CONTROL SYSTEM FOR A DERRICK

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Field of Search... 182/2, 141, 148; 91/412, 414; 60/54.5, 36

References Cited

UNITED STATES PATENTS

3,378,103 4/1968 Zwight et al.................. 182/2

2,615,302 10/1952 Camerota.......................... 91/412
2,648,949 8/1953 Taylor.......................... 60/54.5 R

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ABSTRACT

A derrick having hydraulically operable remote control and main control systems wherein the remote control system is separate from and hydraulically non-communicative with the main control system. The remote control system employs a hydraulic fluid that differs from that used in the main control system such that the most desirable fluid characteristics for each system can be independently selected.

27 Claims, 1 Drawing Figure
This invention is directed to new and useful improvements in derricks and more particularly to hydraulic control means for controlling operative movement of a derrick at a work site.

The beam assembly of a derrick is generally hydraulically actuated through hydraulic work cylinders, movement of which is controlled by a hydraulic control system. The beam assembly is generally equipped with one or more hydraulically actuated accessories such as winches, pole pullers, jib booms and augers, to name a few. It is often desirable to rotate the beam assembly and to accomplish this the beam assembly is usually secured to a turret-mounted mast assembly, which turret is ordinarily rotatable by a hydraulic motor. Outriggers which help maintain the derrick in a stable position during movement of the aforementioned components are also usually hydraulically actuated in and out of a desired position.

Generally all the hydraulically operative parts of a derrick are controlled at a main control station accessible to one workman. The main controls normally include a main hydraulic circuit that actuates the work cylinders of the operating components. If the derrick includes a work station such as a basket or elevated platform, one or more of the derrick components usually have a remote control operable by a workman at his work station. The remote controls generally comprise one or more hydraulic fluid lines forming a hydraulic network that is incorporated into the main hydraulic circuit with both the main and remote control lines being hydraulically communicative with one another and operating from a common fluid source.

Since the fluid lines in the remote control network do not operate work cylinders, the fluid pressures, fluid line diameters, and fluid capacities are substantially less than the pressures, line diameters, and capacities of the main control fluid lines that feed the work cylinders. For example, a known main control fluid line generally has an internal diameter of one-half inch and experiences fluid pressures of 2,500 p.s.i., whereas the remote control fluid lines incorporated in the main control system generally have an internal diameter of three-sixteenths of an inch and experience fluid pressures of 200 p.s.i. Due to this difference in fluid line cross-section and capacity, the viscosity of the hydraulic fluid used directly affects the response of the remote control system, especially in cold winter temperatures. Thus a control system which can be remotely operated at a given response rate one day often operates at a completely different response rate on another day. This inconsistency of response rate is often unpredictable due to unpredictable changes in temperature and can cause damage and injury to the derrick, the derrick operators, or the equipment being serviced by the derrick.

Among the several objects of the present invention may be noted the provision of a novel control system for a derrick wherein remote control fluid lines are hydraulically isolated and non-communicative with main control fluid lines; a novel derrick having one type of hydraulic fluid for the remote control system and another type of hydraulic fluid for the main control system; a novel derrick having hydraulically operable remote control valves mechanically connected to main control valves of the main control system; a novel derrick having a remote control hydraulic system that includes a pump driven by a hydraulic motor in the main control system; and a novel method for remotely controlling movement of derrick beams and other hydraulically actuable components. Other objects and features will be in part apparent and in part pointed out hereinafter.

The present invention relates to a novel derrick wherein a remote control hydraulic system is hydraulically separate from and hydraulically non-communicative with a main control hydraulic system. A first fluid having one set of fluid characteristics such as fixed viscosity is used in the remote control system whereas a second fluid having another set of fluid characteristics such as excellent lubricity is used in the main control system. The main control system includes a bank of manually operable main valves having movable members, which main valves are connected by fluid lines to hydraulic work cylinders. The main control system also includes a hydraulic motor that is rotatable in response to movement of fluid pumped through the main control system fluid lines by a main power pump. The remote control system includes a bank of manually operable master valves hydraulically connected to a bank of slave valves having movable members mechanically interconnected to the movable members of the main valves. Movement of a remote control master valve member causes movement of a corresponding slave valve member, the slave valve also moving the main valve member to actuate a corresponding work cylinder, thereby moving one of the hydraulically actuated components of the derrick.

