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Witwer

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[54] **BOUNCE-PREVENTING CONTROL FOR HYDRAULIC CYLINDER**

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[52] **U.S. Cl.** **212/55,** 91/454, 91/457

[51] **Int. Cl.** **F15b 11/08,** B65c 23/06

[58] **Field of Search** 212/55; 91/454, 457; 60/406

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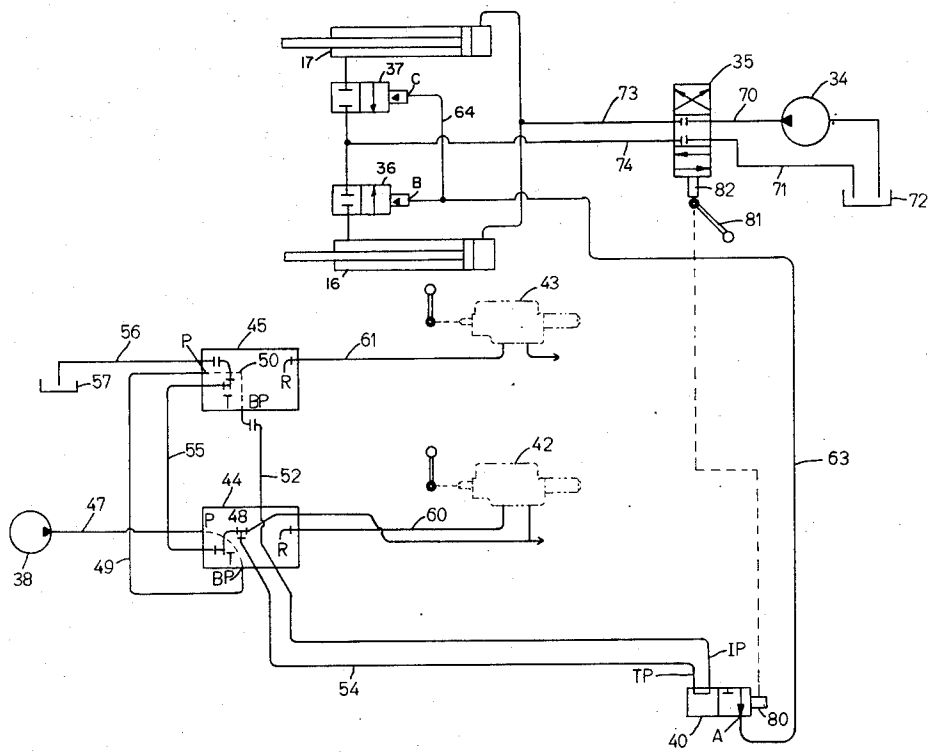
Attorney—James E. Nilles

[57] **ABSTRACT**

A crane boom is raised and lowered by the extendable and retractable cylinder rod of a hydraulic boom hoist cylinder. A main pump supplies pressurized operating fluid to the cylinder through a lever controlled manually operable three-position (raise, lower, neutral) main control valve. A pilot valve operating holding valve on the cylinder maintains the rod in extended position. To prevent bounce and fluctuation as the cylinder rod is retracted and the boom is lowered, the pilot valve is supplied with pilot fluid from a fluid source other than the cylinder or main pump and is operated by the same lever that operates the main control valve.

