United States Patent

[11] 3,583,585

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[54] **HYDRAULIC CONTROL SYSTEM FOR A BACKHOE**
10 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** **214/138,** 214/762, 37/103
[51] **Int. Cl.** **B66f 9/22**
[50] **Field of Search** 214/138, 762; 37/103

[56] **References Cited**
UNITED STATES PATENTS

3,339,763	9/1967	Caywood et al.	214/138
3,414,146	12/1968	Caywood et al.	214/138

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ABSTRACT: A hydraulic control system for a backhoe having a pivoted boom, stick and bucket, and which control system includes a pair of pumps, valves, and related conduits for directing the hydraulic fluid in such a manner that when the digging resistance is above normal during digging movement of the stick, the fluid first causes curling of the bucket to try to relieve the abnormal resistance and then if not relieved, the fluid then causes lifting of the boom to further relieve the resistance. A modified embodiment is shown which utilizes one pump.

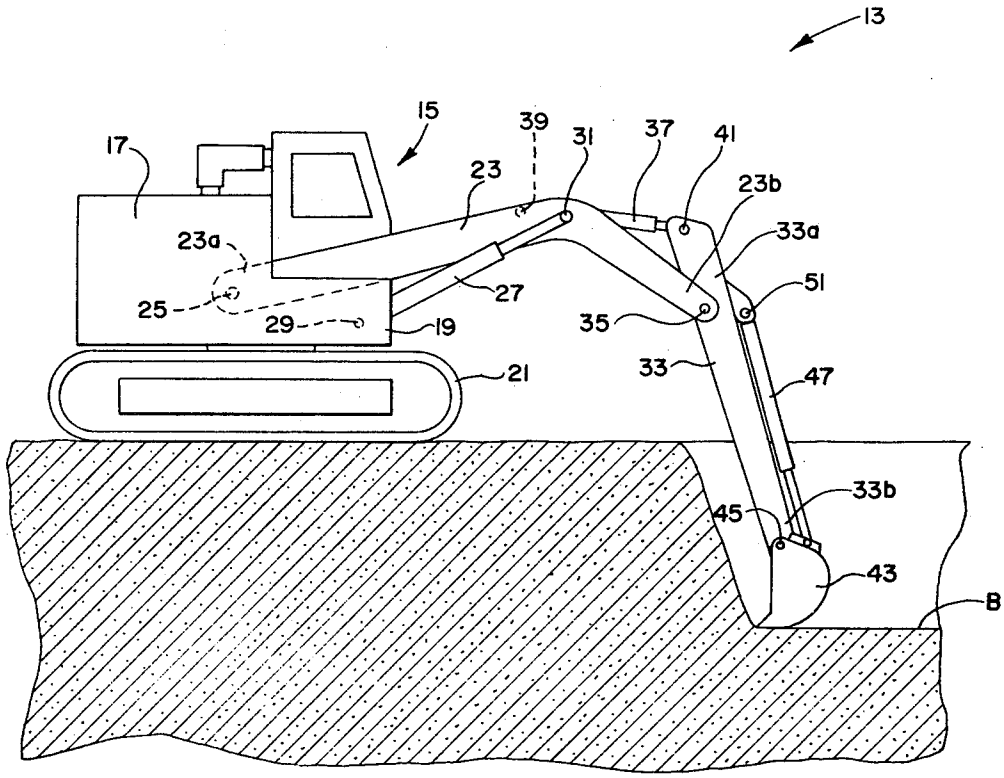

FIG. 1

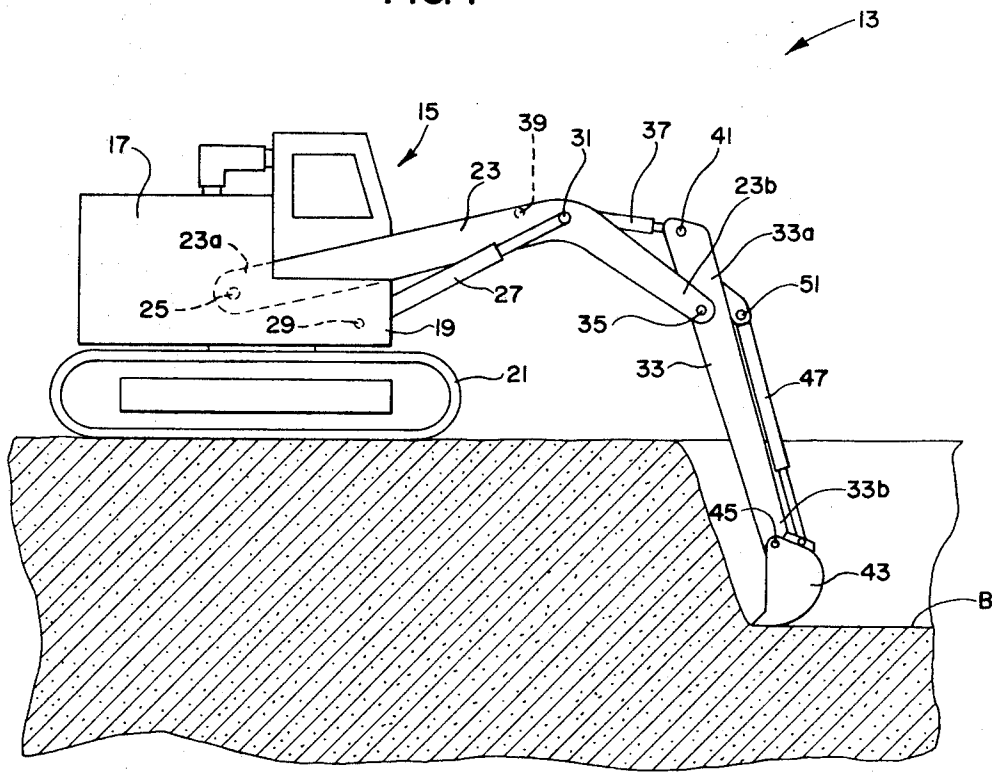

FIG. 3

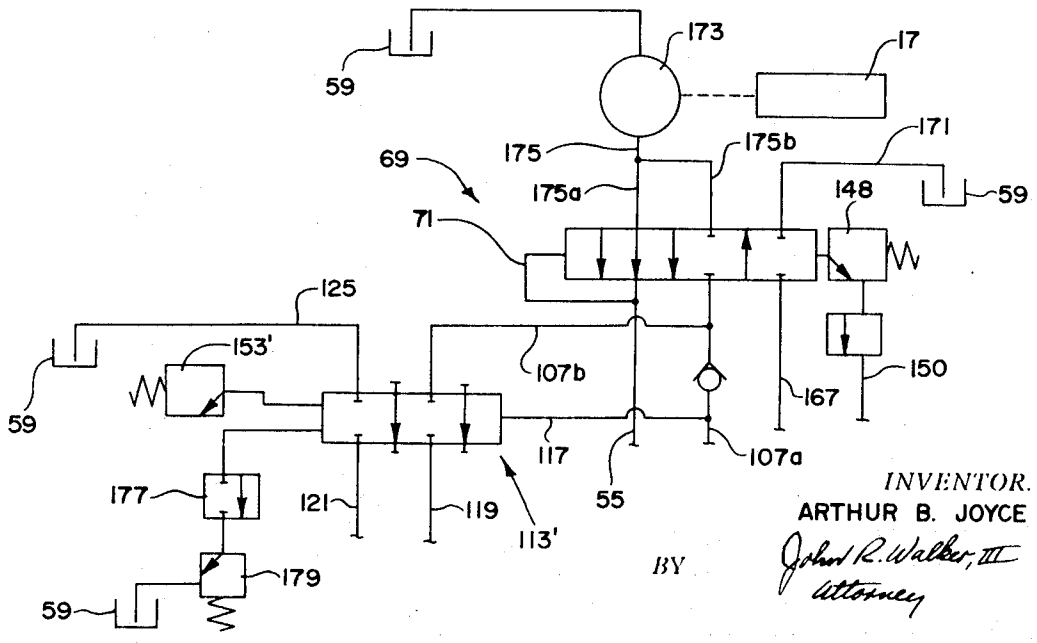

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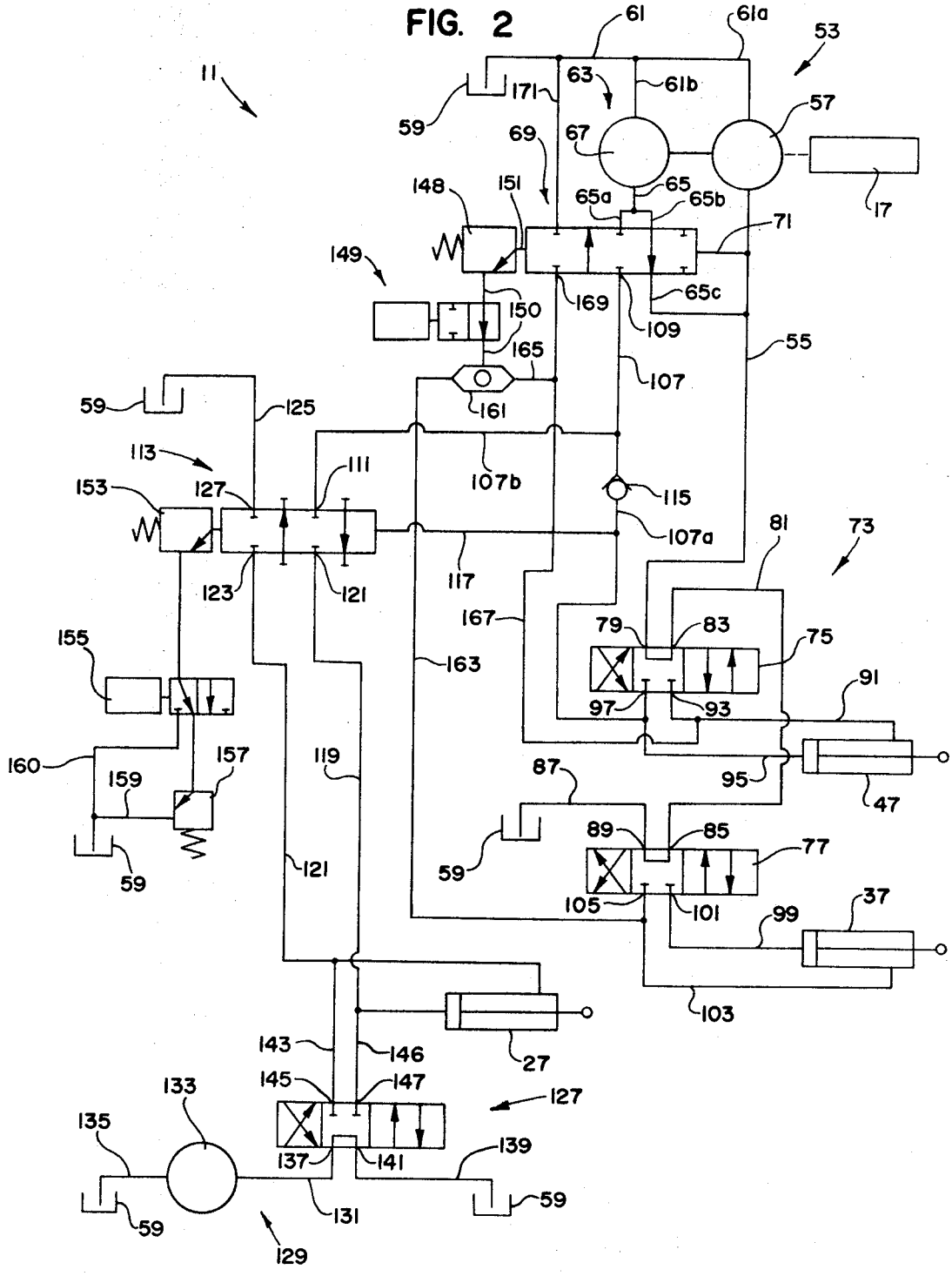
FIG. 2



