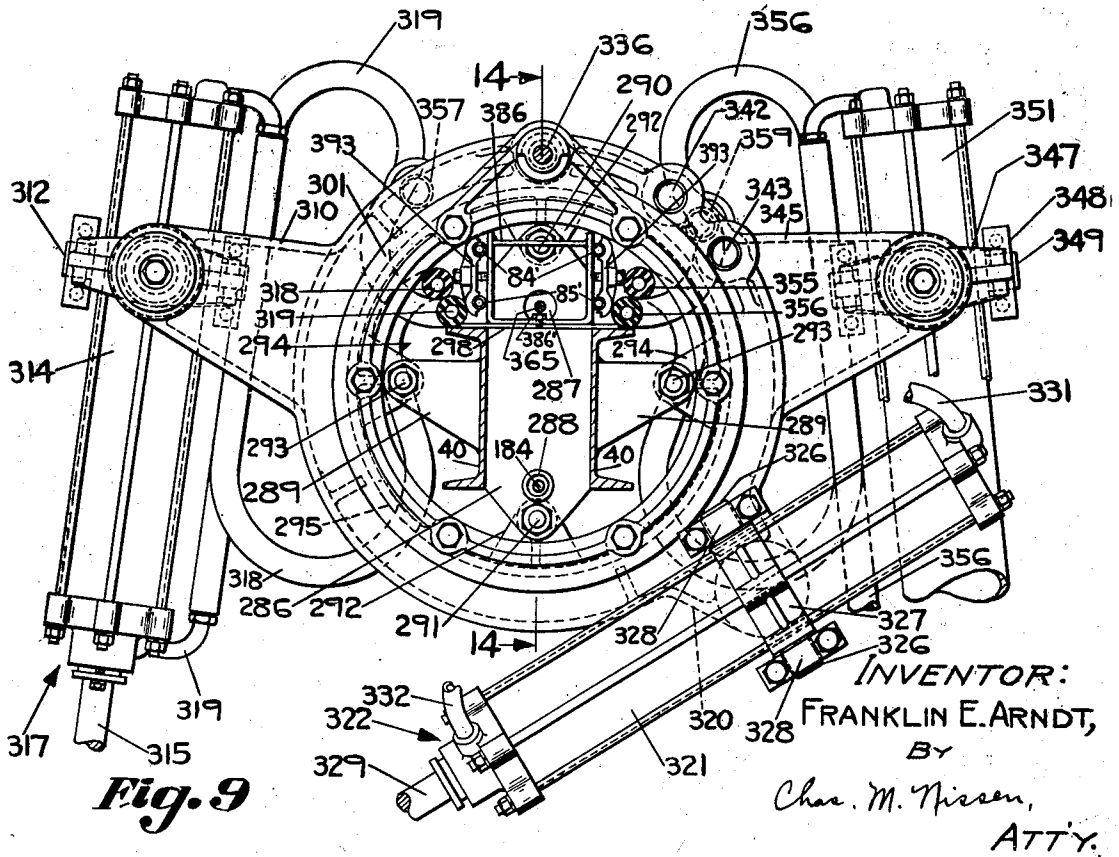



Fig. 9

June 24, 1941. F. E. ARNDT 2,247,007

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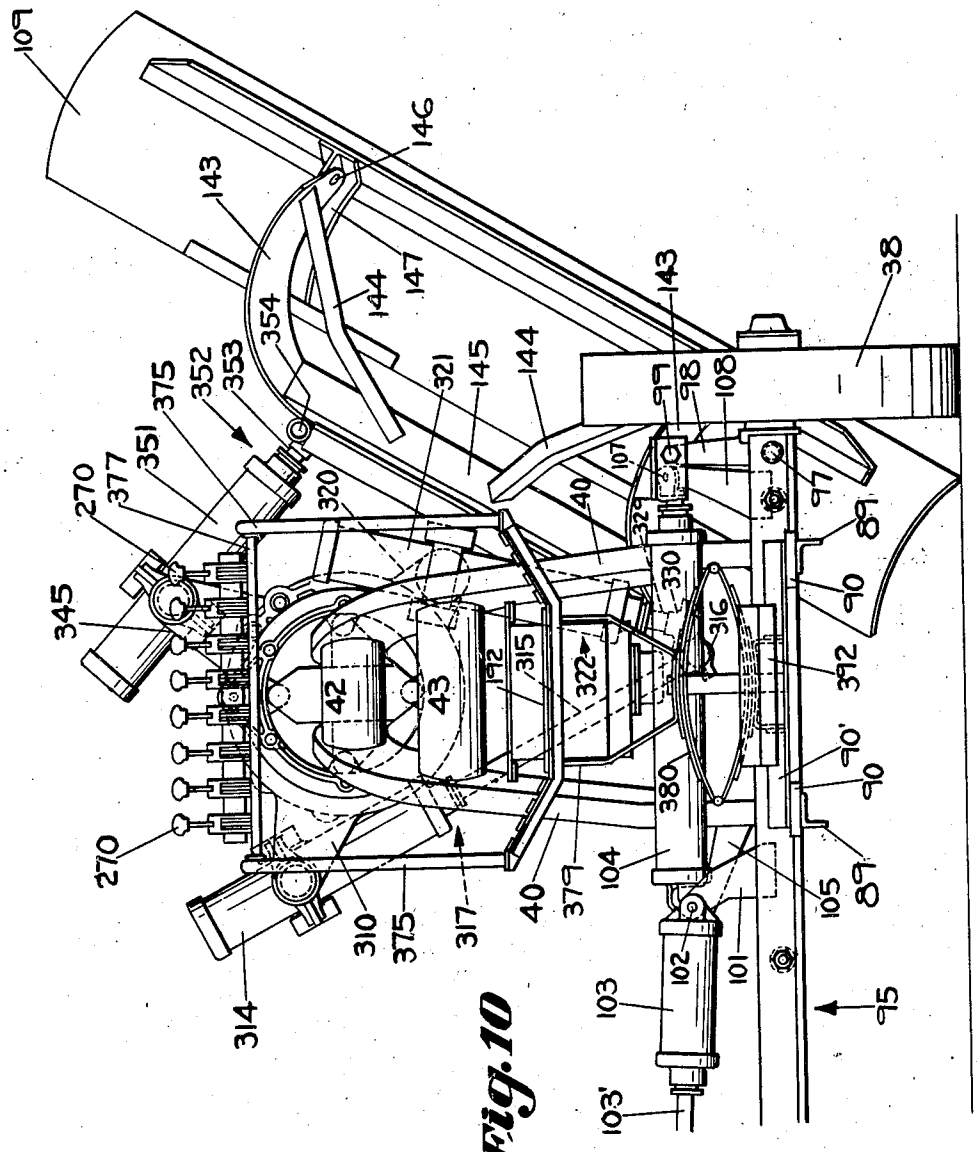



Fig. 10

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ROAD GRADER

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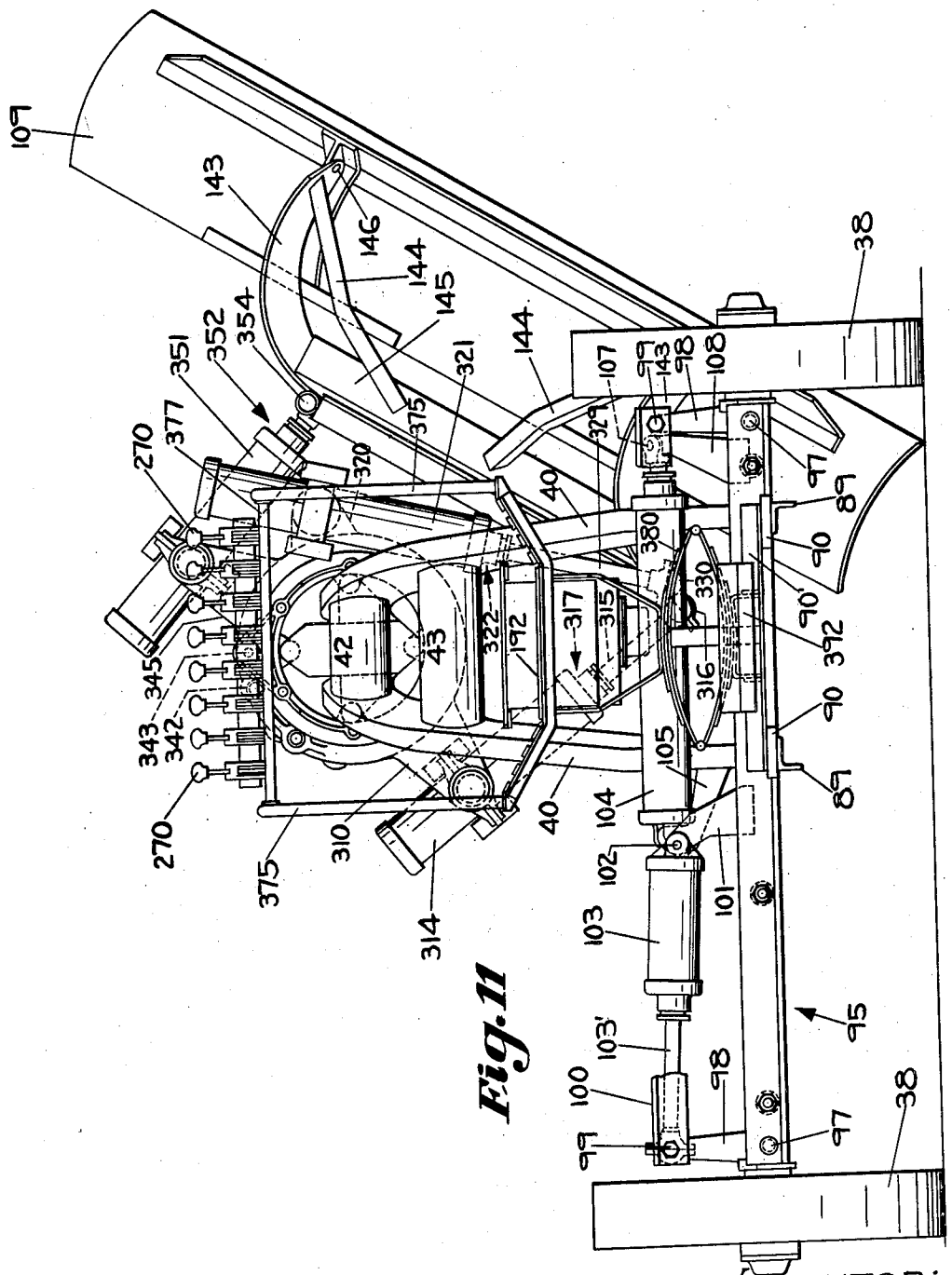



Fig. 11

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June 24, 1941. F. E. ARNDT 2,247,007

ROAD GRADER

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Fig. 16

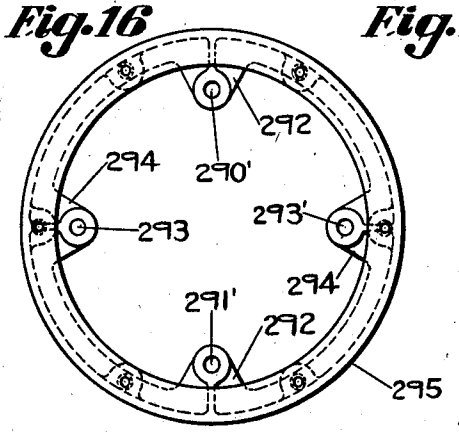



Fig. 17

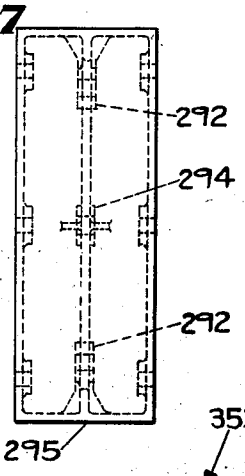






Fig. 12

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ROAD GRADER

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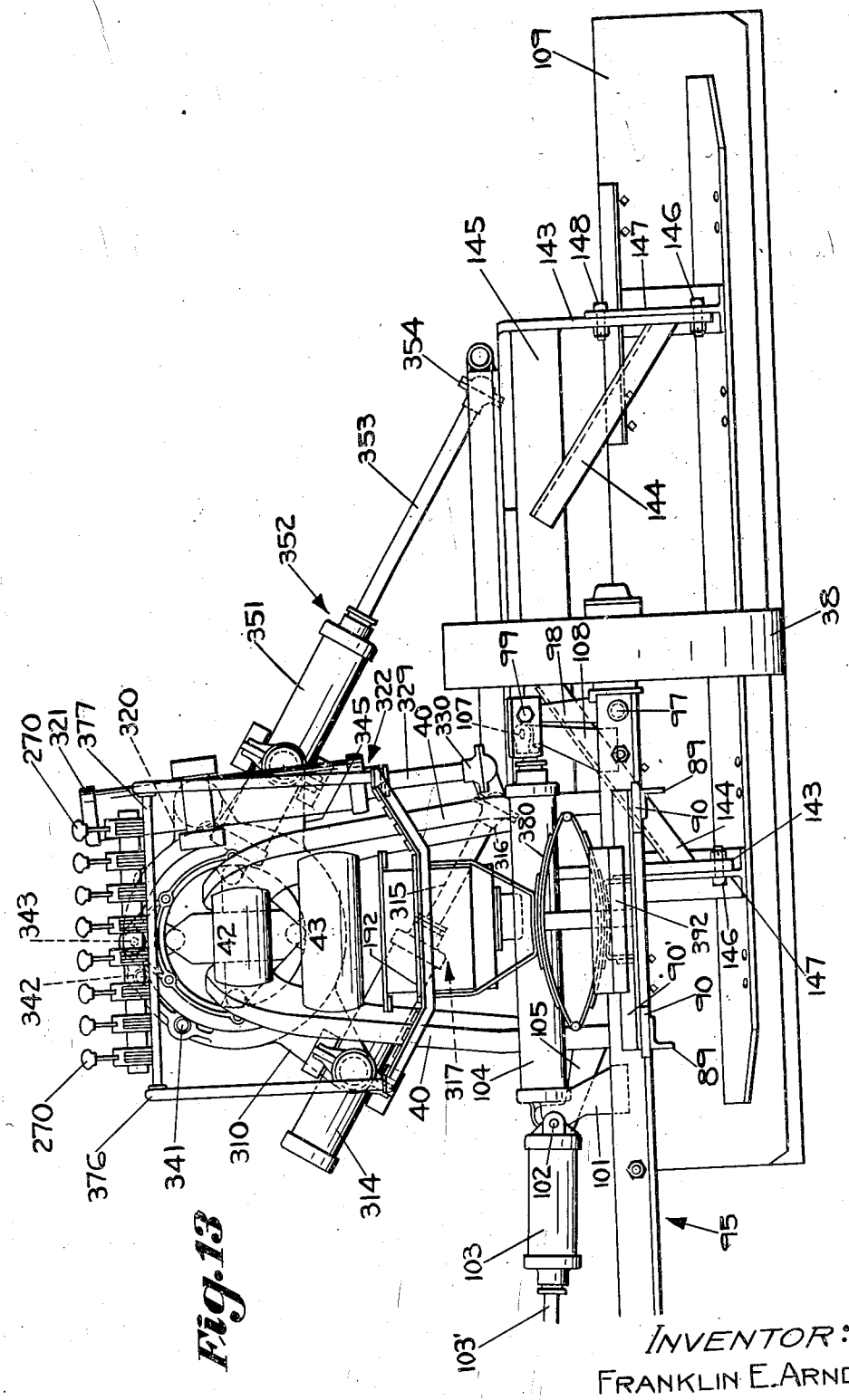



