

July 5, 1966

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3,259,251

EXTENSIBLE BOOM WITH TANDEM OPERATING CYLINDERS

Filed Dec. 26, 1963

5 Sheets-Sheet 1

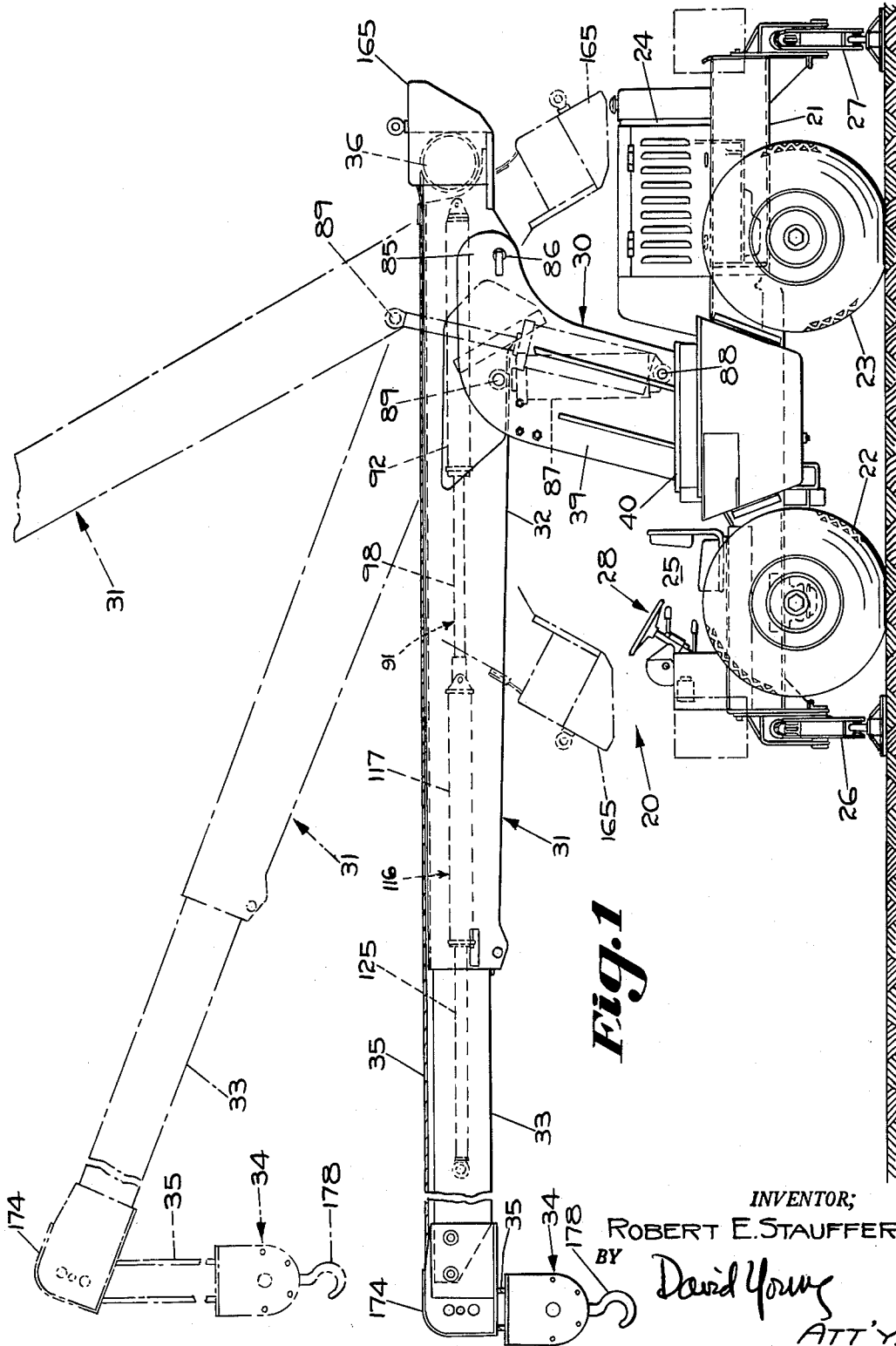


Fig. 1

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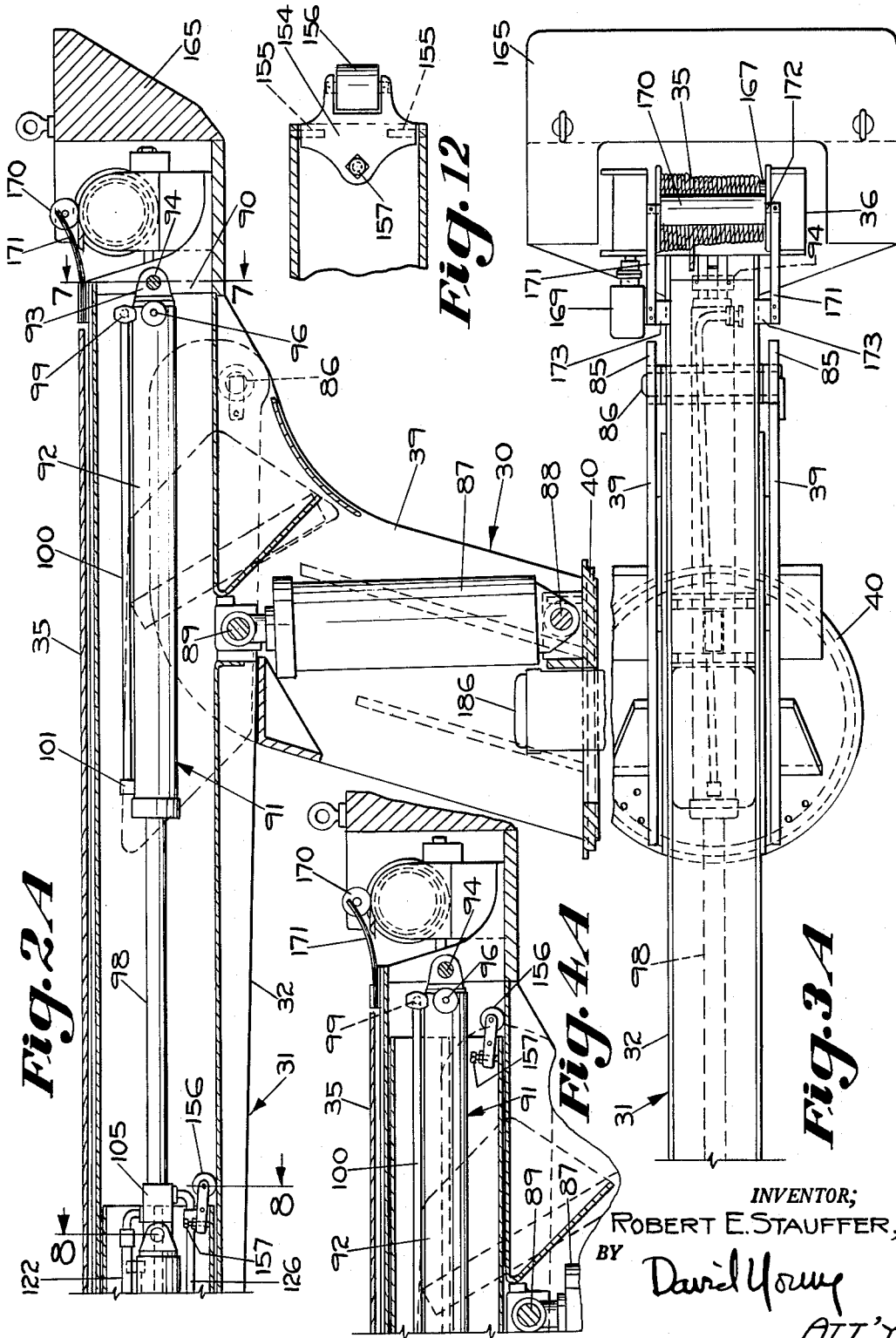
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5 Sheets-Sheet 2



