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[54] **FLUID SYSTEM AND VALVE ASSEMBLY THEREFOR**
10 Claims, 1 Drawing Fig.

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[51] **Int. Cl.** **F16k 11/10,** F16k 11/02
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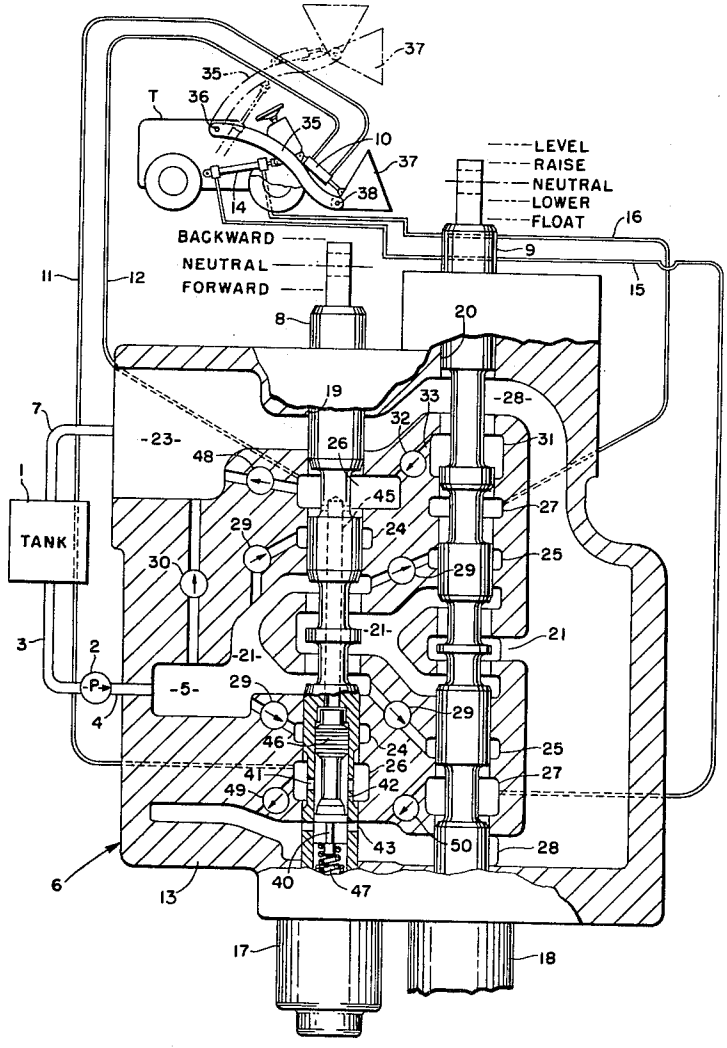
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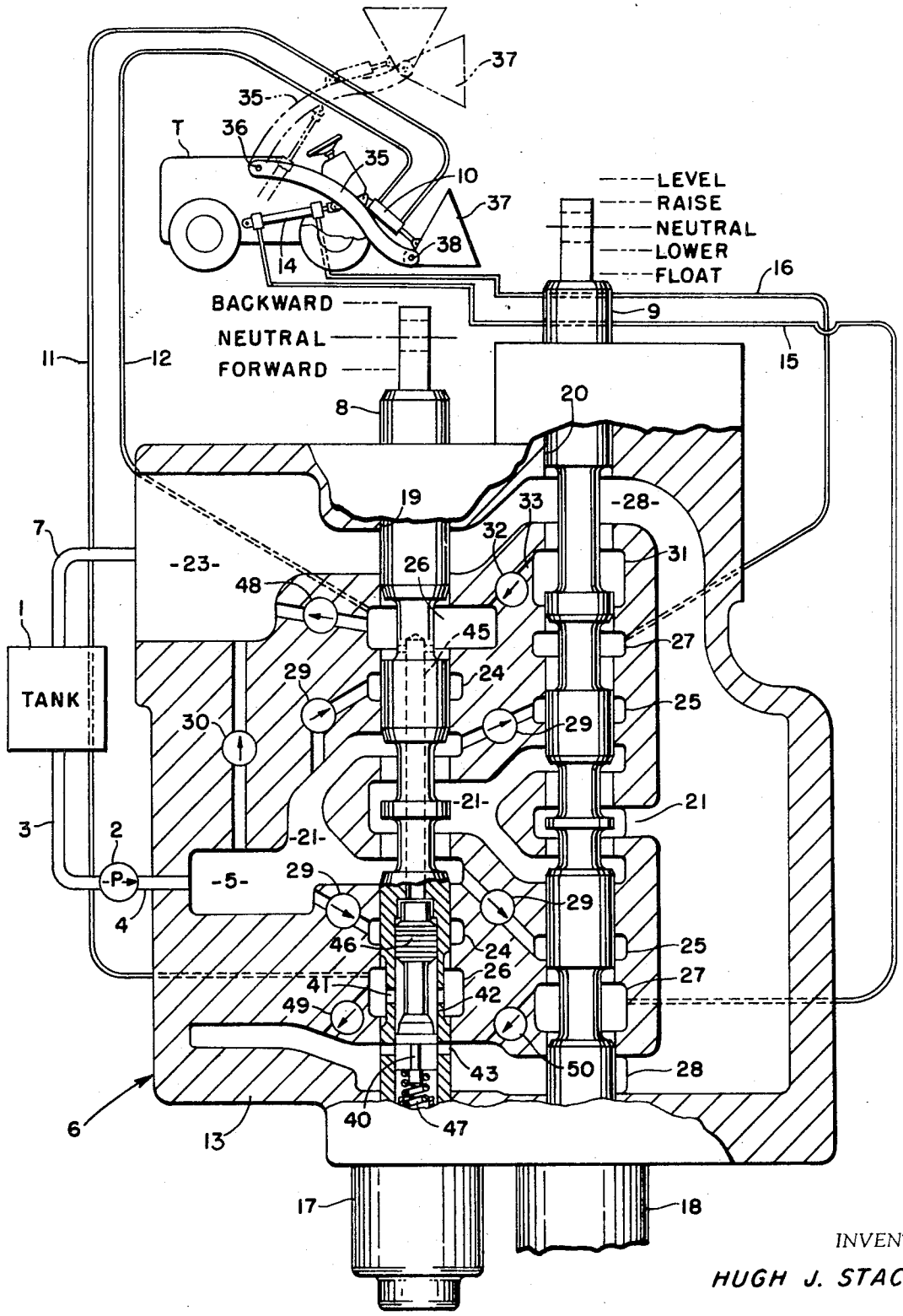
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ABSTRACT: A spool-type valve assembly for automatically leveling the bucket (or scoop) of a front end loader or the like during raising of the boom thereof characterized in that the boom hoist and bucket tilt spool valves are arranged in series so that when the boom hoist spool is in boom raise-bucket leveling position and when the bucket tilt spool is in neutral position, the returning fluid from the boom hoist cylinder is conducted to the tilt cylinder via a check valve between the adjacent motor passages of said valves. A flow control valve for permitting return flow from the tilt cylinder during the automatic leveling operation is disposed within the bucket tilt spool and has a plunger portion in communication with the aforesaid motor passage of the bucket tilt valve so that the flow control valve will open the return passage of the bucket valve in response to pressure acting on the plunger portion and will close the return passage in response to decrease in pressure acting on the plunger portion to prevent the bucket from running ahead of the oil being supplied thereto from the hoist cylinder.





