United States Patent

Seaberg

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[54] **HYDRAULIC CONTROL SYSTEM FOR BACKHOES**

[72] Inventor: **David H. Seaberg**, Davenport, Iowa

[73] Assignee: **J. I. Case Company**

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[52] **U.S. Cl.**.....**214/138 R**, 91/6, 91/387

[51] **Int. Cl.**.....**E02f 3/30**

[58] **Field of Search**.....91/387, 6; 214/138 R, 138 C, 214/762

[56] **References Cited**

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Primary Examiner—Philip Arnold

Attorney—Dressler, Goldsmith, Clement & Gordon

[57] **ABSTRACT**

A hydraulic control system for controlling the pivotal movement of a swing tower of a backhoe and accurately positioning the swing tower in predetermined positions relative to a support. The hydraulic control circuit includes first and second valves disposed in parallel between a fluid motor, a reservoir and pressurized fluid source. The valve spools of the two valves are interconnected by a linkage which can be moved manually to simultaneously move both valves to an actuated position. Signal means cooperate with the swing tower and the linkage to sequentially neutralize the respective valves as the tower approaches a predetermined portion so that only one valve is in an actuated position when the swing tower is in close proximity to the predetermined position and can accurately position the tower.

13 Claims, 3 Drawing Figures

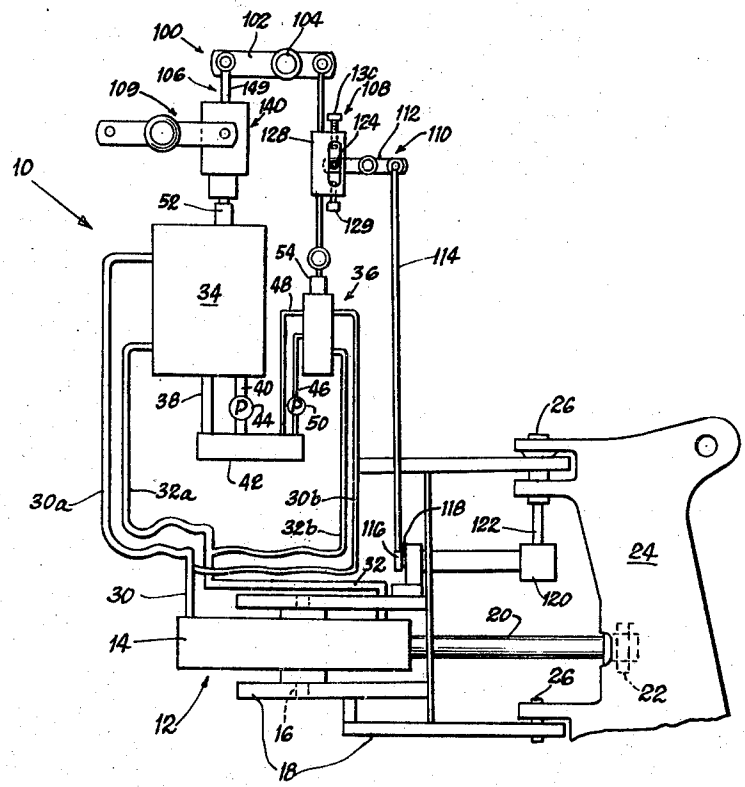
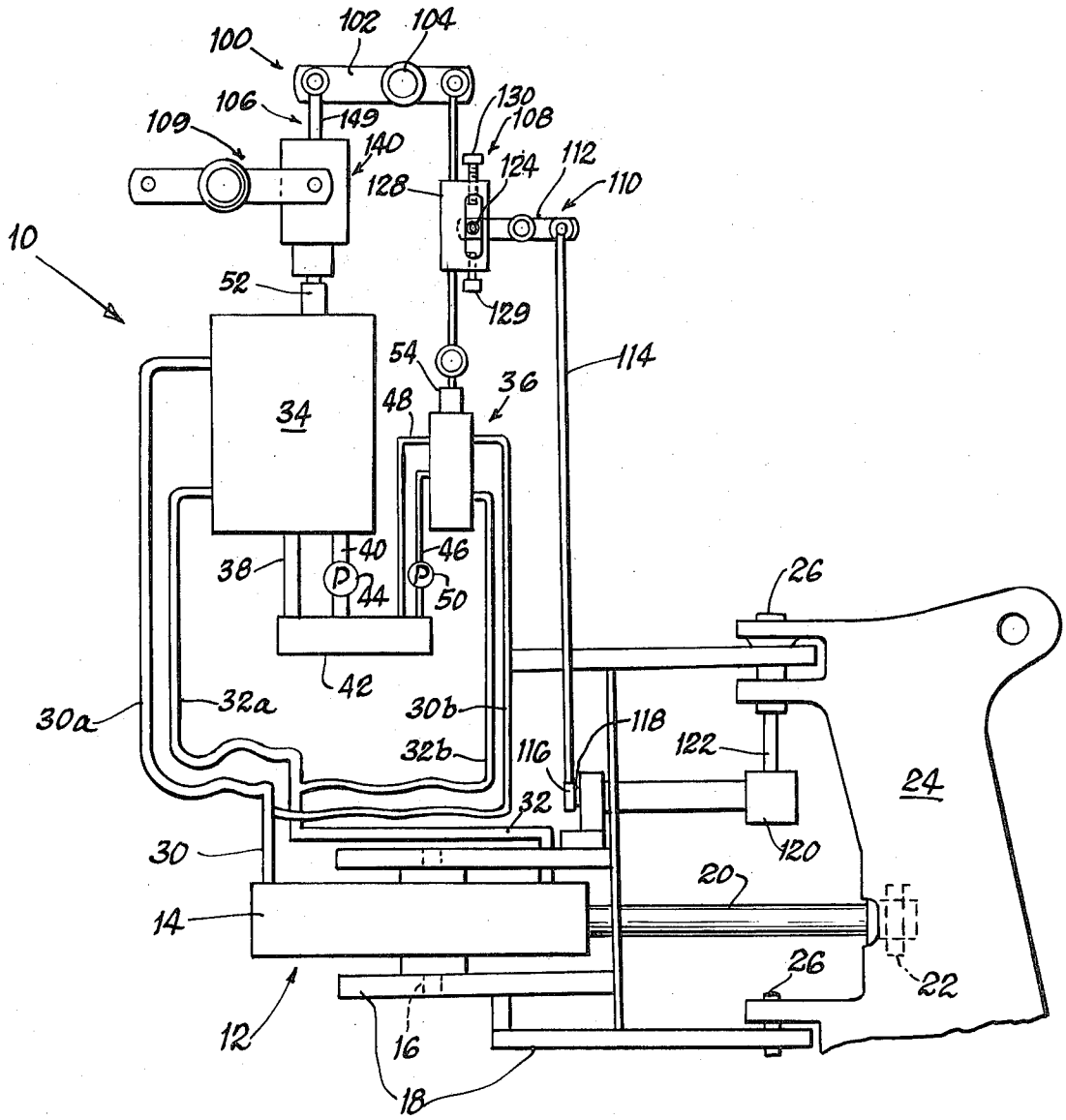