Fig. 13

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June 24, 1941. F. E. ARNDT 2,247,007

ROAD GRADER

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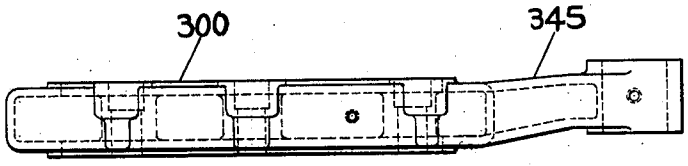



Fig. 19

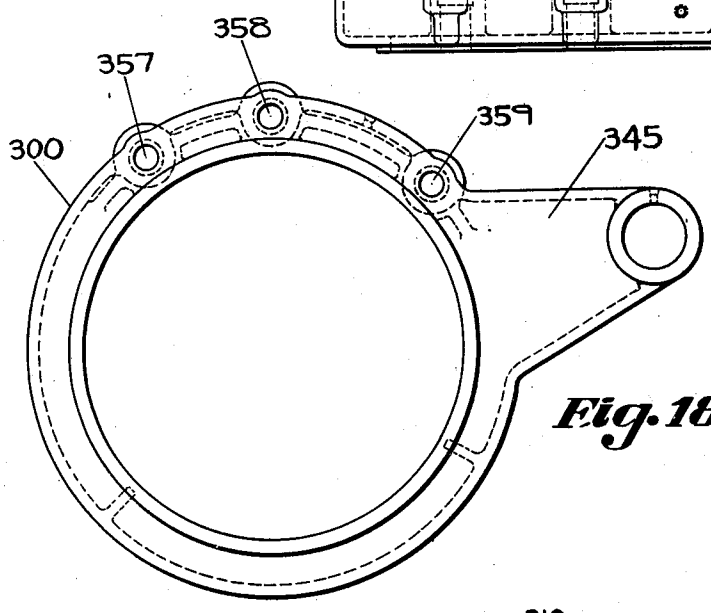



Fig. 18

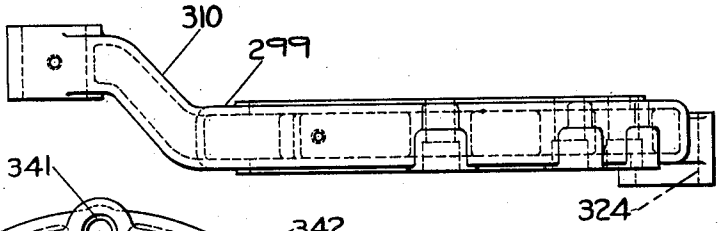



Fig. 21

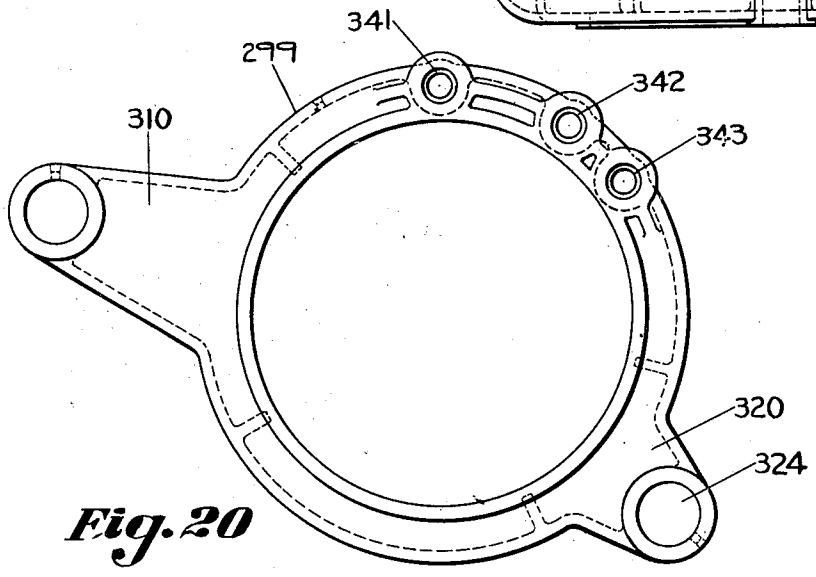



Fig. 20

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June 24, 1941. F. E. ARNDT 2,247,007

ROAD GRADER

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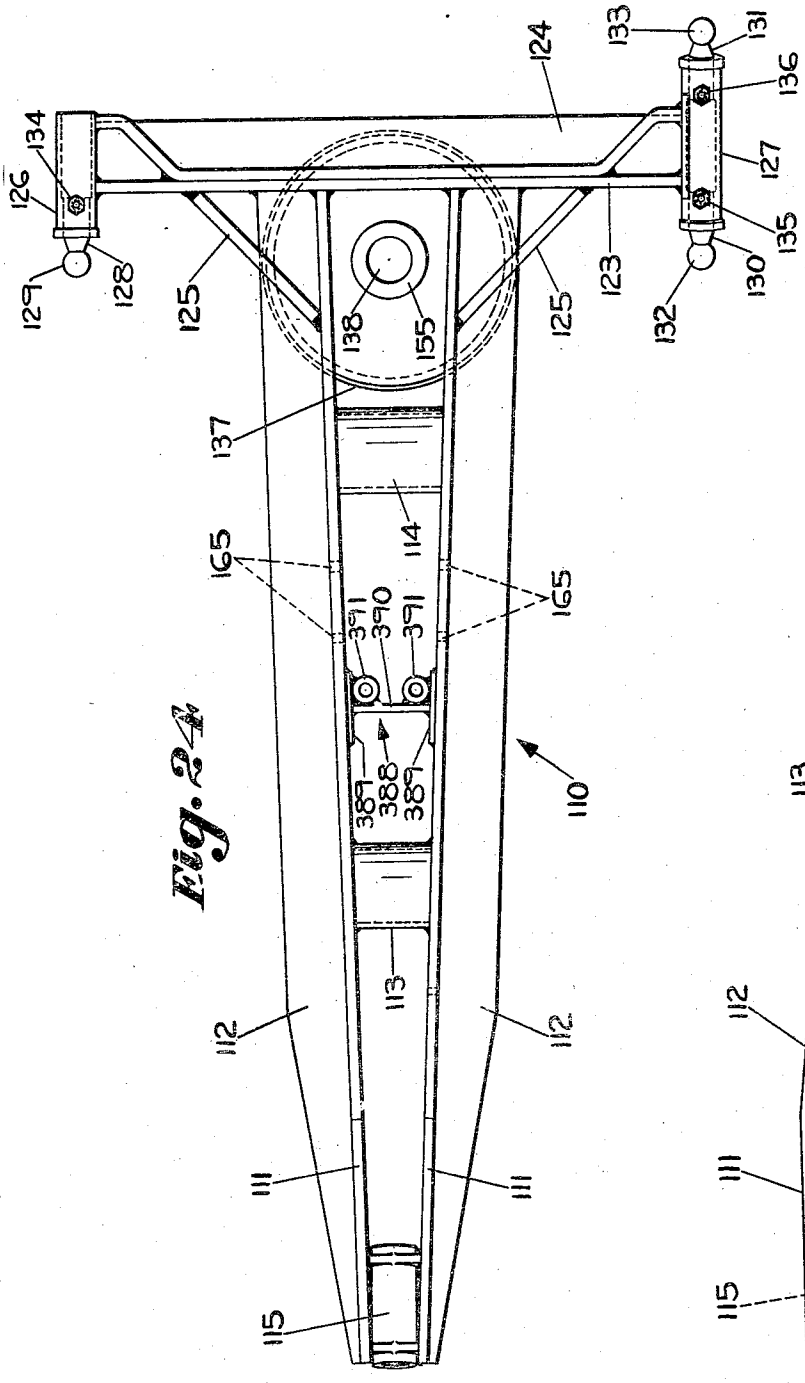



Fig. 24

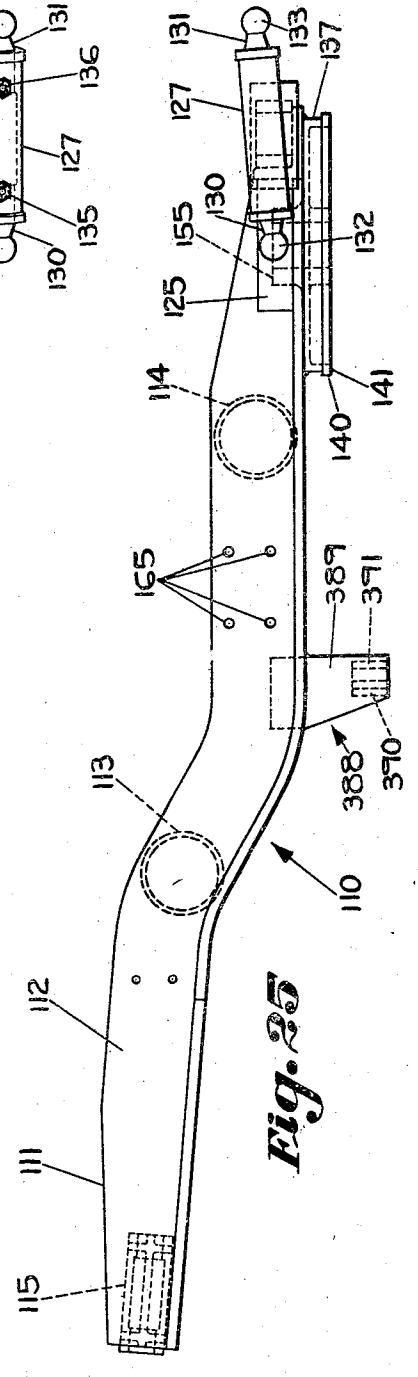



Fig. 25

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June 24, 1941. F. E. ARNDT 2,247,007

ROAD GRADER

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Fig. 26

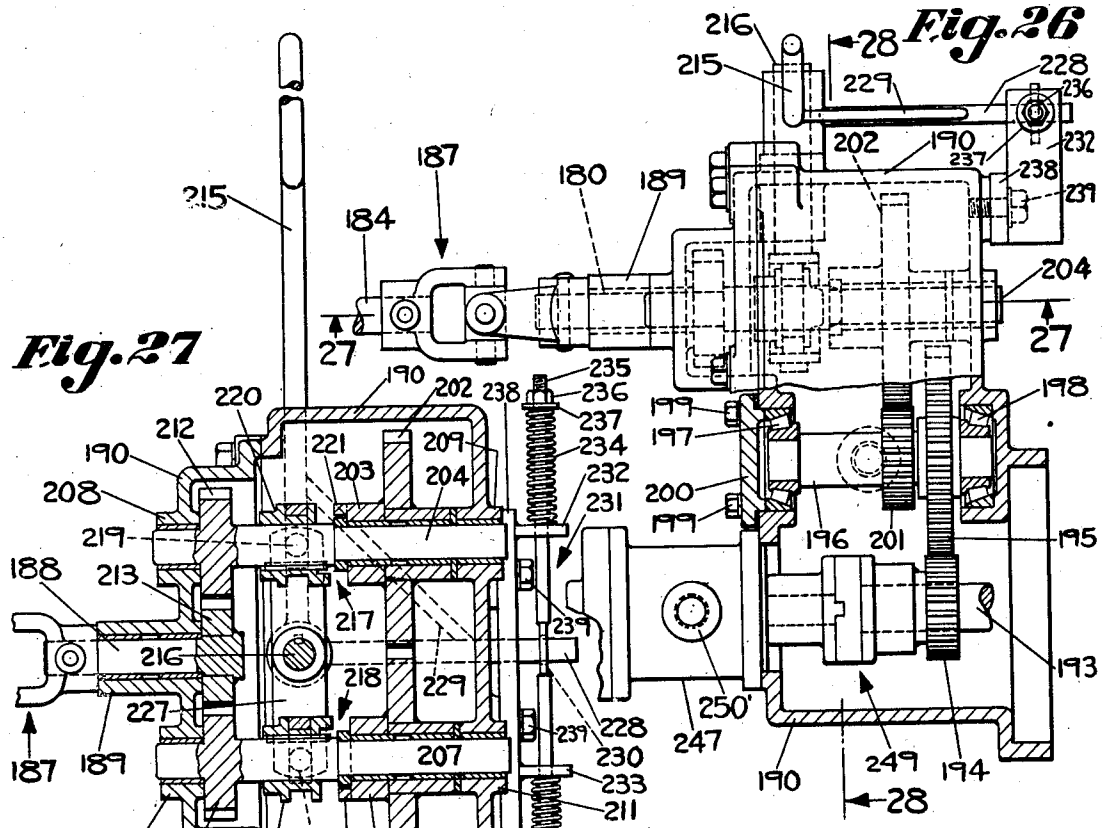



Fig. 27

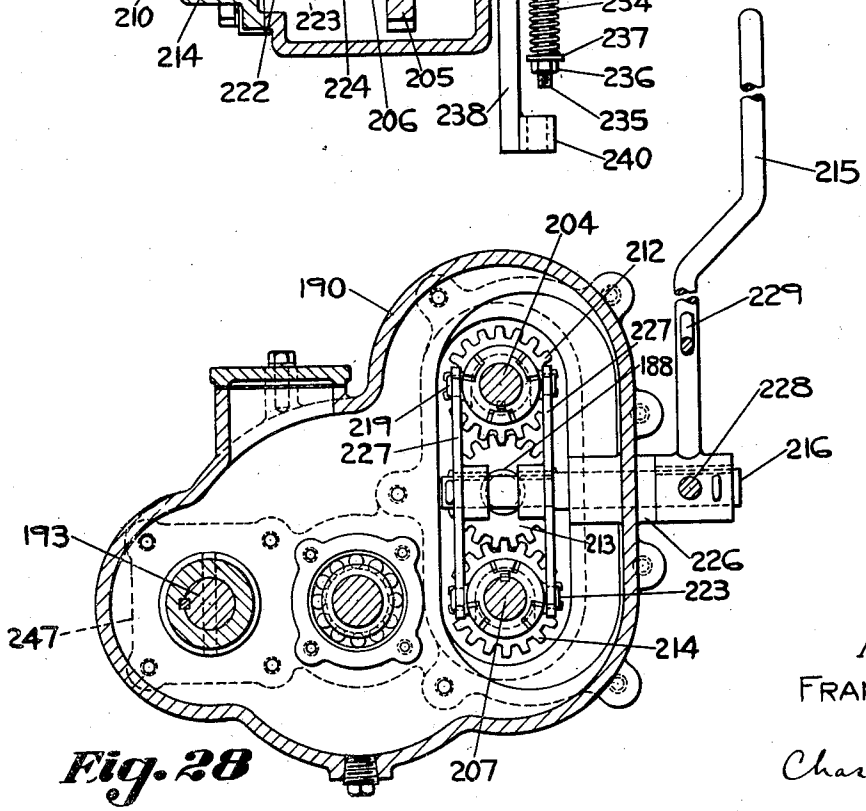



Fig. 28

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June 24, 1941. F. E. ARNDT 2,247,007