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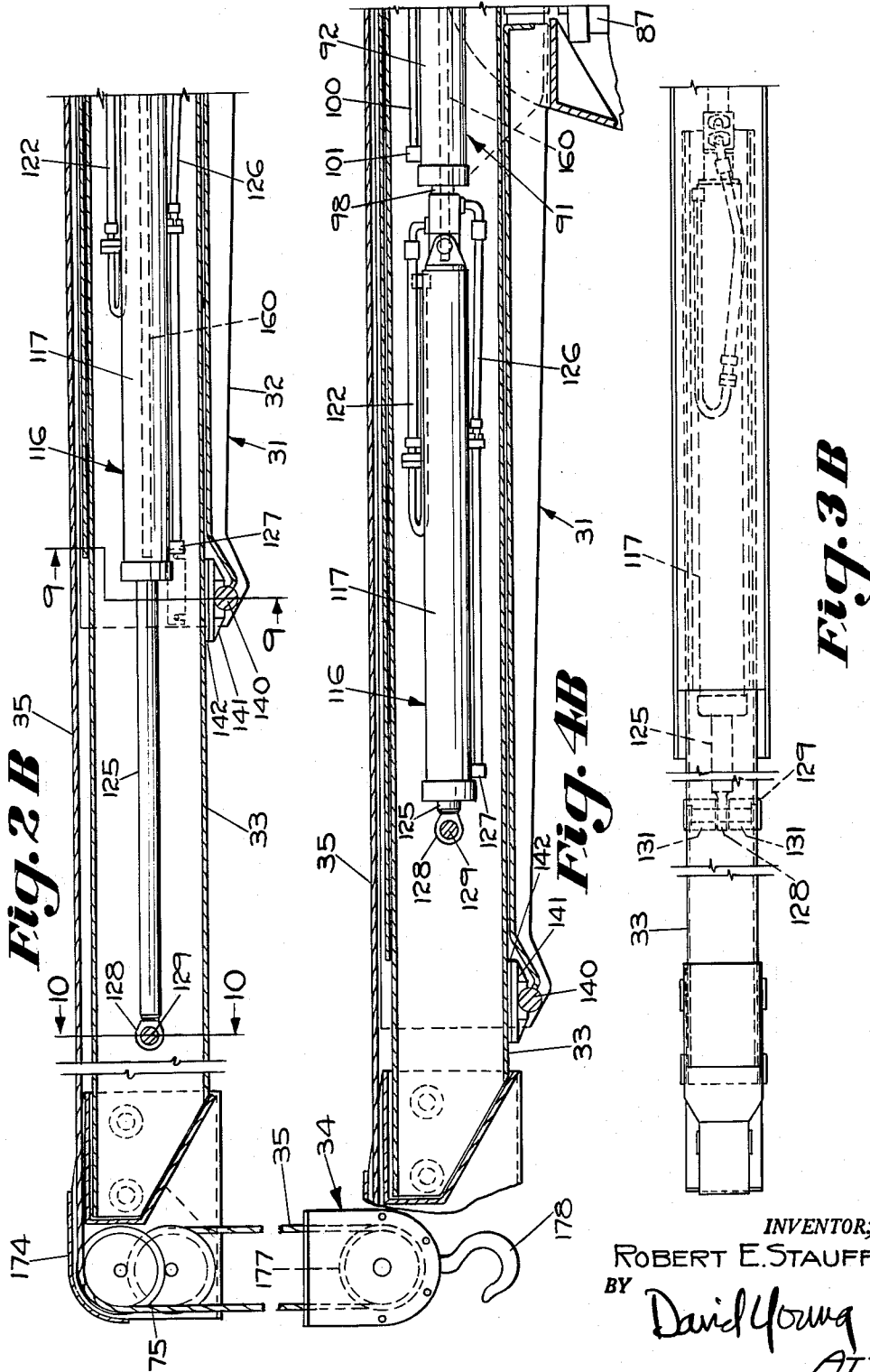
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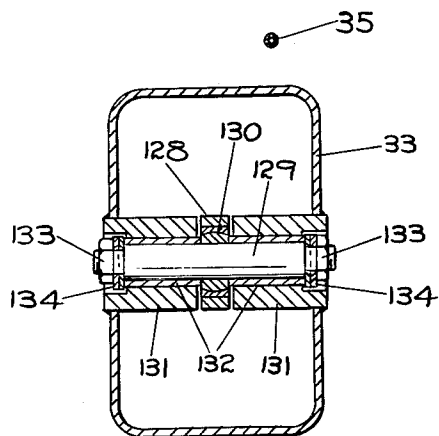


