Feb. 14, 1950 A. L. LADO 2,497,778

MECHANISM FOR ROAD GRADERS

Filed March 17, 1944 8 Sheets-Sheet 1

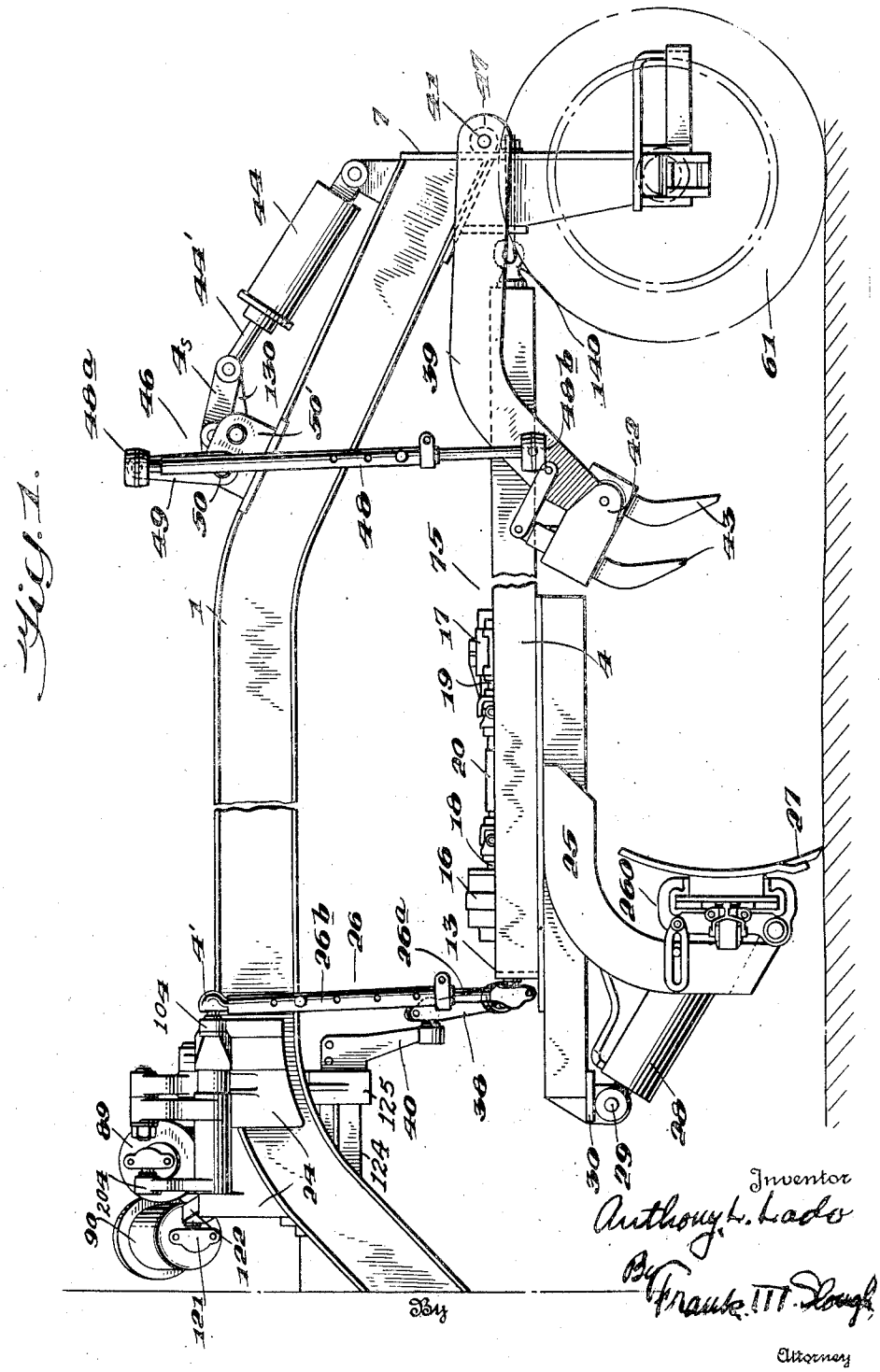


Fig. 1.

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MECHANISM FOR ROAD GRADERS

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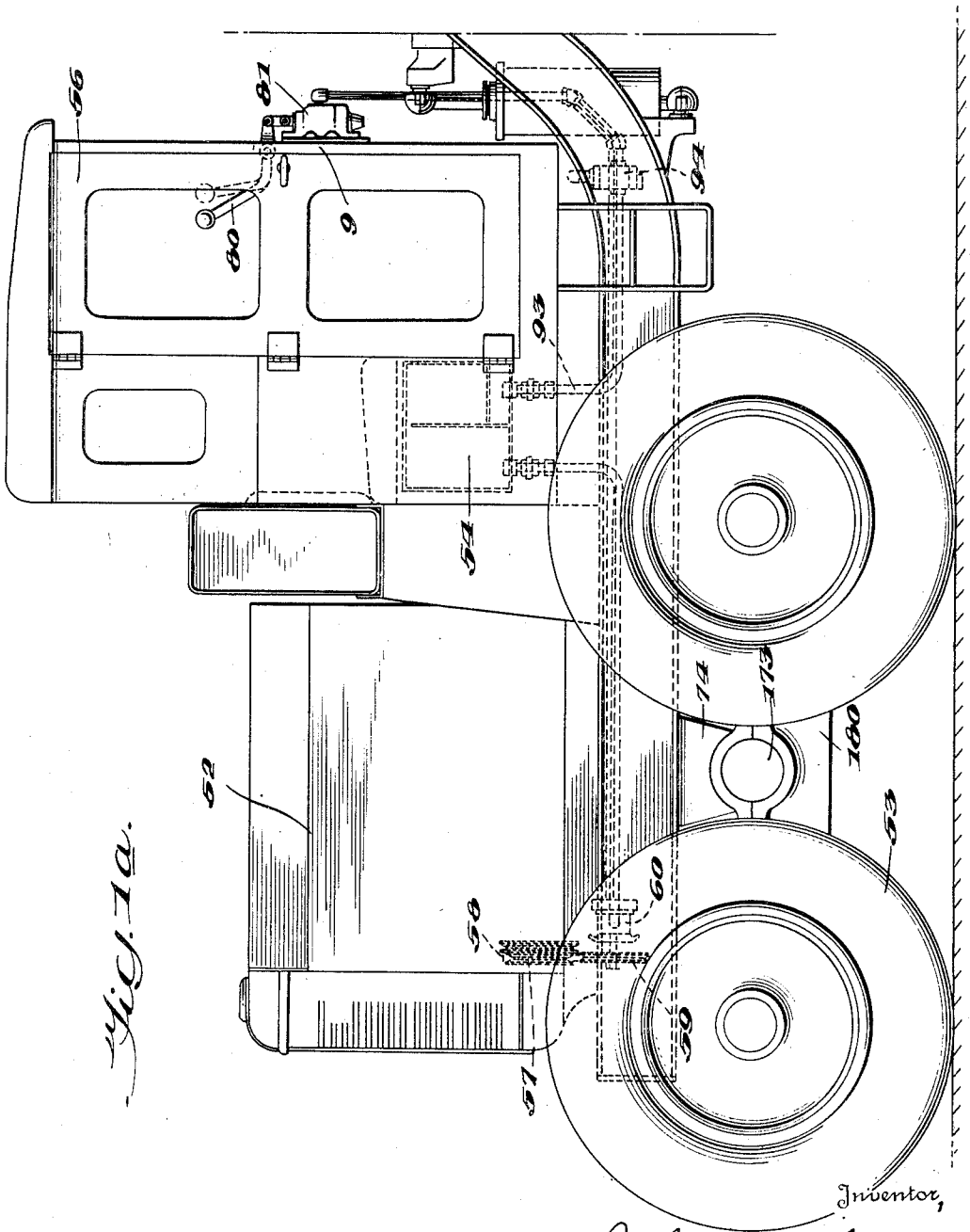


Fig. 1a.

