

[54] **OUTRIGGER HYDRAULIC SYSTEM**

[75] Inventors: **John T. Parrett**, St. Joseph; **David S. Frazer**, Benton Harbor, both of Mich.

[73] Assignee: **Koehring Company**, Benton Harbor, Mich.

[22] Filed: **Dec. 3, 1973**

[21] Appl. No.: **421,337**

[52] U.S. Cl. **212/145, 280/150 C**

[51] Int. Cl. **B66c 23/62**

[58] Field of Search..... 212/145; 104/263; 280/150 C

[56] **References Cited**

UNITED STATES PATENTS

2,365,169	12/1944	Billings	212/145
3,227,287	1/1966	Butcher	212/145
3,784,035	1/1974	Dunbar	212/145

Primary Examiner—Robert J. Spar

Assistant Examiner—Lawrence J. Oresky

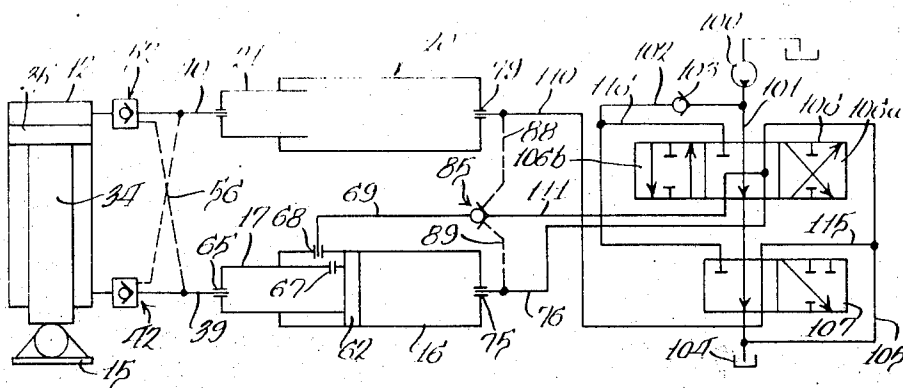
Attorney, Agent, or Firm—Hofgren, Wegner, Allen, Stellman & McCord

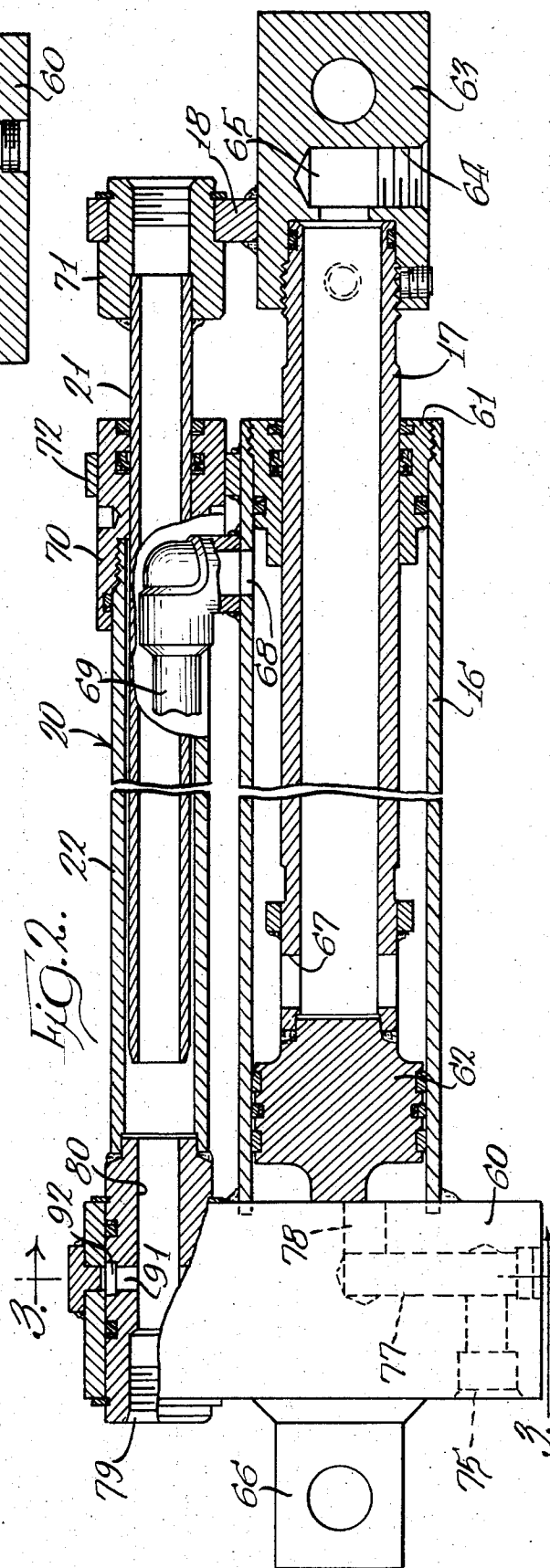
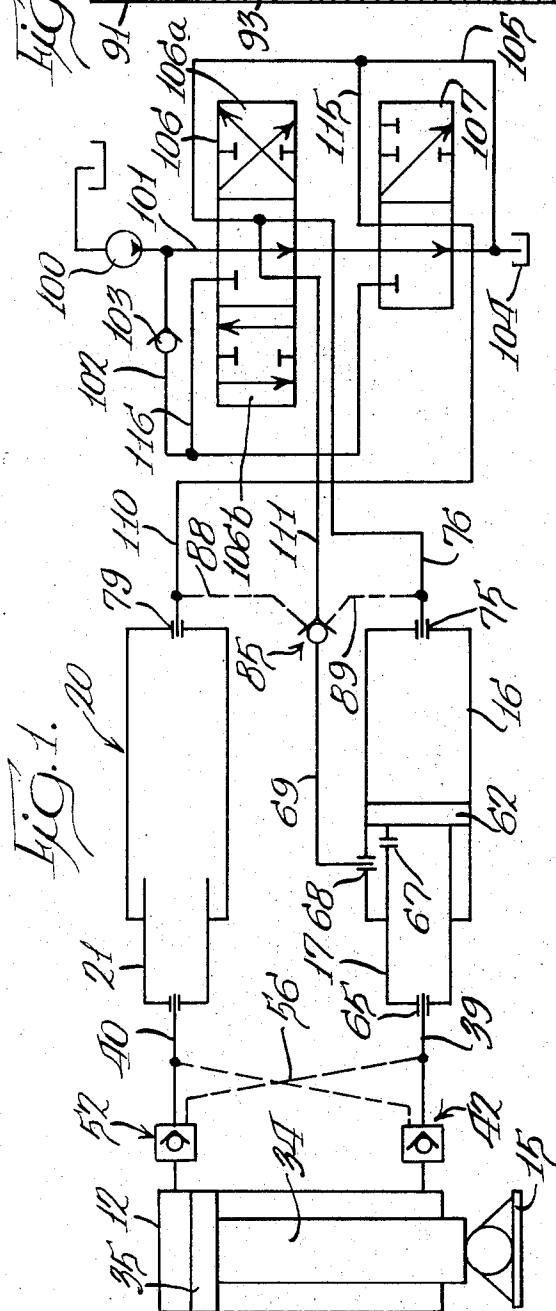
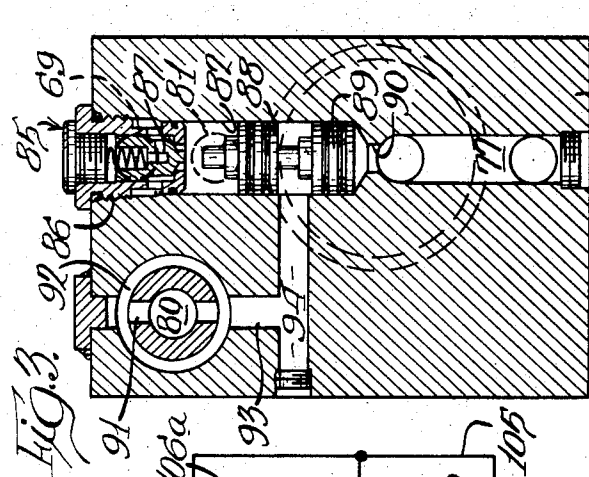
[57] **ABSTRACT**

A hydraulic system for outriggers usable with mobile cranes and the like and for extending and retracting the horizontal extensible beam and the vertical jack cylinders with a beam extension cylinder having a beam extension line for supplying pressure fluid thereto and a beam return line for causing retraction