Fig. 8

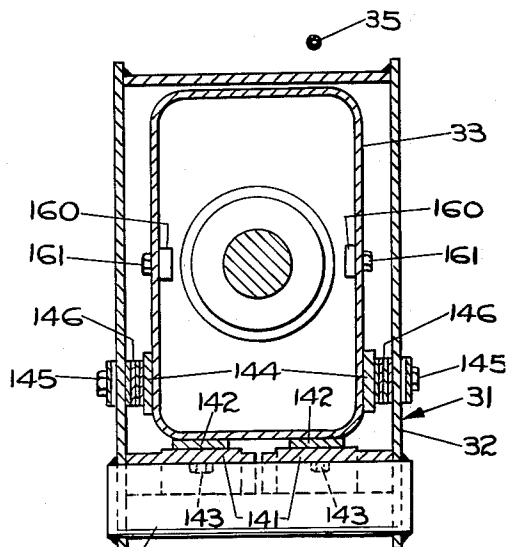


Fig. 7

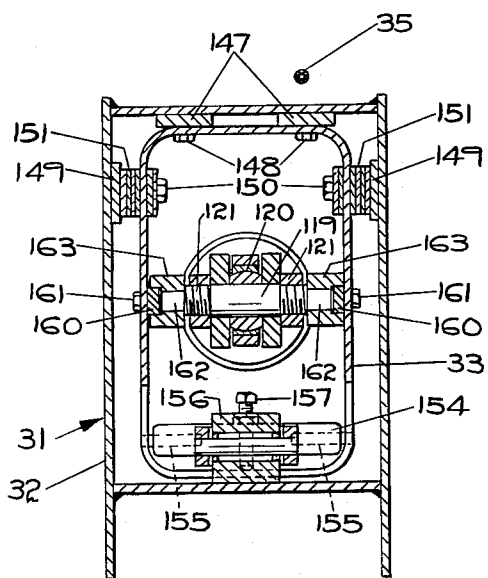


Fig. 6

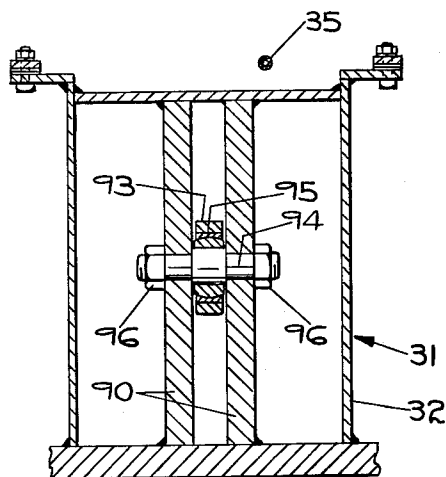


Fig. 5

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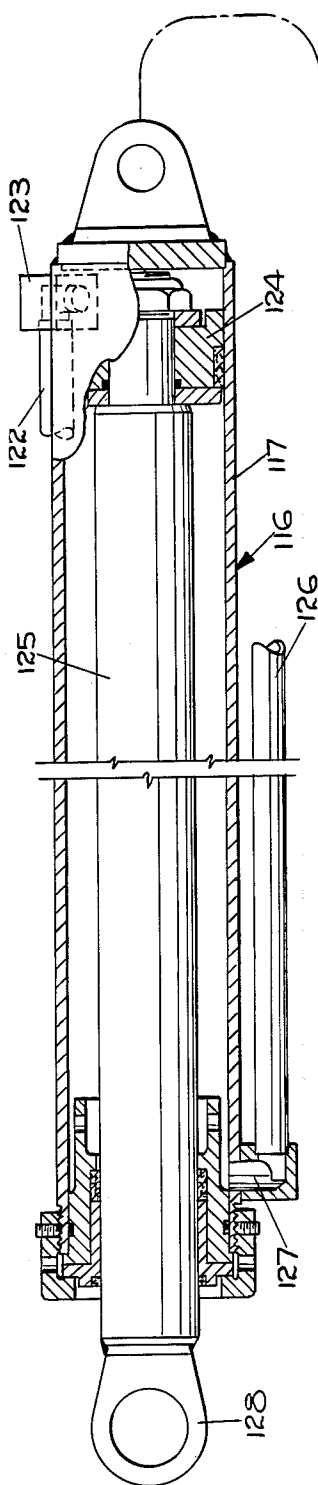
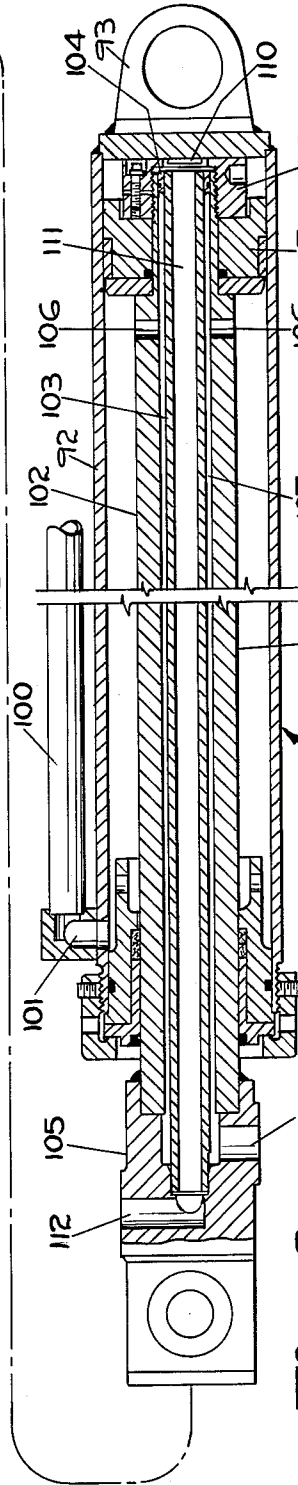