4 Claims, 4 Drawing Figures



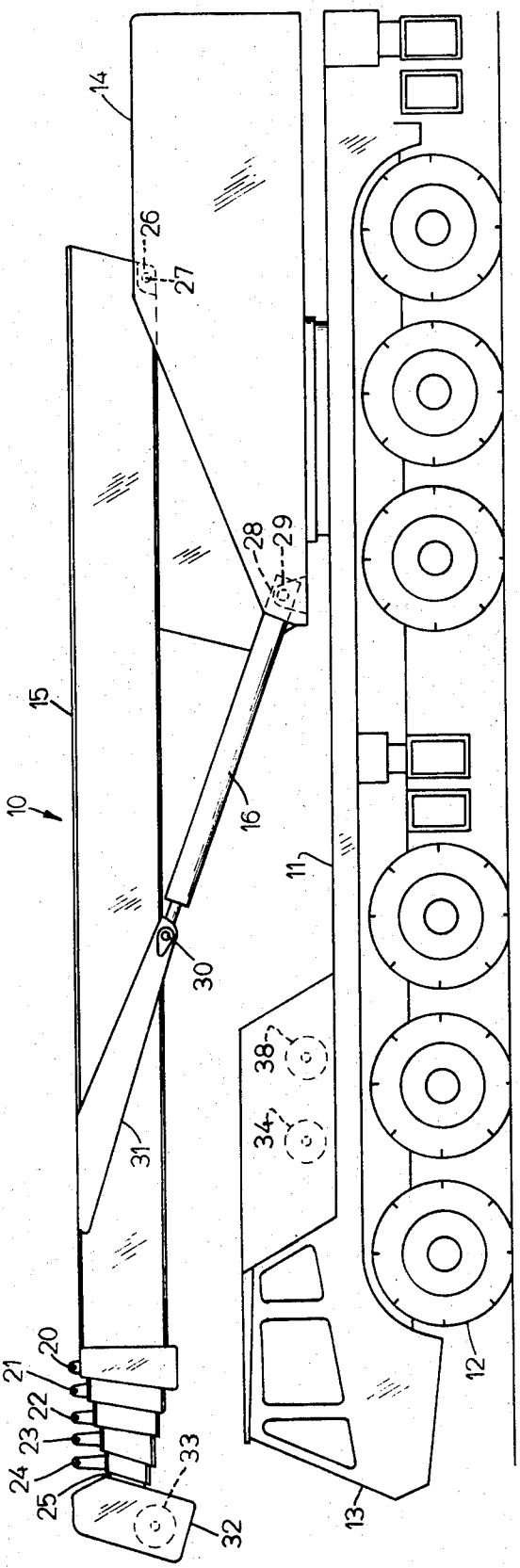


FIG. 1

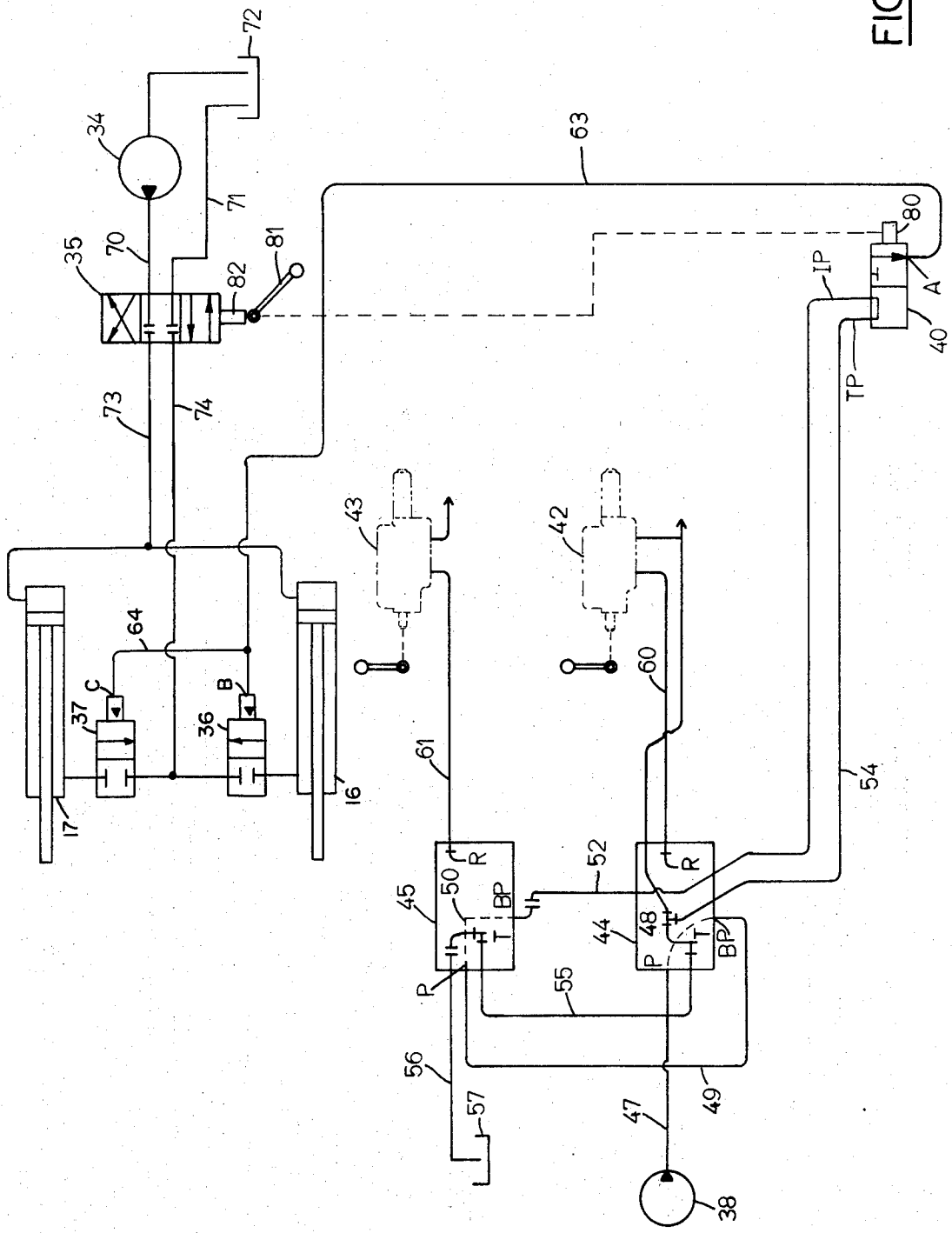