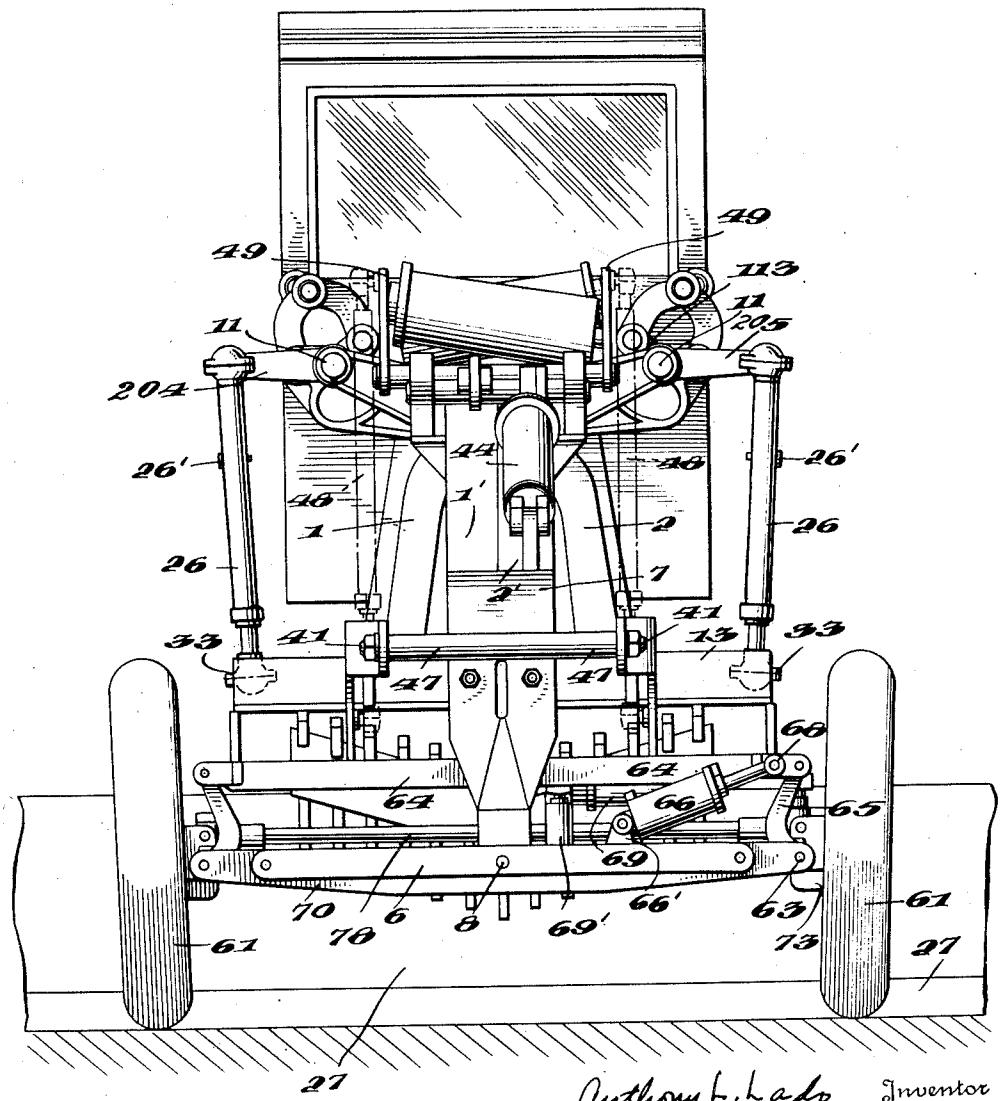
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MECHANISM FOR ROAD GRADERS

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Fig. 2.



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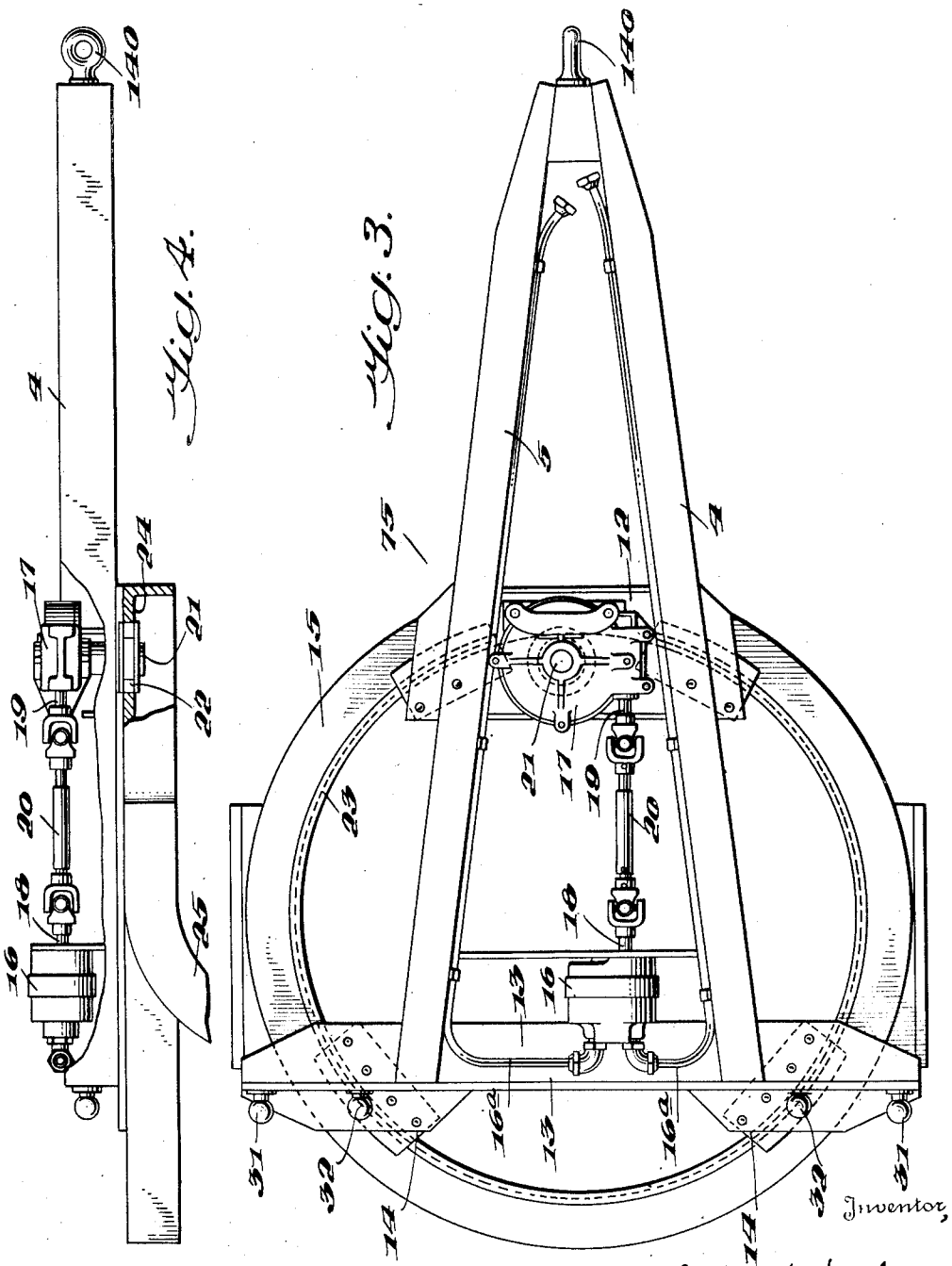
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MECHANISM FOR ROAD GRADERS

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MECHANISM FOR ROAD GRADERS

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Fig. 5.