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HYDRAULIC CONTROL SYSTEM FOR A BACKHOE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to hydraulic control systems for backhoes.

2. Description of the Prior Art

U.S. Pat. No. 3,339,763 discloses an automatic backhoe control system in which there is means responsive to overload pressure in the crowd jack **24** for directing fluid under pressure to the curl jack **26** to cause pivoting of the bucket **20** to decreased digging attitudes, and means responsive to simultaneous overload pressure in the crowd jack **24** and curl jack **26** for directing fluid under pressure to the lift jack **22** to cause pivoting of the lift arm to decreased digging attitudes. The means by which the above-described functions are accomplished are a single hydraulic power pressure source operating in conjunction with various valves and a separate hydraulic signal pressure source to cause the fluid to be directed for the above-mentioned functions from said single hydraulic power pressure source. The system of the U.S. Pat. No. 3,339,763 is quite complicated and a great number of valves are utilized, as may be seen by reference to FIG. **8** of this patent.

U.S. Pat. No. 3,414,146 also discloses an automatic backhoe unit somewhat similar to that of the U.S. Pat. No. 3,339,763 and which also employs a great number of valves and circuits, as will be seen from reference to FIGS. **2***a*, **2***b*, and **2***c* of the U.S. Pat. No. 3,414,146 Also, this patent utilizes a single hydraulic source, namely, pump **72** which is directed to perform the various functions of automatically relieving the overload pressure during digging by means of the various valves shown. In addition, the U.S. Pat. No. 3,414,146 is directed towards utilizing manual means for overruling the automatically actuated pilot operated valves.

There are certain disadvantages in the use of the apparatus of the above-mentioned U.S. Pat. Nos. 3,339,763 and 3,414,146. For example, the operation is not entirely smooth during the relieving of the overload pressures during digging. It is thought that perhaps the lack of smoothness in operation may be due to the fact that in both of these apparatus only a single main pressure source is used for the power functions of the lift, crowd and curl cylinders, and the operations are in sequence. In other words, they are one at a time, with crowding action for a while, then the bucket action, and then the hoist. Also, ordinarily, with previous automatic backhoe units, except in conditions when there is an extremely skilled operator, the bottoms of the ditches dug with previous backhoes have not been smooth but have had a scalloped effect so that it was necessary to send workers into the ditch to level the bottom thereof. This can be understood by reference to FIG. **1** of U.S. Pat. No. 3,414,146 wherein it will be seen the hole that is dug is arcuate and when the tractor moves to the left away from the hole to continue digging thereof, it will produce a scalloped effect at the bottom of the ditch.

Other patents relating to this general subject matter are the following: U.S. Pat. Nos. 2,890,805; 2,945,351; and 3,018,630.

SUMMARY OF THE INVENTION

The present invention is directed towards overcoming the disadvantages and problems relative to previous hydraulic control systems for backhoes. The concept of the present invention is to provide a highly effective and relatively simple hydraulic control system in which there is smooth operation and hydraulic power is provided in the particular places in the system where needed and at the proper time. Applicant accomplishes this concept by providing a pair of hydraulic fluid delivery means, namely, first and second fluid delivery means for supplying hydraulic fluid under pressure. In addition, means is provided for selectively directing the hydraulic fluid from both said first delivery means and said second delivery means to the stick cylinder to cause the stick to move in a digging direction when the fluid pressure in the stick cylinder is below a predetermined amount and for directing the hydraulic fluid from said first delivery means to the stick cylinder and the hydraulic fluid from said second delivery means to the bucket cylinder to cause the bucket to move in a curling direction when the fluid pressure in the stick cylinder is above a predetermined amount. Also, means is provided for directing a portion of the hydraulic fluid from said second delivery means to the lift cylinder to cause the boom to lift when the fluid pressure in the bucket cylinder is above a predetermined amount.