Fig. 9

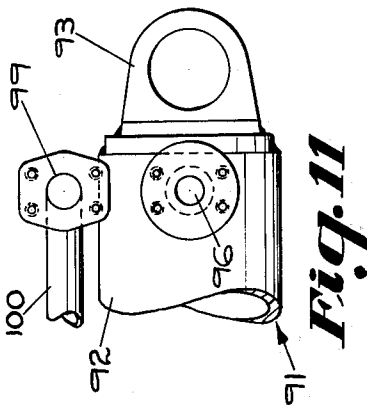


Fig. 11

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3,259,251

EXTENSIBLE BOOM WITH TANDEM OPERATING CYLINDERS

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Filed Dec. 26, 1963, Ser. No. 333,322
10 Claims. (Cl. 212—55)

The instant invention relates to cranes, and more particularly, to improved operating means for the operation of elements of such cranes.

It is an object of this invention to provide an improved operating means for extending and retracting an extensible crane boom.

It is another object of this invention to provide an improved operating means for extending and retracting a crane boom, in which such operating means includes several operating devices which act together to extend and retract the crane boom, whereby the load on an individual operating device is reduced.

It is a further object of the instant invention to provide an improved operating means for extending and retracting a crane boom comprising several cylinder and piston mechanisms connected in tandem for extending and retracting the crane boom, the length of movement of the boom being the sum of the lengths of movement of the cylinder and piston mechanisms.

Still another object of the instant invention is to provide an improved operating means for extending and retracting a crane boom comprising cylinder and piston mechanisms, that is of a simplified construction.

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

In the drawings:

FIG. 1 is a side elevational view of a crane constructed in accordance with the instant invention;

FIGS. 2A and 2B together are an elevational sectional view of the boom in extended position;

FIGS. 3A and 3B together are a top plan view of the boom in extended position;

FIGS. 4A and 4B together are an elevational sectional view of the boom in retracted position;

FIG. 5 is a sectional view of the boom, taken on the line 5—5 in FIG. 2A.

FIG. 6 is a sectional view of the boom, taken on the line 6—6 in FIG. 2A;

FIG. 7 is a sectional view of the boom, taken on the line 7—7 in FIG. 2B;

FIG. 8 is a sectional view of the boom, taken on the line 8—8 in FIG. 2B;

FIG. 9 is a sectional view of the cylinder and piston mechanisms for extending and retracting the boom;

FIG. 10 is a top plan view of the adjacent ends of the cylinder piston mechanisms;

FIG. 11 is a side elevational view of the lower end of the lower cylinder and piston mechanism; and

FIG. 12 is a plan view of the upper boom supporting roller.

Referring to the drawings, particularly FIG. 1, there is illustrated therein a crane 20, which is constructed in accordance with, and embodies the instant invention. The crane 20, which is illustrated herein by way of example, is commonly referred to as a portable or mobile hydraulic crane, by reason of the fact that it is a self propelled machine that may be driven under its own power, and the operating system for the crane mechanisms is of the hydraulic type.

The crane 20 has a main frame or chassis 21 which is mounted on front wheels 22 and rear wheels 23, all of which are driven for propulsion of the crane 20. Both the front wheels 22 and the rear wheels 23 are steerable

to provide the crane 20 with a high degree of mobility. At the rear of the chassis 21 there is provided an engine 24, which provides the power for driving the crane 20, including the hydraulic operating system for the various crane mechanisms. At the front of the chassis 21 there is provided an operator's station 25 at which there are placed the various controls 28 for the crane 20.

At the front of the chassis 21 there is provided a pair of outriggers 26, and likewise, at the rear there is provided a pair of outriggers 27, which are alike in all respects. The outriggers 26, 27 at the front and rear extend to opposite sides of the chassis 21, and may be lowered into bearing contact with the ground, as illustrated in FIG. 1, to provide added support for the crane 20 and thereby to stabilize it.

A pedestal 30 is disposed in a substantially centrally located position on the chassis 21 and extends upwardly therefrom. The pedestal 30 supports the boom assembly 31, and is rotatable in opposite directions on the chassis 21 about an upright axis, whereby the boom assembly 31 may be swung continuously in a full circle. The boom assembly 31 is pivotally mounted on the pedestal 30 and may be raised and lowered, as illustrated in FIG. 1. The boom assembly 31 includes a lower boom 32 and an upper boom 33, the latter being telescoped within the former, and being extensible and retractable relatively to the lower boom 32, whereby the boom assembly 31 may be lengthened and shortened, as needed, to reach various places where it is desired to either pick up or set down a load. At the outer end of the upper boom 33 there is a hook block 34 which depends from the end of the upper boom 33 on a cable 35. A winch is supported on the end of the lower boom 32 for paying out and taking up the cable 35 to raise and lower the hook block 34 as required.

The pedestal 30 comprises laterally spaced side plates 39 which are secured to a turntable base plate 40 having a circular configuration.

The laterally spaced side plates 39 of the pedestal 30 extend upwardly and rearwardly and terminate in overhanging mounting arms 85 on which the boom assembly 31 is pivotally mounted. A pivot pin 86 extends laterally between the opposite arms 85 of the side plates 39 and through the lower boom 32, whereby the pivot pin 86 pivotally connects the boom assembly 31 to the pedestal 30. A lift cylinder and piston mechanism 87 has its cylinder end secured to the turntable base plate 40 by a pin 88, and its piston rod end is secured to the lower boom 32 by a pin 89. The lift cylinder and piston mechanism 87 is disposed in an upright position between the turntable base plate 40 and the boom assembly 31, between the opposite side plates 39. The lift cylinder and piston mechanism 87 may be extended to raise the boom assembly 31 by swinging it upwardly on the pivot pin 86, and contracted to lower the boom assembly 31 by swinging it downwardly. The lift cylinder and piston mechanism 87 is operated by hydraulic fluid under pressure that is supplied thereto for moving its piston and piston rod upwardly and downwardly within the cylinder 87.

