Nov. 9, 1965 F. R. LADD ETAL 3,216,511

DROP HAMMER

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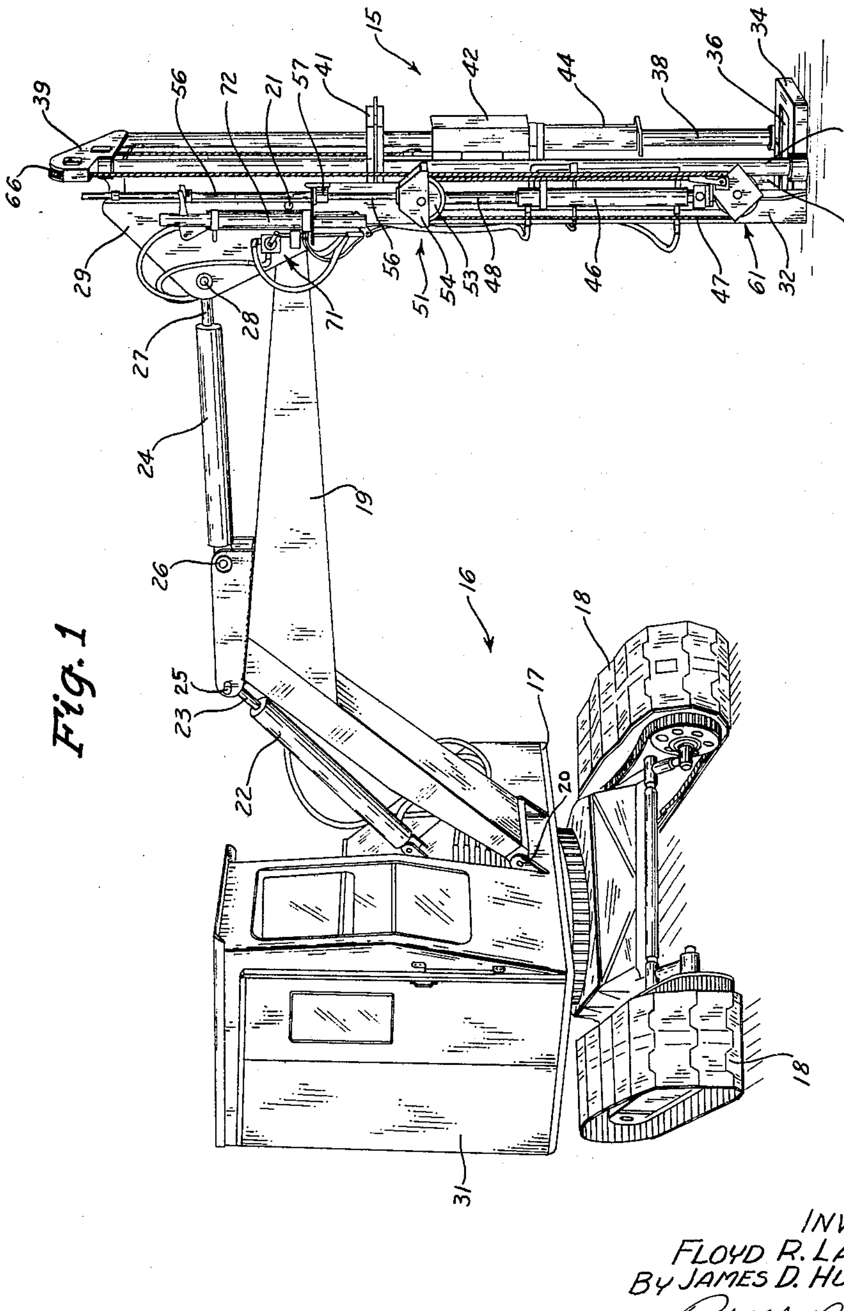

Fig. 1

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Fig. 12

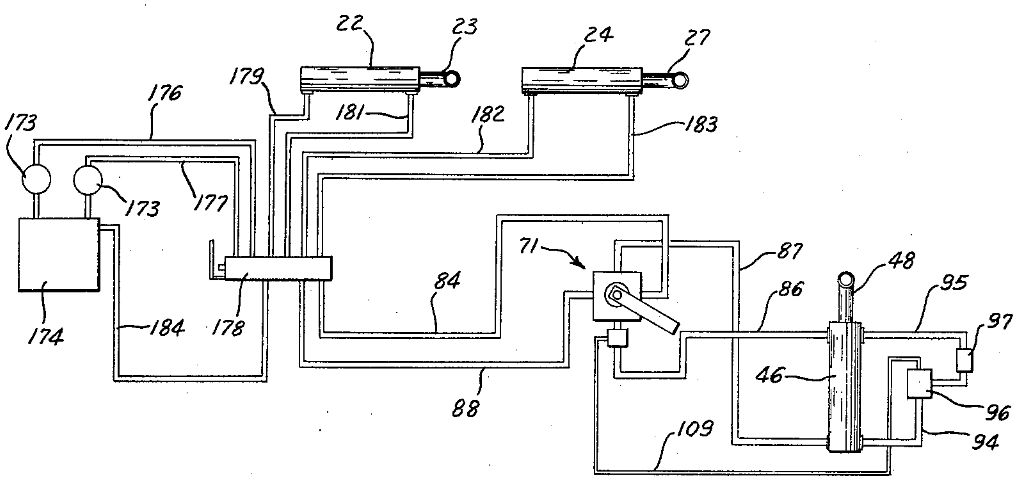


Fig. 3

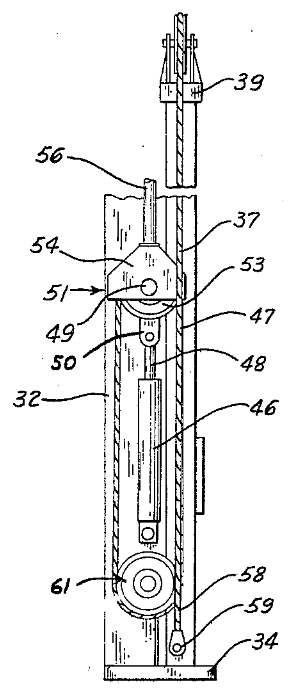
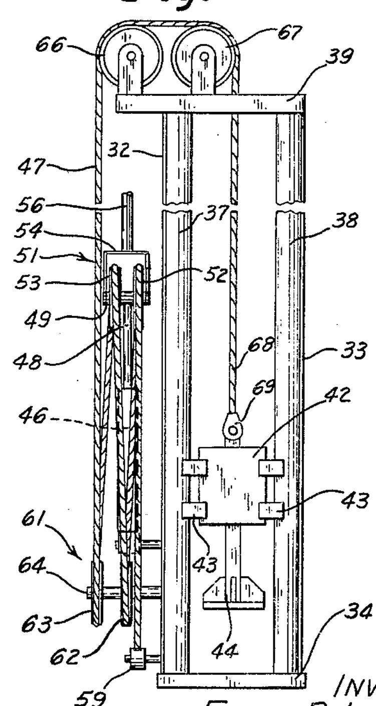