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FLUID SYSTEM AND VALVE ASSEMBLY THEREFOR

BACKGROUND OF THE INVENTION

In a front end loader or the like, there is usually provided a boom which is pivotally mounted on the tractor and which at its free end pivotally carries a bucket, the boom and bucket being controlled by four-way spool valves to raise and lower the boom and to tilt the bucket between loading, holding, and dumping positions. When the bucket is loaded with the boom in down position and with the bucket tilted forward, the material is held in the bucket by tilting the bucket backward so that it is in substantially a vertical position to retain the load therein. However, without automatic leveling equipment if the boom were raised, the load may be dumped on the operator since the bucket will tilt backward as the boom is raised.

In the U.S. Pat. to Stacey No. 3,251,277, granted May 17, 1966, there is disclosed hydraulic leveling means which comprises a separate manifold housing secured to the two-spool directional directional control valve assembly, said manifold housing having therein a check valve communicating the return motor passage of the bucket spool valve with the motor passage the bucket tilt spool valve via a check valve in said manifold housing. Said manifold housing also contains a flow control valve which has a plunger portion exposed to pressure leading to the bucket tilt cylinder whereby return flow from the bucket tilt cylinder during the leveling operation can only occur when there is a positive pressure in the motor passage leading to the bucket tilt cylinder. In this way the bucket is prevented from running ahead at a rate exceeding the rate of supply of oil for bucket leveling derived from the returning fluid from the boom hoist cylinder.