FIG. 1



INVENTOR
David H. Seaberg
by Dressler, Goldsmith, Clement & Gordon Att'ys

FIG. 2

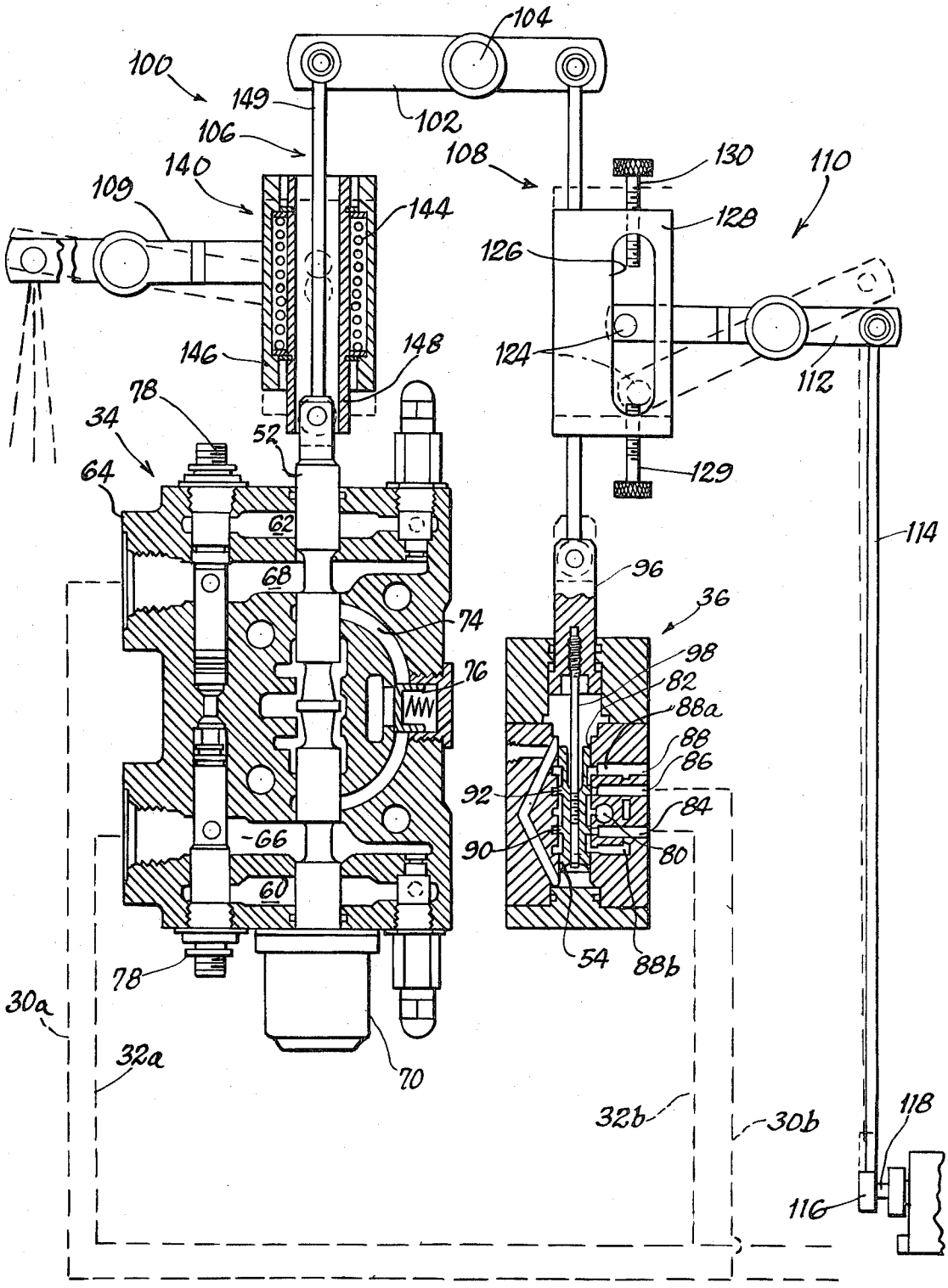
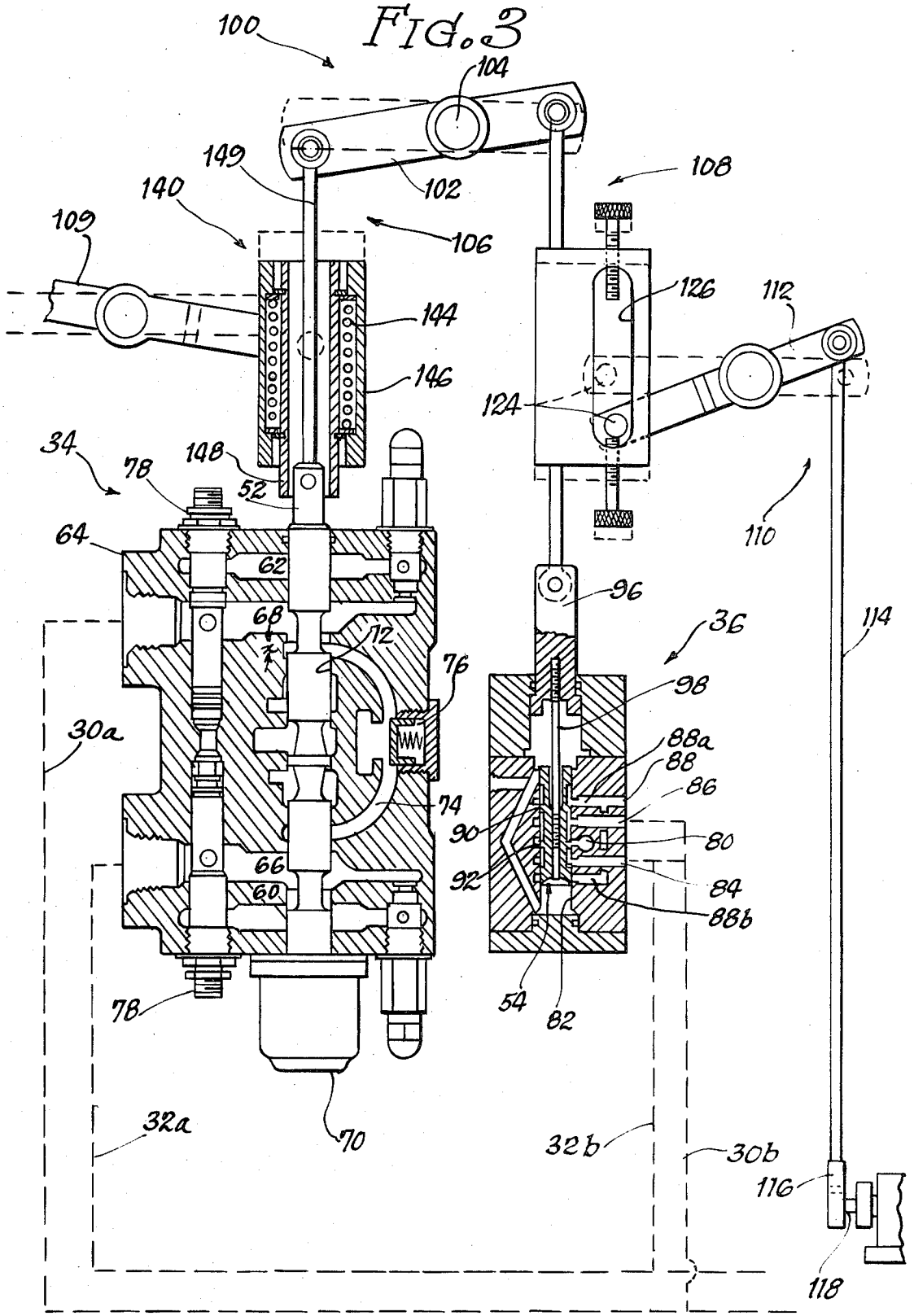