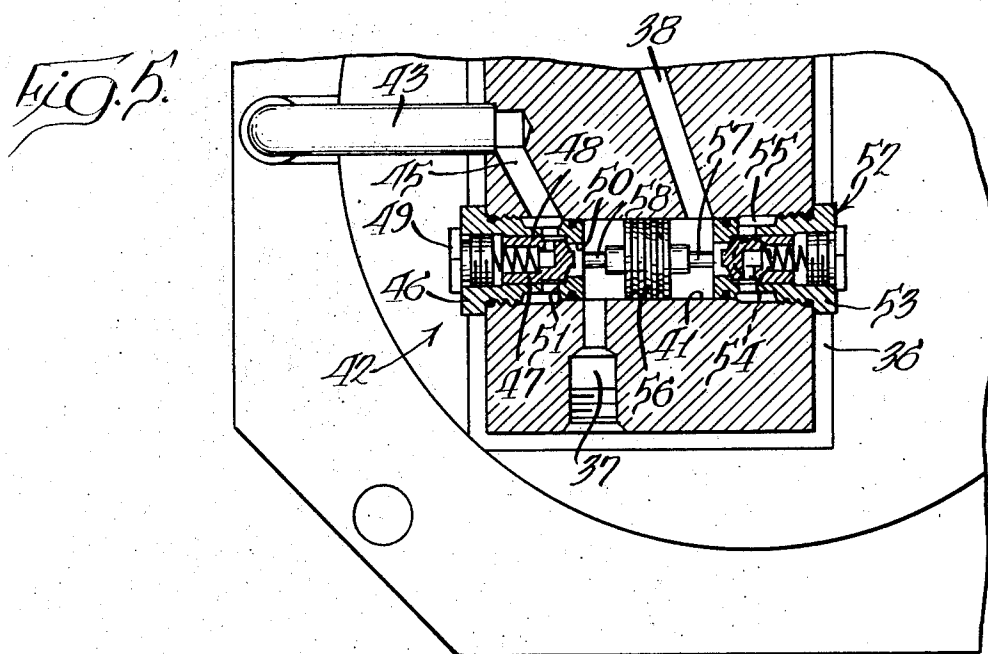
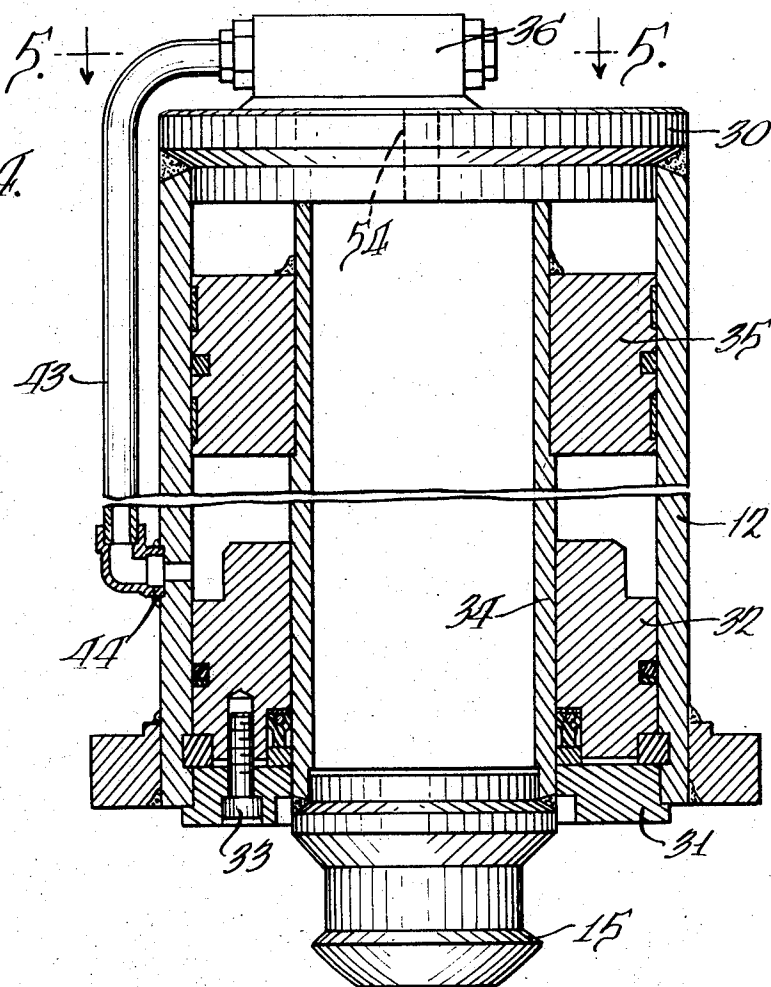
of the extension cylinder and providing a flow connection to tank during extension of the cylinder, hydraulic means for directing pressure fluid to the jack cylinder to cause lowering of the jack and a second line connected to the jack cylinder and to the beam return line whereby said second jack cylinder line is either connected to tank or to pressure similarly to the beam retraction line and with the hydraulic means including a pilot-operated check valve functioning to retain the beam extension cylinder in an intermediate position or a retracted position. The pilot-operated check valve may be either directly in the beam return line with the check valve being piloted open either by pressure fluid supplied to the beam extension line or to the line supplying pressure fluid to the jack cylinder to lower the jack. Alternatively, the pilot-operated check valve is positionable in a line extending to a feed cylinder having a hollow piston rod through which flow passes to the jack cylinder for lowering of the jack and with such line functioning to hold the piston of the feed cylinder in a retracted or partially-extended position and, further, to support the hollow piston rod against buckling as pressure fluid is supplied therethrough and with the pilot-operated check valve being piloted open by supply of pressure fluid to the beam extension line. A master control circuit for a total of four jack cylinders and associated beam extension cylinders with the control valves for the various flow connections being associated on a plurality of valve spools to reduce the number of valve spools and flow lines required in a complete outrigger system for a mobile crane or the like.

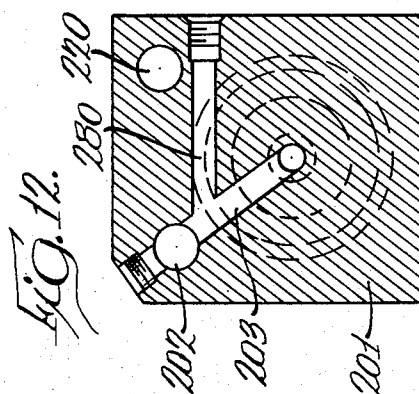
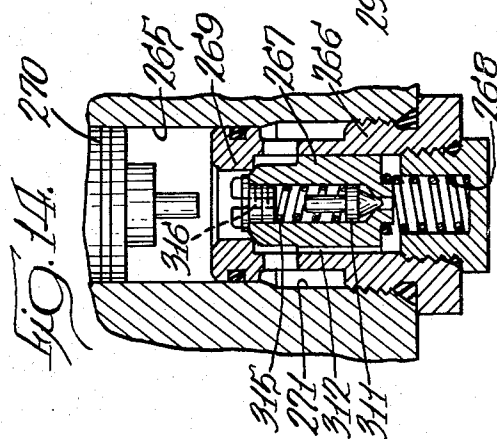
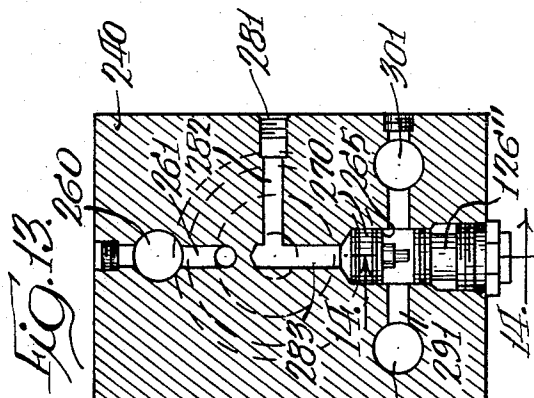
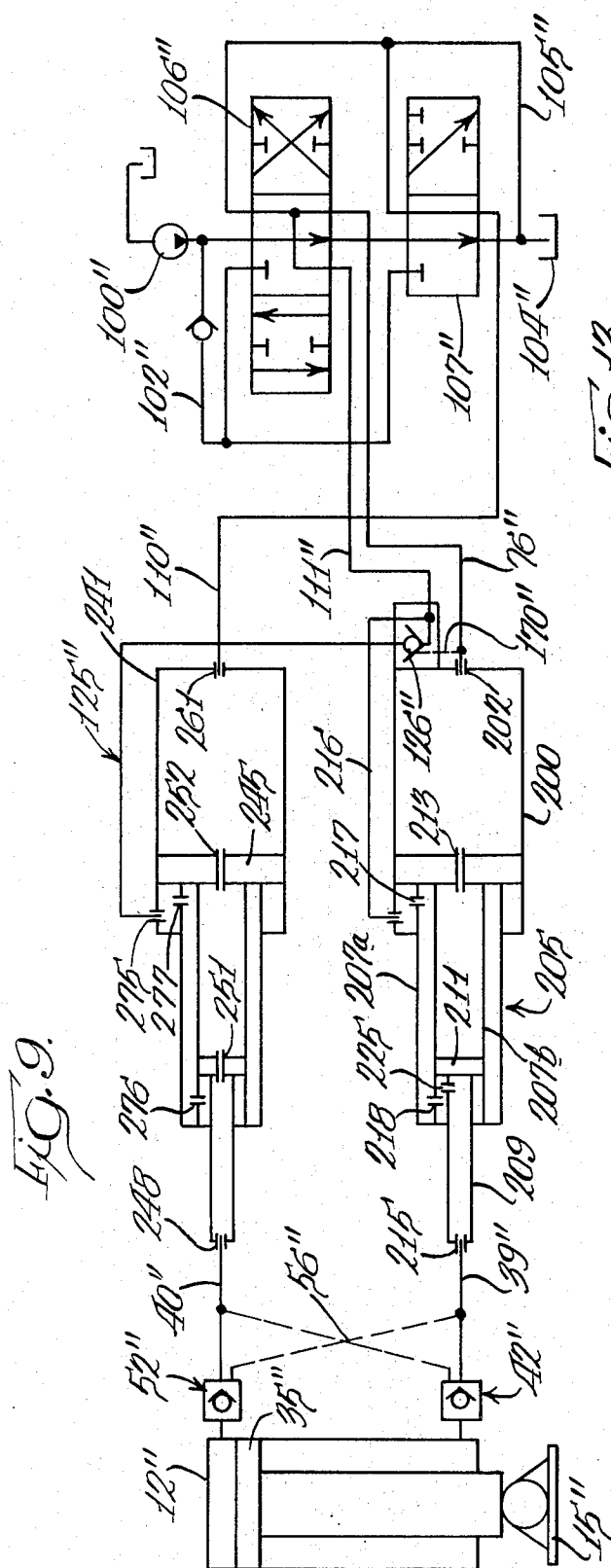
24 Claims, 16 Drawing Figures