SUMMARY OF THE INVENTION

Contrary to the foregoing, in the present valve assembly the unitary housing for the boom hoist and bucket tilt spools has therein a check valve between adjacent motor passages to conduct oil from the boom hoist cylinder to the forward tilt port of the bucket tilt cylinder when the boom hoist spool is in hoist-level position and when the bucket tilt spool is in neutral position whereby, as the boom is being raised, the bucket is leveled by being tilted forward thus to prevent load dumping on the operator. The bucket tilt spool is hollow and has therein a flow control valve which opens the bucket cylinder return circuit when there is predetermined fluid pressure in the motor passage leading to said forward tilt port and which closes the bucket cylinder return circuit when such fluid pressure decreases to less than such predetermined value thus to prevent the bucket cylinder from running ahead of the oil being supplied thereto through said check valve.

BRIEF DESCRIPTION OF THE DRAWING

The single FIGURE of the drawing illustrates a preferred embodiment of the present fluid system and valve assembly therefor, the valve assembly being shown in cross section.

DETAILED DESCRIPTION OF THE INVENTION

As shown in the drawing, the fluid system as a whole comprises a tank 1, a pump 2 which draws fluid from the tank 1 through conduit 3 and delivers it under pressure through conduit 4 to the inlet port 5 of a directional control valve assembly 6, the fluid being returned by way of the conduit 7 to the tank 1 in the event that both valve spools 8 and 9 are in neutral position. The valve spool 8 controls actuation of the bucket tilt cylinder 10 and to this end the valve housing 13 has conduits 11 and 12 connected to the opposite ends of the bucket tilt cylinder 10. The other valve spool controls the operation of the boom hoist cylinder 14 and to that end the valve housing 13 has conduits 15 and 16 connected to the opposite ends of the boom hoist cylinder 14. The reference numerals 17 and 18 denote the spring return and spring return-detent mechanisms for the respective spools 8 and 9, the mechanism 18 being effective to yieldably retain the valve spool 9 in one or more operating positions and to automatically restore the spool to its neutral position when the detent positioning stop has been overcome by manual force applied on the spool 9. These mechanisms 17 and 18 may be of known construction and therefore have not been illustrated in detail herein.

Referring now in detail to the directional control valve assembly 6, the valve housing 13 has two parallel bores 19 and 20 in which the respective spools 8, 9 are axially reciprocable. Each bore 18 and 19 is intersected axially therealong starting at the middle by a conventional bypass passage 21 which communicates the inlet port 5 with the return port 23 when both spools 8 and 9 are in neutral position; by a pair of pressure feed passages 24;24 and 25;25 straddling the bypass passage 21; by a pair of motor passages 26;26 and 27;27 which lead to the respective motors 10 and 14 via conduits 11–12 and 15–16; and by a pair of return passages 28;28 which communicate with the bypass passage 21 and return port 23. The pressure feed passages 24;24 and 25;25 are communicated with the portion of the bypass passage 21 which is upstream of both spools 8 and 9 through check valves 29 which prevent reverse flow from one motor 10 or 14 to the other in the event that one motor has a greater load thereon than the other and which prevent load dropping in the event of loss of pump pressure. Between the inlet port 5 and the return passage 28 is a relief valve 30 which limits the maximum pressure of the system, and between the upper motor and return passages 27 and 28 is an automatic leveling passage 31 which, as hereinafter explained in detail, is in effect an extension of the upper motor passage 27 to communicate the latter with the upper motor passage 26 via the check valve 32 and passage 33, or with the upper return passage 28.

The front end loader herein shown comprises a tractor T with a pair of boom arms 35 pivoted thereto at 36 and a bucket or scoop 37 pivoted at 38 to the free ends of said boom arms 35.

With reference to the bucket tilt circuit, it can be seen that when the bucket spool 8 is moved downwardly or upwardly from the neutral position to the "FORWARD" or "-BACKWARD" position, the bypass passage 21 will be closed and fluid under pressure will be conducted to either end of the bucket tilt cylinder 10 through one set of adjacent passages 24–26 and the return flow from the other end of the bucket tilt cylinder 10 will be conducted to the tank 1 through the other set of adjacent passages 26–28.