Fig. 2



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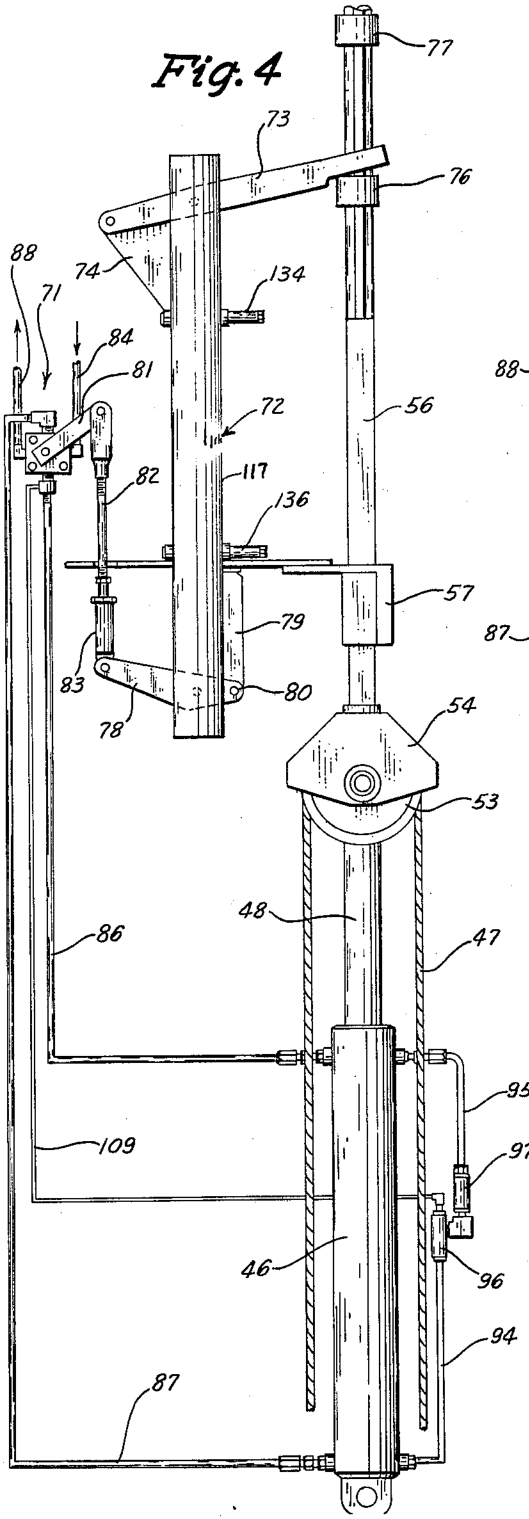