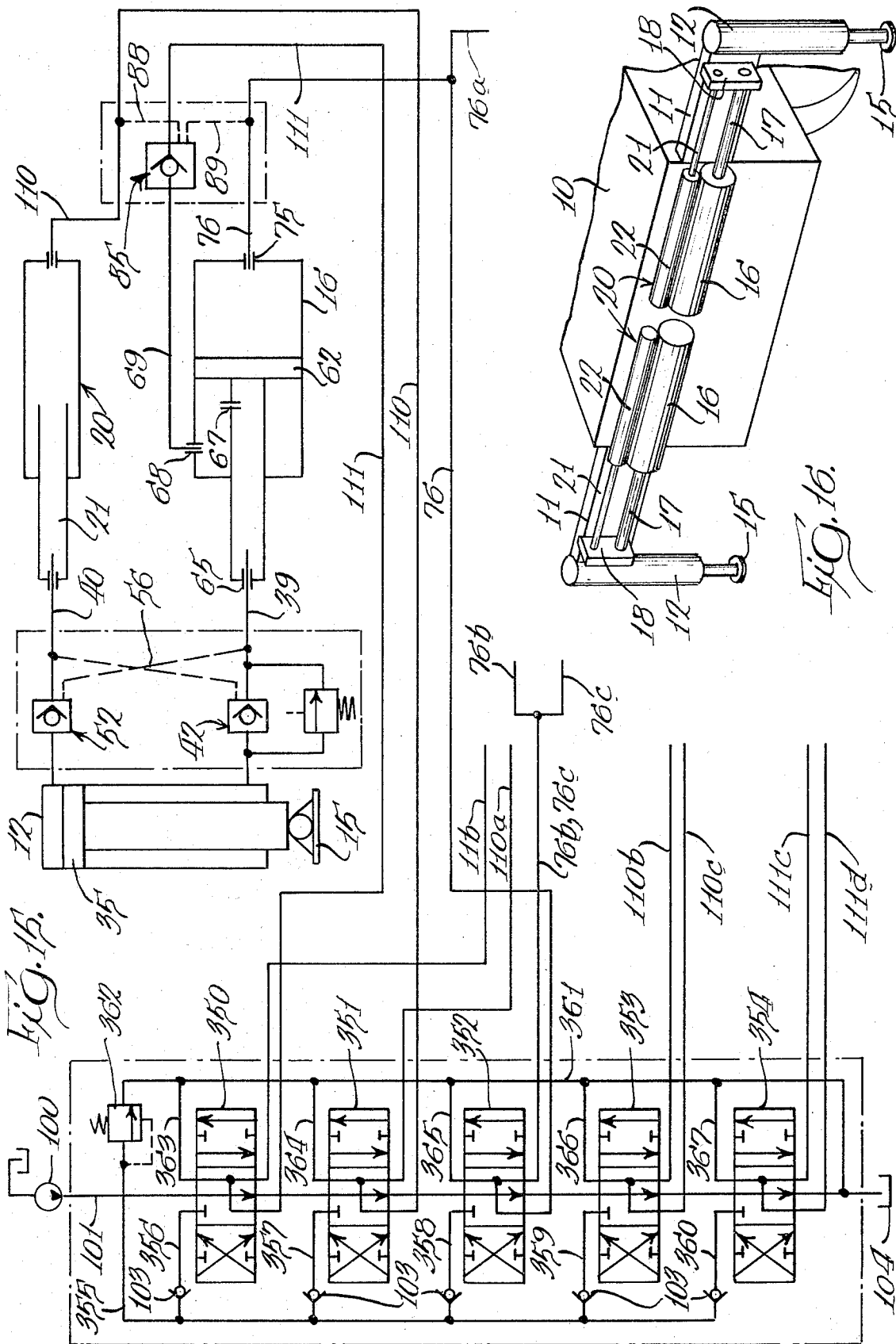




SHEET 2 OF 6







OUTRIGGER HYDRAULIC SYSTEM

BACKGROUND OF THE INVENTION

This invention pertains to an improved hydraulic system for outrigger supports for mobile cranes and other types of equipment requiring rigid ground support during use thereof.

Mobile crane outriggers are well known in the art and conventionally there are four jack cylinders positioned at the approximate four corners of a vehicle, such as a mobile crane, with each jack cylinder carried on an extensible beam for movement to a location at a desired distance from the vehicle. Such extension can be for the full length of the beam or to an intermediate position of extension of the beam. Structure of this general type is shown in Parrett U.S. Pat. No. Re. 27,224. This prior patent is also of interest in disclosing fluid feed lines having extensible sections with provision for preventing columnar buckling when fluid under pressure is delivered therethrough and with this concept being embodied in parts of the structure disclosed in this application.

In the known outrigger systems, each outrigger has a jack cylinder and a beam extension cylinder, with there being two fluid lines connected to the jack cylinder and two additional lines connected to the beam extension cylinder. These four lines extend to a control station with control valves having spool sections for controlling the connection of the four lines to either tank or pressure fluid. This required one spool section for each fluid line or a total of 16 fluid lines controlled by 16 valve sections. This number has been reduced by simultaneous extension and/or retraction of the beams at one side of the mobile crane. This arrangement did not maximize the reduction in fluid lines and control valve sections, with the result that more valve spools and fluid lines have been used than are required, which has made the hydraulic system more expensive than necessary.

SUMMARY OF THE INVENTION

A primary advantage of the invention disclosed herein is in an improved hydraulic system for outriggers for a device such as a mobile crane wherein the jacks and the extensible beams mounting the jacks are extended and retracted with utilization of the minimum number of control valve sections and fluid lines.

In carrying out the foregoing, the beam extension cylinder of each outrigger support has a beam extension line for supplying pressure fluid thereto to extend the beam and a beam return line for supplying pressure fluid thereto to retract the beam, with each of the lines being connected to tank when not supplied with pressure fluid. There are additionally two fluid lines connected to the jack cylinder, with one of these fluid lines being controlled by a control valve to supply pressure fluid to the jack cylinder and cause extension and lowering of the jack. The second of the jack cylinder fluid lines connects to the beam return line and, thus, the supply of fluid to this latter fluid line for raising of the jack and flow to tank of fluid discharged from the jack cylinder is through the beam return line and subject to control by the control valve in circuit with the beam return line. In this manner, there is a reduction in the number of valve spool sections required for operating the beam extension cylinder and the jack cylinder and

a reduction in the number of fluid lines extending between the control valves and the cylinders.

Further with respect to the advantages embodied in the system disclosed herein, hydraulic means are provided to hold an outrigger beam in retracted position or in an intermediate extended position including the use of a pilot-operated check valve and which is piloted by a connection to the beam extension line whereby extension of the beam extension cylinder opens the pilot-operated check valve to permit flow to tank and when the check valve closes further return flow to tank terminates to preclude extension of the outrigger beam.

In one embodiment of the invention, the pilot-operated check valve is positioned in the beam return line extending from the extension cylinder and, thus, this check valve normally blocks flow to tank from the beam return line which is in fluid communication with the fluid line extending to the jack cylinder. In this embodiment, there is an additional pilot connection to the check valve whereby the check valve is opened when pressure fluid is supplied to the jack cylinder to extend the jack whereby fluid can flow to tank from the opposite end of the jack cylinder through its connection to the beam return line.

In a second embodiment of the invention, the beam return line does not have a pilot-operated check valve and does not function to block the flow to tank from the beam return line to limit extension of the extension cylinder. The holding of the beam in either retracted or intermediate position is accomplished through the use of an extendable fluid feed device which connects with the fluid line to the upper end of the jack cylinder. This extensible fluid feed device includes a feed cylinder with a hollow feed piston rod positioned therein in spaced relation and having a hollow piston connected thereto and with the piston rod being operably connected for movement with the beam as it extends and retracts. A line connects with the feed cylinder and the space within the cylinder surrounding the hollow piston rod and connects to the beam return line and has the pilot-operated check valve disposed therein with the check valve being piloted by a pilot connection to the beam extension line. In this embodiment, supplying of pressure fluid to the extension cylinder causes extension of the beam with return flow from the extension cylinder through an unobstructed beam return line. The check valve is opened to permit flow from the surrounding space of the feed cylinder as the hollow feed piston advances correspondingly with extension of the beam. When the beam extension line is not subjected to pressure fluid, the pilot-operated check valve is closed to thus block further extension of the beam by blocking further movement of the hollow feed piston.

A further feature of this construction is that the blocked fluid surrounding the hollow piston rod in the feed cylinder functions to strengthen the hollow piston rod when pressure fluid passes therethrough to the jack cylinder for lowering of the jack and avoids buckling of the hollow feed piston rod by columnar forces.