ROAD GRADER

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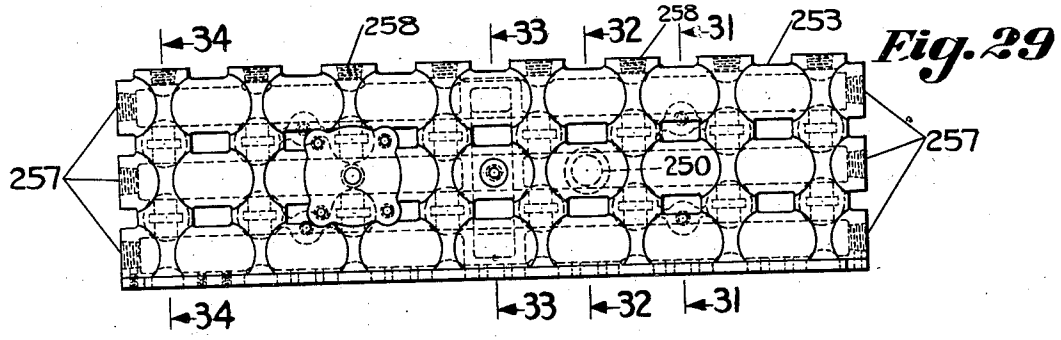



Fig. 29

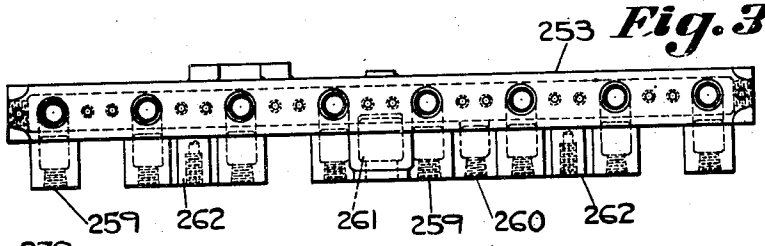



Fig. 30

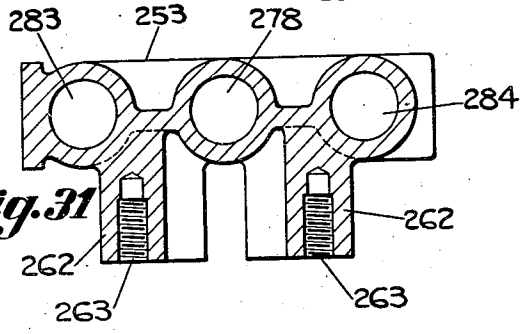



Fig. 31

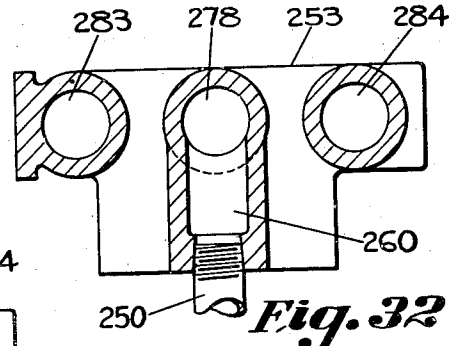



Fig. 32

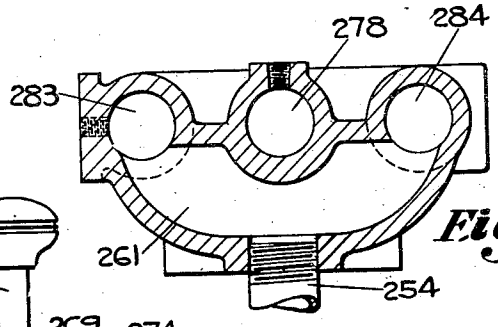



Fig. 33

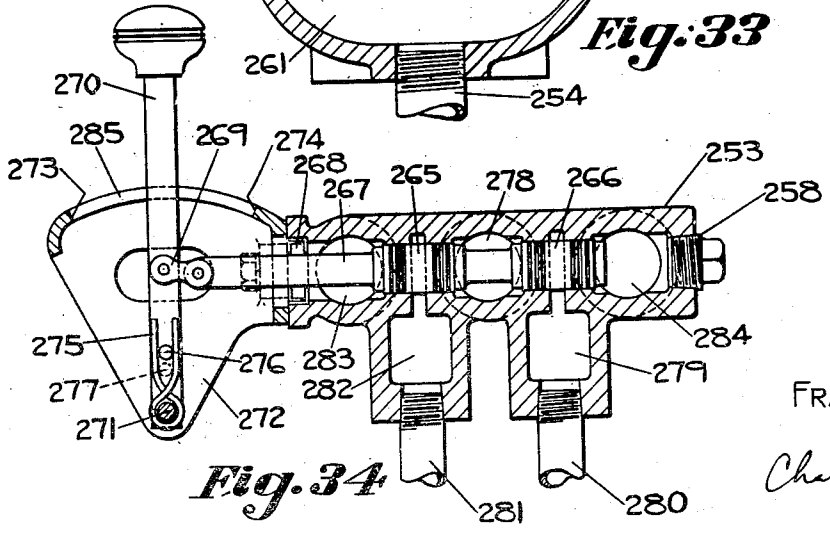



Fig. 34

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Patented June 24, 1941 2,247,007

# UNITED STATES PATENT OFFICE

2,247,007

## ROAD GRADER

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

Application November 23, 1938, Serial No. 241,979

37 Claims. (Cl. 37—156)

My invention relates to road graders, and one of its objects is the provision of improved and efficient means for adjusting the moldboard of a road grader from a position under the machine to a steep bank-cutting position at one side of the path of travel of the machine.

More particularly it is the object of the present invention to provide fluid-pressure motor mechanism controllable from the operator's station for adjusting the moldboard of a road grader in elevation and transverse inclination and to laterally shift the positions of the moldboard for the purpose of carrying on road grading operations or bank-sloping operations.

A further object of the invention is the provision of improved and efficient laterally shifting mechanism for a road grader comprising extensible hangers and an extensible laterally shifting link, embodying means for expanding and contracting such hangers and link in co-operation with transversely adjustable supporting structure on the main frame to secure maximum lateral adjustment of the moldboard while occupying a horizontal road grading position.

Another object of the invention is the provision of fluid-pressure motor mechanism between the main frame and drawbar of a road grader and means for controlling such fluid-pressure motor mechanism to secure adjustment of the moldboard from under the machine to an upright bank-cutting position with the cutting edge spaced laterally from the path of travel of the machine.

A further object of the invention is the provision of extensible hangers and laterally shifting mechanism between the drawbar of a road grader and arcuately adjustable supports on the main frame, combined with means for holding such supports in adjusted positions whereby the moldboard may be supported in steep bank-cutting positions.

Another object of the invention is the provision of adjustable links on the main frame of a road grader connected by fluid-pressure motor mechanism to the drawbar to effect adjustment of the moldboard in elevation and transverse inclination when under the machine and to adjust the moldboard to steep bank-cutting position when at one side of the machine.

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

In the accompanying drawings,

Figs. 1 and 2, placed end to end, show a side elevation of the road grader embodying my improvements;

Figs. 3 and 4, placed end to end, show a plan view of the road grader shown in Figs. 1 and 2, but with the moldboard shifted to a longitudinal position from the transverse position shown in Fig. 2;

Fig. 5 is an enlarged sectional plan view of the gearing for operating the circle to shift the moldboard from the transverse position shown in Fig. 2 to the longitudinal position shown in Fig. 4;

Fig. 6 is a sectional elevation taken on the line 6—6 of Fig. 5, looking in the direction of the arrows;

Fig. 7 is a rear elevational view of the structure shown in Fig. 2;

Fig. 8 is a sectional elevation of the front steering wheel unit, looking forward, the section being taken on the line 8—8 of Fig. 1, looking in the direction of the arrows;

Fig. 9 is an enlarged sectional elevational view taken on the line 9—9 of Fig. 2, looking in the direction of the arrows and showing the positions of the reciprocating hydraulic motors the same as that shown in Fig. 7;

Fig. 10 is a rear elevational view showing the inter-relation of the reciprocating hydraulic motors when the moldboard is in intermediate steep bank-cutting position;

Fig. 11 is a rear view similar to Fig. 10 to illustrate the operation of the left-hand hanger to move the rear supporting ring anti-clockwise to a position where it may be locked to the main frame preparatory to moving the moldboard to the vertical position illustrated in Fig. 12;

Fig. 12 shows the inter-relation of the reciprocating hydraulic motors and the locked positions of the rings on the main frame for supporting the moldboard in upright bank-cutting position spaced from one side of the path of travel of the machine;

Fig. 13 is a rear elevational view showing the inter-relation of the reciprocating hydraulic motors and their connections to the two rings on the main frame held in such predetermined positions as to enable the moldboard to be shifted laterally to a maximum extent while occupying a horizontal or road grading position;

Fig. 14 is a sectional elevation taken on the line 14—14 of Fig. 9, looking in the direction of the arrows, to show the releasable locking mechanism for the rings mounted for arcuate movement on the main frame of the machine;

Fig. 15 is a fragmentary elevational view of the manual mechanism for operating the releasable locking mechanism shown in Figs. 2 and 14;

Fig. 16 is a detail view showing in front eleva-

tion the drum of the guiding structure illustrated in section in Fig. 14;

Fig. 17 is a side elevational view of the drum of the guiding structure shown in section in Fig. 14 and in front elevation in Fig. 16;

Fig. 18 is a detail view in elevation (looking forward) of the front ring, the arm of which is adapted to be connected to the right-hand hanger shown in Fig. 7;

Fig. 19 is a plan view of the structure shown in Fig. 18;

Fig. 20 is a detail view in elevation (looking forward) of the rear ring, the arms of which are adapted to be connected to the left-hand hanger and the laterally shifting motor as shown in Fig. 7;

Fig. 21 is a plan view of the structure shown in Fig. 20;

Fig. 22 is a detail view in elevation (looking forward) of the ring adapted to be secured to the guiding drum bearing shown in Figs. 14, 16 and 17;

Fig. 23 is a side elevation of the structure shown in Fig. 22;

Fig. 24 is a plan view of the supplemental frame serving as a drawbar, as shown in Figs. 3 and 4 placed end to end;

Fig. 25 is a side view of the structure shown in Fig. 24 adapted to serve as a drawbar, as illustrated in Figs. 1 and 2 placed end to end;

Fig. 26 is a plan view, partly in section, of the power-transmission gearing adapted to connect the internal combustion engine on the rear end of the main frame of the grader to the circle operating mechanism shown in Figs. 1 and 2;

Fig. 27 is a sectional elevational view taken on the line **27—27** of Fig. 26, looking in the direction of the arrows;

Fig. 28 is a sectional view taken on the line **28—28** of Fig. 26, looking in the direction of the arrows;

Fig. 29 is a plan view of the valve manifold mounted at the rear end of the machine, as shown in Figs. 2 and 4;

Fig. 30 is a rear elevational view of the structure shown in Fig. 29;

Fig. 31 is an elevational view taken on the line **31—31** of Fig. 29, looking in the direction of the arrow;

Fig. 32 is a sectional view taken on the line **32—32** of Fig. 29, looking in the direction of the arrow;

Fig. 33 is a sectional view taken on the line **33—33** of Fig. 29, looking in the direction of the arrow;

Fig. 34 is a sectional view taken on the line **34—34** of Fig. 29, with the addition of valve elements and manual mechanism for operating the same; and

Fig. 35 is a piping diagram for the hydraulic system used in the road grading machine.

The machine shown in the accompanying drawings comprises a vehicle frame **36** mounted on the front steering wheel unit **37** and the rear wheels **38, 38**, as shown in Figs. 1, 2, 3, 4. The front wheels **39, 39** and the rear wheels **38, 38** 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 **36** comprises longitudinal spaced-apart beams **40, 40** parallel and relatively close together at the forward portion of the machine and diverging and downwardly extending at the rear portion of the machine, as shown in Figs. 1, 2 and 4. The spaced-apart beams **40, 40** are rigidly connected by the tubular cross-braces **41, 42, 43, 44**, as shown in Figs. 2 and 4, thereby affording a very rigid vehicle frame structure adapted to resist weaving or twisting during road grading and bank sloping operations.

As shown in Fig. 1, the forward ends of the spaced-apart beams **40, 40** of the vehicle frame are rigidly connected, preferably by welding, to the upright post **45** the lower end of which is mounted by means of the ball and socket joint **46** on the yoke or bolster **47** rigidly connected to the axle tree **48** of the front wheel steering unit. As shown in Fig. 8, the axles **49** for the front wheels **39, 39** are pivoted at **50, 50** to the ends of the axle tree **48** on longitudinally extending axes. The axles **49** are provided with vertical arms **51, 51** to the upper ends of which is pivoted the cross-piece **51'**. Between one of the arms **51** and one of the legs of the bolster **47** is pivotally connected a hydraulic motor comprising a cylinder **52** and a piston rod **53**. The right-hand end of the cylinder **52** as viewed in Fig. 8 is pivoted at **54** to the right-hand diagonal leg of the bolster **47**, and the left-hand end of the piston rod **53** is pivotally connected to the upper end of the left-hand vertical arm **51**.

As hereinafter explained, the hydraulic motor comprising the cylinder **52** is double-acting in that the liquid flows into and out of the cylinder on both sides of the piston thereof, as indicated by the ports **55** and **56**, and therefore when the leaning of the wheels **39** is adjusted they may be locked in adjusted position by closing the valve controlling the flow of liquid through the ports **55** and **56** into and out of the cylinder **52**.

Figs. 1, 2, 3, 4 illustrate a pull type of grader having a vehicle tongue **57**, secured by means of a plate **58** to the vertical post **59**, the upper end of which is journaled at **60** to the front side of the bolster **47**, the lower end of the post **59** being journaled at **61** to the front axle tree **48**.

A cross-piece **62** is secured to the tongue **57**, as shown in Fig. 3, for supporting at its ends the cylinders **63, 63** for receiving compression springs **64**. Rods **65** extend through the springs **64** and have nuts and washers mounted on their forward ends, as indicated at **66** in Fig. 3. The rear ends of the rods **65** are connected to abutment blocks **67, 67** adapted to abut against the forward ends of the cylinders **63, 63**.

The front ends of the hydraulic cylinders **68, 68** are pivoted at **69, 69** to the abutment blocks **67, 67**, as shown in Fig. 3. The pair of hydraulic reciprocating motors **70, 70** comprise the cylinders **68, 68** and the piston rods **71, 71**, the rear ends of which are connected by universal joints **72, 72** to the axle tree **48**, in spaced-apart relation to the vertical pivot post **59**. As hereinafter more fully explained, the hydraulic motors **70, 70** are oppositely acting in that when one is pulling, the other is pushing, the pushing action being positive by pressure of the abutment block **67** against the rear end of the cylinder **63**. The pulling action, however, is yielding by means of the springs **64** since the nut and washer may move along the interior of the cylinder **63**.

Mounted on top of the front post **45** is the socket **73** for receiving the bearing pin **74** to which is pivoted the ring **75** at the forward end of which is pivotally connected at **76** the bracket **77** which is secured to the forwardly and downwardly inclined plate **78**, as shown in Fig. 1. The forward end of the plate **78** is secured by means of the straps **79** to the rear end of the

long spring 80 which is connected at its front end to the hook 81 mounted on the cross-piece 82 which is welded to the tongue 57. The spring 80 serves to counterbalance the weight of the tongue 57 to relieve the strain of the pivot post 59 on the journal connections 60, 61.