Fig. 4

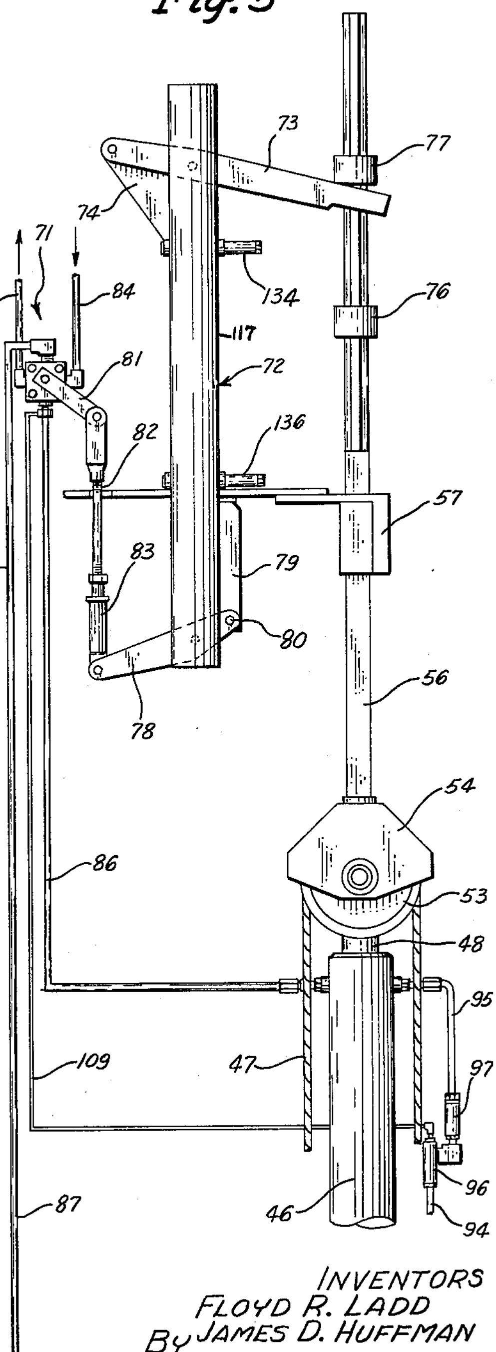

Fig. 5

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Fig. 6

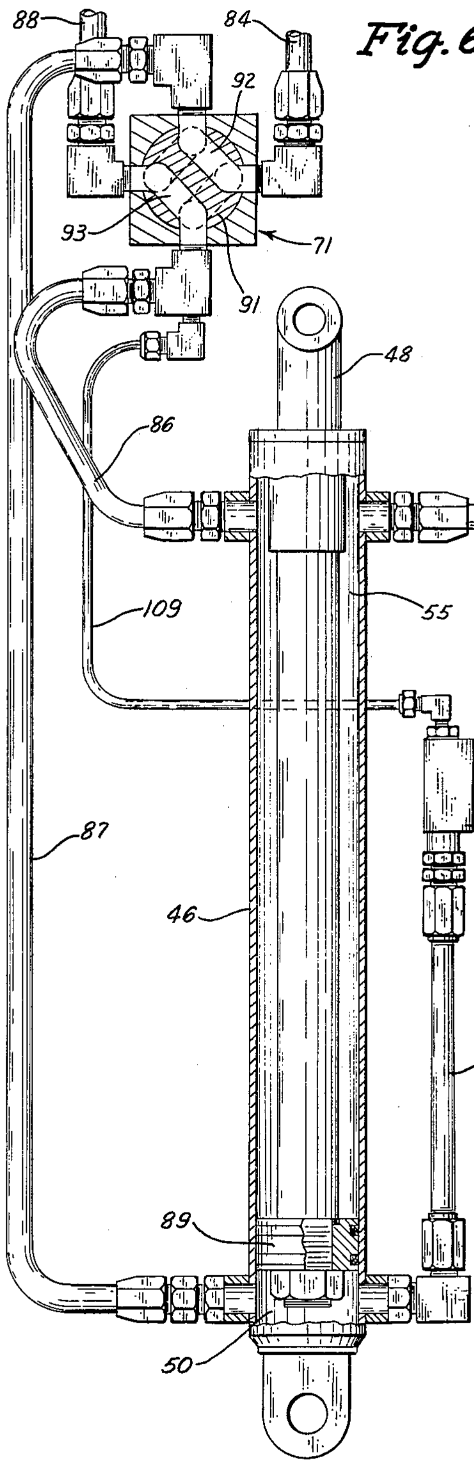

Fig. 8

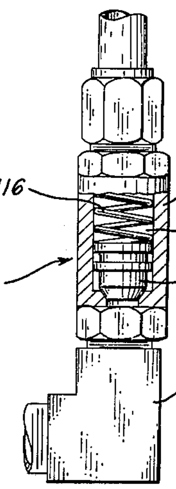

Fig. 7

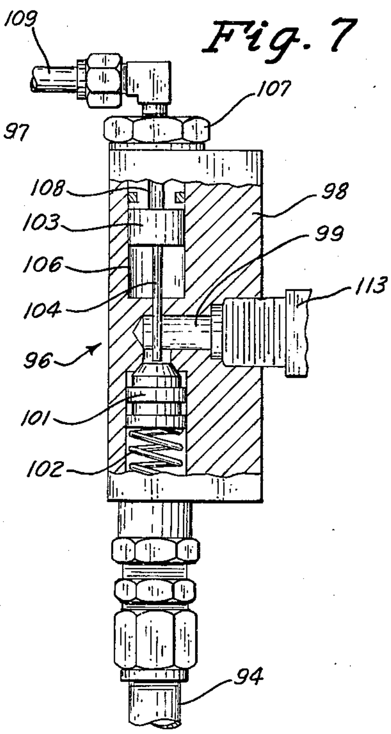

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Fig. 9

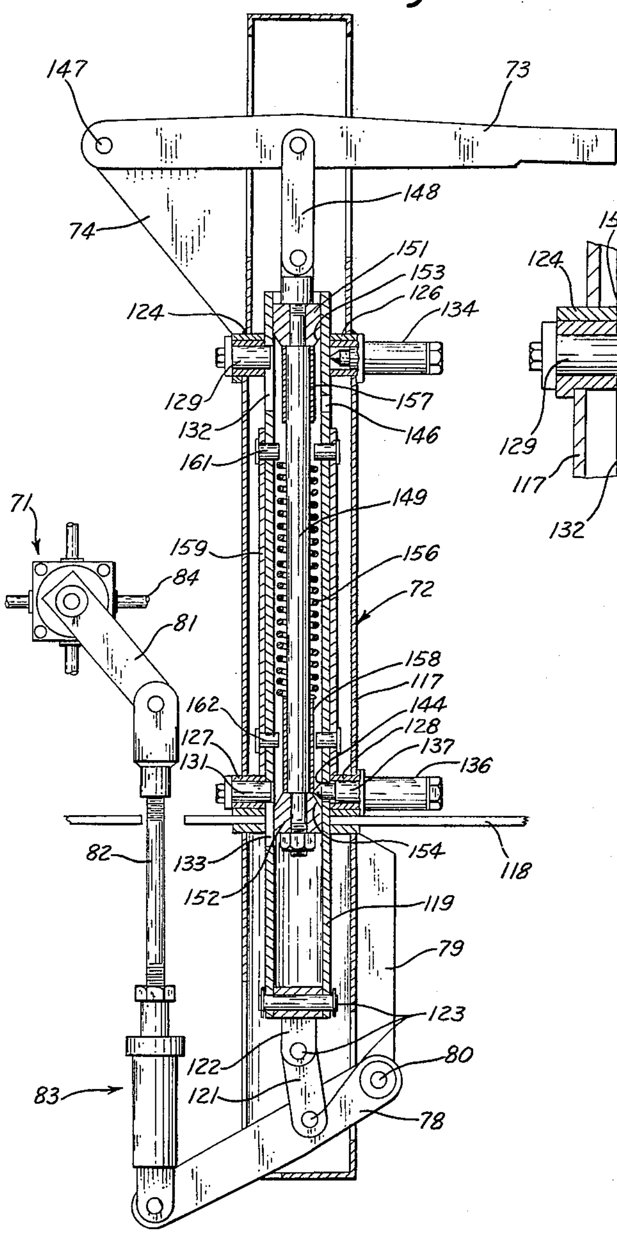


Fig. 10

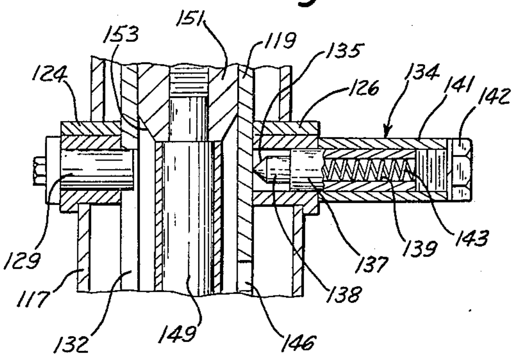
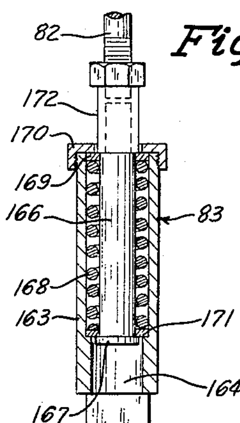


Fig. 11



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United States Patent Office 3,216,511 Patented Nov. 9, 1965

3,216,511
DROP HAMMER

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Filed Jan. 16, 1963, Ser. No. 251,809
6 Claims. (Cl. 173—19)

This invention relates to a drop hammer apparatus and more particularly to a control system for a drop hammer assembly mounted on a vehicle.