Still another embodiment of the invention is similar to that described above and having similar advantages, with the extension cylinder and the feed cylinder each being a two-stage unit to allow a greater extended length of the components and the beam for the same closed length of the components as in the previous embodiments. With the two-stage unit for the feed cylinder, the line extending therefrom to the beam return

line communicates with two surrounding spaces in the cylinder to provide forces acting to prevent buckling when pressure fluid is directed therethrough to the jack cylinder for lowering of the jack.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic view of a jack cylinder and beam extension cylinder and associated structure including an illustrative control circuit for a single outrigger;

FIG. 2 is a side elevational view of the beam extension cylinder and fluid feed means associated therewith, with the beam extension cylinder and fluid feed means being shown in vertical section and with part of the base mounting shown in section;

FIG. 3 is a vertical section, taken generally along the line 3—3 in FIG. 2;

FIG. 4 is a vertical section of the jack cylinder shown in FIG. 1;

FIG. 5 is a plan view of the jack cylinder with parts thereof shown in section as taken generally along the line 5—5 in FIG. 4;

FIG. 6 is a schematic view of a second embodiment of the hydraulic system including a jack cylinder and a beam extension cylinder and associated structure including a control circuit;

FIG. 7 is a view, similar to FIG. 2, showing the beam extension cylinder and fluid feed means with parts thereof in section;

FIG. 8 is a vertical section, taken generally along the line 8—8 in FIG. 7;

FIG. 9 is a schematic view of a third embodiment of the invention showing the hydraulic system including the jack cylinder, beam extension cylinder and associated structure including a control circuit;

FIG. 10 is a side elevational view of the beam extension cylinder used in the system shown in FIG. 9 and with parts thereof in central vertical section;

FIG. 11 is a side elevational view of the fluid feed means used in the embodiment shown in FIG. 9 and with parts thereof shown in central vertical section;

FIG. 12 is a vertical section, taken generally along the line 12—12 in FIG. 10;

FIG. 13 is a vertical section, taken generally along the line 13—13 in FIG. 11;

FIG. 14 is a section, on an enlarged scale, taken generally along the line 14—14 in FIG. 13;

FIG. 15 is a schematic view of a hydraulic control circuit for controlling the outriggers positioned at four corners of a vehicle, such as a mobile crane; and

FIG. 16 is a fragmentary perspective view of a vehicle showing two of the four outriggers associated therewith.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring initially to FIG. 16, a vehicle, such as a mobile crane 10, has an over-the-road capability and, when in use, requires sturdy, strong support from the ground. The mobile crane 10 has an outrigger support located generally at each of the four corners thereof with the two outrigger supports associated with the rear of the mobile crane being shown diagrammatically in FIG. 16. Each of the outrigger supports includes an extensible beam 11 movable relative to the body of the vehicle to an extended position, as shown in FIG. 16. The extensible beam 11 carries a jack cylinder 12 hav-

ing a jack 15 movable therein and being extendable to a lowered ground-engaging position. The extensible beam 11 is moved between extended and retracted positions by a beam extension cylinder 16 having a piston rod 17 extending therefrom and connected by means of a suitable bracket 18 to the extensible beam 11. Fluid connections to the jack cylinder 12 are provided by a fluid connection through the beam extension cylinder 16 and, additionally, through fluid feed means, indicated generally at 20, including a hollow piston rod 21 connected to bracket 18 and movable with respect to a feed cylinder 22. There are hose connections (not shown) to the jack cylinder 12 from the aforesaid fluid connections and, additionally, a pair of conduit connections to the base of the beam extension cylinder 16 and a single conduit connection to the fluid feed means 20. The construction of the outrigger support at the other three corners of the mobile crane 10 is the same as that described above.

The first embodiment of the invention is shown in FIGS. 1 to 5, with the jack cylinder 12 and associated structure shown particularly in FIGS. 4 and 5 and being the same for all three embodiments of the invention disclosed herein.

The jack cylinder 12 has a cylindrical wall closed at opposite ends by a pair of end caps 30 and 31 secured thereto and in fluid sealing relation. The end cap 31 has a bearing 32 secured thereto as by fasteners 33 to provide a bearing support for a hollow piston rod 34 connected at its lower end to the jack 15 and carrying a piston 35 movable within the cylinder 12. A valve block 36 is attached to the upper end cap 30 for the vertically extending cylinder 12 and has a pair of fluid passages 37 and 38 connectable to fluid hose lines 39 and 40 (FIG. 1), respectively. The fluid passages 37 and 38 communicate with a central part of a valve bore 41 in the valve block 36 for coaction with a pair of pilot-operated check valves. A first check valve, indicated generally at 42, is effectively positioned to block flow from the lower side of the jack cylinder 12 to tank. This flow path includes an external conduit 43 connectable into the lower part of the jack cylinder 12 through a passage 44 in the wall of the cylinder and connected into a fluid passage 45 in the valve block 36 which communicates with a section of the valve bore 41. The check valve 42 has a body 46 threaded into an end of the valve bore 41 and sealed relative thereto, with a valve member 47 spring-urged by a spring 48 to a closed position against a valve seat provided by an annular shoulder on the valve body 46. The spring engages against a threaded end cap 49. When the valve member 47 is moved off its seat, a flow path is established through a central bore 50 in the valve member body, and a series of openings 51 in the peripheral wall of the valve body which communicate with the fluid passage 45 leading to the external conduit 43. The valve block 36 mounts a second pilot-operated check valve, indicated generally at 52, which is of the same construction as the check valve 42, with a valve body 53 threaded into an opposite end of the valve bore 41. This check valve controls fluid flow between the fluid passage 38, which connects to hose line 40, and to a passage 54 in the valve block 36 and the end cap 30 of the cylinder, which extends to the space within the cylinder above the piston 35. This latter passage communicates with the valve bore 41 in the area of the valve bore, indicated at 55. The piston rod 34 is hollow

and always has fluid therein. When pressure fluid oil is supplied through passage 54, the pressure within piston rod 34 provides added strength thereto.

Both of the check valves 42 and 52 are pilot-operated, whereby hydraulic fluid is maintained in the cylinder at one side or the other of the piston 35. Delivery of pressure fluid to one side of the piston 35 causes opening of the check valve in the other fluid line to permit flow from the opposite side of the piston 35 to tank. This piloting action is obtained by a double-acting pilot piston 56 located centrally in the valve bore 41 and having oppositely extending stems 57 and 58 extending toward the check valves 52 and 42, respectively. When pressure fluid is directed through fluid line 40 to lower the jack 15, the pressure fluid in fluid passage 38 shifts the pilot piston 56 toward the left, as viewed in FIG. 5, to open the check valve 42 whereby fluid can flow from the lower side of the piston 35 through the conduit 43 to the fluid passage 37 and hose line 39 to tank through a fluid circuit subsequently to be described. At the same time, pressure fluid acts directly against the exposed end of the check valve 52 to open the check valve and communicate pressure fluid with the passage 54 to the upper side of the piston 35.

When the jack 15 is in lowered position and is to be raised, pressure fluid is directed through hose line 39 to the fluid passage 37 and against the pilot piston 56 to shift it to the right, as viewed in FIG. 5, and open the check valve 52. This connects the fluid passage 54 from the upper side of the piston 35 to the fluid passage 38 whereby fluid can flow to tank through hose line 40. Additionally, pressure fluid acts against the check valve 42 to open the latter check valve and direct pressure fluid through the conduit 43 to the lower side of the piston 35. The beam extension cylinder 16, fluid feed means 20, and associated structure are shown particularly in FIGS. 2 and 3. The beam extension cylinder 16 is a tubular member having an end fitted into and secured to a mounting base 60 and extending therefrom. The opposite end of the tubular member has a closure in the form of an end cap 61 threaded into the end of the cylinder and sealed to the cylinder and further providing a bearing for the hollow piston rod 17 movable within the cylinder. The piston rod 17 has a solid piston 62 secured to the left-hand end thereof, as viewed in FIG. 2, and, at its opposite end, has a hose coupling 63 secured thereto with a hose connecting port 64 for hose line 39 communicating with a passage 65 which communicates with the hollow interior of the piston rod 17.

The mounting base 60 has a mounting element 66 whereby the base can be attached to the body of the mobilecrane 10. The attaching bracket 18 for connection to the extensible beam is secured to the hose coupling 63 at the end of the hollow piston rod 17.

The hollow piston rod 17 is spaced from the interior of the cylinder 16 and has a series of ports 67 through the wall thereof which communicate with the space interiorly of the cylinder. The cylinder wall has a port 68 connected to a beam return line 69 secured to the cylinder 16 and extending to the mounting base 60. These ports place the hose coupling 63 in communication with beam return line 69. The fluid feed means 20 is broken away in FIG. 2 in order to show the beam return line 69 partly in full line which is disposed to the rear of the fluid feed means in the view of FIG. 2. The fluid feed means 20 has the cylinder 22 fixedly attached at

one end to the mounting base 60 and with an end cap 70 closing the opposite end thereof and providing a bearing for the hollow rod 21 which is movable with respect to the cylinder 22. The hollow rod 21 has a hose coupling 71 secured to the end thereof and connected to the bracket 18. The hose line 40 extends from the hose coupling 71. An additional bracket 72 is secured to the end cap 70 of the cylinder 22 of the fluid feed means and to the cylinder 16 to interconnect the ends thereof remote from the mounting base 60.