With the use of the hydraulic system of the present invention, a ditch can be dug which has a level bottom even when unskilled personnel are used.

Another feature of the present invention is to provide means for preventing chattering of the device during retracting or dumping motion of the bucket or the stick.

DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side elevational view of a backhoe in which the hydraulic control system of the present invention is provided, and which is shown in the process of digging a ditch.

FIG. **2** is a schematic diagram of the hydraulic control system of the present invention and the related parts of the backhoe to which the hydraulic system is coupled.

FIG. **3** shows a modification of a portion of that shown in FIG. **2**.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The hydraulic control system **11** of the present invention is adapted to be used with a typical backhoe, as backhoe **13** shown in FIG. **1**. Backhoe **13** typically includes a vehicle or tractor **15** having the usual engine **17**, mounted on a chassis or frame **19**, crawlers **21**, and other suitable components typically found on a backhoe. In addition, backhoe **13** includes the usual lift arm or boom **23** pivotally mounted adjacent the inner end **23***a* thereof as at **25** from chassis **19**. A ram or boom cylinder **27** is pivotally attached to chassis **19** as at **29** and pivotally attached adjacent the other end as at **31** to boom **23** so that retraction of boom cylinder **27** causes downward pivoting of the boom and extension of the boom cylinder **27** causes upward pivoting of the boom. A crowd arm or stick **33** is pivotally mounted adjacent the inner end **33***a* thereof as at pivot point **35** to boom **23** adjacent the outer end **23***b* thereof. The crowd or stick cylinder **37** is pivotally attached at one end thereof as at **39** to boom **23** and pivotally attached at the opposite end thereof as at **41** to stick **33** for pivoting stick **33** in an inwardly or digging motion or disposition (clockwise as viewed in FIG. **1**) when stick cylinder **37** is extended and for pivoting the stick **33** in an upwardly or retracting disposition (counterclockwise as viewed in FIG. **1**) when cylinder **37** is retracted. A bucket **43** is pivotally attached as at **45** to stick **33** adjacent the outer end **33***b* of the stick. A curl or bucket cylinder **47** is coupled to bucket **43** adjacent one end of the cylinder and is pivotally attached as at **51** to stick **33** for pivot of the bucket **43** relative to stick **33** in an inwardly curling motion or disposition (clockwise as viewed in FIG. **1**) when cylinder **47** is extended and for pivot of the bucket in a retracting motion or disposition (counterclockwise as viewed in FIG. **1**) when cylinder **47** is retracted.

Referring now to the preferred embodiment shown in FIG. **2**, hydraulic control system **11** includes a first fluid delivery means **53** including a first fluid conduit **55** and means providing fluid under pressure thereto, which preferably includes a first pump **57** receiving hydraulic fluid from tank **59** through the branch **61***a* of the supply conduit **61**. Pump **57** is of any suitable type, such as a gear pump, coupled to and driven by engine **17**. A second fluid delivery means **63** is provided which includes an output line **65** having branches **65***a* and **65***b* and means providing fluid under pressure thereto including a second pump **67** which receives fluid from the tank source **59** through the second branch **61***b* of supply conduit **61**. Second

pump 67 is similar to pump 57 and preferably is also driven by engine 17. It will be understood that pumps 57, 67 may be either two separate pumps, or a double pump with two pump sections on the same shaft, or if desired, may be any two other means for providing fluid under pressure to the respective conduit or lines 55, 65.

A first pilot operated control valve 69 is provided which senses the pressure in first conduit 55 through the line 71 and is operative in two positions depending upon the pressure in first conduit 55. Thus, when the pressure in first conduit 55 is below a predetermined amount, the valve 69 will be in a first condition shown in FIG. 2, and when the pressure in conduit 55 is above a predetermined amount, valve 69 will shift to the left as viewed in FIG. 2. When valve 69 is in said first position, the fluid from branch 65*b* will be directed by the valve through the line 65*c* to the first conduit 55 so that the output from the combined pumps 57 and 67 will be provided in first conduit 55. First conduit 55 leads to the manual control valve means 73 for directing the hydraulic fluid to the bucket cylinder 47 and stick cylinder 37. Manual control valve means 73 is of any suitable construction and preferably as shown in FIG. 2 wherein there are two three-way valves, a control valve 75 for bucket cylinder 47 and a control valve 77 for stick cylinder 37. The arrangement of the various conduits are preferably as follows: First conduit 55 connects to a port 79 on valve 75. A conduit 81 leads from a port 83 on valve 75 to a port 85 on valve 77. A conduit 87 leads from port 89 on valve 77 to tank 59. A conduit 91 leads from a port 93 of valve 75 to the front or rod end of bucket cylinder 57. A line 95 leads from a port 97 of valve 75 to the base end of bucket cylinder 47. A conduit 99 leads from a port 101 of valve 77 to the base end of stick cylinder 37 and a line 103 leads from a port 105 of valve 77 to the front or rod end of stick cylinder 37. From the foregoing, it will be understood than when valves 75, 77 are in the center positions shown in FIG. 2, the bucket and stick cylinders 47, 37 will be held in a fixed position and the oil pressure from first conduit 55 will be returned to the tank 59 through conduits 81 and 87. Also, it will be understood that when valve 77 is shifted to cause the right end of the valve, as viewed in FIG. 2, to line up with the ports 89, 105 and 85, 101 the fluid will flow through the valve, through the line 99 and cause the stick cylinder 37 to extend and the stick 33 to be moved in a digging disposition. Also, it will be understood that when the left end of the valve 77 is moved into alignment with the ports, the stick 33 will be caused to move into the heretofore mentioned retracting disposition. When valve 75 is moved so that the right end of the valve is in alignment with the ports 79, 97 and 83, 93 the hydraulic fluid from first conduit 55 will be directed by the valve through the conduit 95 to the base end of the bucket cylinder 47 to extend the bucket cylinder 47 to cause a curling disposition of bucket 43. Then, when the left end of valve 75 is moved into position in alignment with the ports, the hydraulic fluid will be caused to move through the valve and the line 91 to the front or rod end of the bucket cylinder 47 to cause bucket 43 to move in a retracting or unloading motion.