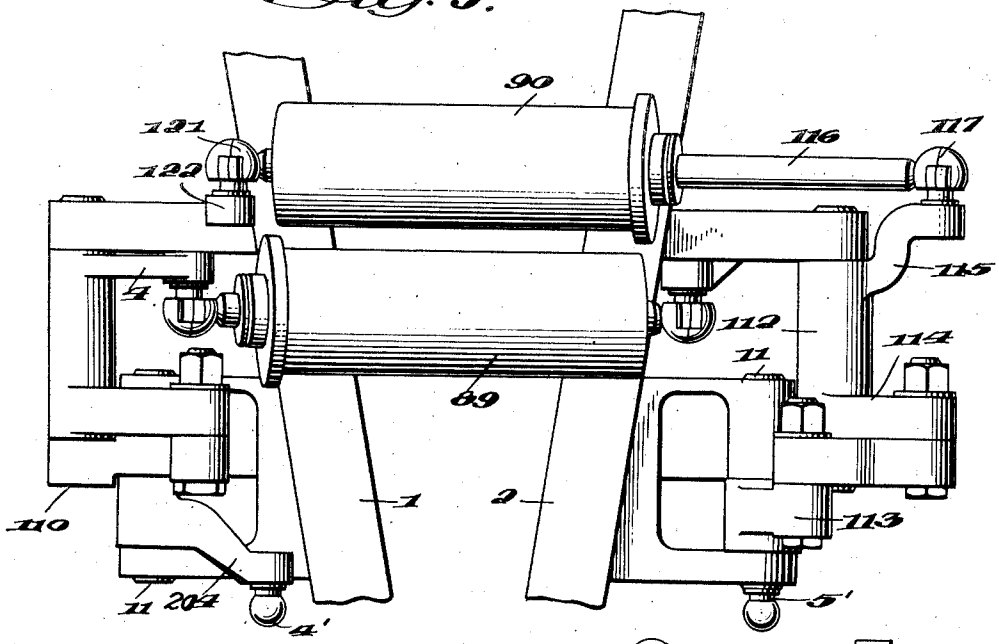


Fig. 6a

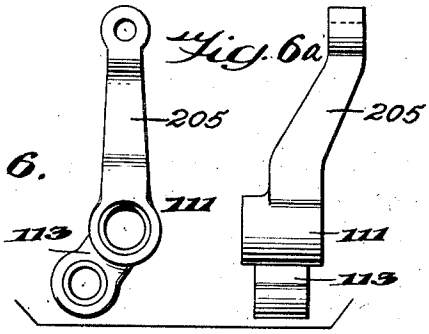
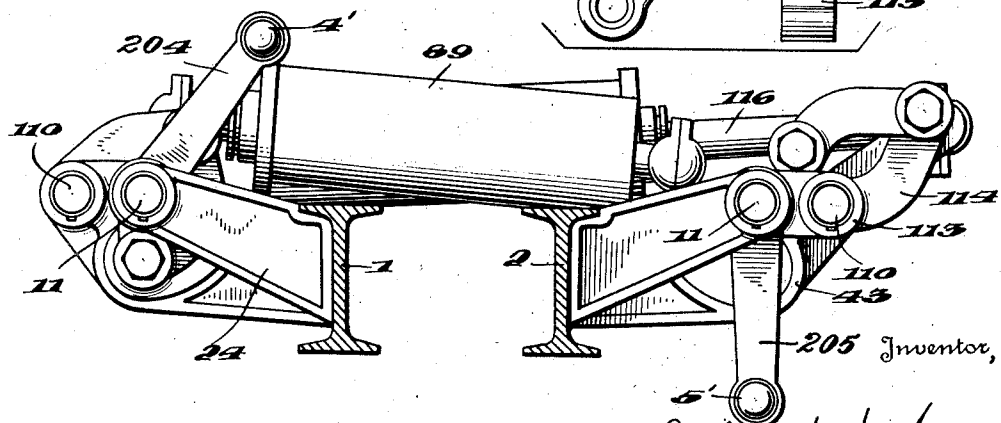


Fig. 6.

Fig. 7.



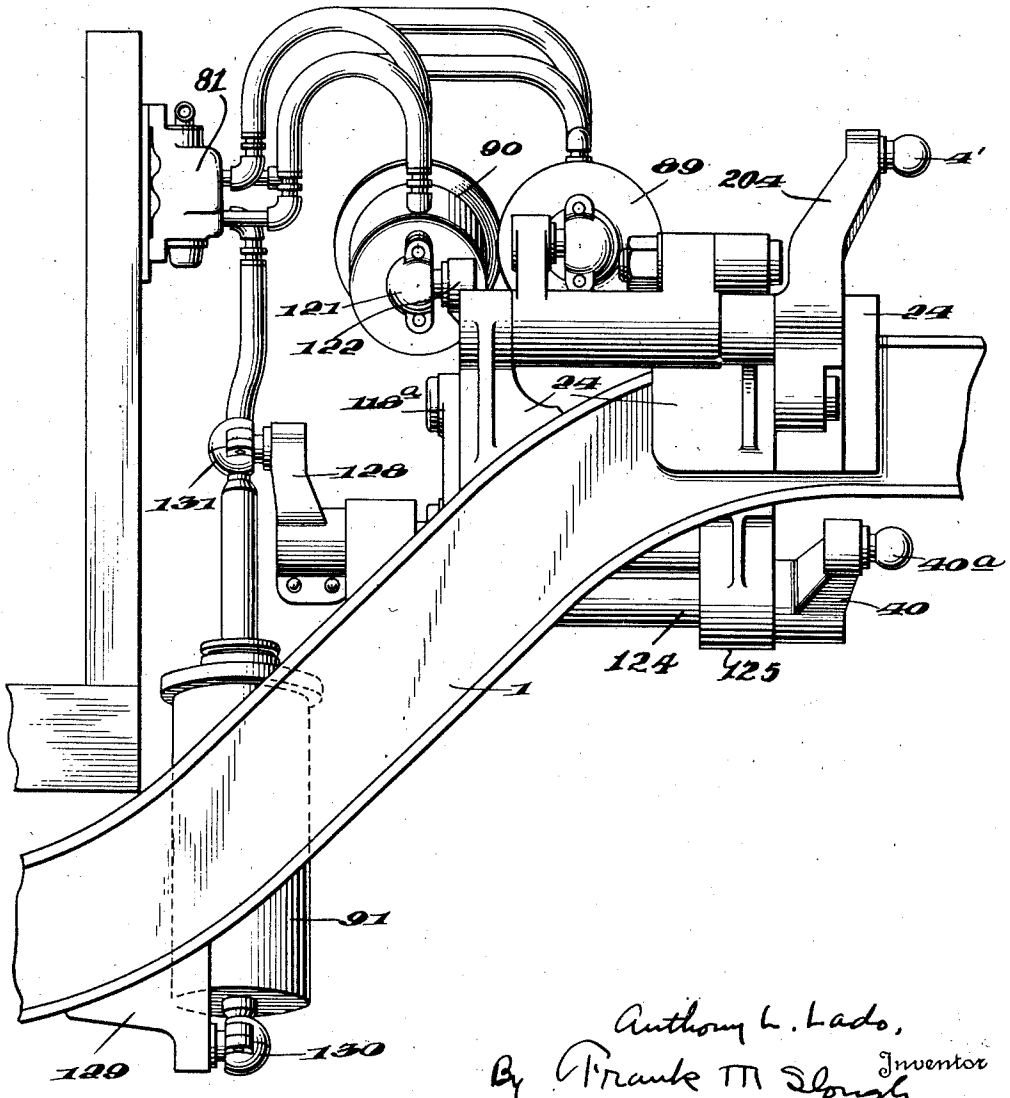
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Feb. 14, 1950 A. L. LADO 2,497,778

MECHANISM FOR ROAD GRADERS

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Fig. 8.