It is the object of the present invention to provide an improved drop hammer apparatus having a hammer control system which permits the free fall of the hammer.

Another object of the invention is to provide a vehicle having a movable boom with a drop hammer assembly pivotally mounted on the boom for angular movement with respect to the boom.

A further object of the invention is to provide an automatic hydraulic control system for a drop hammer which raises the hammer and permits the free fall thereof.

Another object of the invention is to provide a control system for a drop hammer which may be manipulated to provide for a complete cyclic operation of raising and freely dropping the hammer, or for the automatic continuation of successive cyclic operations.

Still another object of the invention is to provide a trip mechanism operable in response to movement of the piston of a double acting cylinder for reversing the flow of fluid to the cylinder.

An additional object of the invention is to provide a versatile and portable drop hammer assembly which is rugged in construction and reliable and efficient in use.

The exact nature of the invention as well as other objects and advantages thereof will be readily apparent from the consideration of the following specification relating to the annexed drawings in which:

FIG. 1 is a perspective view of a hammer assembly mounted on a crawler type vehicle;

FIG. 2 is an enlarged front elevational view of the hammer assembly of FIG. 1;

FIG. 3 is a side elevation view of the hammer assembly shown in FIG. 2;

FIG. 4 is an enlarged view of the hammer control system when the hammer is in an elevated position;

FIG. 5 is a view illustrated similarly to FIG. 4 showing the hammer control system when the hammer is in a dropped position;

FIG. 6 is an enlarged view partly in section showing the cylinder mechanism and control valve of the hammer control system shown in FIGS. 4 and 5;

FIG. 7 is an enlarged sectional detail view of a pilot check valve which forms part of the cylinder mechanism shown in FIG. 6;

FIG. 8 is an enlarged sectional detail view of a check valve which forms part of the cylinder mechanism shown in FIG. 6;

FIG. 9 is an enlarged sectional view of the trip or actuating mechanism for the cylinder mechanism shown in FIG. 6;

FIG. 10 is an enlarged sectional detail view of a spring biased locking means which forms a part of the actuating mechanism shown in FIG. 9;

FIG. 11 is an enlarged sectional detail view of a lost motion connection which is shown generally in FIG. 9; and

FIG. 12 is a diagrammatic showing of the fluid system for operating the vehicle boom and hammer assembly.

Referring to the drawing, there is shown in FIG. 1 a drop hammer assembly 15 in combination with a crawler type vehicle 16 having tracks 18 and a frame 17 carried

between the tracks for rotation about a vertical axis. An angular tower or boom 19 extended upwardly and outwardly from the frame 17 is pivotally supported at its lower end to the frame by means of a horizontal extended pivot pin 20. The drop hammer assembly 15 is pivotally connected to the outer end of the boom 19 by means of a horizontal extended pivot pin 21. The up and down pivoted movement of the boom 19 is controlled by a hydraulic cylinder 22 which is pivoted at one end to the frame 17 and has a piston rod 23 pivoted by pin 25 to the mid-section of the boom 19. The angular or tilted position of the drop hammer assembly 15 about the pivot pin 21 is controlled by a hydraulic cylinder 24 which is pivotally connected by means of a pin 26 to the mid-section of the boom 19 and includes a piston rod 27 which is connected at its outer end by means of a pivot pin 28 to a triangular-shaped bell crank member 29 which forms a part of the upper section of the drop hammer assembly 15. The controls for the hydraulic cylinders 22 and 24 are positioned in the vehicle cab 31 so that the operator of the vehicle may readily change the position of the hammer assembly 15 within the operating limits of boom 19.

Referring to FIGS. 1 and 2, the drop hammer assembly 15 has a frame formed by a pair of longitudinally extended side angle beams 32 and 33 secured to a transverse extended rectangular base 34 having a central opening 36. The upper sections of the angle beams 32 and 33 are secured to the base of the triangular-shaped bell crank 29.

A pair of laterally spaced cylindrical side rails 37 and 38 extend longitudinally of the hammer assembly 15 substantially parallel to the angle beams 32 and 33. The lower ends of the guide rails 37 and 38 are secured to the mid-section of the rectangular base 34 and the upper ends of the guide rails are connected by a housing 39 which is secured to the upper portion of the angle beams 32 and 33. The mid-sections of the cylindrical guide rails 37 and 38, as shown in FIG. 1, are reinforced with a U-shaped member 41, the legs of which are secured to the outer sides of the respective rails 37 and 38.

A hammer 42 (FIG. 2) is positioned between the guide rails 37 and 38 and is guided thereon by guide blocks 43 which are connected to the hammer 42 and are in slidable engagement with associated arcuate portions of corresponding side rails 37 and 38. A tool 44, such as a tamper, chisel or breaker, is removably secured to the lower end of the hammer 42. The cylindrical guide rails 37 and 38 form an elongated path which guides the tool 44 for reciprocal movement through the opening 36 in the base 34 (FIG. 1). The hammer 42, preferably of a weight which exceeds 1,000 pounds, is allowed to fall with a minimum amount of resistance to drive the tool 44 with an impact force into the surface of the ground.

A fluid motor 46, such as a hydraulic cylinder mechanism shown in FIGS. 1, 2, and 3, cooperates with a cable 47 to raise the hammer 42 to its upper limit of movement at the upper end of the hammer assembly 15. The cylinder mechanism 46 is secured in an upright position to the side of the angle beam 32 remote from the angle beam 33 and has a piston rod 48 projecting in an upward direction. The outer end of the piston rod 48 is connected by means of a pair of plates 50 to a pulley unit 51 having a pair of axially spaced sheaves 52 and 53 mounted on an axle 49 and a block member 54 surrounding the upper arcuate section of the sheaves. Projected upwardly in axial alignment with the piston rod 58 is a control rod 56 which constitutes an extension of the piston rod 48 and is directed through a bearing 57 secured to the angle beam 32. The control rod 56 reciprocates in an up and down direction with the piston rod 48.

