Dec. 20, 1966 R. S. ZIMMERMAN 3,292,498

FLUID MOTOR INCLUDING RECIPROCATING FLUID RESPONSIVE VALVES

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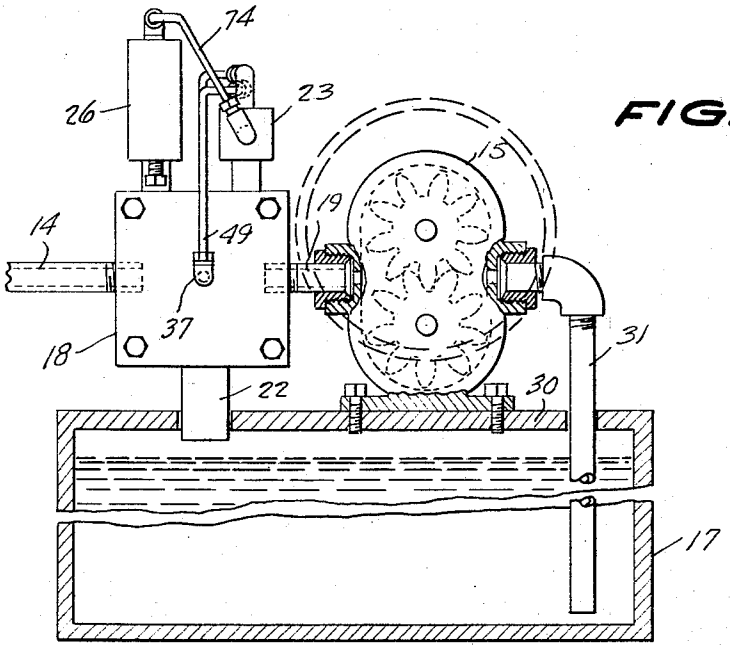


FIG. 1.

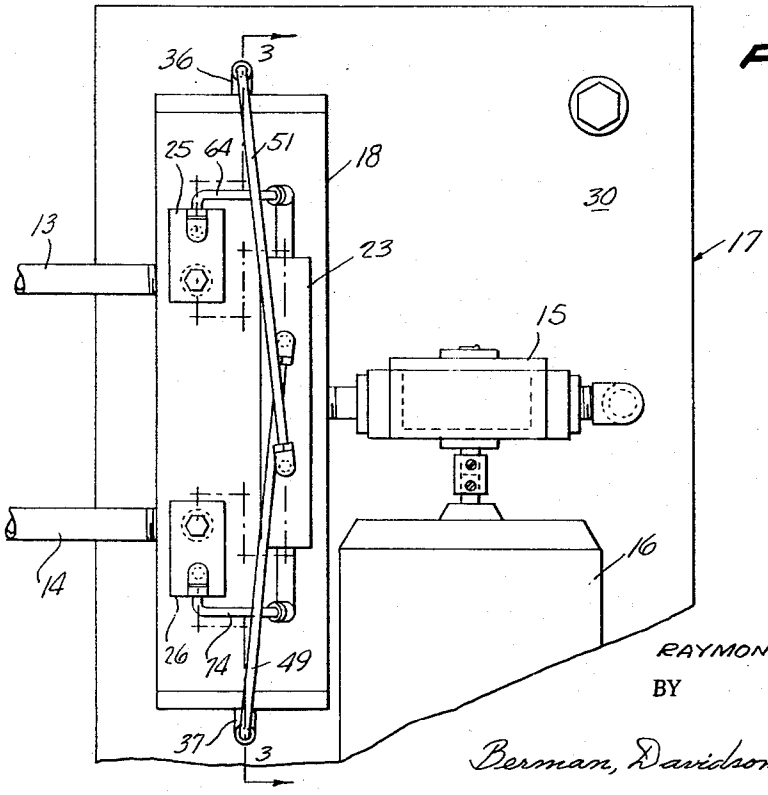


FIG. 2.

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FIG. 3.