Clips 83, 83 may be relied on to secure the flexible conduits 84, 85 in parallel relation while such clips are supported on the bracket 77 and plate 78, as shown in Fig. 1. The two conduits 84, 85 are connected to the steering motors 70, 70 as shown in Fig. 35 to secure their simultaneous operation in opposite directions for operation of the steering wheel unit 37. It should be understood that although only two conduits 84 and 85 are shown in Fig. 1, two additional conduits 86 and 87 (Fig. 35) are also associated with the clips 83, 83 and are extended to the ports 55 and 56 of the front leaning wheel cylinder 52 shown in Fig. 8.

It should be particularly understood that the leaning of the front wheels by means of the hydraulic motor mechanism shown in Fig. 8 may be taken advantage of to co-operate with the steering of the machine by means of the hydraulic motors 70, 70 (Fig. 3), to counteract the tendency of the moldboard during operation along the roadway to shift the front end of the machine sidewise. For instance, if the moldboard is in road grading position at an angle to the line of draft with the front end of the moldboard nearer the steering wheel unit, 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 moldboard 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 moldboard to shift the front end of the machine sidewise.

Furthermore by means of the hydraulic motors 70, 70 (Fig. 3), 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 moldboard to shift the front end of the machine sidewise.

Moreover, the operator at his single station at the rear end of the machine has under his direct observation the operation of the moldboard 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 59, the hydraulic motors 70, 70 being in very efficient positions to resist swerving of the front wheel unit on the axis 59 either 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 40, 40 is a cross-supporting structure 88 (Fig. 2), comprising angle irons 89, 89 (Fig. 7) and the cross-pieces 90, 90. Guides are provided at 91, 92 for the transverse members 93, 94 (Fig. 2) and for the rear wheel supporting frame or axle tree 95 (Fig. 4). The axles 96, 96 for the rear wheels 38, 38 are pivoted at 97, 97 to the ends of the frame 95 (Fig. 7). Secured to the rear wheel axles are vertical crank arms 98, 98 the upper ends of which are pivoted at 99, 99 to the cross-piece 100.

A vertical bracket plate 101 is secured to the frame 95 and to its upper end at 102 is pivoted a cylinder 103 of a hydraulic motor comprising a piston rod 103' the outer end of which is pivoted at 99 to the upper end of the crank arm 98 at the left-hand side of the machine, as viewed from the rear (Fig. 7). The hydraulic motor comprising the cylinder 103 is double-acting in that the liquid flows to and from the cylinder 103 on both sides of the piston therein, and the controlling valve for this hydraulic motor is such that when it is closed, the crank arms 98, 98 will be locked in adjusted positions, thereby locking the leaning of the rear wheels in adjusted positions.

In order to shift the rear end of the main frame 36 relatively to the rear wheels, the hydraulic motor comprising the cylinder 104 is pivoted at its left-hand end, as viewed in Fig. 7, to the upper end of the bracket 105 which is secured to one of the beams 40 of the main frame and extends laterally therefrom. The piston rod 106 which is connected to the piston that moves in the cylinder 104, is pivoted at its outer end at 107 to the upper end of the bracket 108 which is secured to the frame 95. The hydraulic motor comprising the cylinder 104 and piston rod 106 is parallel to the transverse frame or axle tree to the ends of which the rear wheels are connected. Consequently when this hydraulic motor is operated its piston rod 106 is maintained in parallel relation to the frame 95. The pivotal connection between the cylinder 104 and the bracket 105 is illustrated at 105' in Fig. 2, and by comparing this view with Fig. 7 it will be seen that the pivots 105' and 107 are at substantially the same elevation above the road surface. It will also be seen that the hydraulic motor comprising the cylinder 104 and piston rod 106 is in parallel relation to the guideways 91, 92, and consequently when the motor is expanded or contracted, the rear end of the main frame 36 will have free sliding movement along the axle tree 95 to effect shifting of the rear end of the main frame relative to the rear wheels.

The hydraulic motor comprising the cylinder 104 is double-acting and controlled by valve mechanism including locking of the laterally shifted position of the main frame relative to the rear wheels. Furthermore, the lateral shifting of the main frame relatively to the rear wheels may be effected independently of the operation of the motor 103 for the leaning of the rear wheels.

The leaning of the rear wheels may conform to the leaning of the front wheels. Therefore, when the moldboard is in road grading position inclined relative to the line of draft, 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 moldboard to shift the whole machine toward that side where the front end of the moldboard is located. The shifting of the rear end of the main frame relatively to the rear wheels enables the rear wheel at the operating side of the machine to be kept in alinement with the front wheel at the operating side of the machine.

As illustrated in Fig. 13, the lateral reach of the moldboard when in road grading position is at its maximum, and such adjustment is facilitated by the lateral shifting of the rear end of the frame relative to the rear wheels while maintaining the rear and front wheels at the operating side of the machine in approximately the same

path of travel. It will thus be seen that the shifting of the rear end of the main frame relative 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 when the moldboard is shifted laterally to its maximum extent while in road grading position, as illustrated in Fig. 13.

Referring now to the road-working implement comprising a moldboard or scraper blade 109 and the structure for supporting the same, it will be seen that the supplemental frame 110 constitutes a drawbar for the moldboard 109. This supplemental frame or drawbar is a rigid structure relatively narrow and elongated throughout most of its length, particularly at its forward end portion, to facilitate its movement laterally of the narrow elongated main frame, when the moldboard is shifted from road-grading position to steep bank-cutting position at one side of the machine, as illustrated in Fig. 12. By referring to Fig. 3 of the drawings it will be seen that the forward portion of the main frame is narrower than the main portion of the drawbar, but the latter is tapered at its forward end where it is even narrower than the main frame.

While the main frame is upwardly arched to provide ample room for the drawbar and moldboard in its various positions of adjustment, the drawbar is so shaped as to have its rear end portion approximately horizontal when the moldboard is in road grading position. The intermediate portion of the drawbar is inclined upwardly and forwardly, as shown in Figs. 1 and 2 placed end to end, and as shown in Fig. 25. The forward end portion of the drawbar slopes upwardly and forwardly more gradually than the intermediate portion and has its upper portion at 111 approximately horizontal so as to increase the space between the front end of the drawbar and the beams 40, 40 of the main frame which slopes downwardly and forwardly at its forward end, as viewed in Fig. 1. It should be understood that the main frame and drawbar are thus specially shaped to facilitate movement of the moldboard to steep bank-cutting position. These special shapes of the frames are particularly desirable when the moldboard is to be shifted to the upright bank-cutting position shown in Fig. 12.

The drawbar, as shown in Figs. 24 and 25, comprises spaced-apart angles 112, 112 connected by the transverse bracing tubes 113, 114, the ends of which are welded to the angles 112, 112. Welded between the forward ends of the angles 112, 112 is a longitudinally extending tubular socket 115. As shown in Fig. 1, an eye-bolt 116 is adapted to be swiveled to the front end of the drawbar having its screw-threaded rod 117 extended through the socket 115 and secured in place by the nut 118. A horizontal U-bolt 119 extends through the eye-bolt 116, as shown in Fig. 1, and this U-bolt extends through openings in the laterally extending brackets 120, 120 and is held rigidly connected to the vertical post 45 by means of the nuts 121. The rear side of the post 45 has a semi-circular recess, as indicated at 122 in Fig. 3, for receiving the forward end of the eye-bolt 116 but it should be understood that while the U-bolt 119 occupies a horizontal plane, and the eye-bolt 116 occupies a vertical plane, a universal connection is afforded to the extent that the eye-bolt may be moved laterally on a vertical pivot relative to the U-bolt 119 and also vertically on a horizontal pivot relative to the U-bolt 119. By reason of the universal connection between the front end of the drawbar 110 and the post 45, the front end of the drawbar may be swung laterally and vertically and also rotated in either direction on the axis of the bolt 117.

To the rear ends of the heavy structural angles 112, 112 is welded the cross-piece 123 to which in turn is welded the additional cross-piece 124. Diagonal braces 125, 125 are welded at their ends to the structural angles 112 and the cross-piece 123. To the outer ends of the cross-pieces 123 and 124 are welded the longitudinally extending tubular sockets 126, 127. The socket 126 is adapted to receive the neck 128 of the spherical head 129 which is adapted to serve as the ball of the ball and socket joint at the lower end of an extensible hanger, as hereinafter fully explained. The socket 127 is adapted to receive at its ends the necks 130 and 131 of the spherical heads 132 and 133, respectively. The head 132 is adapted to serve as the ball of a ball and socket joint at the lower end of another extensible hanger at the opposite side of the machine. The head 133 is adapted to serve as the ball of a ball and socket joint for one end of the laterally shifting hydraulic motor as hereinafter fully explained. The neck 128 is held in the socket 126 by means of the bolt 134. The necks 130 and 131 are held in the socket 127 by means of the bolts 135 and 136, as shown in Fig. 24.

To the under sides of the structural angles 112, 112 and the under sides of the cross-pieces 123, 124 is welded a shallow cup-shaped bearing support 137 having a central opening 138 for receiving the king pin 139 shown in Fig. 2. The lower side of the bearing support 137 is circumferentially flanged at 140 to provide on its under side the annular bearing 141. It will thus be seen that the drawbar structure shown in Figs. 24 and 25 is well braced and reinforced in an all welded assembly including the bearing support 137.

The semi-circle 142 is preferably forged integrally with the moldboard knees 143, 143 which are connected by the diagonal braces 144, 144 to the cross-piece 145, as shown in Fig. 4. The lower or depending ends of the knees 143 are pivoted at 146 to the moldboard carrier 147 which may be adjustably connected to the knees 143 by means of the bolts 148 and perforations 149, as shown in Fig. 2.

The semi-circle 142 is reinforced by the diagonal braces 150, 150 which are secured at their rear ends to the cross-piece 145, as shown in Fig. 4. The semi-circle 142 is additionally reinforced by the structural angles 151, 151, 152, 152 and 153, as shown in Fig. 4. Within the square space enclosed by the structural angles 152, 152, 153 and the cross-piece 145, is located the wheel shaped bearing support 154, the cylindrical periphery of which is preferably welded to the cross-piece 145 and the structural angles 152, 152, 153. The bearing support 154, as shown in Fig. 2, is of the same diameter as the flange 140 of the bearing support 137. The upper peripheral ring portion of the bearing support 154 engages the lower peripheral portion 141 of the bearing support 137. The bearing support 137 is provided with a hub 155 concentric with the hub 156 of the lower bearing support 154. The hub 155 is rigid with the drawbar structure, and the hub 156 is rigid with the semi-circle structure, the lower end of the hub 155 being engaged by the upper end of the hub 156 when the king pin 139 is in

the position shown in Fig 2. A cap plate 157 of larger diameter than the king pin 139 is secured to the lower end of the latter by means of the cap screw 158 in position to engage the lower end of the hub 156. The washer 159 engages the upper end of the hub 155 and a nut 160 locked to the upper end of the king pin 139 is relied on to hold the bearing supports 137 and 154 in mutual engagement over wide areas of bearing surfaces. That is to say, not only are the adjacent ends of the hubs 155 and 156 held in engagement with each other but the annular bearing surfaces of the circular bearing supports 137 and 154 are also held in engagement with each other.

The mechanism for rotating the semi-circle 142 together with the moldboard 109 carried thereby is power-operated under control of the operator at his station at the rear end of the machine shown in Fig. 2, and this power-operated mechanism is so arranged as to be fully operative in any position of adjustment of the moldboard, including steep bank-cutting positions such as those shown in Figs. 10, 11 and 12. As shown in Fig. 6, annular gearing 161 is secured to the semi-circle 142 and with this annular gearing meshes a pinion 162 carried by the lower end of the shaft 163 (Fig. 5) journaled in a bearing 164 detachably bolted to the structural angles 112, 112 of the drawbar frame. For this purpose transverse perforations 165, 165 are provided in the vertical flanges of the structural angles 112, 112, as shown in Figs. 24 and 25.

As shown in the enlarged sectional elevation of Fig. 5, the housing 166 for the journal bearing 164 spans the space between the structural angles 112, 112 and is bolted thereto by means of the bolts 167, 167. Keyed to the upper end of the shaft 163 is a worm wheel 168 located in the housing 169, and this worm wheel meshes with a worm 170 which is keyed to the shaft 171 which extends longitudinally of the drawbar frame and toward the front end thereof, as shown in Fig. 2. By means of cap screws 172 a cover 173 is secured to the gear housing 169. A nut 174 locks the worm wheel 168 to the shaft 163, as shown in Fig. 5. By connection to the fitting 175, lubricant may be introduced into the housing 169 without removing the cover 173. The worm gearing 168, 170 is preferably self-locking to hold the moldboard in adjusted position on the king pin 139 relative to the drawbar frame.

The forward end of the shaft 171 is connected by means of the universal joints 176, 177 and connecting link 178 to the shaft 179, the forward end of which is connected to a spur gear rotatable on a longitudinal axis and meshing with another spur gear connected to the rearwardly extending shaft 179', the spur gearing being mounted in the housing 180 which is attached to the vertical flange of the structural angle 112 shown in Fig. 1.

By placing Figs. 1 and 2 end to end it will be seen that the rearwardly extending shaft 179' is connected by means of the universal joints 181, 182 and intermediate connecting link 183 to the horizontal rearwardly extending shaft 184. The link 183 is extensible in length in that it comprises a tubular section 185 having a socket square in cross-section into which fits the rod 186 also square in cross-section.

The rear end of the horizontal shaft 184 is connected by means of a universal joint 187 to a shaft 188 which is journaled in the bearing 189 in the front side of the housing 190, as shown in Figs. 26, 27, 28. Within the housing 190 is located manually controlled power-operated reversing mechanism for effecting rotation of the moldboard in opposite directions on the axis of the king pin 139. For this purpose, an internal combustion engine 191 is mounted on the main frame adjacent the operator's platform 192, as shown in Fig. 2, and connected by means of the shaft 193 (Fig. 26) to the gearing within the housing 190.

Mounted on the engine driven shaft 193 is a pinion 194 which meshes with a large gear 195 mounted on the shaft 196, the ends of which are journaled in the conical thrust bearings 197, 198 between the inner walls of the housing 190. By means of lag screws 199 a follower plate 200 is held in place to cover the opening in which the thrust bearing 197 is located.

The shaft 196 carries a relatively small gear 201 which meshes with a larger gear 205, the latter being secured to a sleeve 206 journaled loosely on the shaft 207.

It should be understood that Fig. 26 is a plan view partly in section and that Fig. 27 is an elevational sectional view taken on the line 27—27 of Fig. 26, looking in the direction of the arrows. Below the gear 202 and meshing therewith is another gear of the same diameter designated 205 in Fig. 27. The gear 205 is mounted on a sleeve 206 which is loosely journaled on the shaft 207. The shaft 204 is mounted in the journal bearings 208, 209 at the front and rear sides of the housing or casing 190. In a similar manner the lower shaft 207, which is parallel to the shaft 204, is mounted in the journal bearings 210 and 211. Secured to the forward end of the shaft 204 is a gear 212 which meshes with the gear 213 at the rear end of the shaft 188. At the forward end of the shaft 207 is a gear 214 which also meshes with the gear 213.

By means of an upwardly extending operating lever 215 which is adapted to be moved forwardly and rearwardly on the pivot 216, either the clutch 217 or the clutch 218 may be operated to effect reversal of rotation of the moldboard semi-circle operating mechanism.