The mounting base 60 has connections for three fluid conduit lines from the control circuit valving, with a port 75 being connectable to a beam extension line 76 and with internal passages 77 and 78 placing the port 75 in communication with the interior of the cylinder 16 and to the left of the piston 62 as viewed in FIG. 2 whereby the left-hand side of the piston may be subjected to pressure fluid or connected to tank. A second fluid port 79 connects with control circuit valving through a suitable conduit and with a bore 80 in the mounting base 60 extending directly into the cylinder 22 of the fluid feed means 20. A third fluid port (not shown) in the mounting base connects a conduit line with a passage 81 leading to a bore 82 in the mounting base. One end of the bore 82 mounts a pilot-operated check valve, indicated generally at 85, which is of generally the same construction as the check valves 42 and 52 previously described with a valve body 86 threaded into and sealed to the bore 82 and with a valve member 87 urged downwardly as shown in FIG. 3 into engagement with the valve seat. When this check valve is opened, pressure fluid may pass from the passage 81 to the beam return line 69 or conversely flow from the beam return line may flow through passage 81 to tank. This check valve 85 is pilot-operated by a pair of pilot connections and associated with a pair of individual pilot pistons 88 and 89 movably mounted in the bore 82. When there is pressure fluid in the passage 77, this is communicated to the bore 82 through a connecting passage 90 and moves the pilot piston 89 upwardly, as viewed in FIG. 3, to also move the pilot piston 88 upwardly with a stem on the latter pilot piston engaging the valve member 87 of the check valve to open the check valve. When pressure fluid is supplied through passage 80 to the fluid feed means, a part of this pressure fluid passes through radial openings 91 to an annular passage 92 in base 60 which communicates with a first passage 93 and an intersecting passage 94 at a right angle thereto which leads to the bore 82. This directs pressure fluid against the upper pilot piston 88 to move the pilot piston and open the check valve 85.

An illustrative control circuit for a single outrigger of the embodiment shown in FIGS. 1 to 5 is shown in FIG. 1 wherein pressure fluid is supplied by a pump 100 to a line 101 and to a line 102 having a check valve 103 preventing reverse flow. A tank 104 has a tank line 105 leading thereto, with there being a pair of control valves 106 and 107 in the circuit. With the control valves positioned as shown in FIG. 1, the valves are open-centered, with flow from line 101 directly to tank and with all conduits leading to the outrigger components being connected to tank. A primary feature of the invention is in the utilization of only three conduits to the outrigger structure, including a primary conduit 110 leading to the port 79 for the fluid feed means, a primary conduit 111 connected to the beam return line 69 and the conduit 76 previously described as the beam

extension line. The conduit 110 extends from the control valve 107 and, as shown in FIG. 1, connects through to the open center valve to a line 115 from the control valve connected to the tank line 105. The primary conduit 111 connects to the control valve 106 and, as shown in the open center position of the valve, is connected through the open center to the tank line 105. The beam extension line 76 also extends to control valve 106 and connected through the open center thereof to the tank line 105.

In order to extend the extensible beam and the extension cylinder 16, the control valve 106 is shifted to the left, as viewed in FIG. 1, whereby pressure line 101 is blocked and a line 116 connected to line 102 directs pressure fluid through the spool section 106a of the control valve to the beam extension line 76 to extend the beam. The beam return line is connected to primary conduit 111 by the check valve 85 being opened through piloting thereof from the beam extension line 76 whereby the primary conduit 111 communicates with the tank line 105. When the beam has been extended to the desired position, either intermediate or full extension, the control valve 106 is returned to neutral open center position. The control valve 107 is then shifted to the left as viewed in FIG. 1 to place a continuation of the pressure line 102 in communication with the primary conduit 110 to deliver pressure fluid through the fluid feed means 20 to the jack cylinder by direct opening of the check valve 52. The check valve 42 is opened by the previously described pilot connection including pilot piston 56. Fluid from the underside of the piston 35 of the jack cylinder flows through the open check valve 42 and through the hose line 39 to the hollow piston rod 17 and beam return line 69 and to tank through the open center tank connection of the control valve 106. The return flow from the beam return line 69 is permitted by opening of the check valve 85 through the pilot connection from the primary conduit 110 acting on the pilot piston 88.

The control valve 107 can then be returned to neutral position, with the jack 15 being maintained in extended position by the check valve 42 and 52 which remain closed. The beam is retained in its set position of extension by the beam return line 69 being blocked by the check valve 85. With there being a pair of outriggers acting in opposition to each other, the prevention of further extension of either one effectively holds them in position even though the beam extension lines 76 are connected to tank. Pressure flow through the check valve 42 to the jack cylinder 12 does not occur because of mechanical forces including the weight of the supported vehicle on the jacks. This circuit additionally functions to hold the extension cylinder and extensible beam in retracted position for over-the-road travel. This is caused by the beam return line 69 being blocked by the check valve 85 and further by the jack 15 being in its uppermost position whereby there can be no flow from the rod end of the beam extension cylinder 16 to the jack cylinder 12.

When the outrigger is to be withdrawn to inactive position, the control valve 106 is shifted to the right, as viewed in FIG. 1, whereby pressure fluid from line 116 is directed through spool section 106b to the primary conduit 111 which directly acts against and opens the check valve 85 to supply pressure fluid to the beam return line 69 and to the rod end of the beam extension cylinder 16. This same connection delivers pressure

fluid through the hose line 39 to open the check valve 42 (and through the pilot connection open the check valve 52) whereby pressure fluid to the underside of the piston 35 raises the jack 15. With the weight of the vehicle as it is lowered to the ground assisting in the retracting movement of the jack, this operation occurs in advance of the action of pressure fluid urging the piston 62 of the beam extension cylinder to its retracted position. When the outrigger support is fully retracted, the control valve 106 is again brought to a neutral position.

With the foregoing structure, it will be seen that a fewer number of conduits are required in connecting the control valve circuitry to the beam extension cylinder and the jack cylinder and with one less valve spool section correspondingly being required because of the lesser number of fluid conduits to the cylinders.

A second embodiment of the invention is shown in FIGS. 6 to 8 with the added feature of preventing buckling of the hollow piston rod of the fluid feed means and with a different arrangement for preventing extension of the beam and beam extension cylinder from either a retracted over-the-road position or an intermediate position. In this embodiment, the control circuit, including the two control valves; the three primary conduits leading therefrom to the operating components, the beam extension cylinder, the beam return line, and the jack cylinder are of the same construction as in the first embodiment and the same reference numerals have been applied thereto with a prime affixed.

In this embodiment, the beam return line 69' is in continuous communication with the primary conduit 111' extending from the control valve 106'. The beam return line 69' therefore functions to supply pressure fluid to the underside of the jack cylinder 12' to raise the jack and to return the extensible beam and the beam extension cylinder to retracted position as before. However, with the control valve 106' having an open center position, the beam return line does not have a check valve and does not function to hold the beam and beam extension cylinder in retracted over-the-road position or in an intermediate position of extension. These functions are accomplished in the embodiment of FIGS. 6 to 8 by a line 125 which connects with the primary conduit 111' through a check valve 126 which, when closed, blocks flow from the line 125 to the tank 104'. This line 125 connects to a feed cylinder 130 positioned within a cylindrical sleeve 131 and spaced therefrom with the cylindrical sleeve having one end fastened to a projecting section 132 of a mounting base 133 and the opposite end closed by a cap 134 which has a plug member 135 associated therewith providing a closure for one end of the cylinder 130 and a bearing for a hollow piston rod 136. The opposite end of the cylinder 130 is closed by fitting onto a cylindrical projection 137 extending outwardly from the projection section 132 of the base and having a flow passage 138 therein communicating with the hollow interior of the piston rod 136. The piston rod 136 carries a hose coupling 140 at its outer end which is attached to a bracket 141 also connected to the fitting 63' for the beam extension cylinder, with this bracket being suitably connected to the extensible beam 11.

The opposite end of the hollow piston rod 136 carries an open center piston 142 whereby the piston rod is subjected to columnar forces as pressure fluid is directed into the cylinder 130 from the fluid passage 138.

In order to prevent buckling movement of the hollow piston rod 136 when pressure fluid is supplied therethrough to the upper side of the jack cylinder 12', a space surrounding the piston rod 136 and within the cylinder 130 is subjected to fluid under pressure by means of the line 125, previously referred to. More specifically, and referring to the mounting base 133, an annular groove 150 communicates through a radial passage 151 with a longitudinal fluid passage 152 in the projecting section 132 of the base, with this passage 152 leading to a space between the cylindrical sleeve 131 and the cylinder 130. This latter space communicates with a space within the cylinder 130 and surrounding the hollow piston rod 136 through a series of radial ports 155 in the wall of the cylinder 130. The primary conduit 111' connects to a passage 157 in the mounting base 133 and delivers pressure fluid under certain positioning of the appropriate control valve to a bore 156 in the base 133 having the pilot-operated check valve 126. This check valve is of generally the same construction as the check valve 85 previously described having a body 158 threaded and sealed into an end of the bore 156 and a valve member 159 spring-urged to the left, as viewed in FIG. 8, against a seat. Supply of pressure fluid to the bore 156 from primary conduit 111' causes opening of the check valve to deliver pressure fluid to intersecting passages 160 and 161, with the latter passage leading to the annular groove 150, with the result that pressure fluid is directed to the space within the cylinder 130 surrounding the hollow piston rod 136. When the check valve is closed, fluid under pressure is trapped within the cylinder 130 to resist extension of the hollow piston rod 136.