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By

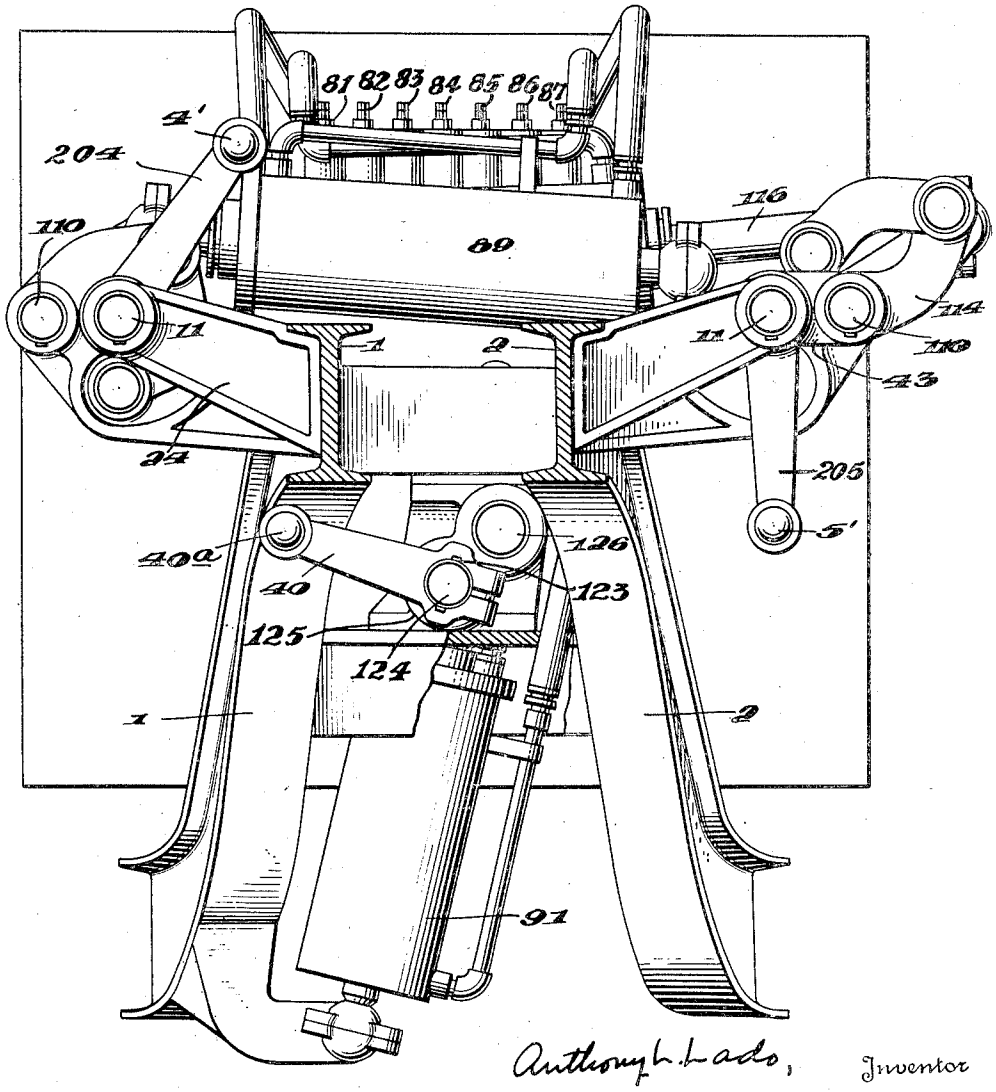
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MECHANISM FOR ROAD GRADERS

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Fig. 9.



Anthony L. Lado, Inventor

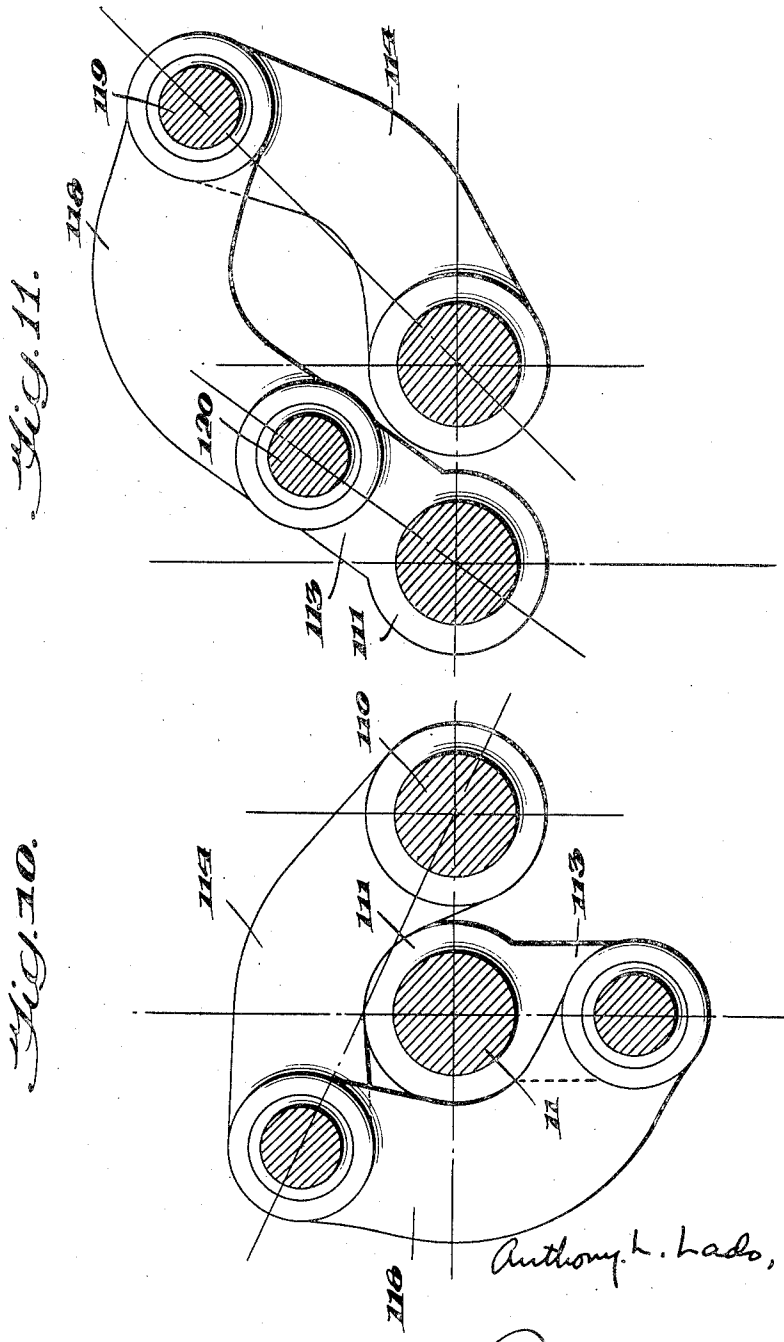
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MECHANISM FOR ROAD GRADERS

Filed March 17, 1944 8 Sheets-Sheet 8



Anthony L. Lado, Inventor

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Patented Feb. 14, 1950 2,497,778

UNITED STATES PATENT OFFICE

2,497,778

MECHANISM FOR ROAD GRADERS

Anthony L. Lado, Rome, N. Y., assignor, by mesne assignments, to The Union Fork & Hoe Company, Columbus, Ohio, a corporation of Ohio

Application March 17, 1944, Serial No. 526,959

8 Claims. (Cl. 37—156)

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My invention relates to mechanisms for road graders and relates more particularly to hydraulic ram actuated mechanisms therefor.

The following are objects of my invention:

To provide an improved positively operating compactly disposed crank and lever mechanism adaptable to be positioned, as at the sides of a road grader main frame, for converting a necessarily restricted throw of a crank lever which is actuated by a motor of the reciprocating type, such as a hydraulic ram, to an increased rotational adjustment of a crank lever for variably adjusting a grader road working implement.

Another object of my invention is to provide a pair of such mechanisms, as set forth in the preceding object, one disposed at each side of the grader mechanism to effect, in combination with a suitable similar mechanism for adjusting the implement laterally of the main frame of the grader, the various implement adjusting movements, which may be required in the operation of the road grader in doing different kinds of work.

Another object of my invention is to provide improved mechanisms of the type set forth in the preceding objects, so designed as to facilitate mounting thereof, and to achieve such compactness as to not materially obscure the view of the rearwardly positioned road grader operator as to the positioning of and work being done by the grader implement.

Another object of my invention is to provide an improved mechanism of the aforesaid type which will be durable, capable of transmitting sufficient force to operate the implements of the grader, and to maintain them in any desired adjusted position, under severe conditions of operation and without undesirable lost motion between parts of the mechanism.

Another object of my invention is to provide improved means to transmit to the laterally disposed grader blade lifting cranks, adjustment movements of the movable element of a reciprocating type motor, such as a hydraulic ram, and to permit the positioning of a pair of said rams transversely of the vehicle frame and mounting thereof upon respectively opposite sides of said frame, whereby to permit the operator to readily observe the road and bank surfaces being, and to be, operated upon by the grader implement or implements.

Other objects of the invention and the nature of the invention will be clear to those skilled in the art to which my invention appertains from the following description of an embodiment of

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my invention, and the accompanying drawings illustrating the said embodiment.