By means of a shipper 219 the clutch element 220 may be connected to the clutch element 221 at the left-hand end of the sleeve 203 when the upper end of the lever 215 is moved rearwardly, and thereby the gear 202 may be operatively connected through the shaft 204 and gear 212 to the gear 213 to effect power-operated rotation of the shaft 188. When the lever 215 is moved forwardly, the clutch element 222 may be moved by means of the shipper 223 to engage the clutch element 224 at the left-hand end of the sleeve 206, thereby effecting rotation of the shaft 207 in a direction opposite to the rotation of the shaft 204 when the latter is rotated. That is to say, the transmission from the drive shaft 193 to the shaft 207 is in a direction opposite to the rotation of the shaft 204. Consequently when the lever 215 is moved rearwardly the moldboard is rotated on the king pin 139 in one direction and when the lever 215 is moved forwardly the moldboard is rotated in the opposite direction.

It should be noted that while the internal combustion engine 191 may be continuously operated at relatively high speed, the reduction gearing 194, 195, 201, 202, co-operates with the worm gearing 168, 170 and effects such speed of rotation of the moldboard on the axis of the king pin 139 as to enable the operator to adjust the position of the moldboard relative to the drawbar

with accuracy while under his observation, and this is particularly true since the main frame of the machine is open and relatively narrow adjacent the moldboard.

The shipper mechanism connected to the lever 215 for operation of the clutches 217 and 218 is shown in elevation in Fig. 28. The lower end of the lever 215 is secured to the rock shaft 216 which is journaled in the bearing 226 and extends into the casing 190. Secured to the inner end of the rock shaft 216 to rock therewith are the spaced-apart vertical parallel bars 227, 227, to the upper and lower ends of which are connected the shipper elements 219 and 223. It should be particularly noted that when one clutch 217 is applied, the other clutch 218 is released and vice versa.

When the lever 215 is released spring-actuated centering mechanism automatically returns the lever to neutral position where both of the clutches 217 and 218 are in released position, the self-locking worm gearing 168, 170 (Fig. 5) being then relied on to hold the moldboard in adjusted angular relation to the drawbar. This centering mechanism comprises a horizontal bar 228 secured at its forward end to the lower end of the lever 215. The bar 228 may also be connected to the lever 215 by means of the diagonal bar 229. The horizontal bar 228 extends rearwardly through an opening 230 in the central reduced portion of the vertical centering rod 231. The centering rod extends upwardly and downwardly through openings in the brackets 232, 233 which extend rearwardly and serve as abutments for the centering springs 234, 234. The upper and lower ends of the centering rod 231 are screw-threaded at 235, 235 to receive nuts 236, 236 which engage the washers 237, 237. The brackets 232, 233 are mounted on the vertical plate 238 which is detachably secured to the rear side of the casing 190 by means of cap screws 239. The lower end of the plate 238 has secured thereto a lug 240 provided with a vertical opening for receiving a bolt so that the plate 238 may be secured to the platform 241 (Fig. 2) to which the internal combustion engine 191 is secured. The platform 241 is mounted on brackets 242, 243 which are secured rigidly to the channel beams 40, 40 of the main frame.

Secured to the top plate 241 to depend therefrom between the downwardly and rearwardly inclined beams 40, 40 of the main frame, is a supply tank 244 provided with a filling pipe 248 and a suction pipe 246, the latter extending upwardly through the top of the supply tank to the suction side of the gear pump 247 shown in elevation in Fig. 2, in plan view in Fig. 26 and diagrammatically in Fig. 35. The oil return line 254 leads downwardly from the manifold 253 (Fig. 2) to the pipe 245 which is welded to the inside of the tank 244 and extends to within a few inches of the bottom thereof so that the oil may be discharged into the tank without foaming. The filling pipe 248 is provided at its upper end with a removable cap having an opening therethrough to provide an air vent for the tank.

By means of a coupling 249 (Fig. 26), the engine shaft 193 is directly connected to the gear pump 247 to drive the latter whenever the internal combustion engine is operated. As shown in Fig. 2, a supply pipe 250 leads upwardly from the supply port 250' (Fig. 26) of the pump 247. In a return pipe 251 connected to the lower portion of the supply tank 244 shown in Fig. 2, is a relief valve 252. It can be seen by referring to Fig. 35 that the relief valve 252 is in a by-pass around the gear pump 247. It will also be seen by referring to Fig. 35 that the supply pipe 250 is connected directly between the pump 247 and the manifold 253 of the operator's control valve mechanism and that return line 254 leads directly from the manifold 253 to the discharge pipe 245 in the supply tank 244 as shown in Fig. 2, the return line 254 being separate from the by-pass 251.

As shown in Fig. 2, the manifold 253 is mounted on the rear ends of the spaced-apart brackets 255, 255, the latter being secured at their forward ends as shown in Figs. 2 and 4, to the transverse angle iron 256 which may be welded at its ends to the longitudinal and rearwardly diverging beams 40, 40 of the main frame 36.

The manifold is shown in detail in Figs. 29 to 34, inclusive, and comprises a single casing having a plurality of spaced-apart longitudinal passageways and a plurality of spaced-apart transverse passageways with the ends of the transverse passageways closed by means of the screw plugs 257, 257 and with the forward ends of the longitudinal passageways closed by means of the screw plugs 258. A plurality of vertical passageways are also provided, the lower ends of which are closed by means of the screw plugs 259 except those shown in Figs. 32 and 33. The vertical passageway 260 in Fig. 32 is connected to the supply pipe 250, and the passageway 261 of Fig. 33 is connected to the exhaust pipe or return pipe 254. Depending from the manifold 253 are vertical legs 262, 262 which have screw-threaded recesses 263, 263 for receiving cap screws 264 which extend upwardly through openings in the rear ends of the brackets 255, as shown in Fig. 2.

The passageways, the front of which are closed by the screw plugs 258, extend longitudinally of the machine and the rear ends of these passageways are open to receive the double valve illustrated in Fig. 34. As shown in Fig. 34, two valves 265 and 266 are mounted on the same valve stem 267 which extends rearwardly through the stuffing box 268 mounted in the rear opening of the manifold 253. The rear end of the valve stem 267 is connected by a link 269 to the operating lever 270, the lower end of which is pivoted at 271 to the bracket plate 272 secured to the rear end of the manifold 253. Abutments are provided at 273, 274 to limit the movements of the lever 270 rearwardly and forwardly. Centering springs 275 are secured at their lower looped ends to the plate 272, on the pivot 271, the upper portions of the spring 275 engaging opposite sides of the laterally and oppositely extending pins 276, 277. When the lever 270 is released the centering mechanism reutrns it to the neutral position shown in Fig. 34 and at the same time restores the valves 265 and 266 to their neutral positions shown in this view. When the lever 270 is moved forwardly the supply passageway 278 is connected to the port 279 and the pipe 280 while the pipe 281 is connected through the port 282 to the passageway 283. When the lever 270 is moved rearwardly the supply passageway 278 is connected through the port 282 to the pipe 281, and at the same time the pipe 280 is connected through the port 279 to the passageway 284.

It should be understood that the bracket 272 in reality comprises spaced-apart plates to provide a slot 285 to guide the lever 270 and to provide mountings for the pivot pin 271, the laterally and oppositely extending pins 276, 277 be-

ing on the lever 270. It should also be understood that the same valve structure shown in Fig. 34 is provided for each of the operating levers 270 shown in plan view in Fig. 4, and that the passageways of the manifold are connected to the various operating motors on the machine, as illustrated in Fig. 35, as will be more fully explained hereinafter in connection with the explanation of the operation of the various hydraulic motors in the grading and bank-sloping operations of the machine.

The laterally shifting mechanism for shifting the moldboard to its maximum extent to one side of the machine as shown in Fig. 13, and the means for shifting the moldboard to the bank-sloping positions shown in Figs. 10, 11 and 12, will now be described. Mounted between the beams 40, 40 of the main frame, above the rear end of the drawbar is a vertical plate 286. As shown in Fig. 9 which is a section taken on the line 9—9 of Fig. 2, looking in the direction of the arrows, the plate 286 may be welded to the channel beams 40, 40 and provided with openings 287 and 288, the latter being adapted to serve as a loose bearing for the forward end of the shaft 184 immediately back of the universal joint 182. Extending laterally from the channel beams 40, 40 are bracket plates 289, 289 approximately in the vertical plane of the plate 286. The upper and lower ends of the plate 286 are bolted at 290 and 291 to the inwardly extending plates 292, 292 and the outer ends of the plates 289, 289 are bolted at 293, 293 to the inwardly extending plates 294, 294. The plates 292, 292 and 294, 294 extend inwardly from the center of the drum shaped bearing 295 shown in section in Fig. 14 and in elevation in Figs. 16 and 17. The bolts 290, 291 extend through the openings 290′ and 291′ of Fig. 16 while the bolts 293, 293 extend through the openings 293′, 293′. It will thus be seen that the drum bearing 295 is rigidly connected to the main frame by means of the plates 286, 289, 289, and that the plate 286 by being welded to the beams 40, 40 assists the cross-connecting tubes including those designated 41 and 42 in Fig. 2 in reinforcing the main frame, to make it very rigid. The rigidity of the main frame is also enhanced by the cross-pieces 296, 297 and 298 connecting the tops of the beams 40, 40 by being welded thereto, as shown in Figs. 3 and 4 placed end to end.

Mounted on the bearing drum 295 are two concentric supporting rings 299 and 300, each being rotatable or arcuately adjustable on the same horizontal longitudinally extending axis. The supporting rings 299 and 300 are held in place on the bearing drum 295 in interfitting relation by means of the rear retaining ring 301 and front retaining ring 302 bolted respectively to the rear and front sides of the drum 295. The front retaining ring 302 is shown in elevation (looking rearwardly) in Figs. 22 and 23 and in section in Fig. 14. Bolts 303, 303 extend through openings 304, 304 in the retaining ring 302 and secure the latter to the annular flange 305 at the front end of the bearing drum 295, as shown in Fig. 14. The rear retaining ring 301 is secured by means of the bolts 306, 306 to the annular flange 307 at the rear end of the drum 295. The retaining rings 301 and 302 are similar in construction except that the rear retaining ring has a rearwardly extending socket 308 while the forward retaining ring 302 has a forwardly extending socket 309. Since the retaining rings 301, 302 are each greater in diameter than the diameter of the drum 295 their peripheral extensions co-operate with the drum to provide a retaining or guide groove having a width equal to the combined thicknesses of both of the supporting rings 299 and 300. In other words, the retaining rings 301 and 302 confine the supporting rings 299 and 300 to rotation or arcuate adjustment on the drum 295 while the latter is mounted in stationary position relative to the main frame.

As shown in Figs. 2 and 4, the rear supporting ring 299 is provided with a radial arm 310 to the outer end of which is pivoted on a longitudinal axis parallel to the axis of rotation of the ring 299, a bracket 311. This bracket is in the form of a yoke having spaced-apart arms the ends of which are pivoted at 312 to the ring 313 which is secured to the cylinder 314 intermediate the ends of the latter. In the cylinder is a piston connected to the depending piston rod 315, the lower end of which is provided with a ball socket 316 for receiving the ball 132 (Fig. 24). It will thus be seen that the cylinder 314 is connected to the arm 310 on axes which are at right angles to each other. The hydraulic motor 317 is therefore universally connected to the supporting ring 299 and constitutes an extensible hanger the lower end of which is universally connected to the rear end of the drawbar at the left-hand side looking forward, or as viewed in Fig. 7. The hydraulic motor 317 is double acting, as shown in Fig 35, where the pipes 318 and 319 are connected to opposite ends of the cylinder 314 on opposite sides of the piston therein. After the reciprocating hydraulic motor 317 has been expanded or contracted to adjusted length it may be locked in adjusted position automatically by release of the manual lever 270 at the operator's station, as will be more fully hereinafter explained.

The rear supporting ring 299 is shown in rear elevation in Fig. 20 and in plan in Fig. 21. Spaced approximately 150 degrees from the arm 310 is another radial arm 320 on the ring 299, the arm 320 being shorter in length than the arm 310. By referring to Fig. 9 which is an enlarged sectional elevation taken on the line 9—9 of Fig. 2, looking in the direction of the arrows, it will be seen that the shorter radial arm 320 is connected to the cylinder 321 of the laterally shifting hydraullic motor 322 on rectangularly related axes. The forked bracket 323 (Fig. 2) is journaled in the opening 324 (Fig. 20) and its arms 325 are pivotally connected at 326 to the ring 327 which is secured rigidly to the cylinder 321. As shown more in detail in Fig. 9, the ring 327 may be provided with trunnions 326, 326 journaled in the bearings 328 carried by the arms 325. The structure for pivotally supporting the cylinder 314 on the arm 310 on rectangularly related axes may be similar to that shown for supporting the cylinder 321 on the arm 320 on rectangularly related axes.

The hydraulic motor 322 comprises a piston in the cylinder 321 connected to piston rod 329 the lower end of which is provided with a ball socket 330 adapted to receive the ball 133 (Fig. 24). The ball 133 is at the rear end of the socket 127, as shown in Fig. 24, and consequently the lower end of the laterally shifting hydraulic motor 322 is connected to the left-hand side of the rear end of the drawbar structure, as viewed in Fig. 7. By referring to Fig. 35 it will be seen that the hydraulic laterally shifting motor 322 is double-acting because the pipes 331 and 332 are connected to the ends of the cylinder 321 on opposite sides of the piston therein. After the laterally shifting

motor 322 has been contracted or expanded to adjust the length thereof, it may be locked in adjusted position automatically by release of the manual control lever at the operator's station.

Releasable locking mechanism is shown in Figs. 2 and 14 for holding the rear supporting ring 299 in three different angular positions relative to the main frame. Between the spaced-apart bracket plates 333 mounted on the cross-piece 256 is pivoted at 334 an operating lever 335. Extending through the lever 335 is a rod 336 the rear end of which is screw-threaded to receive the nut 337. The forward end of the rod 336 is pivotally connected at 337' to the rear end of a rod 338 which slides through an opening in the abutment plate 339 as shown in Fig. 14. The forward end of the rod 338 is connected to a plunger 340 adapted to extend into a socket 341. As shown in Fig. 20, additional sockets 342 and 343 are spaced circumferentially around the ring 299 at the upper portion thereof. A spring 344 is located between the plunger 340 and the bracket 339 and surrounds the rod 338. When the operator at the operator's station pulls rearwardly on the lever 335 he may release the plunger 340 from the socket 341, whereupon the ring 299 will be released. When the ring 299 is thus released the operation of the hydraulic motors 317 and 322 may be controlled to effect anticlockwise rotation of the ring 299, as viewed in Fig. 7. In this manner the ring 299 may be adjusted relative to the main frame so that the plunger 340 will extend into any one of the sockets 341, 342 or 343 to hold the rear ring 299 in adjusted position relative to the main frame. For instance, in Fig. 7 the plunger 340 extends into the socket 341 to hold the ring 299 in the position shown in this view. The ordinary road grading operations may then be performed.

By changing the position of the front ring 300 anti-clockwise but moving the rear ring in a clockwise direction and locking the rings in adjusted positions, the moldboard may be shifted laterally to its maximum extent as shown in Fig. 13, for road grading operations partly under the machine and partly along the shoulder or berm of the roadway. In Fig. 13 the plunger 340 extends into the socket 343 of Fig. 20. An intermediate position of the moldboard while horizontal in road grading position, between that shown in Fig. 7 and that shown in Fig. 13, may be obtained by adjusting the ring 299 to a position where the plunger 340 will fit in the socket 342 to lock the ring 299 in fixed position relative to the main frame.