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FIG. 2

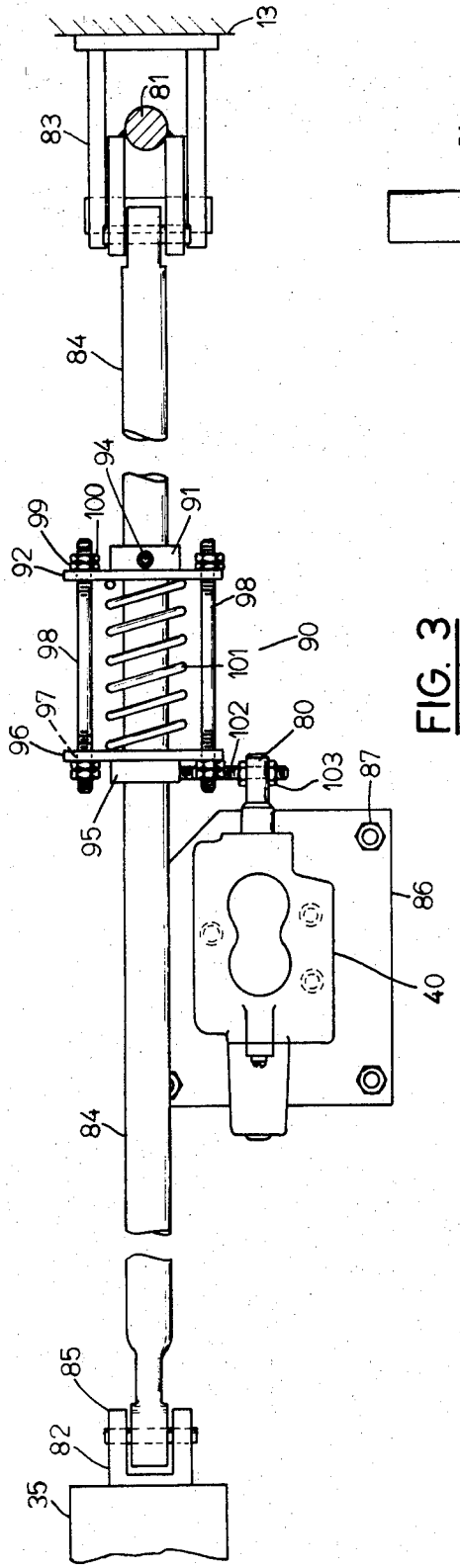
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FIG. 3