In the drawings:

Figs. 1 and 1*a* illustrate respectively in side elevational view the front and rear portions of a power grader mechanism embodying the principles of my invention;

Fig. 2 is a front elevational view of the mechanism of Fig. 1;

Fig. 3 is a top plan view of the implement-carrying sub-frame;

Fig. 4 is a side elevational view of an implement-carrying sub-frame of the general type commonly employed to support a grader blade in different operative positions;

Fig. 5 illustrates a plan view of a pair of hydraulic power rams carried upon the main frame and novel motion-multiplying crank operating lever linkage for variably throwing the side lifting cranks of a grader mechanism to elevate and otherwise adjust the two sides of the sub-frame of Figs. 3 and 4 with respect to the terrain and the main frame;

Figs. 6 and 6*a* illustrate in either elevational and side elevational views respectively a lever link employed in the apparatus of Fig. 5;

Fig. 7 is a front elevational view of the apparatus of Fig. 5;

Fig. 8 is a side elevational view of the apparatus;

Fig. 9 is a view of the apparatus of Fig. 8 taken as from the right side of the showing of Fig. 8; and

Figs. 10 and 11 are views of a diagrammatic nature to illustrate the principle of operation of the motion multiplying mechanism employed.

Although my invention is subject to application to graders of widely varying types, I have illustrated the same as applied to an improved design road grader of the power grader type wherein a prime mover such as an automotive engine carried by the grader vehicle frame produces power for the various mechanisms with which the grader is equipped. More particularly, the illustrated grader is in the heavy duty class which employs a tandem wheel driving mechanism, the two pairs of tandem wheels of which support the rear engine and operator cab equipment.

My invention, in part, relates to the application of hydraulically operated motors preferably including a rotary type motor and reciprocatory motors in the form of hydraulic rams, the rotary motor being preferably employed to rotate the circle which carries the grader blade, and the rams being employed to adjustably actuate and

adjustably hold various elements of the grader mechanism, such as the blade and the scarifier in order to suitably apply such blade and scarifier implements to the terrain being operated upon.

More particularly, because the grader is of the self-propelled type, the disposition of the various elements including the hydraulic rams and mechanisms associated therewith are quite important in order to preserve to the operator the ability to see beyond said rams and mechanisms to the terrain being approached during traveling operating periods; also, the mechanical functions served by the hydraulic rams and the linkage by which the implements are motivated by the hydraulic power of the rams are quite efficiently achieved by the disposition of parts hereinafter related.

Referring now to the various figures of drawing in all of which like parts are designated by like reference characters, the illustrated preferred embodiment of my invention is shown as applied to a power grader having a longitudinally extending arched main frame comprising a pair of generally converging main frame beams 1 and 2, welded together at their forward ends at 1' and 2', with a plurality of cross frame braces such as that shown at 3. The longitudinal main frame beams 1 and 2 preferably converge from the rear of the vehicle, where they are supported co-axially of the swiveling axis of the tandem rear wheel bogie assembly, not shown, by a bracket 74 depending from the main frame and carrying a journal for the laterally extending bogie shaft 173 upon which the main frame is supported and journalled. While the longitudinal main frame beams may be of any commonly employed cross-sectional form, I have shown these as of I-beam section.

The grader comprises also a supplemental or sub-frame 75 comprising a pair of forwardly converging beams 4 and 5, the cross-beams 12 and 13, the forward portion being flexibly universally connected at 140 to an upstanding forward bolster 7 which is rigidly bolted or welded to the main frame, and in turn is hingedly secured to the front axle 6, by an interconnecting bearing pin 8 which is disposed in the longitudinal axis of the vehicle.

The sub-frame is universally connected to the bolster to permit independent lateral universal upward and swinging movements of the rear end of the sub-frame without communicating similarly operating force to the main frame or to the front axle. The sub-frame extends rearwardly from its point of connection with the bolster element of the main frame to a region therebelow disposed substantially in advance of the operator's control panel 9.

The sub-frame cross beams 12 and 13, as shown in Fig. 3, support bearing elements 14, provided to support the rotatable implement carrying circle 15 which is journalled for rotation upon said bearings.

To opposite sides of the circle 15, spaced implement supporting arms 25, shown in Fig. 1, extend pendantly to carry the moldboard assembly 260, which moldboard supports the grader blade 27.

The rearmost cross beam 13 of the supplemental frame 75 is provided with two like pairs of outer and inner rearwardly presented ball elements 31 and 32, one pair of said ball elements 31 being disposed nearest the ends of the cross beam 13 and each ball of the other pair 32 is spaced somewhat inwardly of said cross beams.

When the grader is employed to grade a slope disposed entirely laterally of the front and rear wheels extending angularly upwardly, the side shift crank and link exercises a lifting effort applied towards the side of the rear portion of the sub-frame which is being adjusted to a relatively lowermost position, the lift crank and link disposed nearest the slope being then attached to the uppermost side of said sub-frame rear portion and the more remotely disposed lift crank and link exercises a predominantly lateral thrust upon the lowermost rear side portion of said sub-frame according to now well known common practice.

The steepness of the slope which may be thus operated upon by the blade 27 carried by the sub-frame is increased by the extensible nature of the side lift links 26 which comprise an upwardly extending rod 26a telescoped into the downwardly extending tubular portion 26b, the rod having a transversely extending bore which is alignable with one or the other of the transverse bores extending through the outer tube whereby the effective length of the links 26 may be varied.

Briefly, the lift cranks 204 and 205, Fig. 2, are preferably journalled upon stationary shafts 11 which, in turn, are each rigidly carried by the main frame beams 1 and 2 by brackets 24 preferably welded to the sides of said beams, and said cranks are adapted to rotate about said shaft axis, different rotative positions of said cranks 204 and 205 being illustrated in Figs. 1, 8 and 9.

As best shown in Fig. 1, a pair of lift links 26 interconnect by a universal joint connection with the free end of each said lift crank 204 or 205 with the associated ball connector 31 secured to the rearmost sub-frame cross beam 13 which is disposed at the corresponding lateral end of said sub-frame cross beam.

Therefore, upon rotation of either or both of the lift cranks 204 and/or 205 from the position, as shown in Fig. 1, to any more upwardly disposed position, each of said cranks will lift the corresponding side of the grader sub-frame to elevate the corresponding end of the blade according to the degree of elevation of the end of such lift crank.

The side shift crank 40, shown in its lowermost position in Fig. 1, when rotated about the crank axis by rotation of the shaft 40' supporting said crank 124 will shift the entire sub-frame laterally according to the degree of rotation of said side shift crank by virtue of the pull or thrust communicated to the sub-frame by the side shift link 38 which is universally connected at its two ends to the ball connector 40a at the end of the crank and one of the ball connectors 32, each of which is carried by the rearmost sub-frame cross beam 13 and each being spaced inwardly on said beam a short distance towards the middle of the beam.

All universal joint connections of said lift and side shift links to the crank connector balls and sub-frame connector balls are preferably of the usual ball and socket type, said connectors carrying the sockets which are fitted in encompassing relation onto the connector balls. The side shift crank is adapted to be interchangeably connected to either one of the connector balls 32 to better adapt the side shift crank to shift the sub-frame alternately towards or to the two sides of the vehicle.

For bank-sloping by making the link nearest the slope shorter and the remote lift link longer,

the sub-frame may be so adjusted laterally of the vehicle as to grade very steep slopes. The degree to which the sub-frame may be adjusted laterally and vertically of the main frame supports is also increased by the employment of what is termed herein motion multiplying linkage mechanism, later herein described, the principle of operation being illustrated in Figs. 10 and 11.

All of the reciprocating type motors employed in the illustrated grader are provided with an enclosing cylinder and a piston longitudinally reciprocable therein according to any difference in pressure at the two ends of the cylinder. The valves 81 to 87 inclusive are each of that type whereby fluid from the pressure line may be directed through either of the conduits *a* or *b*, at will, and whereby either of said conduits of each pair may be placed in communication with the return line leading to the reservoir; also, whereby communication between both of the conduits *a* and *b* of each pair may be completely cut off. In other words, the liquid is trapped in the conduits *a* and *b* and the cylinder of the particular hydraulic motor involved.

In prior types of road grader mechanisms wherein the varying adjustments of the blade-carrying sub-frame are achieved by rotary movements of operating cranks which, in turn, are moved by manual effort imposed upon a hand wheel or the like at the operator's station between such a hand wheel or the like and the associated operating crank, there was commonly interposed a reduction gearing mechanism comprising gears, pinions, rack or the like whereby the crank being moved through a relatively small angle of rotation by a substantially greater rotation of such hand wheel usually involving a number of revolutions thereof, the manual power required at the operator's station was considerably reduced at the expense of a greater length of time to accomplish the operation.