While the moldboard may be shifted laterally to a certain extent while occupying a horizontal position in road grading position, such lateral shifting may be increased by shifting the ring 299 in an anti-clockwise direction, as viewed in Fig. 7, and locking the same in its new position. But the extended lateral shifting of the moldboard while horizontal in road grading position may be still further increased by shifting the front ring 300 in a clockwise direction and locking it in adjusted position. The front ring 300 is shown in rear elevation in Fig. 18 and in plan in Fig. 19. This front ring 300 is provided with a radially extending arm 345 having an opening in its outer end to serve as a journal bearing for the bracket 346, as shown in Fig. 4. The bracket 346 is provided with branching arms 347 having at their outer ends journal bearings 348 for the trunnions 349 which extend outwardly diametrically from the ring 350 secured to the cylinder 351 as shown in Figs. 4 and 9. The cylinder 351 is therefore mounted on the arm 345 on rectangularly related axes.

As shown in Fig. 7, the cylinder 351 forms a part of a hydraulic motor 352, the piston rod 353 of which is provided at its lower end with a socket 354 for receiving the ball 129 (Fig. 24) at the right side of the rear end of the drawbar, as viewed in Fig. 7. The hydraulic motor 352 constitutes an extensible hanger in that it may be expanded or contracted as to length. The hydraulic motor 352, as shown in Fig. 35, is double-acting since the cylinder 351 is connected at its ends to the pipes 355 and 356 on opposite sides of the piston in the cylinder 351. The hydraulic motor 352 may be locked at adjusted length by releasing the operating lever 270 at the operator's station.

As shown in Fig. 18, the front ring 300 is provided with three circumferentially spaced sockets 357, 358 and 359 each of which is adapted to receive the locking plunger 360, as shown in Fig. 14. Secured to and projecting upwardly from the top central portion of the transverse bracing tube 41 is a support 361, to the upper end of which is pivoted at 362 a double arm rocking lever 363. To the lower end of the lever 363 is pivoted at 364 the front end of a rod 365 which extends rearwardly through the opening 287 in the supporting plate 286. As shown in Figs. 2 and 15, the rear end of the rod 365 is extended through the lower end of the operating lever 335. The rear end of the rod 365 may be screw-threaded to receive a nut 366. The nuts 337 and 366 may be used to adjust the effective lengths of the rods 336 and 365 so that the desired operations of the plungers 340 and 360 may be secured in connection with the supporting rings 299 and 300.

To the upper end of the lever 363 is pivotally connected at 367 the front end of a link 368, the rear end of which is pivoted at 369 to the rod 370 which extends through the abutment plate 371. The rod 370 extends through a spring 372 and is connected at its rear end to the plunger 360, the rear end of which is adapted to fit into any one of the sockets 357, 358, 359 (Fig. 18) in the front ring 300.

Since the rear ends of the rods 336 and 365 slide freely through the openings in the lever 335, the nuts 337 and 366 are relied on to act as abutments when the lever 335 is moved against the front sides of said nuts 337 and 366. For instance, when the lever 335 is moved forward the spring 344 is permitted to move the plunger 340 forward into a socket in the rear ring. At the same time that the upper end of the lever 335 is moved forward, the lower end thereof engages the nut 366 to pull the rod 365 rearwardly and this effects movement of the lever 363 in such direction as to pull the plunger 360 forwardly to release the same from a socket in the front ring 300. When the upper end of the lever 335 is moved rearwardly the lower rod 365 is released and the spring 372 is free to act to move the plunger 360 rearwardly into a socket in the front ring.

It should be understood that neither the rod 336 nor the rod 365 can be pushed forward by movement of the lever 335. The springs 344 and 372 act to automatically push the plungers 340 and 360 into the sockets in the rings 299 and 300. When one plunger 340 is manually released by actuating the lever 335, the other plunger is being acted upon by its spring to push it into one of the sockets. In other words, both plungers can not be manually released at the same time be-

cause the interlocking mechanism connected to the lever 335 is such that when one plunger is released the other is applied so as to assure the continuance of the locking of one ring 299 or 300 while the other is released. It should also be noted that when one plunger is released and the ring with which it is associated has been shifted through a short angle, the lever 335 may be released. This enables the operator to concentrate his attention on shifting the released ring 299 or 300 with the assurance that its plunger will snap into the next socket in the released spring to effect automatic relocking.

By comparing Figs. 7, 14, 18 and 20 it will be see that when the arms 310, 320 and 345 are in the positions illustrated in Fig. 7, the plunger 340 is in the socket 341 and the plunger 360 is in the socket 358.

Now upon releasing the plunger 360 from the front ring 300 the hydraulic motor 352 may be contracted to move the arm 345 to the lower position illustrated in Fig. 13 and when this position is reached the plunger 360 snaps into the socket 357 to lock the ring 300 in stationary position relative to the main frame. During this operation the rear ring 299 remains locked to the main frame. After the arm 345 has been locked in the position shown in Fig. 13, the plunger 340 may be released and the hydraulic motors 317 and 322 operated to shift the rear ring 299 anticlockwise until the plunger 360 is opposite the socket 343 in the rear ring 299. If desired, the anti-clockwise movement of the rear ring 299 may be effected step by step in that the plunger 340 is released to snap first into the socket 342 of Fig. 20, and then released for further anti-clockwise movement of the rear ring 299 until the plunger 340 snaps in the socket 343. When the plunger 360 is in the socket 357 and the plunger 340 is in the socket 343, the relative positions of the arms 310, 320 and 345 will be as shown in Fig. 13. The hanger 317 will then be in an inclined position and the laterally shifting motor 322 will be in an almost vertical position. The hanger 352 will be inclined downwardly toward the right as viewed in Fig. 13. With this arrangement of the motors 317, 322 and 352 the moldboard may be shifted laterally to its maximum extent and by contracting and expanding the motors the moldboard may be adjusted in elevation relative to the road surface while occupying a horizontal position. It will also be seen that when the moldboard is thus laterally shifted to its maximum extent, the moldboard may be adjusted in inclination relative to the line of draft and this is particularly useful in grading the shoulders of roadways. The outer laterally extending end of the moldboard may be inclined downwardly and such adjustment is particularly useful for the trimming of berms or the roadside banks of ditches.

When the moldboard is to be shifted to the bank-sloping position shown in Fig. 10 from the road grading position shown in Fig. 7, the plunger 340 is left in the socket 341 to hold the arms 310 and 320 in the relative positions shown in Fig. 7. By releasing the plunger 360 the arm 345 may be shifted upwardly by expanding the hanger 352 until the plunger 360 snaps into the socket 359 (Fig. 18) to lock the arm 345 in the position shown in Fig. 10. When the arms 310, 320 and 345 are locked in the relative positions shown in Fig. 10 the hanger 352 may be contracted, the hanger 317 expanded and the laterally shifting motor 322 contracted to effect movement of the moldboard to the steep bank-cutting position shown in Fig. 10, with the heel of the moldboard inside of the path of travel of the adjacent rear wheel 38.

Whenever desired, to facilitate movement of the moldboard from a horizontal position under the main frame, as shown in Fig. 7, to the bank-sloping position shown in Fig. 10, the moldboard may be first elevated from the road surface and then swung around on the axis of the king pin 139 to the position shown in Fig. 4. Then while the forward end of the moldboard rests on the ground, the arm 345 may be shifted in an anti-clockwise direction and locked in the position shown in Fig. 10, whereupon the moldboard may be lifted from the road surface so as to provide ample clearance therefrom while the motors 317, 322 and 352 are operated to move the moldboard out from under the machine whereupon the moldboard may again be swung on its king pin pivot 139 to adjust the height of the forward end of the moldboard while its heel or lower rear end still clears the road surface.

In preparation for adjustment of the moldboard from the steep bank-cutting position shown in Fig. 10 to the upright bank-cutting position shown in Fig. 12, the heel of the moldboard is permitted to rest on the road surface while the motor 352 remains locked in its contracted position shown in Fig. 10. Then by releasing the plunger 340 (Fig. 14), the motors 317 and 322 may be operated to shift the rear ring 299 in an anti-clockwise direction to permit the plunger 340 to snap into the socket 342, whereupon the arm 310 will occupy a position intermediate that shown in Fig. 10 and that shown in Fig. 11. The moldboard may then be moved to a position intermediate that shown in Fig. 10 and that shown in Fig. 12.

By releasing the plunger 340 from the socket 342, the motors 317 and 322 may be further operated to move the arm 310 down to the position shown in Fig. 11, whereupon the plunger 340 will snap into the socket 343 (Fig. 20).

In the relative positions of the parts shown in Fig. 11 the arms 310 and 345 have been shifted in anti-clockwise directions to their maximum extent and then the plunger 340 is in the socket 343 of the rear ring 299 and the plunger 360 is in the socket 359 of the front ring 300. When the arms 310 and 345 are locked in the positions shown in Fig. 11, the hanger 352 may be locked in its contracted position while the motor 322 is contracted and the motor 317 expanded to the position shown in Fig. 12, to effect adjustment of the moldboard to upright bank-cutting position outside of the path of travel of the adjacent rear wheel 38. When in such upright bank-cutting position the upper end of the moldboard may be adjusted in height by control of the power-operated mechanism for swinging the semi-circle on the king pin 139. Furthermore, while the moldboard is outside of the path of travel of the adjacent rear wheel 38, the lower end of the moldboard may be adjusted toward and from such path of travel of the rear wheel 38 to a limited extent, because as shown in Fig. 12 contraction of the motor 322 will permit contraction of the motor 317 to effect movement of the lower end of the moldboard toward such path of travel. It will also be seen by referring to Fig. 12 that since the hanger 322 is fully contracted when the moldboard is in upright position, the upper end of the moldboard may be

moved through a relatively wide angle by expansion of the hanger 352.

By reason of the adjustments of the lower end of the moldboard toward and from the path of travel of the rear wheel and the adjustments of the upper end of the moldboard toward and from the main frame, the moldboard may be adjusted in various parallel upright positions at varying distances from the main frame.

In whatever position that the moldboard has been adjusted to it is held rigidly connected to the main frame, the rear and front rings 299 and 300 being locked to the main frame, the semicircle 142 being locked to the drawbar by the self-locking worm gearing 168—170, and the hydraulic motors 317, 322 and 352 being locked at their adjusted lengths. On account of the relative angularity of the motors 317, 322 and 352 in all positions on the moldboard, the latter are interlocked to effectively resist being shifted either laterally or up and down relative to the main frame by cutting operations of the machine whether in road grading position, ditching position, steep bank-cutting positions, or upright bank-cutting position. That is to say, the extensible reciprocating motors 317, 322 and 352 while locked at adjusted lengths, by rigidly holding the blade to its work, effectually resist all stresses and strains during all operations of the machine, including bank-cutting operations, and the leaning of the wheels may be relied on to prevent lateral skidding of the machine particularly during upright bank-cutting positions of the moldboard.

By referring to Figs. 10, 11 and 12 it will be seen that the shifting of the rear end of the vehicle frame laterally relative to the rear wheels enables the moldboard 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 thrust during bank-sloping operations. Consequently the locking of the motors 317, 322 and 352, the locking of the frame shifting motor 104, and the locking of the leaning wheel motors 103 and 52, effect the holding of the moldboard rigidly in bank-sloping position while at the same time locking all of the adjustments to resist the lateral thrust during bank-sloping operations. Furthermore, when a tractor is hitched to the tongue 57 to pull the machine along a roadway while the moldboard is operating on a sloping bank, thet hydraulic steering motors 68, 68 may be set in certain positions and locked there with the assurance that the travel of the front wheels over rough ground or an irregularity, will not throw the setting of the steering mechanism out of adjustment.

The internal combustion engine 191 and the pump 247 (Fig. 2) to which it is connected, are mounted on a platform 241 rigidly connected to the channel beams 40, 40 of the main frame. The fluid-pressure medium, such as oil, is drawn from the supply tank 244 by the pump 247 and forced through the various pipes or conduits shown in Fig. 35. The valves for the respective hydraulic motors are banked back of the manifold 253 so as to have all of the operating levers 270 thereof within the reach of the operator on the platform 192 at the rear end of the machine, as shown in Fig. 2.

The front end of the platform 192 is pivoted as indicated at 373 in Fig. 2, to the brackets 374 secured to the beams 40, 40 of the main frame. Mounted on the corners of the operator's platform 192 are uprights 375, 375 for supporting at their upper ends the horizontal hand rails 376 and the forward cross-connecting hand rail 377 within easy reach of the operator while standing on the platform 192. A gasoline tank 378 for the engine 191, may be secured to one of the horizontal longitudinally extending hand rails 376.

While the forward end of the operator's platform 192 is pivoted at 373 as shown in Fig. 2, the rear end is mounted on a depending bracket 379, the lower end of which is secured to the top of the leaf spring 380, the latter in turn being secured at its lower side to a cross-piece 90'. The ends of the cross-piece 90' are secured to the members 90, 90 which in turn are secured to the rear ends of the longitudinal angle irons 88, 88, as shown in Figs. 2 and 7. It will thus be seen that the operator's platform 192 is resiliently mounted on the rear end of the main frame channel beams 40, 40.

The operation of the various adjustments by means of the hydraulic motors may best be understood by referring to the piping diagram in Fig. 35. Each motor is provided at the manifold 253 with manually operated mechanism similar to that shown in Fig. 34, so that each motor may be individually controlled. When the vehicle tongue 57 is in its central position shown in Fig. 3 and it is desired to turn the front axle tree 48, the motors 70, 70 are operated in opposite directions. By pulling the lever 270 rearwardly the supply pipe 250 is connected through the supply passageway 278 in the manifold to the passageway 284 therein, allowing the liquid to be moved forwardly into the rear of the left-hand motor 70 and the front of the right-hand motor 70. The exhaust will be from the front of the left-hand motor 70 and the rear of the right-hand motor 70 into the pipe 84 and thence along the passageway 283 in the manifold to the port 261 and the return pipe 254. This can readily be understood by comparing Fig. 34 with Fig. 35.

When the lever 270 is released, the spring centering mechanism closes the valves in Fig. 34 to lock the pistons in the motors 70 against movement in either direction. The front leaning wheel motor 52 is connected to separate valve mechanism by means of the pipes 86, 87, the rear leaning wheel motor 103 is connected to separate valve mechanism by means of the pipes 381, 381, the frame shifting motor 104 is connected to separate valve mechanism by means of the pipes 382, 382, the left-hand motor hanger 317 is connected to separate valve mechanism by the pipes 318, 319, the right-hand hanger motor 352 is connected to separate valve mechanism by means of the pipes 355, 356, and the laterally shifting motor 322 is connected to separate valve mechanism by means of the pipes 331, 332. The ports designated 279 and 282 in Fig. 35 are arranged in the manifold, as shown in Figs. 29 to 34, inclusive.

The rear leaning wheel motor 103 and frame shifting motor 104 are connected in parallel to the source of fluid-pressure supply through the manifold, and therefore both motors may be operated simultaneously if desired. In a similar manner the front leaning wheel motor may be operated at the same time that the steering motors are being operated. The hanger motors 317, 352 and the laterally shifting motor 322 are also connected in parallel to the source of fluid-pressure supply, and therefore while one motor

is being expanded another may be contracted. For instance, when the moldboard is approaching the position shown in Fig. 10, the motor 317 may be expanded while the motor 322 is being contracted. As may be seen by referring to Figs. 4 and 35, each of the motors on the machine may be automatically locked in adjusted position by release of its controlling lever 270 connected to its respective valve mechanism.