It will be seen that the passages 160, 161 and additional passages leading to the interior of the cylinder 130 collectively define the line 125 identified in the schematic view of FIG. 6. The pilot-operated check valve 126 is pilot-operated to an open position when pressure fluid is supplied to the beam extension line 76' by means of a pilot piston 170 movably mounted in one end of the bore 156 and subjected to pressure fluid directed to the beam extension line 76' by a passage 171 in the base 133 connected to the fluid port at the exterior of the base and connected to the bore 156 by a passage 172 to direct fluid pressure against the pilot piston 170. When the pilot piston 170 is shifted, the check valve is opened whereby fluid can flow from the space within the cylinder 130 surrounding the hollow feed piston 136 as is necessary when the beam 11 is being extended. A passage 173 extends from passage 171 and through a lateral connecting passage 174 connects the beam extension line 76' to the piston 62' of the beam extension cylinder. The beam return line 69' is in direct communication with the primary conduit 111' at all times through the direct communication including the bore 156. With the description of operation in the embodiment of FIGS. 1 to 5, it is believed that the operation of the embodiment shown in FIGS. 6 to 8 will be clear. The shifting of the control valve 106' of one of its positions causes pressure fluid to be delivered to beam extension line 76' to extend the beam and the beam extension cylinder with the pilot connection to the check valve 126 opening the line 125 whereby the space within the cylinder 130 of the fluid feed means is connected to tank through the primary conduit 111'.

When the extension movement is discontinued, fluid is locked within the cylinder 130 of the fluid feed means whereby delivery of pressure fluid to the primary conduit 110' to lower the jack 15' does not cause any buckling of the hollow feed piston 136 because of the compressive pressure forces within the cylinder 130, resulting from the check valve 126 being closed. Additionally, the beam is held in the desired position of extension because of the closed check valve 126 preventing outward movement of the beam by the fluid pressure acting on the right-hand side of piston 142, as viewed in FIG. 7. The piston 62' of the beam extension cylinder does not function to maintain an intermediate position, since the beam return line is connected to tank when the outrigger support is in such position. When the jack is to be raised and the extensible beam retracted, pressure fluid is supplied to the primary conduit 111' which functions in the same manner as the first embodiment to raise the jack and to retract the beam extension cylinder and the beam. During this operation, the check valve 126 is opened directly by fluid pressure to also direct fluid to the right-hand side of the piston 142 of the fluid feed means, as viewed in FIG. 7, in order to maintain the space within the cylinder 130 filled with fluid under pressure.

A third embodiment of the invention is shown in FIGS. 9-14, which is a system substantially identical to the system embodied in the structure of the second embodiment shown in FIGS. 5 to 8, with the variation being in the utilization of two-stage units for the beam extension cylinder and the fluid feed means to allow more extended length for the same closed length of the beam extension cylinder and the fluid feed means. In this embodiment, the structural elements which are common to those in either or both of the first two embodiments are given the same reference numeral with a double prime affixed thereto and with the structural components differing from those in the preceding embodiment described in detail.

The beam extension cylinder 200 is shown diagrammatically in FIG. 9 and in detail in FIGS. 10 and 12, with a mounting base 201 for the beam extension cylinder 200 having an internal passage 202 connectable at a face of the base 201 to the beam extension line 76'' and communicating through a fluid passage 203 with the left-hand end of the cylinder 200, as viewed in FIG. 10 and to the left of a primary piston 204 movable within the cylinder 200. The primary piston 204 connects to a secondary double-walled cylinder 205 and forms an end cap therefor with the cylinder 205 being movable within an end cap 206 defining a closure for the extension cylinder 200 and a bearing for movement of the secondary cylinder 205 outwardly of the primary cylinder. The secondary cylinder 205 is of a double-wall construction having an external wall 207a and an interior wall 207b spaced from the external wall. An end cap construction 208 fits to the right-hand end of both the external and interior walls 207a and 207b of the secondary cylinder 205 for sealing of said ends and additionally provides a bearing for a hollow piston rod 209 carrying a piston 210 at its left-hand end, as viewed in FIG. 10. The piston 210 is movable within the secondary cylinder 205 and has a plug 211 blocking communication between an interior passage 212 of the hollow piston rod 209 and a passage 213 in the primary movable piston 204. The exposed end of the hollow piston rod 209 carries a hose coupling 215.

A beam return line 216 connects to the exterior of the extension cylinder 200, with a passage through the wall of the latter to communicate with a space between the extension cylinder 200 and the secondary cylinder 205. This space is in fluid communication by means of ports 217 in the exterior cylinder wall 207a, with a space between the exterior cylinder wall 207a and the interior cylinder wall 207b and additionally with a space between the exterior of the hollow piston rod 209 and the internal cylinder wall 207b by means of ports 218 in the interior cylinder wall 207b. The beam return line 216 extends to the base 201 and connects to a passage 220 in the base which has a hose jumper connection to the fluid feed means to be described. When pressure fluid is directed to the passage 202 in the base 201 from the beam extension line 76'', the primary piston 204 is moved to the right, as viewed in FIG. 10, to shift the secondary cylinder 205 therewith and pressure fluid is directed through passage 213 against the plug 211 to move the hollow piston rod 209 to the right within the cylinder 205 whereby a two-stage action is obtained. At this time, the fluid spaces surrounding the hollow piston rod and the secondary cylinder 205 are connected to tank through the beam return line 216. When the parts are to be retracted, the beam return line 216 is subjected to pressure fluid from primary conduit 111'' which acts against the right-hand face of the primary movable piston 204 and also acts against the right-hand side of the plug 211, as viewed in FIG. 10. This latter action is derived from a connection of the space surrounding the hollow piston rod 209 with the interior of the hollow piston through a series of radial ports 225 in the wall of the hollow piston rod 209 near the left-hand end thereof, as viewed in FIG. 10. It is these ports which also place the hollow piston rod 209 in fluid communication with the hose line 39'' leading to the lower side of the jack cylinder 12''.

The structure of the fluid feed means of this embodiment is shown in FIGS. 11, 13 and 14 and shown schematically in FIG. 9. A base 240 mounts one end of a primary feed cylinder 241 with its opposite end closed by an end cap structure 242 and providing a bearing for a double-walled secondary cylinder having outer and inner walls 243 and 244 in spaced-apart relation, each of which, at their left-hand end, is fitted onto a movable hollow piston 245 movable in the primary feed cylinder 241. An end cap structure 246 closes the right-hand end of the secondary cylinder, as shown in FIG. 11, and provides a bearing for a hollow feed piston rod 247 having a hose coupling 248 at the exposed end thereof, with a hose port 249. The inner end of the hollow feed piston rod 247 has an open center piston 250 fitted thereon and the hollow feed piston rod 247 has an internal passage 251 in direct communication with a central passage 252 in the primary piston 245.

In this embodiment, the primary conduit 110'' which connects the upper side of the jack cylinder 12'' to the control valve circuitry operates directly through the center of the fluid feed means. The primary conduit 110'' connects at 260 to the base 240 with an internal passage 261 extending into the left-hand end of the primary cylinder 241 whereby flow through the primary piston passage 252 and the bore 251 in the hollow feed piston rod may flow directly to the hose fitting 248 and to the hose line 40''. The pilot-operated check valve 126'' is mounted in the base 240 within a valve bore 265 and has a valve body 266 threaded into and sealed

to the bore 265 and with a movable valve member 267 urged by a spring 268 against a valve seat 269. A pilot piston 270 movable in the bore may be shifted downwardly, as viewed in FIGS. 13 and 14, to open the check valve. A section of the bore 265, identified at 271, communicates directly with the line 125'' extending to a location on the primary cylinder wall of the feed means and into fluid communication with the interior thereof through a port 275 whereby the space between the primary and secondary cylinders of the feed means is connected with the bore 265. This space communicates with the space between the secondary cylinder and the hollow feed piston rod 247 disposed therein by means of a plurality of ports 277 in the secondary cylinder wall 243 and a plurality of ports 276 in the secondary cylinder wall 244. When the beam is to be extended, pressure fluid is directed to the beam extension cylinder 200. It is necessary to connect the line 125'' leading from the spaces in the fluid feed means of FIG. 11 to tank and this is accomplished by opening the pilot-operated check valve 126''. Referring to FIG. 12, the base 201 has a passage 280 connecting with the passage 203 which communicates with the beam extension line 76''. A hose jumper, (not shown) connects the passage 280 with a port 281 in mounting base 240 and with intersecting passages 282 and 283 directing pressure fluid against the pilot piston 270 to move it downwardly, as viewed in FIG. 13 and open the check valve 126''. The opening of the check valve 126'' places the line 125'' in communication with a passage 290 in the base 240 by means of a connecting passage 291, with the passage 290 connecting to the primary conduit 111''. The beam return line 216 connects to the primary conduit 111'' by extending to a straight-through passage 300 in the base 201 for the extension cylinder which is connected by a jumper hose (not shown) to a passage 301 in the base 240 for the fluid feed means and with the connecting passage 291 connecting the passage 301 to the passage 290 which connects to the primary conduit 111''. The mounting base 240 has an attachment fitting 310 for connection to the vehicle. Also, the hollow piston rod 209 and the hollow feed piston rod 247 are connected to the extensible beam by a bracket (not shown).