Previously also, fluid pressure motors of the rotary and linearly operative ram types have been employed with some success, the former being objectionable because of the large sizes required, the lack of efficiency thereof and the difficulty of so disposing the same to avoid interfering with the forward vision of the operator currently required to view the terrain at and ahead of the operating grader blade and the latter being commonly objectionable for various reasons depending upon the particular arrangements employed but mainly because such a ram, when directly connected through a rotative shaft to such an operative crank, inherently can only rotate such a crank over a limited angle of rotation, which, under most favorable conditions of practical use for the purpose here involved, can not readily exceed a maximum of 108°.

My present invention involves the utilization of a novel system of inter-related levers interposed between a movable element of such a ram and such an operating crank effective when the ram is operated to rotate the crank over a much greater angle, than such hydraulic rams, as previously employed on grader mechanisms, have previously been capable of accomplishing.

By the use of such a lever linkage, as illustrated in duplicate particularly in Figs. 5 and 6, and Figs. 8 and 9, as well as in the more or less diagrammatic views of Figs. 10 and 11, and as illustrated elsewhere in other figures of drawing, as will hereinafter appear, I readily achieve a rotative oscillatory adjustment of such an operating crank by virtue of a single thrust movement of the associated power ram over any part of an angle at least up to and including an angle of 216°. This is accomplished by a single operation of a single hydraulic ram with simply constructed relatively inexpensive mechanism, such as herein disclosed in Figs. 10 and 11. A pair of stationary mounting rods or shafts 11 and 110 are rigidly carried by a fixed element of the vehicle frame, herein later more specifically identified.

Also, as hereinafter more fully set forth, from the ability to achieve such an increased crank arm adjustment angle by a single movement of a single hydraulic ram, other advantages hereinafter related in connection with the blade reversing operation accrue, and the necessity of frequently readjusting the lengths of the extensible links disposed between the operated cranks and the operated implement is minimized, and results in the ability to quickly adjust the blade over a clear range of widely varying adjusted positions.

The following description of my improved transmission mechanism is based primarily upon the disclosures of Figs. 10 and 11 which respectively show two opposite extreme adjusted positions of essential elements of mechanism, reference, however, being made from time to time to other figures of the drawing which show said elements in association with other associated elements of mechanism and as applied to a road grader. The principle of operation may be understood by reference to Figs. 10 and 11, the few parts therein illustrated being identified with the corresponding parts as employed in connection with the operating cranks 204 and 205 shown in other figures of the drawings.

It is to be understood that in certain embodiments of my invention, such as are employed for the lift link cranks 204 and 205, Figs. 5 and 7, that said shafts 11 and 110 are rigidly immovably mounted upon the grader main frame as distinguished from cranks 113 and 114 of said transmission mechanism which, in said embodiments, are journalled upon said fixed shafts for relative oscillatory rotary movement thereon by their hubs 111 and 112, respectively.

In other embodiments, such as that employed for the blade side shifting crank 40, said hubs are rigidly secured to shafts similarly positioned with respect to the rest of the mechanism but which, in such case, are themselves rotatably journalled within elements of the grader frame and said hubs are rigidly and relatively non-rotatably carried by such shafts.

It will be understood that although such are not shown in said figures, the crank hub 111 is provided with a second crank arm integrally formed with said hub and arm, said second arm for the hub 111 being identified in Figs. 5 to 7 inclusive, 8 and 9 and elsewhere, as a laterally disposed lift crank such as shown at 204. Therefore, the hub 111 carrying two crank arms 113 and 5 is, in fact, a bell crank element and is the final operated element of the mechanism.

Similarly, the crank hub 112, in addition to the arm 114, is provided with another crank arm not shown in the diagrammatic Figs. 10 and 11, but also illustrated in the above recited figures of drawing, such additional crank arm being best illustrated at 115, Fig. 5, which, incidentally, shows the hub 112 and arms 114 and 115 in one particular position of adjustment, and moreover, clearly shows that the arm 115 is that to which the piston rod 116 of the lift link hydraulic cyl-

inder 90 is universally connected by the ball and socket universal joint 117.

The bell crank unit 112, 114 and 115, therefore is readily understood as being that unit of the transmission mechanism which is initially actuated by the hydraulic ram and transmits a rotative effort to the intermediate link 118 which, by hinge pins 119 and 120, is hingedly connected with and interconnects the ends of the crank arms 114 and 118 of the mechanism.

Both the crank arm 114 for the first or motivating element of the transmission and the link 118 are, as illustrated, advantageously and usually preferably arcuately formed whereby, in the ultimate position of the parts, as illustrated in Fig. 10, they are adapted to closely embrace the hub 111 which is journalled upon the fixed shaft 11.

By virtue of the above form and disposition of the curved crank arm 114 and curved link 118 interconnecting the crank hub 112 and the outer end of the short crank arm 113, together with the radially spaced positioning of the axes of hubs 111 and 112 when the hub 112 is rotated over a given angle, as for instance an angle of 108° communicated to it by the hydraulic ram as through the piston rod 116, universal joint 117 and motivating crank arm 115, as shown in Fig. 5, the crank arm 114 is moved in a clockwise direction about the axis of the hub 112, a distance of 108° as indicated in Fig. 11.

The hinge link pin 119 is moved about the axis of hub 112 accomplishing an "unwinding" pull upon the short crank 113 through the two hinge connectors 119 and 120, thereby "unwinding" the arm 114 and link 118 from about the crank hub 111 to cause the above designated parts to take the relative positions shown in Fig. 11 wherein the crank arm 113 which, in Fig. 10, is illustrated as extending directly downwardly from its hub axis is, in Fig. 11, shown as having rotated a distance of 216°.

In other words, the hub 111 for the crank arm 113 being with its other crank arm 205 which constitutes a blade-lifting crank for rotating over an angle of 216° shown in Fig. 2 and elsewhere, precisely twice the angle of rotation of the crank 114 from which the rotative movement of the crank 205 is communicated through the intervening crank 114, link 118 and crank 113. Since, as previously stated, even though the motivating ram such as 90 of Fig. 5 is universally connected to its fixed mount by the universal joint 121 to its mounting bracket 122 which, in turn, is rigidly carried by a main frame beam such as 1, the combined fact of the longitudinal thrust of the piston rod 116 and the concurrent progressive tilting of the ram cylinder 90 and rod 116 can not practically rotate a crank such as 115 over an angle greater than 108°. Such rotative movement of a crank arm 115 is converted by the intervening and interlinked cranks 115 and 114 to a rotative movement of a lift crank 205 in the ratio of 1:2 or to an angular movement of such a crank 205 of 216°.

Of course, to accomplish this greater angularity in movement through the motion multiplying effect of the interlinked elements of the mechanism, the ram must be of correspondingly greater power and therefore of greater diameter.

The above described rams and hubs for the bell-crank arms comprising the actuating arms to which the piston rods are connected and the actuated lift arms to which the lift links are connected comprise a unitary assembly of lift link operating parts; all of said parts are mounted upon the bracket means 24 and all together can be unitarily assembled in advance of mounting upon the grader frame beams 1 and 2 either by bolting or welding. The bases of said brackets 24, said rams, and motion multiplying linkage, and associated parts are well out of the way of any moving part of the grader mechanism or any portion of the adjustable sub-frame and without requiring the usual relatively long rock shafts commonly provided to remove the rams and associated parts from interfering proximity with the sub-frame, the blade carried thereby or other movable parts of the grader mechanism.

I prefer, for ordinary present-day power road grader operations that the arms 205 and 113 extend from the common hub 111 in the relative angular relationship illustrated in Fig. 6, although I am aware that relative angular dispositions of the arms of the bell crank lever may be otherwise than as illustrated therein with useful results, particularly for certain kinds of work.

The angular relationship as between the arms 114 and 115 extending from the common hub 112 will be dictated by the mounting position and attitude of the ram such as that shown at 90, Fig. 5, employed to actuate the transmission mechanism through the piston rod 116, and motivating arm 115 universally connected at its end to the end of said piston rod.

The relative angularity of said arms 114 and 115, as illustrated in the various drawings, is that deemed best for general purposes with the rams disposed in substantially horizontal position extending transversely of the grader frame beams and immediately about said beams which position is deemed highly desirable for a number of reasons, elsewhere herein set forth and which I therefore believe would be inventively novel, whereas in the foregoing description, I have made particular reference to the mechanism as illustrated at the right side of Fig. 9, i. e., disposed at the left side of the vehicle frame viewed from the rear.