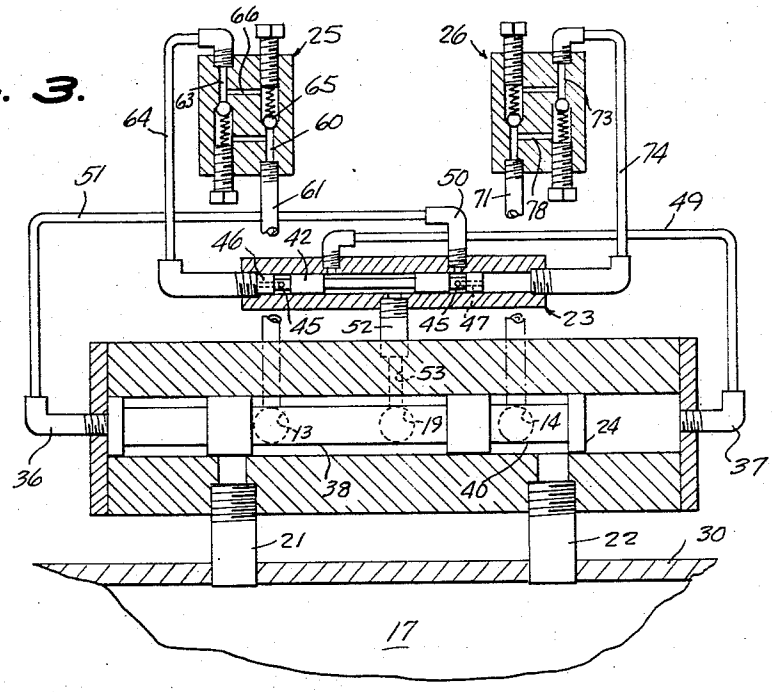
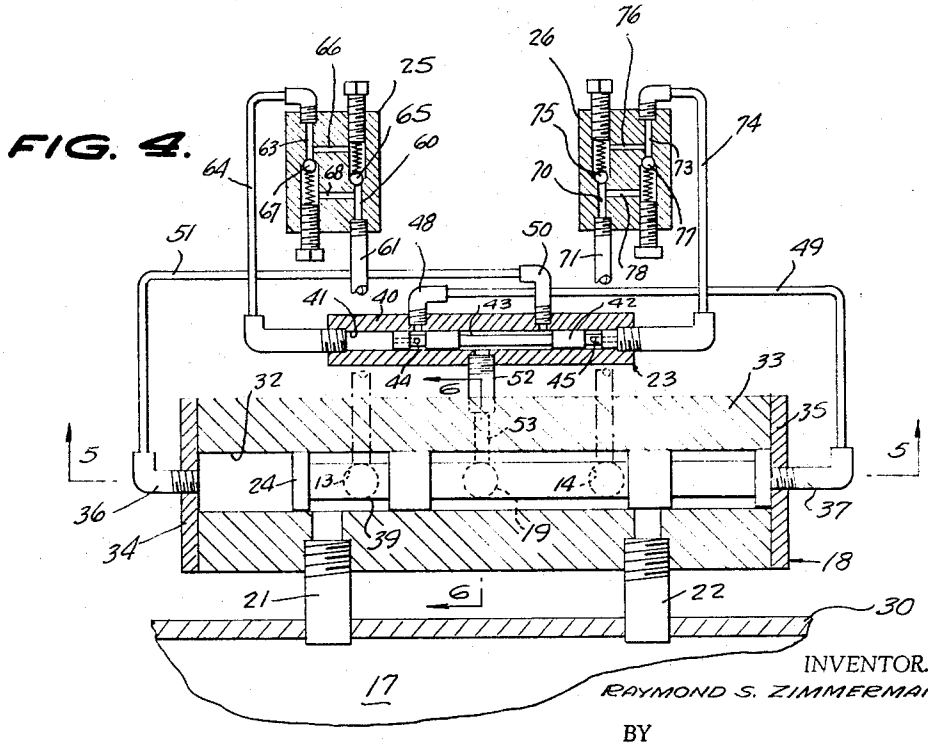


FIG. 4.



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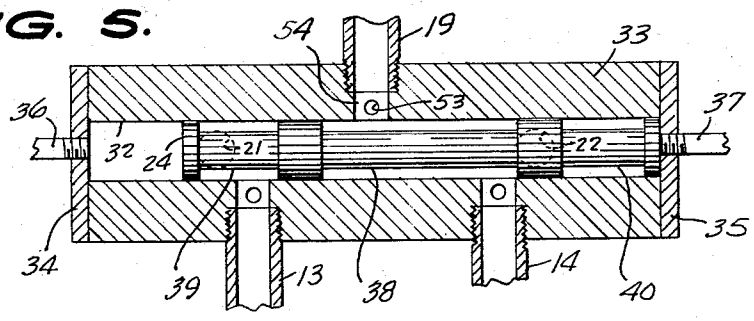
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FIG. 5.