With the description of the structure, it is believed the operation will be apparent, particularly from the description of the embodiment of FIGS. 6 to 8, with the action being the same in sequencing the extension of the beam followed by lowering of the jack and with subsequent re-elevation of the jack and returning of the beam to retracted position, with the line 125'' functioning to strengthen the fluid feed means and prevent buckling thereof as pressure fluid is directed to the upper side of the jack cylinder 12''. The structure disclosed in the third embodiment provides for further extension of both the extension cylinder 200 and the fluid feed means whereby a larger extended length is obtained for the same closed length of the structure.

The pilot-operated check valve 126'' is of a different construction in providing for thermal relief and may be constructed similarly to Hoffman U.S. Pat. No. 3,349,671 for this purpose. The valve member 267 carries a poppet valve 311 subject to pressure in passage 125'' by a peripheral flat 312 on the outer surface of the valve member. When pressure exceeds the setting of a spring 315, the poppet valve 311 opens and

fluid can flow through a passage 316 to tank by way of passage 290.

A master control circuit for four outrigger supports located approximately at the four corners of the vehicle is shown in FIG. 15 wherein the control circuits disclosed with each of the embodiments have been combined into a single control circuit having five valves with multiple spool sections. In the master control circuit, the pump 100 supplies pressure fluid to a line 101 which extends to and through, in series, five control valves 350, 351, 353, and 354. A branch line 355, extending from the pressure line 101, connects through a series of one-way check valves to lines 356, 357, 358, 359, and 360 which extend to the control valves 350-354, respectively. A tank line 361 connects to the tank 104 and has a pressure relief valve 362 connected to the pressure line 101 to provide for pressure relief flow to tank. The tank line 361 is connected to the center of the control valves 350-354 through lines 363, 364, 365, 366, and 367, respectively.

The extension of the beam extension cylinders for the outrigger supports is controlled by the control valve 352. This control valve has the beam extension line 76 for the outrigger support shown in FIG. 15 connected thereto and with a branch beam extension line 76a provided for connection to a second outrigger support at the same side of the vehicle. Thus as the control valve 352 is shifted to the left, as viewed in FIG. 15, pressure fluid from line 358 is directed to the beam extension line 76 and the branch beam extension line 76a to extend the outriggers at one side of the vehicle. This action corresponds to positioning of spool section 106a of the control valve 106 in operative position in the embodiment of FIG. 1. When the control valve 352 is shifted in the opposite direction from its center position, pressure fluid from line 358 is directed to beam extension lines 76b and 76c for extending the beams at the opposite side of the vehicle. When the control valve 352 is in open center position, the beam extension lines are all connected to the tank line 361 through the open center connection to drain.

Assuming that all four beams have been extended, the next action is to lower the jacks 15 of the four outrigger supports. This action is obtained by operation of control valves 351 and 353. The control valve 351 connects to the primary conduit 110 for the outrigger support shown schematically in FIG. 15 and also to primary conduit 110a for the outrigger support at the opposite side of the vehicle. The control valve 353 has two shifted positions for controlling pressurization of the primary conduit line 110b extending to a jack at the same side of the vehicle as the primary conduit 110a and for pressurization of a conduit 110c extending to an outrigger support at the same side of the vehicle as conduit 110.

The control valves 350 and 354 control the retraction of the extensible beams and elevation of the jacks 15 for the four outrigger supports. The primary conduit 111 for the outrigger support shown schematically in FIG. 15 extends to the control valve 350 whereby, when this control valve is shifted to the left as viewed in FIG. 15, the primary conduit 111 is pressurized to lift the jack and retract the beam extension cylinder 16 and the extensible beam. A second primary conduit 111b extends to the same control valve whereby when the valve is shifted in the opposite direction the jack 15 at the opposite side of the vehicle and the extensible beam

at said location are retracted. The control valve 354, when shifted to the right as viewed in FIG. 15, pressurizes a primary conduit 111c which raises the jack and retracts the beam at a side of the vehicle the same as the outrigger support shown in FIG. 15 while shift of the control valve 354 in the opposite direction pressurizes a primary conduit 111d which extends to the fourth of the outrigger supports.

From the foregoing, it will be seen that a single spool section of each of the control valves 350, 351 and 352 is required for complete control of the outrigger support, shown schematically in FIG. 15, with the result that there need be only three primary conduits 76, 110 and 111 extending from a master control station to the operating components of the outrigger support. Specifically, a spool section of control valve 352 in FIG. 15 corresponds to spool section 106a of the control valve 106 disclosed in FIG. 1. A spool section of the control valve 350 in FIG. 15 corresponds to the spool section 106b of the control valve 106 in FIG. 1. A spool section of the control valve 351 in FIG. 15 corresponds to the operative spool section, when shifted, of control valve 107 in FIG. 1.

This results in a reduction in the number of valve spool sections and conduits required with respect to systems known in the prior art. When this is integrated into a master control circuit for four outrigger supports, the reduction is of greater magnitude, since there is a saving of four valve spool sections and four primary conduits running from the master control station to the components at the four outrigger supports.

We claim:

1. A hydraulic system for an outrigger support having an extensible beam and a vertical jack cylinder at an end of the beam comprising: a hydraulic extension cylinder connectable to parts of the beam whereby extension of the rod of the extension cylinder extends said beam; a fluid circuit including a beam extension line connected to one end of the extension cylinder and a beam return line connected to the other end of the extension cylinder and a first control valve for selectively connecting said lines to either pressure fluid or to tank; said jack cylinder having a pair of fluid lines for supplying pressure fluid to said jack cylinder for either raising or lowering the jack carried by said cylinder; fluid feed means connected to one of said jack cylinder fluid lines; a second control valve in the fluid circuit for directing pressure fluid to said fluid feed means to cause lowering of the jack; a fluid line connecting the other of the jack cylinder fluid lines to the beam return line; and hydraulic means including a pilot-operated check valve for holding said beam retracted or in an intermediate extended position with said check valve being piloted open by a pilot connection to said beam extension line.

2. A hydraulic system as defined in claim 1 wherein said check valve is in said beam return line between the first control valve and the fluid line extending from the jack cylinder fluid line and set to block flow to tank; and a second pilot connection to said pilot-operated check valve from said fluid feed means to open said beam return line to permit flow to tank from the jack cylinder.

3. A hydraulic system as defined in claim 1 wherein each of said jack cylinder fluid lines has a pilot-operated check valve for blocking flow away from the jack cylinder with each of said last-mentioned check

valves being pilot-operated from the other of the jack cylinder fluid lines to permit induced flow from the jack cylinder; and said fluid feed means connected to one of the jack cylinder fluid lines is an extensible feed tube.

4. A hydraulic system as defined in claim 1 wherein there are four beam extension cylinders and four jack cylinders; a first valve spool having two valve sections incorporating the function of the first control valve in the fluid circuit for connecting pressure fluid to the extension cylinders to cause extension of the four beam extension cylinders; a second pair of valve spools having four valve sections incorporating the function of the first control valve in retracting the four beam extension cylinders; and a third pair of valve spools having four valve sections incorporating the function of the second control valve to lower the jacks; said second pair of valve spools having an open center connection to tank whereby flow from the jack cylinders as the jacks are lowered may flow to tank.

5. A hydraulic system for an outrigger support as defined in claim 1 wherein said fluid feed means includes an extensible fluid feed device including a feed cylinder and a hollow feed piston and piston rod movable therein; means connecting the feed piston to the rod of the extension cylinder; and said hydraulic means for holding said beam retracted or in an intermediate position includes a line from said feed cylinder to said beam return line and said pilot-operated check valve is interposed therebetween.

6. A hydraulic system as defined in claim 5 wherein said line from the feed cylinder connects into the feed cylinder at a location housing the hollow feed piston and piston rod whereby pressure is maintained on said piston rod to prevent buckling thereof when pressure fluid is supplied through the fluid feed means to lower the jack.

7. A hydraulic system as defined in claim 5 wherein there are four beam extension cylinders and four jack cylinders; a first valve spool having two valve sections incorporating the function of the first control valve in the fluid circuit for connecting pressure fluid to the extension cylinders to cause extension of the four beam extension cylinders; a second pair of valve spools having four valve sections incorporating the function of the first control valve in retracting the four beam extension cylinders; and a third pair of valve spools having four valve sections incorporating the function of the second control valve to lower the jacks; said second pair of valve spools having an open center connection to tank whereby flow from the jack cylinders as the jacks are lowered may flow to tank.

8. A hydraulic system for an outrigger support as defined in claim 1 wherein said beam extension cylinder is a two-stage unit including a movable cylinder within a cylinder to increase the ratio of extended length to closed length thereof; said fluid feed means includes an extensible fluid feed device including two-stage feed cylinder with a feed cylinder movable within a feed cylinder and a hollow feed piston and piston rod movable within the innermost feed cylinder and operably connected for movement with the rod of the extension cylinder; and said hydraulic means for holding said beam retracted or in an intermediate position includes a line from said two-stage feed cylinder to said beam return line and said pilot-operated check valve is interposed therebetween, said last-mentioned line acting to block

flow out of said two-stage feed cylinder except when said check valve is open.

9. A hydraulic system as defined in claim 8 wherein said line from the two-stage feed cylinder connects into the outer cylinder of feed cylinder at a location to maintain pressure around the inner cylinder; and means defining a flow connection within said two-stage feed cylinder to further maintain pressure around the hollow feed piston rod when pressure fluid is supplied therethrough to lower the jack.