Although the similar mechanism disposed at the opposite side of the machine to actuate the lift crank 204, as distinguished from that for the lift crank 205, is functionally the same, minor differences in the two mechanisms will be noted, such differences resulting merely from the fact that the ram 89 is disposed more forwardly of the grader frame beams 1 and 2 than the ram 90 and also, from the fact that the actuating movements imparted thereto by similar movements of the ram pistons are in opposite directions, since upon similarly applying predominant fluid pressure to the rear of or in front of the pistons for the two rams, it is highly desirable that the left and right lift cranks 204 and 205 be rotated in opposite rotative directions and vice versa.

As previously described, all of the movable parts for the two transmission mechanisms each adapted to rotatively adjust a different one of the two lift cranks 204 or 205, comprise a pair of bell crank elements intermediately interlinked together, and each of the bell cranks of each unitary mechanism is journalled and supported by its hub upon a different rigidly mounted one of two parallel relatively spaced non-rotatable rods 11 and 110, both rods being preferably disposed in the same horizontal plane, and as is best illustrated in Figs. 9 and 10, said supporting rods at each side of the main frame are rigidly carried by suitable mounting brackets 24, which are rigidly secured by welding or otherwise to the

contiguous main frame beam, being non-rotatably secured thereto. Each of the lift cranks **204** and **205** carries at its end a ball element **4'** and **5'** respectively adapted to be universally connected to the upper tubular element **26b** of a pair of relatively telescoped link elements including also the upwardly extending rod **26a**, the latter terminating downwardly in a socket element **33** of a universal joint connection between said link and the associated joint ball **31**, Fig. 3, carried at the sides of the rear portion of the sub-frame **75**.

The two parts of the extensible links **26** thus provided at the two sides of the vehicle are adjustably connected together by a pin **26'** projected, as previously stated, through any selected one of a plurality of transverse apertures through the upper link element and also, through a preferably larger transverse bore through the inner upwardly extending rod element of said link whereby in advance of operation of the grader, the length of said links may be made such as will best adapt them to most favorably position the blade for the intended work by a single operative adjusting movement of the associated lift crank **204** and/or **205**.

The same lift link length adjustment feature is provided for the other lift link and in accord with long and well known practice as disclosed in United States Letters Patent No. 1,429,026 to Edwards, issued September 12, 1922, and therefore being no part of my present invention.

A third crank **40**, commonly termed a side shift crank, is employed primarily for imparting lateral adjustments to the blade-carrying sub-frame, a link **38** being universally connected at its ends to said crank and one of the pair of ball elements **32** disposed in line with the balls **31**, but slightly inwardly thereof, on the sub-frame cross beams **13**.

The mutual functional relationship as between the two lift link cranks and the side shift crank is well known and understood and is generally disclosed in the Gledhill Patent No. 1,528,325 dated March 3, 1925, and from such disclosure it will be understood that, when the blade is adjusted by said cranks and their associated links to a more or less upright inclined position laterally of the vehicle, as for grading a steep slope, the terms "lift" and "side shift" are both applicable to all of said cranks but herein the usual nominal nomenclature is conveniently employed.

In addition to the precedently described side shift crank **40** and associated link **38**, the so-called side shifting mechanism comprises also a transmission mechanism of the same general type as that illustrated in Figs. 10 and 11 and of which a pair of slightly differently constructed embodiments have been described in connection with the side lift mechanism associated with the lift cranks **204** and **205**.

The principle of operation in both cases being the same, the side shift transmission mechanism may be more briefly described. Referring therefore principally to the drawings of Figs. 1 and 8 and 9, wherein said side shifting crank **40** is shown as rigidly secured at **123** to the shaft **124** which is journalled at its ends in a pair of hangers **125** and **126** which are each secured to one of a pair of cross beam braces **3**, secured to and extending between the main frame beams **1** and **2**, in relatively spaced relation longitudinally of the main frame.

A second shaft **127** is disposed adjacent to, slightly above and to one side of the shaft **124**, and is similarly journalled and carries a crank **128**. A hydraulic ram motor device **91** comprising a cylinder, piston and piston rod is interconnected between the end of the crank **128** and a bracket **129**, the latter being rigidly secured to the main frame beam **2**. Universal joint connections at **130** and **131** are provided for interconnecting said ram motor to said bracket and said crank respectively.

Although, by the nature of the rotative movement of the crank **128**, the ram device may be laterally inclined depending upon the hydraulically effected position of the piston and piston rod **1**, the ram motor is disposed in a generally upright attitude, as illustrated in the drawings, and the two cranks **128** and **40** being rigidly fitted onto their respective crank shafts **127** and **124**, are rotatable therewith.

Means are provided for communicating driving motion from the crank **128** to the side shift crank **40**, said means comprising the crank **113a** rigidly affixed to the shaft **124** and the longer arcuately curved crank **114a** which is rigidly secured to the shaft **127** and the interconnecting link **118** which is hingedly secured at its two ends to the ends of said cranks **113a** and **114a** except for the fact that the crank **40** and crank **113a** are interconnected by the shaft **124**, and the cranks **128** and **114a** are interconnected by the shaft **127**, and the fact that all of said cranks are rigidly secured to said shafts, the modus operandi of the transmission mechanism comprising the elements **113a**, **114a** and **116a** is substantially identical with that described for the corresponding transmission mechanism, as illustrated in Figs. 8 and 9 and Figs. 10 and 11, may be similarly referred to in connection with linkage of the side shift transmission mechanism by considering in Figs. 10 and 11 that the cranks **113** and **114** corresponding to the cranks **113a** and **114a** of the side shifting transmission mechanism, the latter being rigidly secured by their hubs to the supporting shafts whereas the corresponding cranks identified by similar numerals for the lift crank transmission mechanism previously described are relatively rotatable with respect to the fixed rods or shafts upon which, in that case, said cranks are journalled.

Therefore, from the foregoing description of the transmission mechanism of Figs. 10 and 11, it will be understood that the motion multiplying function performed by the cranks and interconnecting links thereof applies also to the transmission mechanism of Figs. 1, 8 and 9 inclusive where the various cranks are all rigidly secured to rotatable shafts instead of themselves being rotatable upon fixed shafts.

Therefore, also as in the case of the lift cranks **204** and **205**, the side shifting crank **40** is susceptible of adjustment to any rotatably adjusted position within angular limits of approximately 216° even though the hydraulic ram is only capable of actuating the primary crank **128** over an angle of 108° whereby extreme lateral adjustments and steep bank cutting adjustments are readily quickly effected upon the blade-carrying sub-frame **75** by a single operation of the hydraulic motors **89**, **90** and **91**, all of the latter being susceptible under the control of the manually operated valves, shown in Fig. 9 at **81**, **87** and **82**, respectively, and that by varying the adjustment of said valves with respect to each other, the position and attitude of the blade-carrying

sub-frame may be variously positioned in various attitudes as may be desired.

Reference is hereby made to my co-pending application, Serial No. 624,748 filed October 26, 1945, and now Patent No. 2,488,016 granted Nov. 15, 1949, and in which the same road grader mechanism is illustrated and described and parts thereof being more specifically and completely shown and described in said co-pending application which is a division from the present original application and therefore descriptive, and illustrated portions of the said co-pending application are incorporated herein by reference for a more specific and complete knowledge of the complete mechanism which comprises the present embodiment of my invention.

Having thus described my invention in certain embodiments thereof, I am aware that my invention may be embodied in structures in many varying forms and for purposes widely variant from that herein illustrated and described, and that numerous and extensive departures may be made from the particular embodiments herein illustrated and described within the scope of my invention.

I claim:

1. In a road grader, the combination with a longitudinally extending upwardly arched main frame, a blade-carrying sub-frame disposed below the main frame and flexibly connected at its forward end to a forwardly disposed portion of the main frame, lift links extending upwardly from a rear blade-carrying portion of the sub-frame and flexibly interconnected therewith, two associated pairs of bellcranks each being disposed at different sides of the main frame above said rear sub-frame portions, each said bellcrank comprising a hub, a primary lever arm, and a secondary lever arm, mount means at each side of the frame, each comprising separate journal means for each of the pair of hubs at that frame side, said mount means adapted to support each of an associated pair of said bellcranks for oscillation on relatively separate and parallel longitudinally extending axes, a link hingedly interconnecting the free end of the secondary lever arm of a first bellcrank of a pair to the primary lever arm of the second bellcrank of the same pair, a pair of hydraulic rams each comprising oppositely extending cylinder and piston rod elements, said rams disposed in side-by-side relationship and extending transversely across said frame, one of said elements of each said rams being flexibly anchored to said mount means disposed at a relatively different side of said main frame, the other element of each said ram being flexibly secured to the primary lever arm of the said first bellcrank of the associated pair thereof, and the secondary lever arm of the second of each associated pair of bellcranks comprising a lift crank, and means to flexibly connect the free end of said lift crank to the upper end of the lift link disposed at the same side of the frame.