The remote control system also includes a pump that is drivenly connected to the hydraulic motor in the main control system such that movement of the remote control pump is attributable to movement of the hydraulic motor, which motor derives its movement from the main power pump.

The invention accordingly comprises the constructions and methods hereinafter described, the scope of the invention being indicated in the following claims.

In the accompanying drawings, in which one of various possible embodiments of the invention is illustrated, the FIGURE of the drawing shows a schematic diagram of the remote control system and main control system of the present invention superimposed on a phantom outline of a derrick beam assembly, mast assembly and turret.

Corresponding reference characters indicate corresponding parts throughout the drawing.

Referring to the drawing, a derrick incorporating one embodiment thereof is generally indicated in phantom outline by reference numeral 10. Derrick 10 symbolically represents a derrick having an articulated beam assembly such as is disclosed in U. S. Pat. No. 3,378,103.

Derrick 10 includes an outer beam 12 having a work basket 14 at the free end thereof, the opposite end of beam 12 being pivotally secured to an inner beam 16. Outer beam 12 is of any suitable known construction such as disclosed in U.S. Pat. No. 3,378,103. Work basket 14 is also of any suitable known construction such as is disclosed in U.S. Pat. No. 3,154,199. Inner beam 16 is in turn pivotally secured to a mast assembly 18 that is mounted on a rotatable turret 20. Inner beam 16, mast assembly 18, and turret 20 are of any suitable known construction such as disclosed in U.S. Pat. No.
3,788,425

3,378,103. A first work cylinder 22 of any suitable known construction such as that disclosed in U. S. Pat. No. 3,396,852 is joined to outer and inner beams 12 and 16 for articulation of outer beam 12 with respect to inner beam 16. A second work cylinder 24 also of any suitable known construction such as disclosed in U. S. Pat. No. 3,396,852 is joined to inner beam 16 and mast assembly 18 for articulation of inner beam 16 with respect to mast assembly 18.

Derrick 10 further includes a main control system generally indicated by reference numeral 30 and a remote control system generally indicated by reference numeral 100. Both control systems are hydraulically operable, with certain parts of the systems identified by reference numerals.

Main control system 30 comprises a fluid supply tank 32 containing a suitable hydraulic fluid such as oil derived from petroleum, tank 32 being connected in series on a fluid line 34 to a known shutoff valve 36 which is in turn connected in series to a known fluid filter 38. The output of filter 38 is connected in series to any suitable main power pump 40 for pumping fluid such as a Vickers pump No. V210-8-1G-12-S49. A known check valve 42 and a known fluid filter 44 are connected in series on the output side of pump 40. Fluid in line 34 is pumped by pump 40 through a main control valve inlet line 46 that is connected to a two-way, three-position main control valve 66 of any suitable known construction. A main control valve outlet line 56 connects valve 66 to a main control valve inlet line 58 that joins a two-way, three-position main control valve 68. Similarly, a main control valve outlet line 60 connects valve 68 to a main control valve inlet line 62 that joins a two-way, three-position main control valve 70. A main control valve outlet line 64 connects valve 70 to a tank return line 48 having a check valve 50 and a hydraulic motor 52 connected thereto.

Main control valves 66, 68, 70, are identical and include a manually operable control handle 72 for actuating a movable valve member 74 which extends inside valves 66, 68, 70. Control handles 72, 72, 72, 72, can be maintained in a predetermined neutral reference position by biasing means such as a spring 76.

Pairs of operating lines 78, 80 and 82, 84, interconnect main valves 68 and 70 with work cylinders 24 and 22. A similar pair of operating lines 86, 88, interconnect main valve 66 with a rotation motor 90 on turret 20.