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88b
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32a
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32b
30b
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FIG. 3


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32b
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HYDRAULIC CONTROL SYSTEM FOR BACKHOES

BACKGROUND OF THE INVENTION

The present invention relates generally to backhoes and more particularly to an improved control system for hydraulically actuated backhoes.

Backhoe units generally consist of a plurality of pivotally interconnected arms with a bucket pivotally mounted on a free end of one arm while the free end of another arm is pivoted on a swing tower about a horizontal axis. Generally, the pivotal movement of the arms relative to each other and to the swing tower is controlled through fluid rams and the bucket is likewise pivoted on the associated arm by a fluid ram. Furthermore, the swing tower is generally pivoted about a vertical axis on a support attached to the rear end of the tractor and the pivotal movement is accomplished through one or more fluid motors.

Units of this type are called "backhoes" since they are normally mounted at the rear of a tractor unit and perform the digging or trenching operation towards the tractor, the direction in which the tractor is positioned to travel. In a trenching operation, it is customary for the operator to position the unit to have the bucket aligned with the trench and to then manipulate the controls to supply fluid to the various rams and fill the bucket with material. Thereafter, the backhoe unit is pivoted on the swing tower sufficiently to raise the bucket above the level of the ground and the swing tower is pivoted about the vertical pivot axis on the support by the fluid motor to locate the bucket to one side of the trench for dumping the material.

After the bucket has been dumped, it is necessary for the operator to manipulate the unit to a position where the bucket is again in alignment with the trench for a subsequent bucket filling operation. The movement of the bucket between the centered and dumped positions requires considerable time and skill in order for the bucket to be properly located with respect to the trench after each dumping operation.

SUMMARY OF THE INVENTION

The present invention contemplates automatically positioning the bucket in alignment with the trench and also in a predetermined dumped position without manipulation of any control levers or foot pedals. According to the invention, this is accomplished by merely having the operator actuate the hydraulic control circuit and hold the manual control member in an operative position. After the actuation of the control system, the automatic mechanism of the present invention will accurately position the unit at a predetermined position, which may be the "dumping" position or the "trenching" position.

Accordingly, the hydraulic control system of the present invention includes a fluid motor for pivoting the tower on the support or frame and the usual reservoir, pump, conduits and a control valve for supplying pressured fluid to the motor and pivot the tower in opposition directions. In addition, a second valve is placed in parallel with the first valve between the fluid motor and the pressured source and the two valves are simultaneously actuated when the swing tower is to be pivoted on the support. A sensing means cooperating with the swing tower operates to sequentially neutralize the first valve and subsequently the second valve.

For this purpose, the two valve spools are operatively interconnected by linkage means including a lever pivoted intermediate its ends with a first link connecting one end of the lever to one spool and a second link connecting the opposite end of the lever to the second spool. The sensing means is operatively connected to one of the links through a lost motion connection which includes an elongated slot in the link and an element of the sensing means disposed within the slot. Adjustable means in the form of said screws cooperate with opposite ends of the slot to vary the effective length of the slot and the adjusting means define the respective stopping positions for the swing tower.

In addition, the manual control means is connected to one of the links through a resilient connection in the form of a spring so that the linkage means and control means are moved simultaneously when the valve spools are moved to an actuated position while the linkage means can move relative to the manual control means as the valve spools are moved to a neutral position. This allows the operator to maintain the manual control means in an operative position while the spools are automatically moved to a neutral position, as will be explained in more detail hereinafter.

The sequential neutralization of the two valves comes as a result of having a large neutral band of movement for the valve spool in one of the valves with only a small neutral band for the other of the valves. In addition, it is desirable to have the majority of fluid supplied to the motor passing through the first valve with only a small segment of the fluid being supplied through the second valve. This further allows for accurate positioning of the swing tower relative to the support.

An additional feature of the present invention is that the hydraulic control system automatically compensates for any "overswing" which inherently occurs in systems of this type because of the large mass that is being pivoted with the swing tower. In the event there is any overswinging of the entire unit, the second valve spool will automatically actuate in the opposite direction to return the bucket to the desired position. Heretofore, "overswing" was controlled exclusively by cross-over relief valves in the system which, many times, did not operate exactly as intended.

BRIEF DESCRIPTION OF SEVERAL VIEWS OF DRAWINGS

FIG. 1 shows a hydraulic control system having the present invention incorporated therein and connected to portions of the backhoe; and

FIGS. 2 and 3 show portions of the hydraulic circuit in various operative positions.