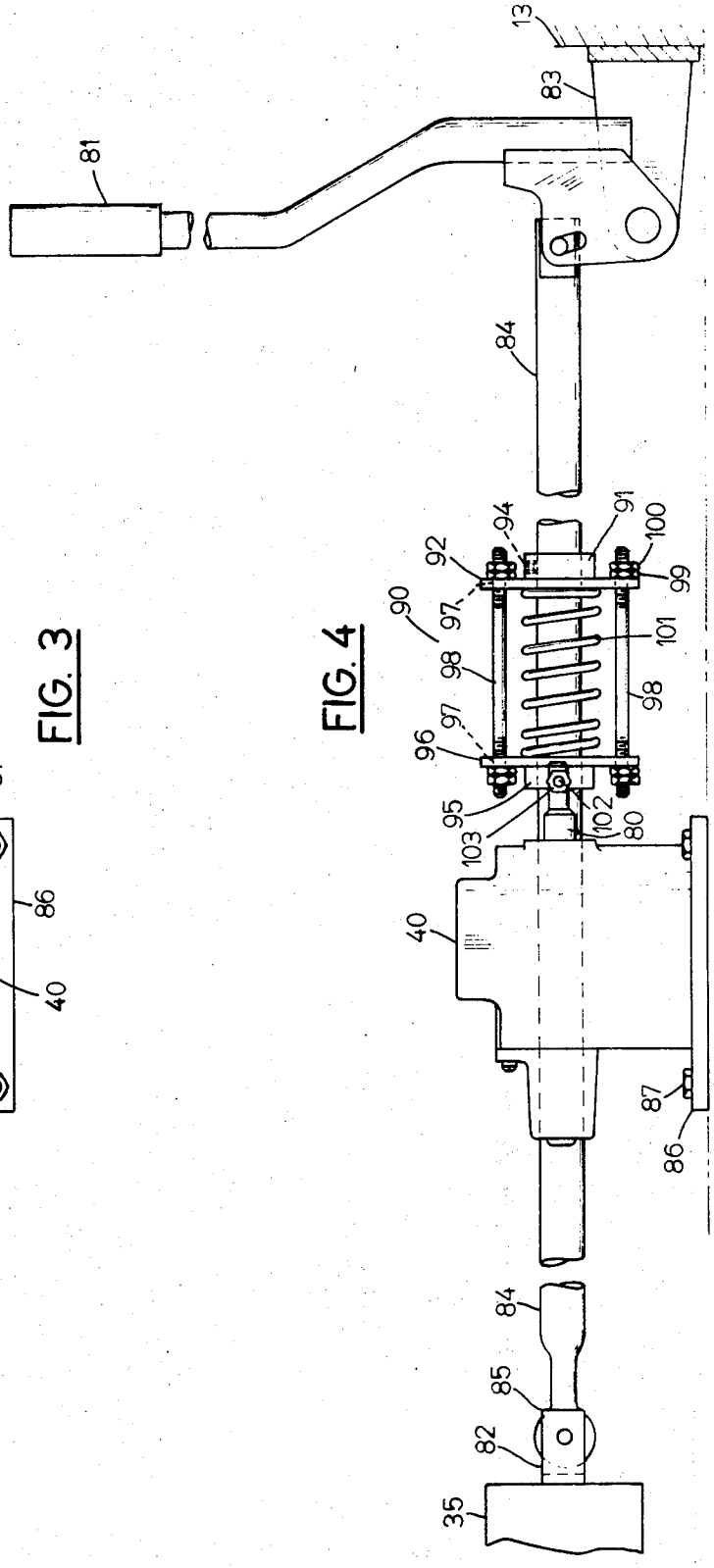
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FIG. 4

BOUNCE-PREVENTING CONTROL FOR HYDRAULIC CYLINDER

BACKGROUND OF THE INVENTION

1. Field of Use

This invention relates generally to hydraulic control for hydraulic cylinders to prevent bouncing as the cylinder rod is being retracted while subjected to a load. In particular, it relates to controls for boom hoist cylinders of cranes, back hoes or the like.