The cable 47 is anchored at one end 58 by means of a connector 59 to the angle beam 32 adjacent the lower end thereof (FIG. 2). The cable 47 extends upwardly over the sheave 52 and then back down to a second pulley unit 61 having a pair of axially spaced sheaves 62 and 63 rotatable on a shaft 64 mounted on the angle beam 32 below the lower end of the cylinder mechanism 46. The cable 47 from the pulley or sheave 52 is traversed in order about the sheave 62, the sheave 53 of the pulley unit 51, and the sheave 63 of the pulley unit 61 to form a tackle assembly which increases the lift advantage of the cylinder mechanism 46. From the tackle assembly the cable 47 extends over a pair of sheaves 66 and 67 rotatably mounted on the top housing 39 for the pivotal connection of its other end 68, by means of a clevis 69, to the top of the hammer 42. When the piston rod 48 is moved in an upward direction by the fluid pressure in the head end 50 of the cylinder mechanism 46 the length of cable in the tackle assembly is increased thereby raising the hammer 42 up along the longitudinal path established by the guide rails 37 and 38.

The flow of fluid under pressure to the cylinder mechanism 46 is controlled by a valve 71 which is operated between a first and second position by a trip or actuating mechanism 72 the operation of which in turn is responsive to the movement of the control rod 56. As shown in FIG. 4, the trip mechanism 72 has a top control lever 73 pivotally mounted on a transverse axis on a bracket 74 secured to a cylindrical housing 117 for movement longitudinally of the hammer assembly 15. The outer end of the lever 73 is engageable with stops 76 and 77 adjustably positioned on the control rod 56. A second lever 78 is pivotally mounted on a bracket 79 secured to the lower section of the housing 117 by means of a transverse pin 80. The lever 78 is linked to the valve operating arm 81 by means of a link formed with a clevis and extensible rod 82 and a spring biased lost motion connection 83.

As shown in FIGURE 4, when the piston rod 48 is in the extended position the lower stop 76 on the control rod 56 engages the lever 73 moving it in a counterclockwise direction. The trip mechanism 72, in a manner to be later described, functions in response to the movement of the lever 73 to rotate the second or lower lever 78 in a clockwise direction to operate the second or lower lever 78 in a clockwise direction to operate the valve operating arm 81 to a first position to direct the fluid in the inlet fluid line 84 through the valve 71 and fluid line 86 to the rod end 55 of the cylinder mechanism 46 (see FIG. 6). In this position valve 71 connects the fluid line 87 leading from the lower or head end 50 of the cylinder mechanism 46 to the exhaust fluid line 88.

As shown in FIG. 5, when the piston rod 48 is in the retracted or lower position the upper stop 77 on the control rod 56, engages the lever 73 rotating it in a clockwise direction. The trip mechanism 72 in response to clockwise rotation of the lever 73 moves the lever 78 counterclockwise about its pivot axis thereby moving the valve operating arm 81 to a second position to connect the inlet line 84 with the fluid line 87 leading to the head end 50 of the cylinder mechanism 46 and the exhaust line 88 by means of fluid line 86 to the upper or rod end 55 of the cylinder mechanism 46.

Referring to FIGS. 5 and 6, when the piston rod 48 is in its retracted position the piston 89 is in the head end 50 of the cylinder mechanism 46. When the piston rod has been moved to its fully retracted position, as shown in FIG. 6, the trip mechanism 72 through the linkage 82 and 83 and valve lever arm 81 rotates the cylindrical valve body 91 so that its fluid passages 92 and 93 provide fluid communication between the inlet fluid line 84 and the fluid line 87 to supply fluid under pressure to the lower or head end 50 of the cylinder mechanism 46. This fluid pressure drives the piston 89 and extends the piston rod 48 from the cylinder 46. The fluid in the

rod end 55 of the cylinder is forced back into a reservoir 174 (FIG. 12) through the fluid line 86, passage 93 of the valve 71 and return or exhaust fluid line 88. When the piston rod 48 has been moved to its extended or raised position, as shown in FIG. 4, the trip mechanism 72, in response to movement of the lever 73, rotates the valve arm 81 to move the cylindrical valve body 91 so that the passages 92 and 93 therein assume the position indicated by the broken lines in FIG. 6. In this position, the fluid in the head end 50 of the cylinder mechanism 46 and the fluid line 87 is discharged back to the reservoir 174 through the return line 88. The supply line 84 is in fluid communication with the fluid line 86 to supply fluid to the rod end 55 of the cylinder 46.

In order to increase the discharge of fluid from the head end 50 of the cylinder 46 during the dropping of the hammer 42 to ensure the free fall of the hammer, the fluid from the head end 50 of the cylinder is by-passed back to the rod end 55 of the cylinder through a fluid line 94 and series connected pilot check valve means 96 and check valve 97.

As shown in FIG. 7, valve means 96 includes a housing 98 having a fluid passage 99 which permits the flow of fluid through the housing. A valve body 101 positioned in the passage 99 is biased by a spring 102 into engagement with a portion of the housing to prevent the flow of fluid from the head end 50 of the cylinder mechanism 46 through the valve means 96. The valve body 101 is moved to an open position against the force of the spring 102 by a piston 103 having an elongated stem 104 which engages the valve body 101. The piston 103 is slidably positioned in axial alignment with the valve body 101 within a bore 106. The head or open end of the bore 106 is closed with a coupling 107 having a fluid passage 108 for directing fluid under pressure against the piston 103. A fluid line 109 couples the fluid line 86 with the coupling 107 of the valve means 96 to provide fluid communication between the fluid line 86 and fluid passage 108.

As shown in FIG. 8, the check valve 97 comprises a housing 111 having a longitudinal passage 112. A right angle coupling 113 connects the check valve 97 with the housing 98 of the valve 96 to connect the fluid passage 99 of the valve 96 with the fluid passage 112 of the valve 97. A check valve 114 biased by a spring 116 is positioned in the passage 112 and permits the flow of fluid from the head end 50 to the rod end 55 of the cylinder 46. The valve 114 prevents the reverse flow of fluid through the line 94 from the rod end 55 to the head end 50 of the cylinder 46.