In operation of main control system 30 shutoff valve 36 is opened and pump 40 is set to operate. Fluid from tank 32 is drawn through filter 38 and pumped through check valve 42 and filter 44 into main control valve inlet line 46. When movable members 74, 74, 74, of main control valves 66, 68, 70, are in a neutral or unactuated position operating lines 78, 80, 82, 84 and 86, 88 are blocked at their respective valves 68, 70, and 66. Fluid in line 46 then enters main control valve 66 and flows directly into outlet line 56. Similarly fluid in outlet line 56 flows to inlet line 58, valve 68 and outlet line 60. Fluid in outlet line 60 then flows to inlet line 62, valve 70 and outlet line 64 which feeds tank return line 48.

If it is desired to articulate outer beam 12 away from inner beam 16, control handle 72 of main valve 70 is pivoted in one direction, thereby moving valve member 74 to a first predetermined position. This first position of movable valve member 74 enables fluid to enter valve 70 through feeder line 62 and to pass outwards of valve 70 to cylinder 22 through operating line 82. Fluid in line 82 causes cylinder 22 to be movably actuated in a manner such as disclosed in U. S. Pat. No. 3,396,852, which actuation causes fluid to pass from cylinder 22 back to main control valve 70 through operating line 84. This returning fluid passes outwards of main valve 70 through outlet line 64 into tank return line 48.

If it is desired to articulate beam 12 in a reverse direction, control handle 72 of main valve 70 is pivoted in a second direction to move movable valve member 74 to a second predetermined position enabling feeder line 62 to pass fluid outwards of valve 70 through operating line 84. Fluid returns from cylinder 22 to main valve 70 through operating line 82 and passes outwards of main valve 70 through outlet line 64 into tank return line 48. Main valve 68 operates cylinder 24 in an identical manner. Main valve 66 also operates the same as valves 68 and 70 but fluid passing out of valve 66 into operating line 86 causes hydraulic motor 90 to rotate in one direction, fluid returning from motor 90 to valve 66 through line 86. Motor 90 is rotatable in a reverse direction when the flow paths in operating lines 86 and 88 are reversed by main control valve 66. Under this hydraulic circuit arrangement it is desirable to operate only one of the main valves 66, 68 and 70 at a time although the circuit can be modified to permit simultaneous operation thereof. In the present hydraulic arrangement, when one of the main valves 66, 68, or 70 is being actuated, the other unactuated main control valves permit fluid to flow therethrough without entering the associated operating lines.

Remote control system 100 comprises a fluid tank 102 containing a suitable silicone oil such as Dow Corning 50 centistokes. This type of silicone oil is a synthetic compound having a relatively flat viscosity curve over a wide range of temperature when compared with the viscosity curve of oil derived from petroleum. It should be noted that silicone oil has relatively poor lubricating qualities in comparison with the lubricity of oil derived from petroleum. Also at present silicone oil is very much more expensive than petroleum-derived oil. Nevertheless the viscosity characteristics of silicone oil make it highly desirable for the purposes of the present invention.

Fluid tank 102 is connected in series with a known shutoff valve 104 and a known suction filter 106, the outlet of which is fed into a suitable pump 108 such as Eastern part No. 102-F21-Q1A. A flexible coupling 110 interconnects pump 108 with hydraulic motor 52 in main control system 30. A known filter 112 is connected to the output side of pump 108, which filter passes fluid to a line junction 114.

A master valve distribution line 116 interconnects junction 114 to a bank 118 of three master valves 120, 122 and 124. Each master valve 120, 122, 124, comprises a pair of two-way, two-position valves 126, 128, of known construction, valves 126, 128, having movable members 130, 132, projecting from an end thereof toward a respective valve actuator handle 134, 136, 138. Actuator handles 134, 136, 138, are pivoted intermediate each pair of valves 126, 128, at a pivot point 140 and include oppositely extending valve member displacer arms 142, 144, arranged to engage movable members 130, 132. Movable members 130, 132, are
maintained in a predetermined reference position by a biasing means such as a spring 146. Distribution line 116 includes three feeder lines 148, 150, 152, each having inlet lines 154, 156, arranged to pass fluid into valves 126 and 128, respectively.