2. Description of the Prior Art

Some machines, such as cranes, back hoes and the like, have a boom which is raised and lowered by one or more hydraulic boom operating cylinders (called boom hoist cylinders) which have extendable and retractable cylinder rods. The boom hoist cylinder is supplied with pressurized fluid to raise and lower the boom from a main pump usually by means of a manually operable three-position main control valve having raise, lower and neutral positions. The boom hoist cylinder is provided with a two-position (closed and open) holding valve which prevents the cylinder rod from retracting when the boom is raised and a load is applied thereto. When the main control valve is moved to boom-lower position, to pressurize the cylinder for retraction of the cylinder rod, the holding valve is also opened to allow fluid flow from the cylinder. The holding valve is operated in response to pilot pressure from a two-position (close and open) pilot pressure control valve. Heretofore, the pilot pressure control valve was located on the cylinder and was operated in response to fluid pressure at the rod end of the cylinder. Since such fluid pressure tended to vary, especially if there was a heavy load on the boom, the result was that operation of both the pilot pressure control valve and the holding valve was also erratic and tended to cause the cylinder rod to fluctuate or bounce as it was being retracted. Such bouncing is undesirable because it imposes undesirable loads on the crane, and makes control of the descending load difficult and dangerous.

SUMMARY OF THE PRESENT INVENTION

In accordance with the present invention there is provided a machine, such as a crane, having a movable component, such as a boom, which is movable in opposite directions, such as to raised or lowered positions, by extension and retraction of the cylinder rod of at least one hydraulic cylinder, such as a boom hoist cylinder.

The cylinder is supplied with operating fluid from a pressurized fluid source, such as a motor-driven main pump on the machine, by means of a main control valve, such as a manually operable, lever operated, three-position (raise, lower, neutral) control valve.

The cylinder is provided with a holding valve, such as a two-position (open and close) valve, which when closed, for example, prevents fluid flow from one side of the cylinder and lowering of the boom.

The holding valve is operated to open position by pilot pressure fluid supplied from an pressurized fluid source which is independent of or unrelated to the source which supplies fluid to the cylinder. Fluid flow from the independent source to the holding valve is controlled by means of a pilot pressure control valve, such as a two-position (open and close) valve, which when opened, for example, supplies pilot pressure to open the holding valve. In a preferred embodiment of the invention the independent source of fluid for pilot pressure is, for example, an auxiliary motor-driven pump which also supplies operating fluid to other machine components, such as main and auxiliary winch brakes.

Means are provided to connect the pilot pressure control valve to the lever which operates the main control valve so that when the main control valve is in neutral, the pilot pressure control valve is closed, but when the main control valve is moved toward boom-lower position, the pilot pressure control valve opens. Such means allow the main control valve to be moved to boom-raise position while the pilot pressure control valve remains closed.

The aforedescribed hydraulic control means or systems for a hydraulic cylinder prevents bounce and enables smooth operation as the cylinder rod is retracted, especially when being retracted while subjected to a load, because pilot pressure control valve for the holding valve is not exposed to a fluctuating or variable source of pilot pressure. The pilot pressure control valve, while open, is only responsive to a steady flow of pilot pressure fluid from a fluid source totally independent of fluid pressure in the boom hoist cylinder or in the main pump. Furthermore, the pilot pressure control valve is open and closed in response to operation of a manual control lever, rather than in response to a pressure condition, and operates positively and simultaneously with operation of the main control valve.

Also, a control system in accordance with the invention is relatively uncomplicated to manufacture and service and is trouble-free in operation.

Other advantages and objects of the invention will hereinafter appear.

DRAWINGS

FIG. 1 is a side view of a crane having a boom bounce preventing control system for the boom operating hydraulic cylinders thereon in accordance with the invention;

FIG. 2 is a schematic diagram of the control system for the crane shown in FIG. 1;

FIG. 3 is a top view of the manually operable control means for the main control valve and the pilot pressure control valve shown in FIG. 1; and

FIG. 4 is a side view of the control means shown in FIG. 3.