When the piston 89 and piston rod 48 are moved into a retracted position by the weight of the hammer 42, the fluid in the head end 50 of the cylinder 46 flows back to the reservoir 174 (FIG. 12) through the fluid line 87 and back to the rod end 55 of the cylinder through the fluid line 94 and valves 96 and 97. The pressure from the source is directed through the valve 71 into the fluid lines 86 and 109. The fluid pressure in the line 109 forces the piston 103 and stem 104 into the bore 106 to move the valve body 101 to open the passage 99 in the valve 96. The fluid in the line 94 is permitted to flow through the passage 99 into the check valve 97 which permits the flow of fluid into the fluid line 95 and the rod end 55 of the cylinder 46. The pressure differential between the head end 50 and the rod end 55 of the cylinder 46 controls the operation of the valve body 114 in the valve 97. When the piston 89 and piston rod 49 are moved to the lowered and retracted position the pressure in the rod end 55 is decreased and the pressure in the head end 50 is increased. This pressure differential causes the valve body 114 to move to an open position against the force of the spring 116 thereby permitting fluid to flow from the head end 50 to the rod end 55 of the cylinder 46.

As shown in FIGS. 9 and 10, the trip mechanism 72 for the fluid valve 71 includes an upwardly extended tubular housing 117 mounted on the side beam 32 by bracket 118. Positioned within the housing 117 is a cylindrical member 119 which is pivotally connected at its lower end to the mid-section of the lever 78 by a pair of links 121 and 122. Pins 123 pivotally connect the adjacent ends of the links 121 and 122, the link 121 with the lever 78, and the link 122 with the lower end of the cylindrical member 119.

The cylindrical member 119 is guided in the housing 117 for limited reciprocal movement by a first pair of guide and stop members 124 and 126 and a longitudinally spaced second pair of guide and stop members 127 and 128. The respective stop members are secured to the housing 117 and project in a transverse direction to engage the outer peripheral surface of the cylindrical member 119. The members 124 and 127 mount stop pins 129 and 131 which project into longitudinal extended slots 132 and 133 in the wall of the cylindrical member 119. The pins 129 and 131 engage the top and bottom edge of the respective slots 132 and 133 to limit the up and down movement of the cylindrical member 119.

The cylindrical member 119 is locked in either its up position or down position by detent means 134 and 136, respectively, transversely positioned in the guide and stop members 126 and 128, respectively. As shown in FIG. 10, detent means 134 comprises a cylindrical plunger 137 having reduced diameter projection 138 formed with a conical end 135 and an axial recess 139. The plunger 137 is opposite the stop pin 129 and is confined within a housing 141. A plug 142 threadably secured to the outer end of the housing 141 engages a compression spring 143 seated in the recess 139 and urges the plunger toward the wall of the cylindrical wall 119. When the cylindrical member 119 is in its down position, as shown in FIGURE 9, the projection 138 of the detent means 136 is received in a hole 144 formed in the wall of the cylindrical member 119. The detent means 136 in cooperation with the stop member 128 locks the cylindrical member 119 in the down position. When the projection 138 of the detent means 134 is received in the hole 146 in the side wall of the cylinder member 119 the cylindrical member is locked in the up position.

The cylindrical member 119 is moved from its locked up position to its locked down position and vice versa by the angular movement of the first lever 73 which responds to the movement of the control rod 56. The lever 73 is pivoted at one end by means of a pivot pin 147 to the bracket 74 which is secured to the housing 117. The mid-section of the lever 73 is pivotally connected by a link 148 to the upper end of a rod 149 positioned concentrically within the cylindrical member 119. The rod 149 is guided for longitudinal movement in the cylindrical member 119 by a first cylindrical guide member 151 secured to the upper end of the rod and a second cylindrical guide member 152 secured to the lower end of the rod. Each guide member has a beveled end 153 and 154 respectively which engage the conical surface 135 of the plunger of the adjacent detent means.

A compression spring 156 telescoped over the rod 149 resiliently connects the rod 149 with the cylindrical member 119. The spring 156 is centrally positioned on the rod 149 by sleeves 157 and 158 which abut the adjacent guide member at one end thereof and abut the adjacent end of the spring at the other end thereof. A stop sleeve 159 surrounds the section of the cylindrical member 119 between the slots 132 and 133. The lower end of the stop sleeve 159 engages the transverse stop members 127 and 128 when the member 119 is locked in the down position and the upper end of the stop sleeve engages the transverse stop members 124 and 126 when the member 119 is locked in the up position. A pair of upper and lower transverse pins 161 and 162 are secured to the end sections of the stop sleeve 159 and to the cylindrical member 119. The transverse pins 161 and 162 extend into the cylindrical member 119 and engage the ends of the spring 156 thereby interconnecting, by means of the spring 156, the rod 149 and the cylindrical member 119. The space between the ends of the pins 161 and 162 and the peripheral surface of the rod 149 is sufficient to permit the sleeves 157 and 158 respectively, to compress the spring 156 against its opposing pair of transverse pins.

As shown in FIGS. 9 and 11, the lower lever 78 is connected at its outer end by means of the dashpot 83 and the clevis and link 82 to the valve operating arm 81 of the valve 71. The dashpot 83 provides the linkage between the lever 78 and the valve operating arm with resilient characteristics to absorb shocks that might otherwise be transmitted to the valve 71. As shown in FIG. 11, the dashpot 83 comprises a cylinder housing 163 having a stepped diameter bore 164. A rod 166 having a head 167 slightly smaller than the minimum diameter of the bore 164 is longitudinally positioned in the bore 164. The rod 82 is threadably secured to the end of the rod 166 opposite the head 167. A compression spring 168 surrounds the rod 166 and is positioned within the large portion of the bore 164 and is retained therein by a washer 169 and cap 170 threadably secured to the housing 163. A buffer nut 172 having a diameter slightly smaller than the central bore in the cap 170 is threadably secured to the upper end of the rod 166. The nut 172 abuts the washer 169 to compress the spring 168 when the dashpot is subjected to compression forces. A washer 171 having a diameter substantially equal to the large diameter of the bore 164 is positioned between the head 167 of the rod 166 and the spring 168. The head 167 of the rod 166 engages the washer 171 to compress the spring 168 when the dashpot is subjected to a tension force.