10. A hydraulic system for an outrigger support having an extensible beam and a vertical jack cylinder at an end of the beam comprising: a hydraulic extension cylinder connectable to parts of the beam whereby extension of the rod of the extension cylinder extends said beam; a fluid circuit including a beam extension line connected to one end of the extension cylinder and a beam return line connected to the other end of the extension cylinder and a first control valve for selectively connecting said lines to either pressure fluid or to tank; said jack cylinder having a pair of fluid lines for supplying pressure fluid to said jack cylinder for either raising or lowering the jack carried by said cylinder; an extensible fluid feed means mechanically connected to the rod of the extension cylinder and flow connected to one of said jack cylinder fluid lines; a second control valve in the fluid circuit for directing pressure fluid to said fluid feed means to cause lowering of the jack; a fluid line connecting the other of the jack cylinder fluid lines to the beam return line; a pilot-operated check valve in said beam return line for hydraulically holding said rod and beam retracted or in an intermediate extended position; a first pilot connection from the beam extension line for opening said check valve; and a second pilot connection from the fluid means for opening said check valve when said jack is being lowered.

11. A hydraulic system as defined in claim 10 wherein said beam extension cylinder and extensible fluid means including a telescopic tube structure are mounted to a common base, said base mounting said pilot-operated check valve; and a pair of in-line pilot members in communication with the first and second pilot connections respectively to effect opening of the check valve when pressure fluid is applied to either of said pilot members.

12. A hydraulic system as defined in claim 10 wherein each of said jack cylinder fluid lines has a pilot-operated check valve for blocking flow away from the jack cylinder with each of said last-mentioned check valves being pilot-operated from the other of the jack cylinder fluid lines to permit induced flow from the jack cylinder.

13. A hydraulic system for an outrigger support having an extensible beam and a vertical jack cylinder at an end of the beam comprising: a hydraulic extension cylinder connectable to parts of the beam whereby extension of the rod of the extension cylinder extends said beam; a fluid circuit including a beam extension line connected to one end of the extension cylinder and a beam return line connected to the other end of the extension cylinder and a first control valve for selectively connecting said lines to either pressure fluid or to tank; said jack cylinder having a pair of fluid lines for supplying pressure fluid to said jack cylinder for either raising or lowering the jack carried by said cylinder; fluid feed means connected to one of said jack cylinder fluid lines; a second control valve in the fluid circuit for di-

recting pressure fluid to said fluid feed means to cause lowering of the jack; a fluid line connecting the other of the jack cylinder fluid lines to the beam return line; said fluid feed means includes a feed cylinder with a hollow piston rod and a flow communicating passage through the piston with the piston rod operably connected for movement with the beam; a line connected to said feed cylinder and to the space therein surrounding the hollow piston rod and extending to said beam return line; a pilot-operated check valve in said last-mentioned line to block flow to said beam return line; and a pilot connection to said check valve to open said check valve when pressure fluid is supplied to said beam extension line.

14. A hydraulic system as defined in claim 13 wherein each of said jack cylinder fluid lines has a pilot-operated check valve for blocking flow away from the jack cylinder with each of said last-mentioned check valves being pilot-operated from the other of the jack cylinder fluid lines to permit induced flow from the jack cylinder.

15. A hydraulic system as defined in claim 13 wherein there are four beam extension cylinders and four jack cylinders; a first valve spool having two valve sections incorporating the function of the first control valve in the fluid circuit for connecting pressure fluid to the extension cylinders to cause extension of the four beam extension cylinders; a second pair of valve spools having four valve sections incorporating the function of the first control valve in retracting the four beam extension cylinders; and a third pair of valve spools having four valve sections incorporating the function of the second control valve to lower the jacks; said second pair of valve spools having an open-center connection to tank whereby flow from the jack cylinders as the jacks are lowered may flow to tank.

16. A hydraulic system as defined in claim 13 wherein said beam extension cylinder is a two-stage unit including a cylinder within a cylinder to increase the ratio of extended length to closed length thereof; and said feed cylinder including a movable cylinder therein and spaced therefrom which movably carries said hollow piston rod and flow communicating piston; and said line which connects from the feed cylinder to said beam return line being in fluid communication with a space surrounding said movable cylinder as well as the space surrounding said hollow piston rod to prevent buckling thereof when pressure fluid is supplied to the jack cylinder to lower the jack.

17. A hydraulic system as defined in claim 16 wherein each of said jack cylinder fluid lines has a pilot-operated check valve for blocking flow away from the jack cylinder with each of said last-mentioned check valves being pilot-operated from the other of the jack cylinder fluid lines to permit induced flow from the jack cylinder.

18. A hydraulic system as defined in claim 17 wherein there are four beam extension cylinders and four jack cylinders; a first valve spool having two valve sections incorporating the function of the first control valve in the fluid circuit for connecting pressure fluid to the extension cylinders to cause extension of the four beam extension cylinders; a second pair of valve spools having four valve sections incorporating the function of the first control valve in retracting the four beam extension cylinders; and a third pair of valve spools having four valve sections incorporating the function of the

second control valve to lower the jacks; said second pair of valve spools having an open-center connection to tank whereby flow from the jack cylinders as the jacks are lowered may flow to tank.

19. A hydraulic system for a plurality of outrigger supports for a mobile crane or the like and each support having a vertical jack cylinder with a movable jack and an extensible beam carrying the jack cylinder comprising: hydraulic means associated with each outrigger support including an extension cylinder for positioning the beam and a plurality of fluid lines including a beam extension line connected to one end of the extension cylinder and a beam return line connected to the opposite end of the extension cylinder and a pair of fluid lines connected to the opposite ends of the jack cylinder, said fluid lines connected to the jack cylinder each having a pilot-operated check valve preventing flow therethrough to a tank but piloted by pressure in the opposite fluid line to the jack cylinder for movement to an open position permitting flow to tank; hydraulic control circuit means connected to the aforesaid fluid lines including a control valve operated to extend or retract the beams at one side of the mobile crane, a control valve for directing pressure fluid to the upper end of a jack cylinder to extend the jack therefrom, and a third control valve operable to supply pressure fluid to the beam return line to retract the extension cylinder; said fluid line connected to the lower end of the jack cylinder for retracting the jack into the jack cylinder being connected to said beam return line whereby operation of said third control valve additionally causes retraction of said jack; and a pilot-operated check valve positioned in said control circuit functioning to hold said extensible beam retracted or in an intermediate position and pilot-operated by pressure fluid supplied to the beam extension line to open and permit flow to tank as said extension cylinder is extended.

20. A hydraulic system as defined in claim 19 wherein said pilot-operated check valve in the control circuit is positioned in the beam return line; and an additional pilot connection to said last-mentioned pilot-operated check valve for opening said check valve when pressure fluid is directed to the jack cylinder to extend the jack from the jack cylinder whereby fluid may flow from the opposite end of the jack cylinder to tank.

21. A hydraulic system as defined in claim 19 wherein the fluid line of the hydraulic means for supplying pressure fluid to the jack cylinder to extend the jack from the jack cylinder includes an extendable feed tube having a cylinder with a hollow piston and piston rod therein and with the piston rod spaced from the cylinder; a line connected to said last-mentioned cylinder and the space surrounding said hollow piston rod and extending to the beam return line; and said pilot-operated check valve in the control circuit being positioned in said line extending to the beam return line whereby fluid is held in said line acting against said piston in the cylinder to prevent further extension of the beam and to exert forces on the hollow piston rod during supply of pressure fluid therethrough to prevent buckling thereof.

22. A hydraulic system for an outrigger support having an extensible beam and a vertical jack cylinder at an end of the beam comprising: a hydraulic extension cylinder connectable to parts of the beam whereby extension of the rod of the extension cylinder extends said

19

beam; a fluid circuit including a beam extension line connected to one end of the extension cylinder and a beam return line connected to the other end of the extension cylinder and a first control valve for selectively connecting said lines to either pressure fluid or to tank; said jack cylinder having a pair of fluid lines for supplying pressure fluid to said jack cylinder for either raising or lowering the jack carried by said cylinder; fluid feed means connected to one of said jack cylinder fluid lines; a second control valve in the fluid circuit for directing pressure fluid to said fluid feed means to cause lowering of the jack; and a fluid line connecting the other of the jack cylinder fluid lines to the beam return line whereby actuation of said first control valve to deliver pressure fluid to said beam return line will initiate lifting of said jack and then retraction of said beam.

23. A hydraulic system as defined in claim 22 wherein each of said jack cylinder fluid lines has a pilot-operated check valve for blocking flow away from the jack cylinder with each of said last-mentioned

20

check valves being pilot-operated from the other of the jack cylinder fluid lines to permit induced flow from the jack cylinder.

24. A hydraulic system as defined in claim 22 wherein there are four beam extension cylinders and four jack cylinders; a first valve spool having two valve sections incorporating the function of the first control valve in the fluid circuit for connecting pressure fluid to the extension cylinders to cause extension of the four beam extension cylinders; a second pair of valve spools having four valve sections incorporating the function of the first control valve in retracting the four beam extension cylinders; and a third pair of valve spools having four valve sections incorporating the function of the second control valve to lower the jacks; said second pair of valve spools having an open center connection to tank whereby flow from the jack cylinders as the jacks are lowered may flow to tank.

* * * * *

25

30

35

40

45

50

55

60

65