A second conduit 107 leads from an outlet port 109 of first pilot operated control valve 69 with one branch 107*a* thereof leading to the base end of bucket cylinder 47 through the conduit 95 and another branch 107*b* leads to an inlet port 111 of a second pilot operated control valve 113. A check valve 115 is provided in branch 107*a* to prevent reverse flow of fluid therethrough to the other portions of the second conduit 107. Second pilot operated control valve 113 is similar to first pilot operated control valve 69 and is operative responsive to the pressure in conduit 107*a* as communicated to the end of the valve spool through the line 117. Second pilot operated control valve 113 is a two position valve in which the valve is movable from and to a first position or condition as shown in FIG. 2 wherein the fluid flow is blocked through the valve and a second condition wherein the valve functions as will be described later. When the pressure in conduit 107*a* is below a predetermined amount, the valve 113 will be in said first position, and when the pressure in conduit 107*a* is above a predetermined amount, the valve 113 will be in said second condition. A third conduit 119 leads from a port 121 in valve 113 to the base end of boom cylinder 27. A line 121 leads from the front or rod end of boom cylinder 27 to the port 123 of second pilot operated valve 113. A line 125 leads from port 127 of second pilot operated valve 113 to tank 59. From the foregoing, it will be understood that when second pilot operated valve 113 is in said first position, the flow of hydraulic fluid through the valve will be blocked to and from the boom cylinder 27, and when the valve is in said second position, the flow of fluid will be permitted through the valve from branch 107*b* to line 119 to the base end of the cylinder to extend boom cylinder 27 and cause elevating motions of boom 23. It will be further understood that the fluid from the cylinder 27 is exhausted through line 121, valve 113 and line 125 to the tank 59.

A manual control valve 127 is provided for boom cylinder 27 as well as a third fluid delivery means 129 including a fluid line 131 and means providing fluid under pressure thereto, which preferably includes a third pump 133 receiving hydraulic fluid from tank 59 through the supply conduit 135. Pump 133 is of any suitable type, such as a gear pump, and is preferably coupled to and driven by engine 17, by suitable means, not shown. Line 131 leads to port 137 of valve 127 and a line 139 leads from port 141 of valve 127 to tank 59. A line 143 connects port 145 of valve 127 to line 121 which in turn leads to the front or rod end of boom cylinder 27, and a line 146 leads from port 147 of valve 127 to line 119 which in turn leads to the base end of the boom cylinder 27. Manual control valve 127 is similar to valves 75 and 77 and is a three-position valve with the center position being shown in FIG. 2 wherein flow is blocked from pump 133 to the boom cylinder 27 and caused to return to tank 59 through lines 131 and 139. When valve 127 is shifted to align the right portion of the valve with the ports 145, 137 and 147, 141 it will be understood that fluid flow is directed from line 131 through the valve, through line 143 and 121 to the rod end of the boom cylinder 27 to cause lifting of the boom 23. When the left end portion of the valve 127 is shifted to line up with the ports, it will be understood that the fluid flow will be to the front end of the boom cylinder 27 to cause lowering of the boom 23.

Means are provided for locking, if desired, first pilot operated valve 69 and second pilot operated valve 113 in said first positions thereof to prevent automatic operation thereof. Thus, first pilot operated valve 69 is provided with a pilot operated relief valve 148 and a two-way manual or solenoid operated valve 149. When the valve 149 is in the first position shown in FIG. 2, the first pilot operated valve 69 is unlocked, whereas, when the valve is in the other position to block flow through the line 150 in which the valve is interposed, then fluid is trapped at the end of the spool of valve 69 so that it cannot shift to the left. In other words, with the fluid being trapped in the portion of line 150 upstream of valve 149, it prevents shifting to the left of the pilot operated relief valve 148 so that the fluid is similarly trapped in the line 151 to prevent shifting of the spool of the valve 69. Similarly, second pilot operated valve 113 is provided with a pilot operated relief valve 153 and manual or solenoid operated valve 155 which operate in the same manner as relief valve 148 and valve 149. Another pilot operated valve 157 is provided downstream of valve 155 whereby when the valve 155 is in a first position, as shown in FIG. 2, the hydraulic system 11 is in a first mode of operation so that in order to shift the pilot operated valve 113 into said second condition thereof, the pressure in line 117 must be above the combined pressures required to operate valves 153 and 157. When valve 155 is moved to the second position in which the right portion of valve 155, as viewed in FIG. 2, is in line with the ports, the flow bypasses valve 157 and flows directly to the tank through the line 160 so that the hydraulic system 11 is in a second mode of operation in which the pressure in line 117 need only be greater than the operating pressure of valve 153 in order to

shift valve 113. The operating pressure of relief valve 153 should be less than the reactive forces operating on bucket 43 so that when valve 155 is in said second position, abnormal resistance on the stick 33 during the digging operation will cause lifting of boom 23 rather than curling of bucket 43, which will be better understood in the description to follow later in the specification These two modes of operation provide for the digging of ditches with smooth bottoms, which will also be better understood in the description to follow later.