Referring to FIG. 9, when the lever 73 is moved upward or in a counterclockwise direction the rod 149 moves the beveled surface 154 of the slide member 152 into engagement with the conical surface 135 of the plunger 137 of the detent means 136. The wedging action of the guide member 152 forces the plunger 137 back into the housing 141 against the force of the compression spring 143. At the same time the sleeve 158 compresses the spring 156 against the upper pair of transverse pins 161 thereby resiliently biasing the cylindrical member 119 in an upward direction. This force is sufficient to trigger the plunger 137 of the detent means 136 out of the locking hole 144 thereby permitting the cylindrical member 119 to move to its up position as a result of which the detent means 134 moves under the force of the spring 139 into the hole 146 to lock the member 119 by inserting the projection 138 into the hole 146. The upward movement of the member 119 rotates the second or lower lever 78 to shift the valve operating arm 81 to its second position.

When the cylindrical member 119 is locked by the detent means 134 in the up position movement of the lever arm downward or in a clockwise direction moves the guide member 151 into engagement with the conical surface 135 of the projection 138 and moves the plunger 137 of the detent against the compression spring 143. The sleeve 157 moves into engagement with the adjacent end of the spring 156 compressing it against the pair of transverse pins 162 thereby resiliently biasing the member 119 in a downward direction. When the plunger 137 of the detent means 134 is moved out of the hole 146 the cylindrical member 119 is forced downward by the action of the spring 156 into its down position. The downward movement of the member 119 rotates the lever 78 counterclockwise thereby shifting the valve control arm 81 back to its first position as shown in FIGS. 5 and 9.

The hydraulic system for controlling the positions of the boom 19 and the hammer assembly 15 and the reciprocating movement of the hammer 42 is shown diagrammatically in FIG. 12. This system includes a pair of pumps 173 connected to a reservoir 174. The pumps 173 displace fluid in the reservoir through fluid lines 176 and

177 to a control valve 178 mounted within the cab 31 of the vehicle 16. The control valve 178 is connected by fluid lines 179 and 181 to the boom control cylinder 22 and by means of fluid lines 182 and 183 to the hammer assembly control cylinder 24. The inlet fluid line 84 and exhaust fluid line 88 to the valve 71 are connected to the control valve 178. Fluid from the control valve 178 is returned to the reservoir 174 through a fluid line 184.

In use, the operator of the vehicle 16 by means of the control valve 178 controls the up and down angular position of the boom 19 by regulating the fluid flow to the cylinder 22. The tilt angle of the hammer assembly 15 is controlled by the cylinder 24 which has a fluid supply controlled by the valve 178.

When the valve 178 is positioned by the vehicle's operator to provide fluid communication from the pumps 173 to the inlet fluid line 84 and connects the exhaust fluid line 88 with the reservoir 174, the cylinder mechanism 46 functions to raise the hammer 42 when the valve 71 is in its first position as shown in FIG. 6.

When the valve 71 is positioned by the trip mechanism 72 to provide fluid communication between the inlet fluid line 84 and the fluid line 87 fluid under pressure is supplied to the head end 50 of the cylinder 46 thereby moving the piston rod 48 to its extended position to lengthen the tackle assembly formed by the cable 47 and the pulleys 51 and 61 and thereby move the hammer 42 up along the guide rails 37 and 38.

As shown in FIG. 4, when the piston rod 48 has reached its extended position the control rod 56 through the stop 76 rotates the lever 73 of the mechanism 72 in a counterclockwise direction to release the detent means 136. When the detent means 136 is released the spring 156 acting on the cylinder 119 quickly moves the valve operating arm 81 and reverses the direction of flow of fluid through the valve 71 as shown in dotted lines in FIG. 6. When the fluid pressure supply is cut off from the bottom or head end 50 of the cylinder 46 the hammer 42 will drop. The sudden release of pressure from the head end 50 of the cylinder and the application of fluid pressure to the rod end 55 of the cylinder produces a slack in the cable 47 permitting the hammer to fall as a free falling body for approximately two feet. The hammer then applies a downward force on the piston rod 48 and thereby increases the pressure in the head end 50 of the piston over the pressure in the rod end 55 thereof. This difference in pressure is sufficient to open the check valve 97 permitting the fluid to flow from the head end 50 to the rod end 55 of the cylinder 46.

As shown in FIGS. 6 and 7, the valve 71 is positioned during the dropping of the hammer to supply fluid under pressure from the inlet fluid line 84 to the fluid line 86 which is connected to the rod end of the cylinder 46. The pressure in the fluid line 86 is transmitted by the fluid line 109 to the pilot valve 96 where it acts as piston 103 to open check valve 101 thereby permitting the flow of fluid from the head end of the cylinder 46 back to the rod end thereof. After the hammer stops, the fluid pressure in the rod end of the cylinder 46 builds up to carry the stroke of the piston 89 into the cylinder a sufficient distance to actuate the trip mechanism 72 thereby switching the valve 71 in the full line position shown in FIGURE 6. The cylinder 46 is in a position to repeat the cycle of raising the hammer 42.

In summary, the hammer 42 is moved to its up or raised position in response to the application of fluid pressure to the head end 50 of the cylinder mechanism 46. When the hammer 42 has reached a predetermined up position, the trip mechanism 72 is automatically actuated to provide a quick action of the valve 71 for reversing the flow of fluid to the cylinder mechanism 46. The fluid pressure in the rod end 55 of the cylinder mechanism 46 in conjunction with the fluid by-pass check valves 96 and 97 provide a quick and positive removal of fluid from the head end 50 of the cylinder mechanism 46 thereby per-

mitting the hammer 42 to have a substantially unimpeded or free fall.

While there have been shown, described, and pointed out the fundamental novel features of the invention as applied to the preferred embodiment, it is to be understood that various omissions, substitutions, changes in form, and details of the apparatus illustrated may be made by those skilled in the art, without departing from the invention. It is intended to be limited only as indicated by the scope of the following claims.