The engine 191 is intended to be operated continuously to drive the pump 247. The supply side of the pump 247 is connected directly to each of the hydraulic motors.

It is desirable to keep all of the pipes completely filled with liquid at all times and the pipes may therefore be located wherever conveniently supported without necessitating drainage by gravity into the tank 244 from any of the return pipes. Flexible hose connections lead from all of the motors in a manner similar to the flexible hose connections designated 84 and 85 in Fig. 1. Flexible hose connections also lead from the manifold to the various motors except that metal pipes lead forwardly from the manifold along the top of the main frame for connection to the rear ends of the flexible hose leading to the front steering wheel motors and the front leaning wheel motors. Such metal pipes are illustrated at 84' and 85' in Figs. 1 and 2 placed end to end. These metal pipes are mounted at intervals on the supports 383, 384 and 386 to the top of the left-hand beam 40. On the other beam 40 are two similar metal pipes connected at their forward ends to the front leaning wheel motor and at their rear ends directly to the manifold.

As shown in Fig. 9, which is a sectional elevation on the line 9—9 of Fig. 2, looking forwardly in the direction of the arrows, a rectangular frame 386 in connected by means of a cap screw 386' to the cross-piece 298, the latter being welded to the top of the beams 40, 40. Bolts extend laterally through the frame 386 and through the clamping members 393 to effect clamping of the metal pipes 84', 85' to the sides of such frame.

As may be seen by reference to Fig. 9, ample space is provided within the ring bearing drum for passage of the metal pipes between the front and rear portions of the main frame. There is also ample space within such ring bearing drum for passage forwardly of flexible hose 318, 319, 355, 356 from the manifold to the hanger motors 317 and 352. The flexible hose leading from the hanger motors 317 and 352 through the supporting rings 299, 300 to the manifold, and the flexible hose 331, 332 leading from the laterally shifting motor 322 to the manifold, are of ample length to form flexible loops (Figs. 2 and 9) to give the motors ample movement bodily relatively to the main frame when the moldboard is shifted laterally and when the moldboard is shifted to its various bank-sloping positions.

If desired the flexible hose connections 318, 319, 355, 356 may extend through the rectangular frame 386 instead of being located at the sides thereof as shown in Fig. 9. When at the sides of the frame 386, the hose connections 318, 319, 355, 356 may be strapped to the metal pipes 84', 85', rearwardly of the frame 386 so as to maintain them in fixed relation to the vehicle frame over those portions extending rearwardly from the ring structure to the manifold.

The capacity of the pump 247 is preferably such as to enable the operator to effect the operation of a plurality of hydraulic motors at the same time. When all of the valves are closed and the pump 247 continues to operate, the relief valve 252 will be opened in the direction of the arrow shown in Fig. 35, to prevent stalling of the pump 247. The by-pass pipe 251 is connected to the supply side of the pump and therefore all pipes on the supply side of the pump are always maintained filled with liquid at full pressure 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. When all of the reciprocating motors are locked in adjusted positions, the continuously operating pump 247 will effect opening of the relief valve 252 for a localized by-pass circuit through the pipe 251. Each reciprocating motor during operation is always connected on one side of its piston to the pressure supply pipe 250 and on the other side of its piston to the return pipe 254. During idling of the pump the relief valve 252 causes full static pressure in the central passageway 278 of the manifold. The passageway 278 is connected in multiple in the manifold to the passageways 283 and 284.

It should be particularly noted that universal flexibility of the machine is obtained under control of the operator at a single station at the rear end of the machine where he has under his observation not only the steering of the machine but also the adjustments of the moldboard in various road grading and bank-cutting positions and the results being produced by operation of the machine. Each hydraulic motor acts as an extensible strut or link to effectually resist compression and pulling stresses and strains. The hydraulic motors are located in the most efficient positions to do their work while rigidly connecting the supports to the members to be adjusted. During operation of the machine each reciprocating hydraulic motor may be subjected at certain times to compression stresses lengthwise thereof, while at other times it may be subjected to pulling strains. For instance, the hydraulic motor 322 will be subjected to pulling strains when the machine is operating as a road grader with the moldboard inclined relative to the line of draft so that the forward end of the moldboard is at the right-hand side of the machine, whereas when operating as a bank-sloping machine as shown in Fig. 10, the motor 322 may be subjected to compression strains.

By reason of the narrow width of the front end of the main frame and the forward tapering to a narrow width of the front end of the drawbar, as shown in Figs. 3 and 24, the drawbar is free to be moved on its flexible connection between the front end of the drawbar and the post 45, to an upright plane where the moldboard is in upright bank-cutting position. This is particularly true by reason of the fact that the vertical flanges of the angle iron structures 112, 112 are spaced apart to a no greater distance than the vertical plates of the channel iron structures 40, 40 of the main frame, as may be seen by referring to Fig. 3. Furthermore, the tapering of the vertical flanges of the angle iron structures 112, 112 at 111 (Fig. 1) enables the hangers to lift the moldboard up off the roadway and to hold the moldboard with ample clearance of the road surface while being shifter laterally to steep bank-cutting position. For all desired adjustments of the drawbar there will be no interference with the front end portion of the main frame.

When the moldboard is operating in steep bank-cutting position it may hook back of an obstruc-

tion in the bank, tending to pull the semi-circle 142 from the king pin axis 139 to the rear end of the drawbar. To assist the king pin to resist such pulling strain, a guide plate 386 may be secured by means of the bolts 387 to the bottom of the bracket 388, as shown in Fig. 2. As shown in Fig. 24, the bracket 388 may comprise plates 389, 389 welded to the inner faces of the vertical flanges of the angle iron structures 112, 112. A cross-plate 390 is shown welded at its ends to the plates 389. Sockets 391, 391 are welded to the plates 389 and 390 in vertical position to receive the bolts 387 of Fig. 2. The bracket structure 388 co-operates with the bracing tubes 113 and 114 to rigidly connect the angle iron structures 112, 112 of the drawbar frame. The upper and lower edges of the semi-circle 142 are guided along the lower sides of the horizontal flanges of the angle iron structures 112, 112, and the lower edge of this semi-circle 142 is guided along the upper surface of the guide plate 386, as shown in Fig. 2.

Since universal flexibility of adjustment is obtained by means of hydraulic motors under control of the operator at his station, the machine may be constructed for the heaviest duties whether in road grading, bank-sloping or bank-cutting operations, all the hard work being performed by the motors while the operator at his station merely opens and closes the controlling valves, one of which is illustrated in detail in Fig. 34. When the valves are closed the adjustable elements remain rigidly connected to the main frame to form a rigid unitary structure mounted on supporting wheels, with the moldboard locked to the main frame against movement in any direction relatively thereto. That is to say, notwithstanding the universal flexibility of adjustments, rigidity of structure in a heavy duty machine is obtained by the reciprocating hydraulic motors each locked at its adjusted length and acting as struts or links in most efficient positions to resist compression stresses and pulling strains during operation of the moldboard whether in road grading position, laterally shifted shoulder or berm trimming position, ditching position, bank-sloping position, or upright bank-cutting position.

The heaviest duty machines are relatively large and heavy with the frame very strong and rugged to effectively resist weaving or twisting and in order to accommodate relatively long moldboards the upwardly arched portion of the frame is relatively high. The operator's platform 192 is therefore relatively high from the road surface in order to enable him to crank the engine 191, conveniently reach the levers 270 of the controlling valves in the manifold 253, and have under his observation the steering of the machine and all operations of the moldboard. An auxiliary platform 392 at a relatively low level is provided at the rear end of the machine, as shown in Figs. 2 and 4, for the operator to ride on during transportation of the machine under overhead bridges, or such auxiliary platform 392 may be used by the operator as a step when climbing to the operator's station.

In such heaviest duty machines it is particularly desirable that the front end of the vehicle frame and the front end of the drawbar be located at high positions relative to the road surface. Such arrangement is shown in Fig. 1 and is secured by providing the lower end of the post 45 with an integral solid ball 46 which fits into a spherical socket on top of the bolster 47, connecting the front end of the vehicle frame rigidly to the top of the post 45 and connecting the front end of the drawbar flexibly to the post above the ball 46 spaced well above the top of the steering wheel unit as shown in Fig. 1. When a self-propelled tractor is hitched to the tongue 57 and pulls the grader along the roadway the steering wheel unit will be free by reason of the ball and socket joint 46, 394, to be tilted laterally by irregularities in the roadway without transmitting any twisting strains to the vehicle frame. Nevertheless, steering may be effected by the operator from his station at the rear end of the grader and when the motors 70, 70 are locked in adjusted positions they will hold the steering wheel unit rigidly connected to the tongue 57 to prevent swerving of the steering wheel unit on an upright axis at the ball and socket connection. Furthermore, while the leaning of the front wheels may be adjusted, they are not steered relatively to the axletree 48, steering being effected by shifting the axletree 48 together with the front wheels 39 as a unit on the upright axis at the ball and socket connections 46, 394. It should also be noted that the sole pulling connection between the front steering wheel unit and the vehicle frame and the drawbar is through the ball and socket connection and the post 45, the spring 80 being relied on to counterbalance the weight of the tongue 57 and the steering motors 70, 70 thereon and thereby keep the bolster 47 under the post 45, as shown in Fig. 1.

The drawbar and circle structure shown in Figs. 1 to 4, inclusive, and in Figs. 24 and 25 are disclosed and claimed in my co-pending application Serial No. 390,953, filed April 29, 1941, for an Improvement in road graders. The flexible connection between the front end of the drawbar and the upright post 45, comprising the interlooping bolts 116 and 119 is disclosed and claimed in my co-pending application Serial No. 391,369, filed May 1, 1941, for an Improvement in road grader.

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 grader, the combination with a traveling supporting frame, of a supplemental frame swiveled thereto, a moldboard carried by said supplemental frame, concentric rings mounted on said supporting frame, releasable means for individually holding said rings in adjusted positions relative to said supporting frame, two spaced-apart hanger reciprocating hydraulic motors one connected between one ring and said supplemental frame and the other connected between the other ring and said supplemental frame, and an additional reciprocating hydraulic motor connected between one of said rings and said supplemental frame in position to co-act with said hanger motors to effect movement of the moldboard from road grading position to steep bank cutting position at one side of the said supporting frame.

2. In a road grading machine, the combination with a vehicle frame, of a drawbar flexibly connected thereto, a road-working tool mounted on said drawbar, a laterally shiftable support on said

vehicle frame, laterally shifting mechanism between said support and said drawbar, releasable mechanism for holding said support in adjusted position relative to said vehicle frame, and means for controlling said laterally shifting mechanism to secure lateral shifting of said support when released and to secure lateral shifting of the drawbar and said road-working tool when said support is held in adjusted position relative to said vehicle frame.

3. In a road grading machine, the combination with a vehicle frame, of a drawbar flexibly connected thereto, a road-working implement carried by said drawbar, a ring support, an annular guide on said vehicle frame for said ring support, latch mechanism comprising a releasable latch rod adapted to fit into any one of a plurality of circumferentially spaced holes in the peripheral portion of said ring support to hold the latter in adjusted position relative to said vehicle frame, and means connected between said ring support and said drawbar to effect lateral shifting of the road-working implement relatively to said vehicle frame while said ring support is being held by said latch mechanism in adjusted position relative to said vehicle frame.

4. In a road grader, the combination with a main frame, of a supplemental frame, a grader blade carried by said supplemental frame, means for supporting said supplemental frame on said main frame for adjustment relative thereto, and laterally shifting means between said main frame and said supplemental frame and comprising a fluid pressure motor serving as a link connected to said supplemental frame.

5. In a road grader, the combination with a supporting frame, of a supplemental frame adjustably mounted on said supporting frame, a scraper blade carried by said supplemental frame, concentric rings mounted on said supporting frame for rotary adjustment relative to each other and each relative to said supporting frame, means connected to said rings and embodying extensible fluid pressure motor hangers pivoted at their lower ends to said supplemental frame for adjusting the elevation and inclination of the scraper blade, means for holding the rings in adjusted positions relative to said supporting frame, and means embodying a link connected to said supplemental frame for effecting lateral shift of the scraper blade relatively to said supporting frame.

6. In a road grader, the combination with a vehicle frame, of a drawbar having its forward end flexibly connected to said frame, a pair of concentric rings mounted on said frame for rotary adjustment relative thereto, mechanism for holding said rings in adjusted positions relative to said frame, radially projecting arms one on each ring, hydraulic reciprocating motors one pivotally connected to one arm and the other pivotally connected to the other arm and both pivotally connected to the rear end portion of said drawbar on opposite sides thereof, a grader blade carried by said drawbar, a reciprocating hydraulic motor connected between one of said rings and one side of the rear end portion of said drawbar, and means for controlling said hydraulic motors to adjust the elevation and inclination and side shift of the grader blade relative to said vehicle frame.

7. In a road grader, the combination with a vehicle frame, of a drawbar flexibly connected at its forward end to the forward end portion of said frame, concentric arcuately movable supports mounted on said vehicle frame, releasable means for holding said supports in adjusted positions relative to said frame, reciprocating hydraulic motors on opposite sides of the frame one pivotally connected to one of said supports and the other pivotally connected to the other support and both hydraulic motors pivotally connected at their lower ends to opposite sides of the rear end portion of said drawbar, an additional reciprocating hydraulic motor pivotally connected to one of said supports and also pivotally connected to one side of the rear end portion of said drawbar in position to extend transversely of the said frame, and means for controlling said motors to move the grader blade from under said frame to a steep angle position at one side of said frame, the construction and arrangement being such that the operator may from his station control the motors to shift the said supports when released or adjust the grader blade when the supports are held in adjusted positions relative to the frame.

8. In a grader, the combination with a supporting frame, of a supplemental frame connected at its forward end to said supporting frame, a grader blade mounted on said supplemental frame, a tertiary frame mounted on said supporting frame for adjustment relative thereto, releasable means for holding said tertiary frame in adjusted position relative to said supporting frame, and means connected between said tertiary and supplemental frames for adjusting the position of said tertiary frame when released and for moving the grader blade from road grading position to bank sloping position when said tertiary frame is held in adjusted position relative to said supporting frame.

9. In a bank cutting machine, the combination with a main frame, of a supplemental frame connected thereto, a cutting blade carried by said supplemental frame, tertiary frame structure mounted on said main frame for adjustment relative thereto, means between said supplemental frame and said tertiary frame structure to adjust the latter relative to said main frame, mechanism for holding said frame structure in adjusted position relative to said main frame, and additional means between said tertiary frame structure and said supplemental frame and adapted to co-operate with the aforesaid adjusting means to effect movement of the cutting blade to steep bank sloping position at one side of the main frame.

10. In a grader, the combination with a main frame, of a supplemental frame pivotally connected thereto, a grader blade carried by said supplemental frame, two arcuately adjustable supports on said main frame, mechanism for holding said supports in adjusted positions relative to said main frame, extensible hangers between said supports and opposite sides of the rear end of said supplemental frame, and laterally shifting means between one of said supports and said supplemental frame, the construction and arrangement being such that the grader blade may be supported in laterally shifted horizontal position for road grading widely extended from under the main frame to one side of the path of travel of the machine.

11. In laterally shifting mechanism for the road-working implement of a road-working machine, the combination with a ring guide adapted to be mounted on the frame of the machine to encircle the same in a plane extending transversely of said frame, of a ring carrier mounted

on said ring guide concentric therewith, an expansible link pivotally connected to said ring carrier and adapted to have one end pivotally connected to the road-working implement carrier, and releasable means for holding said ring carrier in adjusted angular position relative to said ring guide, said link comprising means for expanding and contracting the same to effect shifting of said ring carrier when released and to effect lateral shifting of the road-working implement when said ring carrier is held.