Remote control system 100 also includes return line means for returning fluid from valve bank 118 to tank 102. The return line means comprise a pair of outlet lines 158, 160, extending from valves 126, 128, to junction lines 162, 164, 166, that are respectively connected to a main return line 168 connected to tank 102.

Remote control system 100 further includes a bank of three identical slave valves 170, 172, 174, having a movable piston member 176 and two valve chambers 178 and 180. Movable piston members 176, 176, 176, are mechanically connected (not shown) to movable members 74, 74, 74, of main control valves 66, 68, and 70 and maintained in a predetermined neutral reference position by biasing means such as a spring 182 provided on member 176.

Remote control system 100 additionally includes a first bridge line 184 having a pressure relief valve 186 thereon, which line interconnects junction 114 to slave valve distribution means for distributing fluid to slave valves 170, 172 and 174. The slave valve distribution means include a main distribution line 188 having feeder lines 190, 192, 194, that connect to pairs of inlet lines 196, 198, 200, 202, and 204, 206, which inlet lines pass fluid to slave cylinder chambers 178 and 180, respectively. Known check valves 208 are provided on each inlet line. A first operating line 210 connects slave cylinder chamber 178 of slave valve 170 with valve 128 of master valve 120 and a second operating line 212 connects slave cylinder chamber 180 with valve 126. Operating line pairs 214, 216, and 218, 220, similarly connect slave valves 172, 174, to master valves 122, 124, respectively.

Remote control system 100 also includes a second bridge line 222 having a known check valve 224 thereon, which bridge line extends from first bridge line 184 and main distribution line 188 to return line 168.

In operation of remote control system 100 shutoff valve 104 is opened and pump 108 is set into operation. Movement of pump 108 is attributable to rotation of hydraulic motor 52 in main control system 30, the rotation of motor 52 being transmitted to pump 108 through flexible shaft 110. Fluid from tank 102 is drawn through filter 106 and pumped through filter 112 to master valve distribution line 116 and first bridge line 184. Fluid in first bridge line 184 passes through pressure relief valve 186 and thereafter flows through slave main distribution line 188 and second bridge line 222. Fluid in second bridge line 222 passes through check valve 224 to return line 168 for passage to tank 102.

When remote control handles 134, 136, 138, are not being actuated, the fluid in master valve distribution line 116, feeder lines 148, 150, 152, and inlet lines 154, 156, is blocked from entering valves 126, 128, of master valves 120, 122, and 124. During such blockage the fluid in slave valve main line 188 passes through feeder lines 190, 192, 194, inlet lines 196, 198, 200, 202, 204, 206, and their respective check valves 208 into slave cylinder chambers 178, 180. Fluid exits from slave cylinder chambers 178, 180, into operating lines 210, 212, 214, 216, 218, 220, for passage into a respective valve 128, 126, of master valves 120, 122, 124. Fluid exits from valves 126, 128, to outlet lines 158, 160, junction lines 162, 164, 166, and main return line 168. During this movement of fluid through slave cylinder chambers 178, 180, and valves 126, 128, of master valves 120, 122, 124, movable members 130, 132, thereof are maintained in a fixed reference position by springs 146. This fluid movement continuously bleeds slave valves 170, 172, 174, and master valves 120, 122, 124, even when main control handles 72, 72, 72, of main control valves 66, 68, 70, are being operated. Thus there is complete purging of air in remote control system 100 and any oil which may have been lost, as in periods of inactivity, is restored. This bleeding function occurs automatically with the starting of power pump 40 and continues as long as pump 40 is running. Further the back pressure of the bleed flow is not high enough to overcome biasing springs 76 or 182 and cause movement of movable members 74 or 176 should pressure fail in either slave cylinder chamber 178 or 180. The main control and remote control systems 30, 100, are automatically indexed to a predetermined neutral reference position by springs 76 and 182.