2. In a road grader in combination with the arched main frame and underlying blade carrying sub-frame, flexibly forwardly interlinked therewith, and with the lift links of said grader each flexibly connected at its lower end respectively to the two different sides of the sub-frame, a pair of motion-multiplying mechanisms disposed at different sides of the main frame each comprising a pair of driving and driven bellcranks independently journalled on said main frame, the axes of said journals extending longitudinally of the main frame in closely interspaced parallel relation, a rigid link hingedly interconnecting an arm of said driving bellcrank with an arm of said driven bellcrank, the interconnecting hinge point on said driving lever being more remote from its crank axis than is the hinge point on the driven bellcrank arm from its crank axis, said lift links being each flexibly interconnected at their upper ends with the other arm of the associated said driven bellcrank, of a pair of hydraulic rams each having a fixed end and a longitudinally reciprocable opposite end, said rams disposed in substantially parallel relationship and extending transversely of, and having their fixed ends flexibly secured to said main frame, and said opposite end of each said ram being flexibly connected to the other arm of the driving bellcrank which is disposed at the other side of the main frame.

3. In a road grader the combination with a wheel-supported longitudinally extending arched main frame, a sub-frame flexibly connected at its forward end to a forward portion of said frame, a moldboard carried by said sub-frame, spaced apart links each connected by a lower end of said sub-frame, dual pairs of driving and driven bellcrank levers, each pair positioned on relatively different sides of said frame, the levers of each pair journalled on said frame to rotatably oscillate on relatively parallel longitudinally extending axes, separate link means hingedly interconnecting an arm of the driving bellcrank of each said pair to an arm of the driven bellcrank thereon, means flexibly connecting each of said links with the other arm of each said driven bellcrank, a pair of reciprocating fluid pressure motors disposed transversely of said frame in side-by-side compact relationship, the two ends of each said motor being respectively flexibly connected to an actuating crank arm of the driving one of said levers and to the opposite side of said frame, both said bellcrank levers each with its pair of arms, said lever linkage and said motors comprising a unitary assembly of elements adapted for mounting on said grader frame so as to position the free ends of said lift crank arms substantially in the vertical plane of said lift links.

4. In a road grader, the combination with a longitudinally extending upwardly arched main frame, a blade-carrying sub-frame disposed below the main frame and flexibly connected at its forward end to a forwardly disposed portion of the main frame, lift links extending upwardly from a rear blade-carrying portion of the sub-frame and flexibly interconnected therewith, two associated pair of bellcranks each pair being disposed at different sides of the main frame above said rear sub-frame portions, each said bellcrank comprising a primary lever arm, and a secondary lever arm, mount means adapted to support each of an associated pair of said bellcranks for oscillation on relatively separate and parallel longitudinally extending axes, a link hingedly interlinking the free end of the secondary lever arm of a first bellcrank of a pair to the primary lever arm of the second bellcrank of the same pair, a pair of hydraulic rams each comprising oppositely extending cylinder and piston rod elements, said rams disposed in side-by-side relationship and extending transversely across said frame, one of said elements of each said rams being flexibly anchored to said mount means disposed at a relatively different side of said main frame, the other element of each said ram being flexibly secured to the primary lever arm of the said first bell-

crank of the associated pair thereof, and the secondary lever arm of the second of each associated pair of bellcranks comprising a lift crank, and means to flexibly connect the free end of said lift crank to the upper end of the lift link disposed at the same side of the frame, the radial distance between the interlinking hinge point of said secondary arm of said first bellcrank and its journal axis being greater that the corresponding dimension for said primary lever arm of said second bellcrank.

5. In a road grader, the combination with a longitudinally extending upwardly arched main frame and a tractively related blade-carrying subframe which is flexibly connected by its forward end to a substantially forward portion of the main frame, a pair of motion multiplying mechanisms each thereof being positioned upon a different side of the main frame, each said mechanism comprising a pair of bellcranks, each having an operating and an operated arm and each crank being journalled to swing its said arms about a longitudinally extending axis which is relatively parallel and laterally interspaced with repect to the other crank axis, a link hingedly connecting the operated arm of the first bellcrank of each pair with the operating arm of the second bellcrank of the same pair, the operated arm of said second of said bellcranks of each pair being in the form of a lift lever, a lift link disposed at each side of the frame, each said lift lever being flexibly interconnected with the upper end of the adjacent lift link, each said lift link having its lower end secured to the rear portion of said sub-frame which is normally disposed at the same side of the grader main frame as is said lift link, and a pair of power actuable thrust elements disposed in substantially side-by-side relationship and extending transversely of and comprising a portion anchored upon said main frame, a power delivery thrust member for each said thrust element, each of said pair of thrust members adapted to be outwardly thrust and retracted in relatively opposite directions with respect to the other thrust member, and each said member being secured to, and adapted to communicate thrust and retracting efforts to, the operating arm of the first said crank of that set which is disposed at the side of the main frame towards which said thrust efforts of said member are directed.

6. In a road grader, the combination with the longitudinally extending upwardly arched main frame and a blade-carrying sub-frame thereof, interconnecting means flexibly joining the forward portions of both said frames, a pair of motion multiplying mechanisms, one at each side of the main frame, each said mechanism comprising a pair of bellcranks each having a power receiving crank arm and a power delivery crank arm, link means flexibly interconnecting the power delivery arm of a first relatively driving one of said cranks to the power receiving arm of the second crank, both said cranks oscillatable on relatively parallel closely interspaced and longitudinally extending axes, a pair of lift links each having its lower end flexibly connected to a rear portion of said sub-frame, a pair of hydraulic rams extending transversely of the main frame, each ram comprising relatively oppositely extending cylinder and piston rod elements, one of said elements of both said rams being respectively flexibly connected to relatively opposite sides of said main frame, and the other element

of said rams being each flexibly connected to the power receiving arm of a relatively different driving one of said first cranks, and the power delivery arm of each said receiving crank being flexibly interconnected with the upper end of a relatively different one of said lift links.

7. The road grader mechanism substantially as set forth in claim 5 characterized by the provision of mounting means secured to the main frame and said motion multiplying mechanism and said thrust elements being unitarily secured to and carried by said mounting means.

8. A road grader comprising in combination with a longitudinally extending upwardly arched main frame and a sub-frame tractively engaged by a forward end thereto, two sets of bellcranks, each respectively secured to a relatively opposite side of the main frame, each crank comprising a primary and secondary arm, the cranks of each set being journalled to be swung on substantially longitudinally extending axes which are substantially closely laterally interspaced, the secondary arm of a first crank of each set being longer than that of the primary arm of the second crank of the set, a link interconnecting the ends of said secondary and primary arms of said first and second cranks of both said sets, said link and each said crank set together with its associated link being so formed and disposed as to be adapted to respond to opposite swinging movements of said secondary arm of the said first crank to alternately place the primary arm of said second crank in extended relation to said link, or in re-entrant embraced relation with respect to both said link and said secondary arm of said first crank, the secondary arms of said second cranks of each set being in the form of lift levers for elevating and lowering the grader blade, a pair of lift links at the two sides of the main frame respectively flexibly joined at their upper ends to the free end of a different of said lift levers, and the lower ends of said links being flexibly joined to relatively different side portions of the sub-frame which correspond to the main frame side carrying the associated lift lever, and a pair of power actuable thrust elements disposed in substantially side-by-side relationship and extending transversely of and comprising a portion anchored upon said main frame, a power delivery thrust member for each said element, said pair of members adapted to be outwardly thrust and retracted in relatively opposite directions, with respect to the other members, and each said member being secured to, and adapted to communicate thrust and retracting efforts to, the operating arm of the first said crank of the set which is disposed at the side of the main frame towards which said thrust efforts of said member is directed.

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