DETAILED DESCRIPTION

While this invention is susceptible of embodiment in many different forms, there is shown in the drawings and will herein be described in detail one specific embodiment, with the understanding the the present disclosure is to be considered as an exemplification of the principles of the invention and is not intended to limit the invention to the embodiment illustrated.

Referring to FIG. 1 of the drawings, the hydraulic control system is generally designated by the reference numeral 10 and includes a fluid motor or ram 12 having

its cylinder 14 trunion mounted at 16 on a fixed support 18 while the piston rod 20 is pivotally connected at 22 to the swing tower 24. The swing tower 24 is pivoted on the support 18 about a vertical pivot axis defined by pins 26. Since the remainder of the backhoe forms no part of the present invention no detailed description thereof appears to be necessary. However, for purposes of completeness, the remaining portion of the backhoe unit may be of the type disclosed in U.S. Pat. No. 3,376,984, issued to Elton B. Long, assigned to the assignee of the present invention, and incorporated herein by reference.

The hydraulic control system 10 further includes conduits 30 and 32 respectively connected to opposite ends of the cylinder 14. The respective conduits are divided into branch conduits 30*a*, 30*b*, 32*a* and 32*b* leading to two control valves 34 and 36. Further conduits 38 and 40 connect the valve 34 to a reservoir 42 with the conduit 40 having a pump 44 located therein. Likewise, control valve 36 is connected to the reservoir 42 through conduits 46 and 48 with conduit 46 having a second pump 50 disposed therein. Thus, actuation of valve spools 52 and 54, forming part of the respective valves, will selectively supply pressured fluid to opposite ends of the cylinder 14 and thereby pivot the swing tower 24 in opposite directions on the support 18.

FIG. 2 of the drawings discloses the internal construction of the respective valves. Pressured fluid from conduit 40 is supplied to the bore 72 in the valve housing 64 through passage 74. Spaced chambers 60 and 62 are formed in the valve housing 64 and are in communication with the reservoir 42 through conduit 38 while the conduits 30*a* and 32*a* communicate with chambers 66 and 68. The valve spool 52 is biased to a neutral centered position by a biasing means 70 and, in the neutral position, blocks flow of fluid from the chambers 66 and 68. However, movement of the valve spool 52 in opposite directions from the neutral position, for example downward in FIG. 2, will place the chambers 60 and 66 in communication with each other through the valve bore 72 while placing chamber 68 in communication with the pressure passage or port 74. Thus, pressured fluid will be supplied to the head end of the cylinder 14 while the rod end thereof will be connected to the reservoir 42. Movement of the valve spool in the opposite direction will reverse the connections to retract the piston rod 20. A relief valve 76 cooperates with the pressure port 74 while crossover or cushion relief valves 78 cooperate with the chambers 60 and 62, the latter valve being capable of placing the two chambers in communication with each other to reduce cavitation tendencies.

The second or metering valve 36 has pressured fluid supplied from conduit 46 to an inlet port 80 located at the center of the valve bore 82 while conduits 32*b* and 30*b* respectively communicate with ports 84 and 86 communicating with valve bore 82 on opposite sides of the port 80. The conduit 48 is connected to a port 88 which communicates with the valve bore on opposite sides of the ports 84 and 86 through branch ports 88*a* and 88*b*.

The valve spool 54 of the valve 36 has spaced lands 90 and 92 which are positioned on the spool 54 to block the ports 84 and 86 when the spool is in the neutral position, shown in FIG. 2. However, movement of the valve spool in opposite directions from neutral will connect one of the ports 84,86 to the source of the pressured fluid 80 while connecting the other port to the reservoir 42. For this purpose, the valve spool 54 has an extension 96 connected thereto by a threaded rod 98.

The hydraulic control system 10 further includes linkage means 100 interconnecting the spools 52 and 54 for simultaneous movement. The linkage means 100 includes a lever 102 pivoted at 104 intermediate its ends on the support 18. A first link 106 connects one end of the lever 102 to the valve spool 52 while the opposite end thereof is connected to the spool 54 through a second link 108. A manual control means 109 cooperates with link 106 while a sensing means 110 cooperates with the second link 108.