The lower boom 32 is formed with a box-like construction having a substantially rectangular cross section, as seen in FIGS. 5, 6 and 7. The upper boom 33 is similarly provided with a box-like construction having a substantially rectangular cross section, as seen in FIGS. 6, 7 and 8, and is smaller in sectional dimension than the lower boom 32 to permit the upper boom 33 to be received within the lower boom 32 by a telescoping action of the upper boom 33 into the lower boom 32. Operating means is provided for extending and retracting the upper boom 33 with respect to the lower boom 32, thereby adjusting the length or reach of the boom assembly 31. Such adjustment of the boom assembly 31 may be made in any posi-

tion thereof, whereby the crane 20 has a high degree of flexibility in its operation.

Heretofore, reference has been made to the lower boom 32 and the upper boom 33. The use of the terms "lower" and "upper" for the respective booms 32, 33 is accepted usage, and derives from the fact that the boom assembly 31 most often is disposed in an upwardly extending position in which the upper boom 33 is above the lower boom 32. In the interest of consistency, the terms "lower" and "upper" will be used herein with reference to other elements of the boom assembly 31, to describe the relative dispositions thereof.

A pair of laterally spaced posts 90 are secured to the lower end of the lower boom 32. A cylinder and piston mechanism 91 has its cylinder 92 formed with an ear 93 at the lower end thereof. The cylinder ear 93 is disposed between the posts 90 and is secured thereto by a transverse pin 94, as seen in FIG. 7. A suitable universal bearing 95 is interposed between the pin 94 and the cylinder ear 93. The pin 94 is secured to the posts 90 by a pair of nuts 96, 96, which are turned on the opposite threaded ends of the pin 94. Thus, the cylinder 92 has its lower end anchored to the lower end of the lower boom 32.

The lower end of the cylinder 92 has a port 96 through which hydraulic fluid under pressure is delivered to the lower end of the cylinder 92 to apply force to the piston 97 and to move it and its piston rod 98 upwardly of the cylinder 92, thereby extending the cylinder and piston mechanism 91. A second port 99 for hydraulic fluid under pressure is also located at the lower end of the cylinder 92 above the first port 96. A line 100 connects the second port 99 to a port 101 at the upper end of the cylinder 92. Hydraulic fluid under pressure is supplied through the port 99, the line 100 and the port 101 to the upper end of the cylinder 92 to apply force to the piston 97 to move it and its piston rod 96 downwardly in the cylinder 92, thereby contracting the cylinder and piston mechanism 91.

The piston rod 98 is formed of an outer tubular member 102 and an inner tubular member 103, which are concentrically disposed with respect to each other, and are spaced one from the other. The lower end of the outer tubular member 102 is secured to the piston 97 by a nut 109. The lower end of the inner tubular member 103 is mounted within the outer tubular member 102 in spaced relation thereto by an annular spacer 104, which forms a seal between the lower ends of the outer and inner tubular members 102, 103. The upper end of the outer tubular member 102 is secured to a connector block 105, and the inner tubular member 103 is also secured to the connector block 105 in concentric speed relation to the outer tubular member 102.

The lower end of the outer tubular member 102 has several ports 106 which connect to the annular space 107 that is formed between the outer and inner tubular members 102, 103. The connector block 105 has a port 108 that connects to the annular space 107 at the upper end of the piston rod 98. The hydraulic fluid under pressure, which is supplied to the cylinder 92 through the port 101, flows through the ports 106, the annular passage 107 and to the port 108. A port 110 is centrally disposed in the nut 109 and connects to the lower end of the passage 111 that extends the length of the inner tubular member 103. The connector block 105 has a port 112 that connects to the upper end of the passage 111. The hydraulic fluid under pressure which is supplied to the lower end of the cylinder 92 through the port 96 flows through the port 110 and the passage 111, to the port 112.

The connector block 105 is formed with an ear 115, by which the lower cylinder and piston mechanism 91 is connected to the upper cylinder and piston mechanism 116. The cylinder 117 of the upper cylinder and piston mechanism 116 has a clevis 118 at its lower end, in which the ear 115 is received. The ear 115 is connected to a trans-

verse pin 119 by a suitable universal bearing 120, as seen in FIG. 6. The pin 119 extends to opposite sides of the ear 115 and through the clevis 118, with the pin 119 being secured to the clevis 118 by opposite nuts 121, 121, turned on the threaded portions of the pin 119 and bearing against the opposite sides of the clevis 118. This articulated connection of the lower cylinder and piston mechanism 91 to the upper cylinder and piston mechanism 116 is flexible on the pin 119, to permit relative movement between the respective cylinder and piston mechanisms 91, 116.

A line 122 has one end connected to the port 112 of the connector block 105, and its other end is connected to the port 123 at the lower end of the cylinder and piston mechanism 116. Hydraulic fluid under pressure flows from the port 112 through the line 122 to the port 123 and into the lower end of the cylinder 117 to act on the piston 124 to move it and its piston rod 125 upwardly of the cylinder 117 to extend the cylinder and piston mechanism 116. By reason of the connections between the cylinder and piston mechanisms 91, 116, they are both extended at the same time, and in addition, the cylinder 117 of the upper cylinder and piston mechanism 116 has an upward translatable movement, since it is connected to the upper end of the piston rod 98 and moves therewith.

A line 126 has one end connected to the port 108 of the connector block 105, and its other end is connected to a port 127 at the upper end of the cylinder 117. Hydraulic fluid under pressure flows from the port 108 through the line 126 and through the port 127 into the upper end of the cylinder 117 to act on the piston 124 to move it and its piston rod 125 downwardly of the cylinder 117 to contract the cylinder and piston mechanism 116. By reason of the connections between the lower and upper cylinder and piston mechanisms 91, 116, they are contracted both at the same time, and in addition, the cylinder 117 has a downward translatable movement.