DESCRIPTION OF A PREFERRED EMBODIMENT

FIG. 1 shows a mobile crane **10** comprising a chassis **11**, ground wheels **12**, an operator's cab **13**, a horizontally rotatable crane upper **14** mounted on the chassis, a telescopic boom **15** pivotably mounted on the crane upper, and a pair of boom hoist cylinders **16** and **17** (only **16** visible in FIG. 1) connected between the crane upper and the boom.

FIG. 1 shows that boom **15** comprises a plurality of telescopic boom sections, namely: a base section **20**, an inner mid section **21**, an intermediate mid section **22**, an outer mid section **23**, a fly section **24**, and a manual section **25**. The rear end of base section **20** has trunnion mounts **26** on opposite sides which receive pins **27** that pivotably mount the base section on crane upper **14**. The boom hoist cylinders **16** and **17** are located on opposite sides of base section **20** and are pivotably connected by pins **28** to support brackets **29** on crane upper **14**. The rod ends of the boom hoist cylinders **16**

and 17 are pivotably connected by pins 30 to connecting brackets 31 on opposite sides of base section 20. The forward end of manual section 25 has a working head 32 thereon which, for example, is provided with a pulley 33. The boom 15 also comprises a plurality of hydraulic cylinders therein (not shown) for extending and retracting the boom sections.

As FIG. 2 shows, the cylinders 16 and 17 are supplied with operating fluid from a pressurized fluid source, such as a motor-driven main pump 34 on the machine, by means of a main control valve, such as a manually operable, lever operated, conventional three-position (raise, lower, neutral) control valve 35. The cylinders 16 and 17 are provided with holding valves 36 and 37, respectively, each of which, for example, is a two-position (open and close) valve, which when closed, for example, prevents fluid flow from one side of its associated cylinder and thereby prevents lowering of the boom 15. The holding valves 36 and 37 are operated to open position by pilot pressure fluid supplied from a pressurized fluid source such as a pump 38 which is independent of or unrelated to the source or pump 34 which supplies fluid to the cylinders 16 and 17. Pump 38 is, for example, an auxiliary motor-driven pump which also supplies operating fluid to other machine components, such as main and auxiliary winch brake valves 42 and 43, respectively, through priority valves 44 and 45, respectively. Fluid flow from pump 38 to the holding valves 36 and 37 is controlled by means of a pilot pressure control valve, such as a two-position (open and close) valve 40, which when opened, for example, supplies pilot pressure to open the holding valves.

Priority valves 44 and 45 are each provided with a fluid input port P, a tank port T, a regulator port R and a by-pass port BP. The priority valves 44 and 45 serve to equally divide fluid flow from pump 38 to the brake valves 42 and 43, respectively, and also serve to supply fluid from pump 38 to the pilot pressure control valve 40. Pump 38 is connected by a fluid line 47 to fluid input port P of valve 44 which, in turn, is connected by an internal passage 48 to by-pass port BP of valve 44. Port BP of valve 44 is connected by a fluid line 49 to fluid input P of valve 45 which, in turn, is connected by an internal passage 50 to by-pass port BP of valve 45. port BP of valve 45 is connected by a fluid line 52 to a fluid input port IP of pilot pressure control valve 40. Valve 40 has a tank port TP which is connected by a fluid line 54 to tank port T of priority valve 44. The tank ports T of the priority valves 44 and 45 are interconnected by a fluid line 55 and port T of valve 45 is connected by a fluid line 56 to reservoir or tank 57. The ports R of the priority valves 44 and 45 are connected by fluid lines 60 and 61, respectively, to the main and auxiliary winch brake valves 42 and 43, respectively.

Pilot pressure control valve 40 is also provided with a fluid supply port A which is connected by a fluid line 63 to the pilot pressure port B of holding valve 36 of boom hoist cylinder 16. Port B of valve 36 is connected to pilot pressure port C of holding valve 37 of boom hoist cylinder 17 of a fluid cross-over line 64.

Main pump 34 is connected by a fluid supply line 70 to main valve 35 and the latter is connected by a fluid return line 71 to a fluid reservoir 72. Main valve 35 is also connected by fluid lines 73 and 74 to the extend and retract sides, respectively, of both boom hoist cylinders 16 and 17.