The sensing means 110 (FIG. 1) includes a link 112 pivoted intermediate its ends on a support with one end connected through a rod 114 to an arm 116 carried on one end of a shaft 118. The shaft 118 is rotated in opposite directions in response to pivotal movement of the swing tower 24 through a miter gear box 120 connected to the pivot pin 26 through a stub shaft 122. The opposite end of the link 112 has a pin or element 124 fixedly secured thereto and received in an elongated slot 126 defined on the link 108. The slot 126 is defined in an enlarged member 128 forming an intermediate portion of the link 108. First and second adjustable means 129 and 130 are threaded into opposite ends of the member 128 and have their free ends located within the slot 126, for a purpose which will be described later.

The manual control means 109 is connected to the link 106 through a resilient connection 140 that allows relative movement between the link 106 and the member 109, for a purpose which will be described later. The resilient connection or means 140 includes a spring 144 interposed between an outer member 146, having the manual means or lever 109 connected thereto, and an inner member 148 connected to the valve spool 52. In addition, the valve spool 52 is directly connected to the lever 102 through a rod 149.

The operation of the hydraulic control system will best be understood with reference to FIGS. 2 and 3. The two valve spools are simultaneously actuated by pivoting the manual control means or lever 109 from the solid to the dotted line position in FIG. 2. This pivotal movement may either be through a foot pedal or a hand lever (not shown) and will move the valve spool downward to place the pressurized port 74 in communication with chamber 68 while placing chambers 60 and 66 of valve 34 in communication with each other thereby supplying pressured fluid through conduit 30*a* and connecting conduit 32*a* to the reservoir. Simultaneously, the valve spool 54 will be moved upward, as viewed in FIG. 2, to the dotted line position and will place port 86 in communication with pressurized port 80 to supply pressurized fluid to conduit 30*b*. This will cause the piston rod 20 (FIG. 1) to be extended thereby pivoting the swing tower from a first position, such as the dumped position, to a second or centered position in alignment with a trench, that is in the process of being dug.

The pivotal movement of the swing tower **24** will be transmitted through the sensing means **110** and will cause downward movement of the pin **124** from the solid towards the dotted line position of FIG. **2**. As the pin **124** approaches the lower end of the elongated slot **126**, it will contact the free end of the adjustment screw **129** and will begin to pivot the lever **102** in a clockwise direction and move the valve spools **52** and **54** towards their neutral positions. During such movement, the spring **144** will become compressed to allow the manual control member **109** to remain in an actuated position while the linkage and the valve spools are moved to the neutral positions. It should be noted that spring **144** exerts a force, between members **146** and **148** that is slightly greater than the force required to move the spools and the linkage. Thus, the spring or elastic means will act as a fixed connection between the manual means when the linkage is moved by the manual means and accommodates relative movement between the linkage and manual means when the linkage is moved by the sensing means.

An inspection of FIG. **3** reveals that the valve spool **52** has a relatively large "neutral dead band" which must be traversed to move the valve spool from a spring biased neutral position to an actuated position. Stated another way, once the valve spool has moved axially by the dimension *x* in FIG. **3**, the flow of fluid between chambers **60** and **66** as well as **62** and **68** is blocked so that no more fluid is being supplied through the first valve **34** to the fluid motor **12**. During the remaining portion of travel of the spool **52** in the neutral band, from the solid line position of FIG. **3** to the solid line position of FIG. **2**, the valve spool **54** of valve **36** will still be in a position to accommodate flow to the cylinder. It will be noted from an inspection of FIG. **2** that the axial length of the lands **90** and **92** is substantially equal to the axial dimension of the ports **84** and **86**. Therefore, fluid will be supplied through the valve **36** until such time as the valve spool is in its centered neutral position.