A shuttle valve 161 is provided in connection with first pilot operated valve 69 so that when the bucket 43 and/or stick 33 is being moved in retracting or dumping motions, the valve 69 is locked in said first position which prevents chattering during the retracting or dumping cycle of the bucket 43 or stick 33. More particularly, one end of the shuttle valve 161 is coupled to the rod end of stick cylinder 37 through line 163 and line 103 to which line 163 is coupled. Thus, when there is high pressure on the rod end of the stick cylinder 37 (during retraction of the stick 33), the high pressure causes the shuttle valve 161 to block flow from line 150 and consequently blocks the fluid from the end of the first pilot operated valve 69 and locks the valve in said first position thereof. The other end of shuttle valve 161 is connected through a line 165 and line 167 to line 91 which in turn is connected to the rod end of bucket cylinder 47 so that when there is high pressure in line 91 (when bucket 43 is retracting or dumping) this causes the high pressure to be felt at shuttle valve 161 and causes the shuttle valve to block flow from line 150 and lock the first pilot operated valve 69 as heretofore described relative to the other action of the shuttle valve. In other words, shuttle valve 161 is an "or" valve which blocks the flow from line 150 if there is high pressure in the rod end of the stick cylinder 37 "or" the bucket cylinder 47. Line 167 also leads to port 169 of the first pilot operated valve 69 so that when the valve 69 is in said second position, fluid can flow through valve from line 167 and through line 171 to tank 59.

In describing the operation of the hydraulic control system 11 of the present invention, it is assumed that the boom 23 is at a given position for digging and has been put in this position manually by operating the control valve 127, bucket 43 is at a given angle by manually manipulating the control valve 75, and the stick 33 is swinging in a digging disposition, that is, clockwise as viewed in FIG. 2 with the bucket 43 digging into the earth. Also, it is assumed that valves 149 and 155 are respectively in said first positions with system 11 being in said first mode of operation. It will be understood that the stick 33 is caused to move in said digging disposition by manually manipulating the control valve 77 so that it is in said first position with the right-hand portion of the valve aligned with the ports. With the above described conditions, it will be understood that both pumps 57 and 67 will be pumping hydraulic fluid through first conduit 55, line 81, and line 99 to the base end of the stick cylinder 37, causing the stick cylinder 37 to extend. As long as the ground resistance remains normal, the above conditions will continue to exist. However, when the ground resistance reaches a certain point, as for example, in hard earth, the pressure buildup in line 99 will be felt in first conduit 55, which will cause the first pilot operated valve 69 to shift to said second position by virtue of the pressure being exerted to the left through the line 71 from first conduit 55. This will cause the hydraulic fluid from pump 67 to flow through second conduit 107 and only the fluid from pump 57 to flow through first conduit 55. The fluid flow through second conduit 107 will flow to the base end of the bucket cylinder 47 through the line 95 to cause the bucket cylinder 47 through the line 95 to cause the bucket to move in a so-called "curling" disposition (or clockwise as viewed in FIG. 2) in which disposition the bucket is disposed at an angle so that the digging is easier. In other words, the cylinder 47 extends to cause pivoting of the bucket 43 to an angle which causes less resistance to movement through the earth. As a result of this, ground resistance to the movement of stick 33 decreases which causes a lessening of the pressure in line 99 that is reflected in first conduit 55 to cause the valve 69 to move back to said first position so that the pumps 57 and 67 are pumping once more through first conduit 55, and there is no fluid going to the bucket cylinder 47.

When the ground resistance is so great that a "curling" operation as above described will not decrease the ground resistance to the movement of stick 33, second pilot operated valve 113 will move to said second position or the left, so that the hydraulic fluid will flow from branch 107*b* and line 119 to the base end of the boom cylinder 27. This will cause the boom 23 to lift or move in an elevating motion and thereby decrease the ground resistance to the movement of stick 33, which again will cause the valve 113 and valve 69 to move into said first positions, and both of the pumps 57, 67 to flow into first conduit 55 and to the stick cylinder 37.

To make the bottom of a ditch level or smooth, the heretofore described second mode of operation of system 11 is employed by shifting valve 155 into said second position after the upper part of the ditch has been dug by means of the system being in said first mode of operation. In other words, when the bucket 43 nears the depth at which it is desired to form the bottom of the ditch, the valve 155 is shifted into said second position so that rather than curling the bucket 43, the boom 23 will lift as the stick 33 is moved in a digging disposition to keep the lower end of the bucket 43 along substantially the same level so that the bottom B of the ditch remains horizontal.