12. As an article of manufacture, a supporting ring having a recess extending parallel to its axis of rotation in position to receive a locking plunger to hold the ring in adjusted position on the vehicle frame of a road grader, the ring being adapted to encircle such frame in a vertical plane, and an arm extending radially from the ring for pivotal connection to an extensible link adapted to be connected to the drawbar of such road grader.

13. In a road grader, the combination with a vehicle frame, of a drawbar connected thereto, a grader blade carried by said drawbar, an annular bearing on said frame, concentric rings on said bearing, a reciprocating hydraulic motor connecting one of said rings to one side of the free end of said drawbar, another reciprocating hydraulic motor connecting the other ring to the other side of the free end of said drawbar, said motors being adapted to serve as extensible hangers for said drawbar and grader blade, a laterally shifting hydraulic motor connecting said other ring to said other side of the free end of the drawbar, controlling valve mechanism comprising a manifold, flexible conduits connecting said laterally shifting motor to said manifold, additional flexible conduits extending from the hanger motors through said annular bearing rearwardly along said frame to said manifold, a pump connected to said manifold, and an engine connected to said pump to drive the same.

14. In a road grader, the combination with a vehicle frame, of a drawbar connected thereto, a grader blade carried by said drawbar, a plurality of arcuately adjustable supports mounted on said vehicle frame, adjustable means between said supports and said drawbar to effect support of the grader blade in adjusted position relative to the road surface, and interlocking releasable mechanism for securing said supports in adjusted positions relative to said vehicle frame.

15. In a road grader, the combination with a vehicle frame, of a circular bearing surrounding said frame and secured thereto, a drawbar flexibly connected at its forward end to said vehicle frame, a road-working implement carried by said drawbar, a ring mounted on said circular bearing, fluid-pressure motor mechanism connected between said vehicle frame and said drawbar to adjust the latter relative to said frame, a pump mounted on said frame rearwardly of said bearing, means for driving said pump, and flexible hose connections extending from said pump through said circular bearing to said fluid-pressure motor mechanism.

16. In a road grader, the combination with a vehicle frame, of a drawbar connected thereto, a steering wheel unit for the front end of said vehicle frame, fluid-pressure motor mechanism for operating said steering wheel unit to steer the machine, a grader blade carried by said drawbar, means for adjustably supporting the free end of said drawbar from said vehicle frame, fluid-pressure producing means on the rear end of said vehicle frame, conduits connecting said fluid-pressure producing means to said fluid-pressure motor mechanism comprising metal pipes extending along the top of said frame and flexible hose connecting the forward ends of such metal pipes to said motor mechanism, and mechanism for rigidly clamping said metal pipes to the top of said vehicle frame.

17. In a road grader, the combination with a vehicle comprising a supporting frame, of a drawbar flexibly connected at one end to said frame, a plurality of supports each guided on said supporting frame for arcuate adjustment relative thereto, a road-working implement carried by said drawbar, an operator's station, means operable from said station for holding or releasing said supports individually, and means connected between said supports and said drawbar and operable from said station for adjusting said drawbar and road-working implement relative to said supporting frame when said supports are held in adjusted positions relative to said supporting frame and for effecting arcuate adjustment of any support relative to said supporting frame when such support is released.

18. In a road grading machine, the combination with a main frame, of a supplemental frame, means for supporting said supplemental frame from said main frame for adjustment relative thereto, a laterally adjustable support slidable transversely of said main frame, releasable latch mechanism for holding said support in adjusted position relative to said main frame, mechanism carried by said support and connected to said supplemental frame to effect lateral shifting of said supplemental frame relatively to said support when the latch mechanism holds the support against sliding movement relatively to said main frame, said laterally shifting mechanism being adapted to adjust the position of said support by sliding the same relatively to said main frame when said latch mechanism is in position to release said support, and a road working tool carried by said supplemental frame.

19. In a bank cutting machine, the combination with a main frame, of a supplemental frame connected thereto, a support mounted on said main frame for arcuate adjustment transversely thereof, a link pivotally connected to said support and pivotally connected to said supplemental frame in position to extend diagonally transversely of said main frame, a grader blade mounted on said supplemental frame, an additional support mounted on said main frame for arcuate adjustment transversely thereof independently of said first-named support, and means comprising extensible hangers connected to said supplemental frame one connected to said first-named support and the other connected to the second-named support and arranged to co-operate with the adjustment of said support and the positioning of said link to effect support of the grader blade in bank sloping position, and releasable latch devices one associated with one support and the other associated with the other support, the construction and arrangement being such that when either support is released its position relative to the main frame may be shifted by adjustment of the length of the hanger connected thereto.

20. In a road grading machine, the combination with a vehicle frame, of a drawbar flexibly connected at one end to said vehicle frame, a grader blade carried by said drawbar, ring structure arcuately guided on said vehicle frame, a diagonal

transverse link connected between said ring structure and one side of the rear end portion of said drawbar, hangers on opposite sides of the vehicle frame each extensible in length and each pivotally connected at its lower end to the rear end portion of said drawbar and at its upper end to said ring structure, and releasable mechanism for holding said ring structure in locked relation to said vehicle frame, the ring structure when released being adjustable relative to said vehicle frame by adjustment of said hangers.

21. In a bank cutting machine, the combination with a main frame, of a supplemental frame connected thereto, a cutting blade carried by said supplemental frame, tertiary frame structure mounted on said main frame for adjustment relative thereto, spaced-apart reciprocating hydraulic motors between said supplemental frame and said tertiary frame structure to adjust the latter relative to said main frame, releasable mechanism for holding said frame structure in adjusted position relative to said main frame, and an additional hydraulic reciprocating motor between said tertiary frame structure and said supplemental frame and adapted to co-operate with said spaced-apart motors to effect movement of the cutting blade to bank-cutting position at one side of the machine.

22. In a road grader, the combination with a vehicle frame, of a drawbar flexibly connected at its forward end to the forward end portion of said vehicle frame, a grader blade carried by said drawbar, a tertiary frame mounted on said vehicle frame for adjustment relative thereto, releasable means for holding said tertiary frame in adjusted position relative to said vehicle frame, spaced hangers connected to said drawbar and one connected to the tertiary frame and the other connected to said vehicle frame, and mechanism between said tertiary frame and said drawbar operative to laterally shift the drawbar when the tertiary frame is held in adjusted position relative to said vehicle frame and operative to shift said tertiary frame laterally of said vehicle frame when said tertiary frame is released.

23. In a bank cutting machine, the combination with a main frame, of a supplemental frame connected thereto, a cutting blade carried by said supplemental frame, a tertiary frame structure mounted on said main frame for adjustment relative thereto, means between said supplemental frame and said tertiary frame structure to adjust the latter relative to said main frame, said adjusting means comprising spaced hangers each embodying means for varying the length thereof, releasable mechanism for holding said frame structure in adjusted position relative to said main frame, and additional means extensible in length between said frame structure and said supplemental frame for effecting side shift of said supplemental frame relatively to said main frame and adapted to co-operate with the said hangers to effect movement of the cutting blade to bank sloping position at one side of the main frame.

24. In laterally shifting mechanism for the road-working implement of a road-working machine, the combination with a support for the road-working implement, of a guide adapted to be mounted on the frame of the machine to extend laterally thereof, a carrier mounted on said guide for adjustment therealong transversely of the machine, an expansible link pivotally connected to said carrier and adapted to have one end pivotally connected to the road-working implement support, and releasable means for holding said carrier in adjusted position relative to said guide, said link comprising means for expanding and contracting the same to effect shifting of said carrier when released and to effect lateral shifting of the road-working implement when said carrier is held.

25. In a road working machine, the combination with a main frame, of a supplemental frame pivotally connected to said main frame, a grader blade carried by said supplemental frame, an arcuate support, a bearing for free movement of said support arcuately along a circle surrounding said frame, releasable mechanism for holding said arcuate support in adjusted position relative to said main frame, lifting means between said arcuate support and said supplemental frame, an extensible link between said arcuate support and said supplemental frame and embodying means for expanding or contracting the same to effect lateral shift of the grader blade relatively to the main frame when said arcuate support is held in adjusted position relative to the main frame, said expanding and contracting means being adapted to adjust the position of said arcuate support when released, and connections between said main and supplemental frames adapted to co-operate with said lifting means and said link to effect support of the grader blade either in horizontal position or steep bank-cutting position.

26. In a road grader, the combination with a vehicle frame, of a drawbar connected thereto, a grader blade carried by said drawbar, an annular bearing on said frame, two rings on said bearing, a reciprocating fluid-pressure motor connecting one of said rings to one side of the free end of said drawbar, another reciprocating fluid pressure motor connecting the other ring to the other side of the free end of said drawbar, said motors being adapted to serve as extensible hangers for said drawbar and grader blade, a laterally shifting reciprocating fluid pressure motor connecting one of said rings to one side of the free end of said drawbar, and means for controlling said motors to effect various adjustments.

27. In a road grader, the combination with a main frame, of a supplemental frame pivotally connected thereto, a grader blade carried by said supplemental frame, two laterally adjustable supports on the main frame, mechanism for holding said supports in adjusted positions relative to the main frame, spaced-apart hangers between said supports and opposite sides of the rear end of said supplemental frame, and laterally shifting means between one of said supports and said supplemental frame, the construction and arrangement being such that the grader blade may be supported in laterally shifted horizontal position for road grading widely extended from under the main frame to one side of the path of travel of the machine.

28. In a road grader, the combination with a main frame, of a supplemental frame connected thereto, a road-working implement carried by said supplemental frame, two supports mounted on said main frame each for individual adjustment transversely thereof, an operator's station, means operable from said station for holding or releasing said supports individually, and means connected between said supports and said supplemental frame and operable from said station for adjusting said supplemental frame and road-working implement relative to said main frame

when the supports are held in adjusted positions relative to said main frame and for effecting lateral adjustment of either support relative to said main frame when such support is released.

29. In a grader, the combination with a main frame, of a supplemental frame adjustable relative thereto, a grader blade carried by said supplemental frame, two adjustable supports on said main frame, spaced hangers each extensible in length one connected to one of said supports and the other connected to the other support, both hangers being connected to said supplemental frame, an extensible link connected between one of said supports and one side of the rear end portion of said supplemental frame to occupy a position extending diagonally of said main frame, and releasable mechanism for holding said supports in adjusted positions relative to said main frame, the construction and arrangement being such that adjustments of the lengths of said hangers and of said link serve to adjust said supports when released.

30. In a road grader, the combination with a vehicle frame, of a drawbar having its forward end flexibly connected to said frame, two supports each mounted on said frame for adjustment relative thereto, mechanism for holding said supports in adjusted positions relative to said frame, fluid pressure reciprocating motors one pivotally connected to one support and the other pivotally connected to the other support and both pivotally connected to the rear end portion of said drawbar on opposite sides thereof, a grader blade carried by said drawbar, a reciprocating fluid-pressure motor connected between one of said supports and one side of the rear end portion of said drawbar, and means for controlling said fluid-pressure motors to adjust the elevation and inclination and side shift of the grader blade relative to said vehicle frame.

31. In a road grader, the combination with a vehicle frame, of a drawbar flexibly connected at its forward end to the forward end portion of said vehicle frame, two supports mounted on said vehicle frame for adjustment relative thereto, releasable means for holding said supports in adjusted positions relative to said frame, reciprocating fluid pressure motors on opposite sides of the frame one pivotally connected to one of said supports and the other pivotally connected to the other support and both motors pivotally connected at their lower ends to opposite sides of the rear end portion of said drawbar, an additional fluid pressure motor pivotally connected to one of said supports and also pivotally connected to one side of the rear end portion of said drawbar in position to extend transversely of said vehicle frame, and means for controlling said motors to adjust the grader blade relative to said vehicle frame, the construction and arrangement being such that the operator may from his station control the motors to shift said supports when released or adjust the grader blade when the supports are held in adjusted positions relative to said frame.

32. In a road grader, the combination with a main frame, of a supplemental frame connected thereto, a road-working implement carried by said supplemental frame, a ring structure surrounding said main frame, spaced-apart reciprocating fluid-pressure motors serving as hangers between said ring structure and said supplemental frame, and flexible hose connections extending from said reciprocating fluid-pressure motors through said ring structure to the source of fluid pressure medium for said motors.

33. In a road grader, the combination with a vehicle frame, of an annular bearing mounted thereon, a drawbar flexibly connected at its forward end to said vehicle frame, a road-working implement carried by said drawbar, ring structure mounted on said annular bearing, fluid-pressure motor mechanism connected between said ring structure and said drawbar to adjust the latter relative to the vehicle frame, and flexible hose connections extending from the source of fluid-pressure through said annular bearing to said fluid-pressure motor mechanism.

34. In a road grader, the combination with a vehicle frame, of a drawbar flexibly connected thereto, a road-working implement carried by said drawbar, two arcuate supports arcuately adjustable laterally of said vehicle frame, mechanism releasable by the operator from his station on the machine for holding said supports individually in adjusted positions relative to said vehicle frame, hangers connected between said drawbar and said supports and operable from the operator's station to effect adjustment of the road-working implement, and power-operated laterally shifting mechanism connected to said drawbar and to one of said supports and controllable from the operator's station.

35. In a bank-sloping machine, the combination with a vehicle, of a frame connected at one end to said vehicle for adjustment relative thereto, a cutting blade carried by said frame, spaced supporting hangers each extensible in length and each pivotally connected to the free end portion of said frame, two arcuate supports each arcuately guided transversely of the vehicle, one support being pivotally connected to one of said hangers and the other support being pivotally connected to the other hanger, a link pivotally connected to one of said arcuate supports and pivotally connected at its lower end to said frame in position to extend diagonally and transversely of said vehicle, and means for holding said arcuate supports in adjusted positions relative to said vehicle, the construction and arrangement being such that by adjusting the lengths of said hangers and by adjustment of said arcuate supports, the grader blade may be supported from the vehicle in bank-sloping position at one side thereof.

36. In a bank cutting machine, the combination with a portable main frame, of a supplemental frame flexibly connected at one end to said main frame, a grader blade carried by said supplemental frame, spaced supporting hangers each extensible in length and each pivotally connected at its lower end to the free end portion of said supplemental frame, two arcuate supports each arcuately guided transversely of said main frame and one pivotally connected to one of said hangers and the other pivotally connected to the other hanger, mechanism for locking the arcuate supports in adjusted positions relative to said main frame, and a diagonally extending link extensible in length and pivotally connected at its lower end to the free end portion of said supplemental frame and pivotally connected to one of said arcuate supports, the construction and arrangement being such that adjustments of the two arcuate supports relative to the main frame and the adjustments of the lengths of the hangers and of the said link are adapted to co-operate to support the grader blade in bank sloping position at one side of the machine.

37. In a road grader, the combination with a

main frame, of a supplemental frame connected thereto, a grader blade carried by said supplemental frame, two supports mounted on said main frame for adjustment transversely thereof, adjustible means between said supports and said supplemental frame to effect support of the grader blade in adjusted position relative to the road surface, and releasable mechanism for securing said supports in adjusted positions relative to the main frame, said releasable mechanism being interlocking so that when one support is released the other will remain held in adjusted position relative to the main frame.

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