With reference to the boom hoist circuit, when the boom spool 9 is moved downwardly or upwardly from the neutral to the "LOWER" or "RAISE" position, the bypass passage 21 will be closed and fluid under pressure will be conducted to either end of the boom hoist cylinder 14 through one set of adjacent passages 25–27 and the return flow from the other end of the boom hoist cylinder 16 will be conducted to the tank 1 through the other set of adjacent passages 27–28 (LOWER position) or through passages 27-31-28 (RAISE position). When the boom spool 9 is moved further upwardly to "LEVEL" position, the bypass passage 21 is closed, the lower pressure feed and motor passages 25–27 remain in communication to raise the boom 35, and the upper motor passage 27 remains in communication with the leveling passage 31 while the latter is blocked from the upper return passage 28. Accordingly, the displaced fluid from the upper end of the boom hoist cylinder 14 is returned to upper motor passage 26 via upper motor passage 27, leveling passage 31, and check valve 32. In this way, the fluid under pressure in upper motor passage 26 flows the conduit 12 into the head end of the bucket tilt cylinder 10 to maintain the bucket 37 in level position as the boom 35 is being raised, the displacement of the boom hoist cylinder 14 being related to the displacement of the bucket tilt cylinder 10 to maintain the bucket 37 in approximately level load holding position. The displaced oil from the rod end of the bucket tilt cylinder 10 is returned to the tank 1 via the lower motor passage 26 and the flow control

valve 40 which opens communication between the lower motor and return passages 26 and 28 through passages 41, 42, and 43 of the spool 8, the valve 40 being opened by pressure in upper motor passage 26 in spool passage 45 acting on the plunger portion 46 of said flow control vale 40. Return flow from the bucket cylinder 10 can only occur when the fluid pressure acting on the plunger 46 is sufficient to overcome the bias of the spring 47 which acts on the control valve 40. Thus the bucket 37 is prevented from moving any more than is necessary to maintain it in approximately level condition, since if it tends to move faster than the displacement of oil from the boom hoist cylinder 14, the pressure in the upper motor passage 26 and spool passage 45 will drop with consequent closing of the flow control valve 40. fluid from the motor course, the bucket 37 cannot move in the other direction because of the positive displacement of oil from the boom hoist cylinder 14 per increment of hoisting movement.

If the bucket 37 is rolled forward before the boom lifting-bucket leveling operation is started, and if the bucket cylinder 10 bottoms out while being lifted, the relief valve 48 will allow the oil from the boom cylinder 14 to return to the tank 1 via return port 23 whereby the boom lifting operation may be completed. The bucket tilt spool 8 can, at any time, take over the operation of the bucket 37 and override the automatic leveling.

Lowering of the boom 35 is done in the normal manner without leveling of the bucket 37. Thus, the boom spool 9 will be shifted downwardly from the neutral position to "LOWER" position whereby fluid under pressure flows through the upper check valve 29 into the upper feed and upper motor passage 27. The fluid displaced by the lower end of the boom hoist cylinder 14 is conducted to the tank 1 via the intercommunicating lower motor and lower return passages 27 and 28.

When the boom spool 9 is shifted downwardly beyond the "LOWER" position to the "FLOAT" position, the bypass 21 is open and both motor passages 27 are communicated with the respective return passages 28, the leveling passage 31 being open to the upper return and motor passages 28 and 27. Accordingly, the boom arms 35 are free to move up or down.

The valves 49 and 50 are overload relief valves to prevent buildup of excess pressure due to load inertia when the spools 8 and/or 9 are shifted to neutral position during forward tilt of the bucket 37 and/or during lowering of the boom arms 35.

I, therefore, particularly point out and distinctly claim as my invention:

1. A valve assembly comprising a housing having first and second bores each intersected by a pressure feed passage, a motor passage, and a return passage; first and second valve spools in the respective bores each movable from a neutral position blocking communication between said motor passage and said pressure feed and return passages to operating positions selectively communicating said motor passage with said pressure feed passage or said return passage; the motor passage of said first bore having upstream and downstream portions through which fluid is conducted to said return passage in one of said operating positions of said first spool; check valve means in said housing in an interconnecting passage leading from said downstream portion to the motor passage of said second bore; said first spool having another operating position communicating said upstream and downstream portions with each other and blocking communication between said downstream portion and said return passage whereby a fluid motor adapted to be connected to the motor passage of said second bore may be actuated by fluid from the motor passage of said first bore while said second spool is in neutral position and while said first spool is in said another operating position; and valve means in said second spool actuated by fluid pressure in the motor passage of said second bore to open communication between another motor passage in said second bore and said return passage for return flow of fluid from the motor actuated while said second spool is in neutral position.