As FIG. 2 shows, means are provided to connect the spool 80 of pilot pressure control valve 40 to a manually operable control lever 81 which operates the spool 82 of the main control valve 35 so that when the main control valve is in neutral, the pilot pressure control valve is closed, but when the main control valve is moved toward boom-lower position, the pilot pressure control valve opens. Such means allows the main control valve to be moved to boom-raise position while the pilot pressure control valve remains closed.

As FIGS. 3 and 4 show, manual control lever 81 is mounted for pivotal movement on platform 83 located in the operator's cab 13 of crane 10 and is connected to one end of an axially movable control rod 84. The other end of control rod 84 is pivotably connected by a clevis 85 to spool 82 of main valve 35. Pivotal movement of the control lever 81 effects axial movement of spool 82 of valve 35 to raise, lower or neutral positions. Pilot pressure control valve 40 is rigidly secured by a valve mounting plate 86 and mounting bolts 87 adjacent control rod 84 so that its axially movable spool 80 is parallel to the control rod. A connecting assembly 90 is mounted on control rod 84 and connected to valve spool 80 of pilot pressure control valve 40. Assembly 90 comprises hollow cylindrical set collar 91 which is rigidly attached to a firstspring retainer plate 92 and is rigidly attachable to a desired position on control rod 84 by a set screw 94. A movable link collar 95 is slideably mounted on control rod 84 and is rigidly secured to a second spring retainer plate 96. The plates 92 and 96 are provided with suitable holes, such as 97, which accommodate a plurality of threaded rods 98 which are provided with spacer nuts 99 and lock nuts 100. A coiled compression spring 101 is disposed around control rod 84 between the spring retainer plates 91 and 96. Link collar 95 has a threaded stud 102 extending therefrom which is connected by nuts 103 to the end of spool 80 of pilot pressure control valve 40.

Assuming that manual control lever 81, control rod 84, main control valve spool 82, and pilot pressure control valve spool 80 are shown in neutral position in FIG. 2, operation is as follows. Leftward (forward) or boom-lower movement of lever 81 effects leftward movement of the valve spools 82 and 80 operates main control valve 35 which moves from neutral to boom-lower position and operates pilot pressure control valve 40 from closed to open position. Connecting assembly 90 taken into account any difference in spool travel between the two valves. Righward (rearward or neutral) movement of lever 81 effects rightward movement of the valve spools 81 and 80 and main control valve 35 moves from boom-lower to neutral position and operates pilot pressure control valve 40 from open to closed position. Further rightward (rearward or boom-hoist) movement of lever 81 effects rightward movement of the valve spool 82 (but no movement of valve spool 80) and main control valve 35 moves from neutral to boom-hoist position but pilot pressure control valve 80 remains closed.

DESCRIPTION OF OPERATION

Crane 10 operates in accordance with the invention as follows. Assume that boom 15 is in a hoist position, that both pumps 34 and 38 are in operation, that the brake valves 42 and 43 are closed, that manual control lever 81 is in neutral, that main control valve 35 is in

neutral, that pilot pressure control valve **40** is closed, and that the holding valves **36** and **37** for the boom hoist cylinders **36** and **37**, respectively, are closed.

To raise boom **15** further, the operator moves manual control lever **81** rearward from neutral (rightward with respect to FIG. **4**) to effect hoist operation of main control valve **35** and consequent hoist operation of the boom hoist cylinders **16** and **17**. Since pilot pressure control valve **40** remains closed, the holding valves **36** and **37** also remain closed.

To lower boom **15**, the operator moves manual control lever **81** forward from neutral (leftward with respect to FIG. **4**) to effect hoist operation of main control valve **35** and to simultaneously open pilot pressure control valve **40**. Opening of control valve **40** causes opening of the holding valves **36** and **37**, and the boom hoist cylinders **16** and **17** are enabled to perform a boom-lowering operation.