The upper end of the piston rod 125 has an ear 128, by which the upper cylinder and piston mechanism 116 is connected to the upper boom 33. The ear 128 is connected to a transverse pin 129 by a suitable universal bearing 130, as seen in FIG. 8. Oppositely disposed mounting blocks 131, 131 are secured to the side walls of the upper boom 33, and extend inwardly therefrom to the ear 128. Each mounting block 131, 131 has a bore within which there is received a spacer 132. The transverse pin 129 extends through the opposite spacers 132, 132 and is secured to the mounting blocks 131, 131 by nuts 133, 133 which are turned on the opposite threaded ends of the pin 129, with washers 134, 134 being interposed between the nuts 133, 133 and the spacers 132, 132, to thereby secure the pin 129 to the upper boom 33.

Thus, the assembly, including the lower cylinder and piston mechanism 91 and the upper cylinder and piston mechanism 116, is connected to the lower end of the lower boom 32 and to the upper boom 33 near the upper end thereof, whereby extension of the cylinder and piston mechanisms 91, 116 extends the upper boom 33 with respect to the lower boom 32, and likewise, contraction of the cylinder and piston mechanisms 91, 116 retracts the upper boom 33 with respect to the lower boom 32.

At the upper end of the lower boom 32, there is a transverse pin 140 which extends laterally between the side walls of the lower boom 32 and is secured thereto, as seen in FIG. 7. The pin 140 is disposed below the upper boom 33, and supports a pair of mounting blocks 141, 141 that are journaled on the pin 140. Each mounting block 141 has a flat upper face on which there is secured a wear plate 142, which is formed of a suitable bearing material, such as bronze. Each wear plate 142 is secured to its mounting block 141 by a pair of bolts 143, 143 disposed one on each side of the transverse pin 140. The upper boom 33 is slidably supported by the wear plates 142, 142. Under load, the lower and upper booms 32, 33 are subject to bending, and in order to ac-

commodate to the same, the wear plates 142, 142 and their mounting blocks 141, 141 are journaled on the transverse pin 140 so that the upper boom 33 is properly supported by the wear plates 142, 142. Thus, the wear plates 142 always have a full surface contact with the under side of the upper boom 33.

At the upper end of the lower boom 32, and at each side thereof, there is a wear plate 144 which is secured to a side wall of the lower boom 32 by a pair of bolts 145, 145. Several spacers 146 are interposed between each wear plate 144 and the side wall of the lower boom 32 to properly locate the wear plates 144, 144 in a transverse direction, so as to bear against the sides of the upper boom 33 and to maintain it in a transversely centered position within the lower boom 32. The wear plates 144, 144 are preferably formed of a bearing material, such as bronze, so that the upper boom 33 will be easily slidable on the wear plates 144, 144, as it moves outwardly and inwardly with respect to the lower boom 32.

A pair of wear plates 147, 147 is secured to the top of the upper boom 33 at the lower end thereof. The wear plates 147, 147 are secured by bolts 148, 148 and bear against the top wall of the lower boom 32. The wear plates 147, 147 are preferably formed of a bearing material, such as bronze, so that they are freely slidable on the top wall of the lower boom 32 as the upper boom 33 moves upwardly and downwardly relatively to the lower boom 32.

A wear plate 149 is secured to each side of the upper boom 33 at the lower end thereof. Each wear plate 149 is secured by bolts 150, 150 with several spacers 151, 151 interposed between a side wall of the upper boom 33 and a wear plate 149 to properly locate the latter in a transverse direction for centering the upper boom 33 transversely within the lower boom 32. The wear plates 149, 149 bear against the side walls of the lower boom 32 and are preferably formed of a bearing material, such as bronze, so that the upper boom 33 will be freely slidable relatively to the lower boom 32. When the boom assembly 31 supports a load at its upper end, the force at the lower end of the upper boom 33 causes it to bear against the top wall of the lower boom 32, and such force is resisted by the wear plates 147, 147. When the boom assembly 31 is swung in a circle the forces acting on the upper boom 33 tend to move it laterally relatively to the lower boom 32. Such lateral movement of the upper boom 33 is resisted by the wear plates 149, 149 at the lower end of the upper boom 33, and the wear plates 144, 144 at the upper end of the lower boom 32.

At the lower end of the upper boom 33 there is an arm 154, which is mounted adjacent the bottom wall of the upper boom 33 and extends rearwardly therefrom. The arm 154 is pivotally mounted on the side walls of the upper boom 33 by a pair of opposite pins 155, 155. A roller 156 is rotatably supported on one end of the arm 154 beyond the end of the upper boom 33. The roller 156 rides on the bottom wall of the lower boom 32. An adjusting bolt 157 is threaded through the other end of the pivoted arm 154 and abuts the bottom wall of the upper boom 33 to adjust the position of the arm 154 and the roller 156. When the upper boom 33 is retracted into the lower boom 32, and there is no load on the boom assembly 31, the weight of the upper boom 33 would tend to cause the lower end thereof to drop down on the bottom wall of the lower boom 32. However, the roller 156 supports the lower end of the upper boom 33 so that it maintains its central position spaced above the bottom wall of the lower boom 32.

Within the upper boom 33 there are provided two supporting bars 160, 160, which are secured to the side walls thereof by a plurality of bolts 161, there being one such supporting bar 160 at each side of the upper boom 33. Each supporting bar 160 extends longitudinally along the upper boom 33 from the lower end thereof through a distance that is commensurate with the translatory movement of the upper cylinder and piston mechanism 116, 75

such movement being equal to the travel of the piston 97 and piston rod 98 of the lower cylinder and piston mechanism 91. The transverse pin 119 by which the cylinder and piston mechanisms 91, 116 are connected to each other, has opposite ends 162, 162 which extend to adjacent the opposite supporting bars 160, 160, as seen in FIGS. 6 and 10. On each pin end 162 there is pivotally mounted a slide 163, which has a channel configuration to fit over the supporting bar 160. Thus, the engagement of the slides 163, 163 with the supporting bars 160, 160 provides a support for the flexible or articulated joint between the cylinder and piston mechanisms 91, 116 in all positions thereof. As the joint, which is represented by the pin 119, moves upwardly and downwardly with respect to the boom assembly 31, the slides 163, 163 ride along the supporting bars 160, 160 and maintain engagement therewith. When the boom assembly 31 is supporting a load, there is some bending thereof. The flexible connection of the cylinder and piston mechanisms 91, 116, including the pin 119, permits such bending of the boom assembly 31 to occur without the same being transmitted to the cylinder and piston mechanisms 91, 116 to any degree that will affect the operation thereof. Since the slides 163, 163 are journaled on the ends 162, 162 of the pin 119, these elements do not interfere with the flexibility of the connection between the cylinder and piston mechanisms 91, 116.