Referring now to the modification shown in FIG. 3, which is substantially the same as that shown in FIG. 2, except that a single pump 173 is provided instead of the two pumps 57, 67. The output line 175 of pump 173 branches into the two branches 175*a* and 175*b* and leads to the pilot operated valve 69. Second pilot operated valve 113', which corresponds to valve 113 of FIG. 2, is provided with means for placing the hydraulic system in a first or second mode of operation so that the system of FIG. 3 will function in a similar manner to that of FIG. 2. Thus, a pilot operated valve 153' is provided which corresponds to valve 153 of FIG. 2. However in place of a series arrangement as shown in FIG. 2, an arrangement is provided in FIG. 3 in which a valve 177 (either manual or solenoid operated) is in series with a pilot operated relief valve 179 and said series (177, 179) is in parallel with valve 153' so that when valve 177 is in one position, the system is in a first mode of operation and when valve 177 is in the other position, the system is in a second mode of operation. The remaining parts are the same as shown in FIG. 2 with the same numbers being given to corresponding parts, and the lower portion of the schematic diagram, which is the same as FIG. 2, has been broken away. It will be understood that the parallel-series arrangement of FIG. 3 may be utilized in the system of FIG. 2 and the series arrangement of FIG. 2 may be utilized in the system of FIG. 3 without departing from the spirit and scope of the present invention.

It will be understood that while the form of the embodiment of the invention as herein defined constitutes the preferred embodiments, it is intended not to be so limited but other equivalent forms may be provided without departing from the spirit and scope of the present invention.

I claim:

1. A hydraulic system for a backhoe including a vehicle, a boom pivoted to said vehicle, a stick pivoted to said boom, a bucket pivoted to said stick, a boom cylinder for pivoting said boom relative to said vehicle, a stick cylinder for pivoting said stick relative to said boom, and a bucket cylinder for pivoting said bucket relative to said stick; said system comprising a first hydraulic fluid delivery means for supplying hydraulic fluid under pressure, a second hydraulic fluid delivery means for supplying hydraulic fluid under pressure, means for selectively directing the hydraulic fluid from both said first delivery means and said second fluid delivery means to said stick cylinder to cause said stick to move in a digging direction when the fluid pressure in said stick cylinder is below a predetermined amount and for directing the hydraulic fluid

from said first delivery means to said stick cylinder and the hydraulic fluid from said second delivery means to said bucket cylinder to cause said bucket to move in a curling direction when the fluid pressure in said stick cylinder is above a predetermined amount, and means for directing a portion of the hydraulic fluid from said second delivery means to said lift cylinder to cause said boom to lift when the fluid pressure in said bucket cylinder is above a predetermined amount.

2. A hydraulic system for a backhoe including a vehicle, a boom pivoted to said vehicle, a stick pivoted to said boom, a bucket pivoted to said stick, a boom cylinder for pivoting said boom upwardly and downwardly, a stick cylinder for pivoting said stick selectively in inwardly digging motions ad outwardly retracting motions, a bucket cylinder for selectively pivoting said bucket relative to said stick in inwardly curling motions and outwardly retracting motions; said system comprising a first hydraulic fluid delivery means for supplying hydraulic fluid under pressure, and a second hydraulic fluid delivery means for supplying hydraulic fluid under pressure; a first three-way control valve means selectively for blocking hydraulic fluid flow when in a first position, for directing the fluid to one end of said stick cylinder to cause pivot of said stick cylinder in said digging motions when in a second position, or for directing the fluid to the opposite end of said stick cylinder to cause pivot of said stick in said retracting motions when in a third position; a second three-way control valve means selectively for blocking the fluid flow when in a first position, for directing the fluid to one end of said bucket cylinder to cause inwardly pivot in curling motions when in a second position, or for directing the fluid to the opposite end of said bucket cylinder to cause pivot of said bucket in said retracting motions when in a third position; first means for selectively directing the hydraulic fluid from both said first delivery means and said second delivery means to said first control valve means to said first control valve means to cause said stick to move in a digging motion when said first control valve means is in said second position and when the fluid pressure in said stick cylinder is below a predetermined amount during said digging motions and for directing hydraulic fluid from said first delivery means to said first control valve means and the hydraulic fluid from said second delivery means to said bucket cylinder to cause said bucket to move in a curling motion when said first control valve is in said second position and when the fluid pressure in said stick cylinder is above a predetermined amount during said digging motion, and additional means for directing a portion of the hydraulic fluid from said second delivery means to said boom cylinder to cause said boom to lift when the fluid pressure in said bucket cylinder is above a predetermined amount during said curling motion.

3. The hydraulic control system of claim 2 which includes a third hydraulic fluid delivery means for supplying hydraulic fluid under pressure; a third three-way control valve means selectively for blocking the fluid flow from said third fluid delivery means to said boom cylinder when in a first position, for directing the fluid flow from said third fluid delivery means to one end of said boom cylinder to cause pivot of said boom upwardly when in a second position, or for directing the fluid flow from said third fluid delivery means to the opposite end of said boom cylinder to cause pivot of said boom downwardly when in a third position.