RESUME

A crane **10** has a boom **15** which is vertically movable to raised or lowered positions by extension and retraction of the cylinder rods of a pair of hydraulic boom hoist cylinders **16** and **17**. The cylinders **16** and **17** are supplied with operating fluid from a pressurized fluid source, such as a motor-driven main pump **34**, by means of a manually operable, lever operated, three-position (raise, lower, neutral) main control valve **35**. The cylinders **16** and **17** are provided with holding valves **36** and **37**, each of which is a two-position (open and close) valve, which when closed prevents fluid flow from one side of its hoist cylinder and prevents lowering of the boom. The holding valves **36** and **37** are operated to open position by pilot pressure fluid supplied from a pressurized fluid source, such as a pump **38**, which is independent of or unrelated to the pump **34** which supplies fluid to the cylinders **16** and **17**. Fluid flow from the pump **38** to the holding valves **36** and **37** is controlled by means of a pilot pressure control valve **40**, such as a two-position (open and close) valve, which when opened supplies pilot pressure to open the holding valves.

Means including a control rod **84** and a connecting assembly **90** are provided to connect the pilot pressure control valve spool **80** to the lever **81** which operates the main control valve spool **82** so that when the main control valve **83** is in neutral, the pilot pressure control valve **40** is closed, but when the main control valve **38** is moved toward boom-lower position, the pilot pressure control valve **40** opens. Such means allows the main control valve **35** to be moved to boom-raise position while the pilot pressure control valve **40** remains closed.

The system prevents hydraulic cylinder bounce and enables smooth operation as the cylinder rod is retracted under load, because the pilot pressure control valve **40** for the holding valves **36** and **37** is not exposed to a fluctuating source of pilot fluid pressure but only to a steady flow of pilot pressure fluid from an independent fluid source **38**. The pilot pressure control valve **40** operates in response to operation of the manual control lever **81** simultaneously with operation of the main control valve **35**.

I claim:

1. In a machine having a component movable in opposite directions by at least one extendible and retractable hydraulic cylinder, a main control valve having extend, neutral and retract positions for operating said cylinder, a releasable holding valve being open and closed positions to maintain said cylinder in extended position, a pilot pressure control valve for operating said holding valve, said valves each having an axially movable valve spool, independent sources of hydraulic operating fluid including separate pumps for said main control valve and for said pilot pressure control valve, and operating means comprising a manually operable lever and a control rod movable by said lever for operating said main control valve and said pilot pressure control valve, said control rod being connected to move the valve spool of said main control valve, and said operating means also comprising a connecting linkage between said control rod and the valve spool of said pilot pressure control valve, said operating means effecting operation of said pilot pressure control valve to cause opening of said holding valve when said operating means effects operation of said main control valve to retract position.

2. In a mobile crane having a boom,

at least one extendible and retractable hydraulic boom hoist cylinder for raising and lowering said boom,

a first pump for supplying pressurized fluid to operate said cylinders,

a main control valve connected between said first pump and said cylinder to operate the latter,

said main control valve having boom-hoist, neutral, and boom-lower positions,

a holding valve on said cylinder and having a closed position to maintain said boom extended and having an open position to allow retraction of said boom,

a second pump,

a pilot pressure control valve connected between said second pump and said holding valve to operate the latter,

said pilot pressure control valve having a closed position wherein it maintains said holding valve in closed position and having an open position wherein it maintains said holding valve in open position,

and operating means for said main control valve and said pilot pressure control valve, said operating means effecting closure of said pilot pressure control valve when said main control valve is in neutral position; effecting opening of said pilot pressure control valve when said main control valve is in boom-lower position; and effecting closure of said pilot pressure control valve when said main control valve is in boom-hoist position.

3. A crane according to claim **2** wherein said main control valve and said pilot pressure control valves both have axially movable valve spools and wherein said operating means comprises:

a manually operable control lever,

a control rod connected to said main control valve spool and movable by said lever,

and a connecting linkage between said control rod and said pilot pressure control valve spool.

4. A crane according to claim **3** wherein said connecting linkage comprises:

a first member affixed to and movable with said control rod,

a second member connected to said pilot pressure control valve spool and spaced from said first member,

a compression spring disposed between said first and second members,

and means connected between said first and second members to limit separation of said members while allowing said members to move toward each other.

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