At the lower end of the lower boom 32 there is secured a counterweight 165 for the purpose of counterbalancing the loads supported on the end of the boom assembly 31. The counterweight 165 is U-shaped in plan view, and within the counterweight 165 there is placed the winch 36 having a winch drum 167, on which there is wound the cable 35. The winch 36 is driven by a hydraulic motor 169. A roller 170 is disposed above the winch drum 167 in contact with the cable 35. Leaf springs 171, 171 are secured to the ends of the axle 172 of the roller 170 and to ears 173, 173 at the top of the lower boom 32. The leaf springs 171, 171 press the roller 170 down on the windings of the cable 35 on the winch drum 167, whereby the cable 35 will be properly payed in and out from the winch 36. The roller 170 prevents the condition of the cable 35 merely uncoiling on the winch drum 167, rather than being payed out. When winding the cable 35 on the winch drum 167, the roller 170 assures that the cable 35 is tightly wound thereon.

The cable 35 extends from the winch drum 167 to a boom head 174 at the upper end of the upper boom 33. The boom head 174 includes a plurality of sheaves 175, over which the cable 35 is reeved to a hook block 34, which likewise includes a plurality of sheaves 177, over which the cable 35 is reeved. The hook block 34 has a depending hook 178 by which a load may be engaged to be lifted and moved by the crane 20.

The crane embodying the operating means as described herein operates smoothly and efficiently. The boom assembly is intended to lift substantial loads, and these subject the boom assembly to severe stress. Notwithstanding such loading, the upper boom may be extended and retracted easily by the upper and lower cylinder and piston mechanisms, the operation of which is not impeded by the boom loads.

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 applicant therefore wishes not to be restricted to the precise construction herein disclosed.

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

1. A crane structure comprising, a lower boom and an upper boom in which the upper boom is adapted to be extended and retracted relatively to the lower boom, power means for extending and retracting said upper boom, said

power means including a first power unit and a second power unit arranged in tandem to apply the force of both power units to extend and retract the upper boom, and a flexible joint connection located between said power units and disposed in line with the tandem arrangement of said power units for connecting said power units to each other whereby said power units are yieldable relatively to each other.

2. A crane structure comprising, a lower boom and an upper boom in which the upper boom is adapted to be extended and retracted relatively to the lower boom, power means for extending and retracting said upper boom, said power means including a first extensible and retractable power unit and a second extensible and retractable power unit, said first and second power units being disposed along the upper and lower booms in tandem to apply the force of both power units to extend and retract the upper boom and the extensive and retractive movement of the upper boom being commensurate with the extensive and retractive movements of both power units, and a flexible joint connection located between said power units and disposed in line with the tandem disposition of said power units for connecting said power units to each other whereby said power units are yieldable relatively to each other.

3. A crane structure comprising, a lower boom and an upper boom in which the upper boom is adapted to be extended and retracted relatively to the lower boom, power means for extending and retracting said upper boom, said power means including a first extensible and retractable cylinder and piston mechanism and a second extensible and retractable cylinder and piston mechanism, said first and second cylinder and piston mechanisms extending along the upper and lower booms and being disposed in tandem to apply the force of both cylinder and piston mechanisms to extend and retract the upper boom and the extensive and retractive movement of the upper boom being commensurate with the extensive and retractive movements of both cylinder and piston mechanisms, and a flexible joint connection located between said cylinder and piston mechanisms and disposed in line with the tandem disposition of said cylinder and piston mechanisms for connecting said cylinder and piston mechanisms to each other whereby said cylinder and piston mechanisms are yieldable relatively to each other.

4. A crane structure comprising, a lower boom and an upper boom in which the upper boom is adapted to be extended and retracted relatively to the lower boom, power means for extending and retracting said upper boom, said power means including a first extensible and retractable cylinder and piston mechanism and a second extensible and retractable cylinder and piston mechanism, said first and second cylinder and piston mechanisms extending along the upper and lower booms and being disposed in tandem to apply the force of both cylinder and piston mechanisms to extend and retract the upper boom and the extensive and retractive movement of the upper boom being commensurate with the extensive and retractive movements of both cylinder and piston mechanisms, a fluid connection to said first cylinder and piston mechanism for supplying fluid thereto under pressure to actuate the first piston and piston rod thereof, a fluid connection through said first piston and piston rod to said second cylinder and piston mechanism for supplying fluid thereto under pressure to actuate the second piston and piston rod thereof, and means connecting said cylinder and piston mechanisms to each other comprising an articulated joint connecting the piston rod of said first cylinder and piston mechanism to said second cylinder and piston mechanism whereby said cylinder and piston mechanisms are yieldable relatively to each other.

5. A crane structure comprising, a lower boom and an upper boom in which the upper boom is adapted to be extended and retracted relatively to the lower boom, power means for extending and retracting said upper

boom, said power means including a first extensible and retractable cylinder and piston mechanism and a second extensible and retractable cylinder and piston mechanism, said first and second cylinder and piston mechanisms extending along the upper and lower booms and being disposed in tandem to apply the force of both cylinder and piston mechanisms to extend and retract the upper boom and the extensive and retractive movement of the upper boom being commensurate with the extensive and retractive movements of both cylinder and piston mechanisms, means securing the first cylinder and piston mechanism to the lower boom and means securing the second cylinder and piston mechanism to the upper boom, and articulated joint means located between said cylinder and piston mechanisms and disposed in line with the tandem disposition of said cylinder and piston mechanisms for connecting said cylinder and piston mechanisms to each other whereby said cylinder and piston mechanisms are yieldable relatively to each other.