With the relatively large "neutral band" in valve **34** and virtually no "neutral band" in valve **36**, the valve **34** will be neutralized in advance of the valve **36** while the linkage **100** simultaneously moves both valve spools. Furthermore, by having a greater flow capacity through valve **34** than through valve **36**, the tower can be very accurately positioned because of the limited flow of fluid through valve **36**. By way of specific example and not of limitation, the pump **44** may have an output of 25 GPM while the pump **50** has an putput of 5 GPM. Of course various other methods could be used for varying the flow capacity through the respective valves. For example, the valves could be supplied from a single pump and the internal structure of the valves could be designed to vary the maximum flow capacities.

While the fluid motor for the swing tower has been shown as a single cylinder assembly, two fluid rams or other alternate equivalent motors could be substituted for the single cylinder assembly.

I claim:

1. In a backhoe having a tower pivoted about a fixed pivot axis on a support by a fluid motor interposed between said tower and said support, a hydraulic control system controlling the supply of fluid to said fluid motor and comprising a pressurized fluid source; a reservoir; conduit means connecting said source and reservoir to said fluid motor; valve means in said conduit means for controlling the flow of fluid to and from said motor; and manual means for actuating said valve means, the improvement of means for accurately positioning said tower in a predetermined position relative to said support, said last means including first and second valves defining said valve means and connected in parallel between said source and reservoir and said motor and actuating means responsive to pivotal movement of said tower for sequentially neutralizing said valves.

2. A backhoe as defined in claim **1**, in which said first valve has a flow capacity substantially greater than said second valve so that a majority of fluid supplied to said motor passes through said first valve.

3. A backhoe as defined in claim **1**, in which said valves each have a valve spool movable in opposite directions from a neutral position, and said activating means includes linkage means interconnecting said spools for simultaneous movement with said manual means cooperating with said linkage means.

4. A backhoe as defined in claim **3**, in which said linkage means includes adjustable means for varying said predetermined position.

5. A backhoe as defined in claim **3**, and including sensing means connected to said tower and cooperating with said linkage means, and a lost motion connection between said sensing means and said linkage means.

6. A backhoe as defined in claim **3**, in which said linkage means includes a lever pivoted intermediate its ends on said support adjacent said spools; first and second links respectively connecting opposite ends of said lever to the respective valve spools, said manual means cooperating with one of said links; and sensing means connected to the other of said links.

7. A backhoe as defined in claim **6**, in which said other of said links has an elongated slot and said sensing means has an element in said slot moved in response to pivotal movement of said tower on said support; and adjustable means cooperating with one end of said slot and engaged by said element when said tower approaches said predetermined position to move said linkage means and said valve spools to a neutral position, said adjustable means being capable of varying said predetermined position.

8. A backhoe as defined in claim **7**, and further including elastic means between said manual means and said one of said links accommodating movement of said linkage means to said neutral position while said manual means is in an actuated position.

9. A backhoe as defined in claim **7**, and including a second adjustable means cooperating with an opposite end of said slot to define a second variable predetermined position.

10. In combination with a backhoe having a swing tower pivoted about a vertical axis on a support by a fluid motor, a hydraulic control system including a pressurized fluid source; a reservoir; conduit means connecting said source and said reservoir to said fluid motor; valve means including first and second valve spools connected in parallel in said conduit means and movable in opposite directions from a neutral position; linkage means connected to said valve spools; manual

means cooperating with said linkage means for actuating said spools in either direction from said neutral position and pivot said tower in opposite directions on said support; and sensing means connected to said tower and cooperating with said linkage means to sequentially move said valve spool to said neutral positions when said tower is in predetermined extreme pivoted positions on said support.

11. The combination as defined in claim **10**, further including adjustable means for varying said positions.

12. The combination as defined in claim **11**, in which said sensing means is connected to said linkage means by a lost motion connection to accommodate relative movement and said adjustable means varies the amount of relative movement.

13. The combination as defined in claim **12**, further including means between said linkage means and said manual means (1) defining a fixed connection between said manual means and linkage means when said linkage means is moved by said manual means and (2) accommodating relative movement between said manual means and linkage means when said linkage means is moved by said sensing means.

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