If it is desired to articulate outer beam 12 away from inner beam 16 through remote control system 100, handle 138 of master valve 124 is pivoted to permit arm 144 to move member 132 of valve 128 to a predetermined position. This moved position of member 132 prevents fluid from passing outwardly of valve 128 into outlet line 160, junction line 166 and return fluid line 168. Fluid enters valve 128 of master valve 124 from main distribution line 116, feeder line 152, and inlet line 156, and passes outwardly thereof to operating line 218 for transmission to cylinder chamber 178 of slave valve 174. Fluid accumulates in cylinder chamber 178 due to the presence of check valve 208 on line 204, which fluid accumulation causes movable member 176 to displace. Since movable members 74 and 74 are mechanically interconnected, member 74 also displaces, thereby enabling fluid to pass through operating line 82 to actuate cylinder 22 in a manner previously described. It should be noted that when valve 128 is actuated and arm 142 of remote control handle 138 is not in engagement with movable member 130 of valve 126 there is continuous bleeding of valve 126 and cylinder chamber 180 of slave valve 174 in a manner previously described.

To articulate outer beam 12 toward inner beam 16, remote control handle 138 is pivoted in a reverse direction such that arm 142 moves movable member 130 of valve 126 to a predetermined position wherein valve 126 prevents fluid from passing outwardly thereof into lines 158, 166 and 168. Fluid enters valve 126 through main distribution line 116, feeder line 152 and inlet line 154, and passes outwardly of valve 126 to operating line 220. The fluid in operating line 220 feeds cylinder chamber 180 of slave cylinder 174, accumulating therein due to the presence of check valve 208 on line 206. This fluid accumulation displaces slave valve member 176 and control valve member 74 while slave cylinder chamber 178 and valve 128 are being continuously bled. Movement of member 176 enables fluid to pass through control valve 70 through operating line 84 to actuate cylinder 22 in a reverse direction. Master valves 122, 120, can also be actuated in an identical
manner by moving remote control handles 136 and 134 to respectively articulate inner beam 16 with respect to mast assembly 18 and to bi-directionally rotate hydraulic motor 90 for rotation of turret 20.

As will be apparent to those skilled in the art the present hydraulic control system can be arranged to control hydraulic actuation of outrigger cylinders as disclosed in U. S. Pat. No. 3,378,103 by including in the hydraulic circuit control valves and cylinders which correspond to the outriggers. Similar provisions can be made for hydraulic control of displaceable booms, winches, pole pullers, jib booms, augers, etc., and any other derrick components that can be hydraulically actuated.

If desired, a bypass relief valve (not shown) can be connected to hydraulic motor 52 to enable fluid flow rates beyond a predetermined level to pass through the bypass relief valve instead of hydraulic motor 52. This will insure that motor 52 and pump 108 run within a predetermined speed range regardless of the rate of fluid flow in the main control system. As an alternative to the motor 52 — pump 108 arrangement, remote control system 100 can be independently powered by a separate power pump (not shown).

Some advantages of the novel derrick evident from the foregoing description include a remote control system that has a consistent rate of response over a wide range of temperatures, a remote control system that is hydraulically separate and non-communicative with the main control system such that a breakdown of the remote control system does not necessitate shutdown of the main control system, and a remote control system and main control system which can each operate with distinctly different hydraulic fluids such that the most desirable fluid characteristics for each system can be independently selected.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As various changes could be made in the above constructions and methods without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. An aerial device comprising a movable beam member having a hydraulic cylinder connected thereto, actuation of said cylinder moving said beam, first control means provided at one station on said aerial device for controlling actuation of said hydraulic cylinder, and remote control means provided at a second station on said aerial device for actuation of said first control means, said first control means comprising a first hydraulic circuit having first hydraulic fluid supply means for supplying fluid to said first hydraulic circuit, said remote control means comprising a second hydraulic circuit having second hydraulic fluid supply means for supplying fluid to said second hydraulic circuit, said first and second fluid supply means being noncommunicative with one another, and said first and second hydraulic circuits being noncommunicative with one another such that fluid from said first hydraulic circuit does not flow into said second hydraulic circuit and fluid from said second hydraulic circuit does not flow into said first hydraulic circuit.