6. A crane structure comprising, a lower boom and an upper boom in which the upper boom is adapted to be extended and retracted relatively to the lower boom, power means for extending and retracting said upper boom, said power means including a first extensible and retractable power unit and a second extensible and retractable power unit, said first and second power units being disposed along the upper and lower booms in tandem to apply the force of both power units to extend and retract the upper boom and the extensive and retractive movement of the upper boom being commensurate with the extensive and retractive movements of both power units, a flexible connection for connecting said power units to each other whereby said power units are yieldable relatively to each other, and said upper boom including supporting means in engagement with said flexible connection in all positions of the power units and of the upper boom to support the power units.

7. A crane structure comprising, a lower boom and an upper boom in which the upper boom is adapted to be extended and retracted relatively to the lower boom, power means for extending and retracting said upper boom, said power means including a first extensible and retractable cylinder and piston mechanism and a second extensible and retractable cylinder and piston mechanism, said first and second cylinder and piston mechanisms extending along the upper and lower booms and being disposed in tandem to apply the force of both cylinder and piston mechanisms to extend and retract the upper boom and the extensive and retractive movement of the upper boom being commensurate with the extensive and retractive movements of both cylinder and piston mechanisms, a flexible connection for connecting said cylinder and piston mechanisms to each other whereby said cylinder and piston mechanisms are yieldable relatively to each other, and said upper boom including supporting means slidably engaged with said flexible connection in all positions of extension and retraction of the cylinder and piston mechanisms and of the upper boom to support the cylinder and piston mechanisms.

8. A crane structure comprising, a lower boom and an upper boom in which the upper boom is adapted to be extended and retracted relatively to the lower boom, power means for extending and retracting said upper boom, said power means including a first extensible and retractable cylinder and piston mechanism and a second extensible and retractable cylinder and piston mechanism, said first and second cylinder and piston mechanisms extending along the upper and lower booms and being disposed in tandem to apply the force of both cylinder and piston mechanisms to extend and retract the upper boom and the extensive and retractive movement of the upper boom being commensurate with the extensive and retractive movements of both cylinder and piston mechanisms, an articulated joint connecting an end of one cylinder and piston mechanism to an end of the other cylinder and piston mechanism whereby said

cylinder and piston mechanisms are yieldable relatively to each other, a supporting bar on the upper boom extending along the upper boom, a slide connected to the articulated joint and slidably engaged with the supporting bar to support the articulated joint and the adjacent ends of the cylinder and piston mechanisms in all positions of extension and retraction of the cylinder and piston mechanisms and of the upper boom.

9. A crane structure comprising, a lower boom and an upper boom in which the upper boom is adapted to be extended and retracted relatively to the lower boom, power means for extending and retracting said upper boom, said power means including a first extensible and retractable cylinder and piston mechanism and a second extensible and retractable cylinder and piston mechanism, said first and second cylinder and piston mechanisms extending along the upper and lower booms and being disposed in tandem to apply the force of both cylinder and piston mechanisms to extend and retract the upper boom and the extensive and retractive movement of the upper boom being commensurate with the extensive and retractive movements of both cylinder and piston mechanisms, a pivot pin connecting an end of one cylinder and piston mechanism to an end of the other cylinder and piston mechanism to form an articulated joint between said cylinder and piston mechanisms whereby they are yieldable relatively to each other, a supporting bar secured to the upper boom and extending along the line of movement of the articulated joint as the cylinder and piston mechanisms are extended and retracted, a slide pivotally mounted on said pivot pin and complementally formed with respect to said supporting bar to be slidably engaged with said supporting bar and to support the articulated joint and the adjacent ends of the cylinder and piston mechanisms on the supporting bar in all positions of extension and retraction of the cylinder and piston mechanisms and of the upper boom.

10. A crane structure comprising, a lower boom and an upper boom in which the upper boom is adapted to be extended and retracted relatively to the lower boom, power means for extending and retracting said upper boom, said power means including a first extensible and retractable cylinder and piston mechanism and a second extensible and retractable cylinder and piston mechanism, said first and second cylinder and piston mechanisms extending along the upper and lower booms and being disposed in tandem to apply the force of both cylinder and piston mechanisms to extend and retract the upper boom and the extensive and retractive movement of the upper boom being commensurate with the extensive and retractive movements of both cylinder and piston mechanisms, a pivot pin connecting an end of one cylinder and piston mechanism to an end of the other cylinder and piston mechanism to form an articulated joint between said cylinder and piston mechanisms whereby they are yieldable relatively to each other, a supporting bar secured to the upper boom and extending along the line of movement of the articulated joint as the cylinder and piston mechanisms are extended and retracted, a slide pivotally mounted on said pivot pin and complementally formed with respect to said supporting bar to be slidably engaged with said supporting bar and to support the articulated joint and the adjacent ends of the cylinder and piston mechanisms on the supporting bar in all positions of extension and retraction of the cylinder and piston mechanisms and of the upper boom.

der and piston mechanisms to extend and retract the upper boom and the extensive and retractive movement of the upper boom being commensurate with the extensive and retractive movements of both cylinder and piston mechanisms, a fluid connection to the cylinder of the first cylinder and piston mechanism for supplying fluid thereto under pressure to actuate the piston and piston rod thereof, a fluid connection through the first piston and piston rod to the cylinder of the second cylinder and piston mechanism for supplying fluid thereto under pressure to actuate the piston and piston rod thereof, means for securing one end of the first cylinder and piston mechanism to the lower boom and means for securing one end of the second cylinder and piston mechanism to the upper boom, the other ends of the cylinder and piston mechanisms being disposed adjacent each other, a pivot pin connecting the adjacent ends of the cylinder and piston mechanisms to form an articulated joint between said cylinder and piston mechanisms whereby they are yieldable relatively to each other, a supporting bar secured to the upper boom and extending along the line of movement of the articulated joint as the cylinder and piston mechanisms are extended and retracted, a slide pivotally mounted on said pivot pin and complementally formed with respect to said supporting bar to be slidably engaged with said supporting bar and to support the articulated joint and the adjacent ends of the cylinder and piston mechanisms on the supporting bar in all positions of extension and retraction of the cylinder and piston mechanisms and of the upper boom.

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