We claim:

1. In a control system for a drop hammer,

(a) a source of fluid pressure,

(b) fluid motor means including a cylinder having a head end and a rod end, a piston reciprocally disposed in said cylinder and a piston rod secured at one end to said piston,

(c) valve means connected in fluid communication with said source of fluid pressure and the head and rod ends of said cylinder, said valve means having a valve body selectively operable to supply fluid under pressure to said head end while exhausting fluid from said rod end thereby moving said piston toward the rod end of said cylinder and to supply fluid under pressure to said rod end while exhausting fluid from said head end thereby moving said piston toward the head end of said cylinder,

(d) fluid line means connecting the head end of the cylinder with the rod end thereof,

(e) a first check valve disposed in said fluid line means to block the flow of fluid from the head end to the rod end of said cylinder,

(f) means operably connected to the first check valve and responsive to the fluid pressure supplied to the rod end of the cylinder to open said first check valve thereby allowing fluid to flow from the head end to the rod end of the cylinder, and

(g) a second check valve disposed in said fluid line means between the rod end of the cylinder and the first check valve, said second check valve having a valve body operative to block the flow of fluid from the rod end to the head end of the cylinder and to permit the flow of fluid from the head end to the rod end when the fluid pressure in the head and exceeds the fluid pressure in the rod end of the cylinder.

2. In a control system for a drop hammer.

(a) a source of fluid pressure,

(b) fluid motor means including a cylinder having a head end and a rod end, a piston reciprocally disposed in said cylinder and a piston rod secured at one end to said piston,

(c) first valve means connected in fluid communication with said source of fluid pressure and the head and rod ends of said cylinder, said valve means having a valve body selectively operable to supply fluid under pressure to said head end while exhausting fluid from said rod end thereby moving said piston toward the rod end of said cylinder and to supply fluid under pressure to said rod end while exhausting fluid from said head end thereby moving said piston toward the head end of said cylinder,

(d) fluid line means connecting the head end of the cylinder with the rod end thereof,

(e) second valve means disposed in said fluid line means to block the flow of fluid from the head end to the rod end of said cylinder, and

(f) control means operably connected to said second valve means, said control means having a member responsive to the fluid pressure supplied to the rod end of the cylinder to open said second valve means thereby allowing fluid to flow from the head end to the rod end of the cylinder.

3. In a control system for a drop hammer,

(a) a source of fluid pressure,

(b) fluid motor means having a reversibly movable member,

(c) a fluid system connecting said source of fluid pressure and said motor means, including a control valve for supplying fluid to and exhausting fluid from the opposite ends of said motor means to reversibly move the member therein, and

(d) valve means connected in fluid relation with said control valve and the opposite ends of said motor means, said valve means having a member operable in response to a supply of fluid pressure to one end of the motor means to permit the flow of fluid from the opposite end of the motor means to provide for movement of said movable member in one direction at a rate of speed at least equal to the rate of speed of hammer drop whereby drop of said hammer is unimpeded by said movable member.

4. In a control system including a source of fluid pressure, a fluid motor and a valve in fluid communication with said fluid pressure source and fluid motor for controlling the flow of fluid to and from said motor:

(a) trip means comprising

(b) movable means operably connected to said valve and movable between first and second positions to reverse the flow of fluid through said valve,

(c) detent means engageable with said movable means to lock said movable means in said first and second positions,

(d) linkage means operably connected to said fluid motor, said linkage means including detent release means engageable with said detent means which in response to movement of the fluid motor unlocks said movable means in one position permitting the movable means to move to the other position, and

(e) spring means connected to the linkage means and the movable means, said spring means in response to movement of said linkage means biasing the movable means toward the unlocked position.

5. In a control system for raising a drop hammer,

(a) a source of fluid pressure,

(b) fluid motor means having a cylinder with a piston reciprocally disposed therein and a piston rod attached at one end to said piston,

(c) valve means connected in fluid communication with said source of fluid pressure and said fluid motor means and operable to supply fluid under pressure to and exhaust fluid from said fluid motor means,

(d) trip means mechanically connected to said valve means and said piston rod, said trip means being responsive to movement of said piston rod into the cylinder to operate the valve means to supply fluid pressure to the fluid motor and responsive to movement of the piston rod out of the cylinder to operate the valve means to exhaust fluid from said fluid motor, said trip means comprising

(e) movable means operably connected to said valve means and movable between first and second positions to reverse the flow of fluid through said valve means,

(f) detent means engageable with said movable means to lock said movable means in said first and second positions,

(g) linkage means operably connected to said fluid motor, said linkage means including detent release means engageable with said detent means which in response to movement of the fluid motor unlocks said movable means in one position permitting the movable means to move to the other position, and

(h) spring means connected to the linkage means and the movable means, said spring means in response to movement of said linkage means biasing the movable means toward the unlocked position.

6. In a control system for a drop hammer,

(a) a source of fluid pressure,

(b) fluid motor means including a cylinder having a head end and a rod end, a piston reciprocally disposed in said cylinder and a piston rod secured at one end to said piston,

(c) first valve means connected in fluid communication with said source of fluid pressure and the head and rod ends of said cylinder, said first valve means having a valve body selectively operable to supply fluid under pressure to said head end while exhausting fluid from said rod end to move said piston toward the rod end of said cylinder and operable to supply fluid under pressure to said rod end while exhausting fluid from said head end to move the piston toward the head end of said cylinder,

(d) fluid line means connecting the head end of the cylinder with the rod end thereof,

(e) second valve means disposed in said fluid line means, said second valve means having means operable to block the flow of fluid from the rod end to the head end of the cylinder and to permit the flow of fluid from the head end to the rod end when the fluid pressure in the head end exceeds the fluid pressure in the rod end of the cylinder, and

(f) trip means connected to said first valve means and said piston rod, said trip means being responsive to the movement of said piston rod to operate the valve body of the first valve means to selectively supply fluid under pressure to the rod end and head end of said cylinder.

References Cited by the Examiner

UNITED STATES PATENTS

1,711,079	4/29	Bath	91—330
2,476,390	7/49	Simmonds	173—43
2,658,485	11/53	Dreyer	91—330
2,659,583	11/53	Dorkins	173—86
2,736,297	2/56	MacDonald	91—322
2,897,782	8/59	Kennedy	173—127
2,969,771	1/61	Caudill	91—274

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