2. The valve assembly of claim 1 wherein said housing has relief valve means therein between the motor and return passages of said second bore.

3. A valve assembly comprising a housing having first and second bores each intersected by a pressure feed passage, a pair of motor passages, and a return passage; first and second valve spools in the respective bores each movable from a neutral position blocking communication between said motor passages and said pressure feed and return passages to operating positions selectively communicating said motor passages with said pressure feed and return passages; said first bore being intersected by an interconnecting passage which leads to one motor passage of said second bore; check valve means in said interconnecting passage to permit fluid flow to said one motor passage; said first spool having another operating position whereat one motor passage of said first bore is communicated with said interconnecting passage while said return passage is closed and the other motor passage of said first bore is communicated with said pressure feed passage whereby a fluid motor adapted to be connected to said one motor passage of said second bore may be actuated by fluid from said one motor passage of said first bore while said second spool is in neutral position; and valve means in said second spool actuated by fluid pressure in said one motor passage of said second bore to open communication between the other motor passage of said second bore and said return passage while said second spool is in neutral position.

4. The valve assembly of claim 3 wherein said interconnecting passage intersects said first bore between said one motor passage and said return passage to constitute a downstream portion of said one motor passage when said first spool is in one of said operating positions conducting fluid from said one motor passage to said return passage.

5. The valve assembly of claim 3, wherein said valve means has a plunger portion; and wherein said second spool has a passage leading from said plunger portion to said one motor passage of said second bore whereby said valve means is opened in response to fluid pressure in said one motor passage.

6. The valve assembly of claim 5 wherein spring means in said second spool biases said valve means to closed position.

7. The valve assembly of claim 3 wherein said valve means comprises a valve member movable in said second spool to open communication between passages therein leading respectively to said other motor passage and said return passage.

8. A valve assembly comprising a housing having first and second bores each intersected axially therealong by a bypass passage, by a pair of pressure feed passages straddling said bypass passage, by a pair of motor passages straddling said feed passages, and by a pair of return passages straddling said motor passages, first and second valve spools in the respective bores each movable from a neutral position opening communication through said bypass passage and closing communication between said motor passages and said feed and return passages to operating positions selectively communicating said motor passages with said feed and return passages to control actuation of double-acting fluid motors adapted to be connected to said motor passages; one motor passage of said first bore having a downstream portion between said one motor passage and the adjacent return passage through which fluid flows from said one motor passage to said return passage in one of said operating positions of said first spool; said housing having check valve means in an interconnecting passage for flow of fluid from said downstream portion to one motor passage of said second bore; said first spool having another operating position communicating said one motor passage of said first bore with said downstream portion and blocking communication of said downstream portion with said return passage whereby return flow of fluid is conducted through said downstream portion and said interconnecting passage to said one motor passage of said second bore while said second spool is in neutral position; and valve means in said second spool ac-

tuated by fluid pressure in said one motor passage of said second bore to open communication through said second spool between the other motor and return passages while said second spool is in neutral position whereby a double-acting fluid motor associated with said second bore and spool is actuated by fluid supplied to said one motor passage of said second bore from said downstream portion and interconnecting passage.

9. The valve assembly of claim 8, wherein said housing has relief valve means therein between said one motor passage of said second bore and the adjacent return passage.

10. A valve assembly comprising a housing having first and second bores each intersected by a pressure feed passage, a motor passage, and a return passage; first and second valve spools in the respective bores each movable from a neutral position blocking communication between said motor passage and said pressure feed and return passages to operating positions selectively communicating said motor passage with said pressure feed passage or said return passage; the motor passage of said first bore having upstream and downstream portions through which fluid is conducted to said return passage in one of said operating positions of said first spool; check valve means in said housing in an interconnecting passage leading from said downstream portion to fluid from the motor motor passage of said second bore; said first spool having another operating position communicating said upstream and downstream portions with each other and blocking communication between said downstream portion and said return passage whereby a fluid motor adapted to be connected to the motor passage of said second bore may be actuated by fluid from the motor passage of said first bore while said second spool is in neutral position and while said first spool is in said another operating position; and relief valve means in said housing between the motor and return passages of said second bore.

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