2. An aerial device as claimed in claim 1 wherein said first and second hydraulic fluid supply means each contain different hydraulic fluids.

3. An aerial device as claimed in claim 2 wherein the hydraulic fluid of said first hydraulic fluid supply means is petroleum oil and the hydraulic fluid of said second hydraulic fluid supply means is silicone oil.

4. An aerial device as claimed in claim 1 wherein said first hydraulic circuit includes a first hydraulic motor, said second hydraulic circuit including a pump for pumping fluid through said second hydraulic circuit, said pump being drivenly connected to said first hydraulic motor such that pump movement is attributable to movement of said hydraulic motor.

5. An aerial device as claimed in claim 1 further including slave valve means having a valve member mechanically connected to said first control means, said slave valve means having hydraulic communication with said second hydraulic fluid supply means such that fluid in said second hydraulic circuit passes through said slave valve means and movement of said slave valve member by said second hydraulic fluid effects movement of said first control means through said mechanical connection to actuate said hydraulic cylinder thereby moving said movable beam.

6. An aerial device as claimed in claim 1 wherein said first station is spaced from said beam and said second station is associated with said beam.

7. An aerial device as claimed in claim 6 wherein said second station comprises a basket connected to said beam.

8. An aerial device as claimed in claim 1 further including a rotatable turret for supporting and rotating said movable beam, and a second hydraulic motor drivenly connected to said rotatable turret for rotating said turret, said second hydraulic motor being actuable by said first control means and said remote control means.

9. An aerial device comprising rotatable turret means including hydraulic drive means for rotation of said turret means, a mast assembly mounted to said turret means, a beam member joined to said mast assembly, first control means provided at one station on said aerial device for controlling actuation of said hydraulic drive means and remote control means provided at a second station on said aerial device for actuation of said first control means, said first control means comprising a first hydraulic circuit having first hydraulic fluid supply means for supplying fluid to said first hydraulic circuit, said remote control means comprising a second hydraulic circuit having second hydraulic fluid supply means for supplying fluid to said second hydraulic circuit, said first and second fluid supply means being noncommunicative with one another, and said first and second hydraulic circuits being noncommunicative with one another such that fluid from said first hydraulic circuit does not flow into said second hydraulic circuit and fluid from said second hydraulic circuit does not flow into said first hydraulic circuit.

10. An aerial device as claimed in claim 9 wherein said first and second hydraulic fluid supply means each contain different hydraulic fluids.

11. An aerial device as claimed in claim 10 wherein the hydraulic fluid of said first hydraulic fluid supply means is oil and the hydraulic fluid of said second hydraulic fluid supply means is silicone oil.
12. An aerial device comprising a movable beam member having a hydraulic cylinder connected thereto, actuation of said cylinder moving said beam, first control means provided at one station on said aerial device for controlling actuation of said hydraulic cylinder, remote control means provided at a second station on said device for actuation of said first control means, said first control means and said remote control means each including separate noncommunicative hydraulic circuits, said remote control means including master valve means and said first control means including slave valve means, the hydraulic circuit of said remote control means comprising fluid supply means connected in series to a fluid pump, and first distribution line means connected to said slave valve means for distributing fluid therein, and said fluid pump being connected in series to a fluid line junction having second distribution line means connecting said second distribution line means to said first control means for permitting fluid to flow from said fluid line junction to said first distribution line means, the hydraulic circuit of said remote control means further including return means connecting said first control means and said fluid supply means.

13. An aerial device as claimed in claim 12 wherein the hydraulic circuit of said remote control means further includes a second bridge line connecting said first bridge line and said return line means, said second bridge line having valve means for permitting fluid to flow from said first bridge line to said return line means, said valve means preventing reverse fluid flow.