4. A hydraulic system for a backhoe including a vehicle, a boom pivoted adjacent one end of said vehicle, a stick pivoted adjacent one end of said boom adjacent the end thereof remote from said vehicle, a bucket pivoted to said stick adjacent the end thereof remote from said boom, a boom cylinder for pivoting said boom upwardly and downwardly relative to said vehicle, a stick cylinder for pivoting said stick selectively in inwardly digging motions and outwardly retracting motions, a bucket cylinder for selectively pivoting said bucket relative to said stick in inwardly curling motions and outwardly retracting motions, and first control valve means for directing fluid to said stick cylinder for movement of said stick in digging motions; said system comprising a hydraulic fluid source, a first pump means and a first conduit means for supplying fluid from said source to said first control valve means, first pilot operated valve means shiftable between a first condition responsive to the hydraulic pressure in said first conduit being below a predetermined amount when the digging motion of said stick is normal and a second condition responsive to hydraulic pressure in said first conduit being above a predetermined amount due to digging resistance above a predetermined amount being felt in said stick cylinder, a second pilot operated valve means, a second conduit leading from said first pilot operated valve means and having branches leading to said bucket cylinder and to said second pilot operated valve means, a second pump means for delivering fluid under pressure from said source to said first conduit when said first pilot operated valve means is in said first condition and for delivering fluid under pressure to said second conduit for the curling of said bucket when said first pilot operated valve means is in said second condition, said second pilot operated valve means being shiftable between a first condition responsive to the hydraulic pressure in branch of said second conduit leading to said bucket cylinder being below a predetermined amount when the digging motion of said stick and bucket is normal and to a second condition responsive to the hydraulic pressure in said branch of said second conduit leading to said bucket cylinder being above a predetermined amount when the digging motion of said stick and bucket is abnormal due to resistance in digging, a third conduit leading from said second pilot operated valve means to said boom cylinder for delivering fluid to said boom cylinder from said second conduit to lift said boom when said second pilot operated valve means is in said second condition.

5. The hydraulic system of claim 4 in which is included shuttle valve means for locking said first pilot operated valve in said first condition during retracting motions of said bucket or said stick to prevent chattering.

6. The hydraulic system of claim 4 in which is included means for selectively locking and unlocking said first pilot operated valve and said second pilot operated valve.

7. A hydraulic system for backhoe including a vehicle, a boom pivoted to said vehicle, a stick pivoted to said boom, a bucket pivoted to said stick, a boom cylinder for pivoting said boom relative to said vehicle, a stick cylinder for pivoting said stick relative to said boom, and a bucket cylinder for pivoting said bucket relative to said stick; said system comprising hydraulic fluid delivery means for supplying hydraulic fluid under pressure, means selectively operable in a first mode or a second mode of operation for directing the fluid from said fluid delivery means only to said stick cylinder to cause said stick to move in a digging motion when the fluid pressure in said stick cylinder is below a predetermined amount, for directing at least a portion of said fluid from said fluid delivery means to said bucket cylinder to cause said bucket to move in a curling direction when the fluid pressure in said stick cylinder is above a predetermined amount and when said selectively operable means is in a first mode of operation, and for directing at least a portion of said fluid from said fluid delivery means to said bucket cylinder to cause said bucket to move in a curling direction when the fluid pressure in said stick cylinder is above a predetermined amount and when said selectively operable means is in a first mode of operation, and for directing at least a portion of said fluid from said fluid delivery means to said boom cylinder to cause said boom to lift without curling said bucket and while said stick cylinder is moving in a digging motion to level the bottom of the ditch being dug when said selectively operable means is in a second mode of operation.

8. The hydraulic system of claim 7 in which said fluid delivery means includes a single pump means.

9. The hydraulic system of claim 7 in which said fluid delivery means includes a pair of pump means.

10. A hydraulic system for a backhoe including a tractor, a boom pivoted to said tractor, a stick pivoted to said boom, a bucket pivoted to said stick, a boom cylinder for pivoting said

boom upwardly and downwardly relative to said tractor, a stick cylinder for pivoting said stick selectively in inwardly digging motions and outwardly retracting motions, and a bucket cylinder for selectively pivoting said bucket relative to said stick in inwardly curling motions and outwardly retracting motions and first control valve means for directing fluid to said stick cylinder for movement of said stick in digging motions, said system comprising hydraulic fluid delivery for supplying hydraulic fluid under pressure, first pilot operated valve means receiving fluid delivery means, a first conduit leading from said first pilot operated valve means to said first control valve means, said first pilot operated valve means being shiftable to a first condition responsive to the hydraulic pressure in said first conduit being below a predetermined amount when the digging motion of said stick is normal and being shiftable to a second condition responsive to hydraulic pressure in said first conduit being above a predetermined amount due to digging resistance above a predetermined amount being felt in said stick cylinder,. a second pilot operated valve means, a second conduit leading from said first pilot operated valve means and having branches leading to said bucket cylinder and to said second pilot operated valve means, when said first pilot operated valve is in said first condition the fluid from said fluid delivery means being directed only to said stick cylinder to cause said stick to move in a digging motion, and when said first pilot operated valve is in said second condition, the fluid from said fluid delivery means being directed, at least in part, to said second conduit, a third conduit leading from said second pilot operated valve to said boom cylinder, said second pilot operated valve means being shiftable between a first position in which fluid flow is blocked through said second pilot operated valve means and a second position communicating said second conduit with said third conduit to cause lifting of said boom, means selectively operable in a first condition for shifting said second pilot operated valve means into said second position responsive to a first predetermined pressure in the branch of said second conduit leading to said bucket cylinder which is greater than the pressure required to move said bucket in a curling disposition and operable in a second condition for shifting said second pilot operated valve means into said second position responsive to a second predetermined pressure in the branch of said second conduit leading to said bucket cylinder which is less than said first predetermined pressure and less than the pressure required to move said bucket in a curling disposition.