14. An aerial device as claimed in claim 12 including a pressure relief means on said first bridge line interconnected between said junction of fluid lines and said first distribution line means.

15. An aerial device as claimed in claim 12 wherein the hydraulic circuit of said first control means includes a hydraulic motor, said fluid pump being drivingly connected to said hydraulic motor such that movement of said pump is attributable to movement of said hydraulic motor.

16. An aerial device as claimed in claim 12 wherein the hydraulic circuit of said remote control means further includes valve connection line means interconnecting said master valve means and said slave valve means.

17. An aerial device as claimed in claim 16 wherein said master valve means include a two-way, two-position master valve and said slave valve means include a reciprocable slave valve having at least one fluid chamber, one position of said master valve preventing fluid in said second distribution line means from entering said master valve, said one position of said master valve enabling fluid to flow from said first distribution line means into said slave valve, through said slave valve connection line means into said master valve, and to said return line means for passage to said fluid supply means.

18. An aerial device as claimed in claim 17 wherein said one position of said master valve corresponds to a non-actuated condition of said master valve such that fluid flows through said master valve and slave valve, bleeding said valves and causing no movement of said first control means.

19. An aerial device as claimed in claim 17 wherein a second position of said master valve enables fluid to flow into said master valve from said second distribution line means, through said valve connection line means into said slave valve, said first distribution line means including valve means for preventing fluid flow from said slave valve through said first distribution line means such that fluid flowing into said slave valve from said valve connection line means accumulates in said slave valve.

20. An aerial device as claimed in claim 19 wherein said second position of said master valve corresponds to an actuated condition of said master valve such that fluid accumulating in said slave valve causes movement of said slave valve and corresponding movement of said first control means to actuate said hydraulic cylinder, thereby moving said movable beam.

21. An aerial device as claimed in claim 19 wherein the hydraulic circuit of said remote control means includes a pressure relief means on said first bridge line interposed between said junction of fluid lines and said first distribution line means.

22. An aerial device as claimed in claim 21 wherein the hydraulic circuit of said remote control means further includes a second bridge line interconnecting said first bridge line and said return line means, said second bridge line having valve means for permitting fluid to flow from said first bridge line to said return line, said valve means preventing reverse fluid flow.

23. An aerial device as claimed in claim 19 wherein said slave valve and said first control means include interconnected movable members such that movement of one of said movable members causes corresponding movement of said other movable member and accumulation of fluid in the fluid chamber of said slave valve causes movement of said movable members to actuate said hydraulic cylinder, thereby moving said movable beam.

24. An aerial device as claimed in claim 23 including biasing means connected to said movable members for restoring said movable members to a predetermined reference position when said first control means is unactuated and said remote control means master valve is in said one position.

25. A method for remotely controlling movement of an aerial device beam by a hydraulic cylinder having direct control hydraulic means comprising actuating the movement of the direct control hydraulic means with a remote control hydraulic means, separating the fluid supply means for the remote control hydraulic means from the fluid supply for the direct control hydraulic means, and hydraulically separating remote control hydraulic circuitry from direct control hydraulic circuitry by preventing hydraulic fluid in each respective hydraulic control means from flowing into the other hydraulic control means.

26. The method of claim 25 including using a hydraulic fluid in the remote control circuit having different viscosity characteristics from that of the hydraulic fluid in the direct control hydraulic means.

27. The method of claim 25 including pumping the remote control hydraulic fluid with a pump drivingly connected to rotating means within the direct control hydraulic means.
UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,788,425 Dated January 29, 1974

Inventor(s) Roy Balogh

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

The attorney's name should be --John D. Pope III--.
Column 1, line 43, "experiences" should read --experience--.
Column 3, line 41, "member" should read --member--.
Column 8, line 64, "claim" should read --claim--.
Column 9, line 54, "enabling" should read --enabling--.

Signed and sealed this 6th day of August 1974.

(SEAL)
Attest:

McCoy M. Gibson, Jr.  C. Marshall Dann
Attesting Officer  Commissioner of Patents