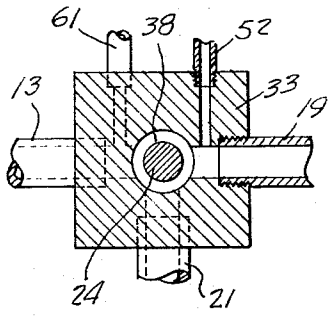
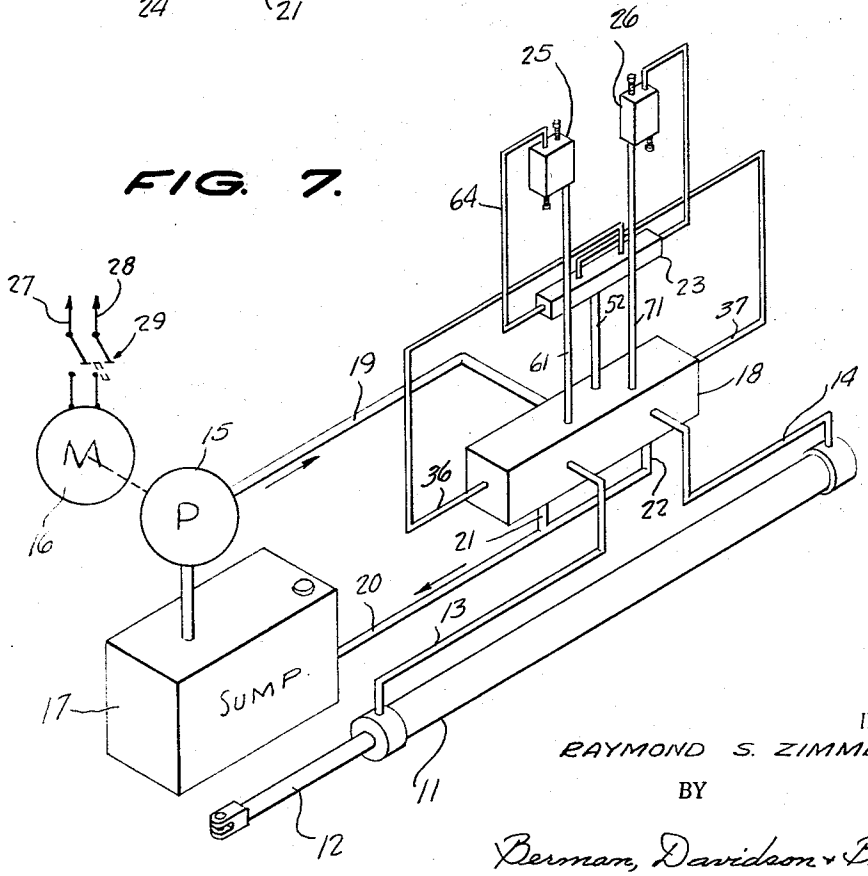


FIG. 6.

FIG. 7.



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FLUID MOTOR INCLUDING RECIPROCATING FLUID RESPONSIVE VALVES

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4 Claims. (Cl. 91—308)

This invention relates to reciprocating control valves, and more particularly to an improved reciprocating control valve adapted to be employed with a hydraulic power unit for reversing the admission of hydraulic fluid under pressure into a hydraulic cylinder continuously, for use in association with various types of equipment such as hydraulic barn cleaners and other hydraulic machinery.

A main object of the invention is to provide a novel and improved hydraulic control valve assembly of the reciprocating type, the valve assembly being relatively simple in construction, being reliable in operation, and involving relatively inexpensive components.

A further object of the invention is to provide an improved reciprocating control valve assembly for reversing the supply of hydraulic fluid under pressure to a power cylinder, the assembly being arranged to operate continuously as long as fluid under pressure is supplied thereto, being durable in construction, involving relatively few parts, and providing efficient utilization of the pressure fluid used to drive same.

Further objects and advantages of the invention will become apparent from the following description and claims, and from the accompanying drawings, wherein:

FIGURE 1 is a transverse vertical cross sectional view taken through an improved reciprocating control valve assembly constructed in accordance with the present invention.

FIGURE 2 is a fragmentary top plan view of the reciprocating control valve assembly of FIGURE 1.

FIGURE 3 is an enlarged vertical cross sectional view taken substantially on the line 3—3 of FIGURE 2, showing the main distributing valve core at the left end of its stroke.

FIGURE 4 is a cross sectional view similar to FIGURE 3 but showing the main distributing valve core at the right end of its stroke.

FIGURE 5 is a cross sectional view taken substantially on the line 5—5 of FIGURE 4.

FIGURE 6 is a transverse vertical cross sectional view taken substantially on the line 6—6 of FIGURE 4.

FIGURE 7 is a schematic perspective view showing the conduit connections of the reciprocating control valve assembly of FIGURES 1 to 6, and also showing the electrical connections of the driving motor associated with the hydraulic pump member of the assembly.

Referring to the drawings, **11** designates the working cylinder of a reciprocating mechanism driving the reciprocating pusher assembly of the manure trench cleaning apparatus employed in a dairy barn which acts to convey manure from the trench as a result of the continuous reciprocating action of the pusher member. The reciprocating motor cylinder **11** is provided with the piston rod **12** which is adapted to be connected in any suitable manner to the reciprocating shaft of the driven apparatus.

The reciprocating motor cylinder **11** operates by the alternate admission of hydraulic fluid into its opposite end portions, with concurrent release of hydraulic fluid from one end portion as hydraulic fluid under pressure is admitted into the other end portion. Thus, in the schematic arrangement illustrated in FIGURE 7, a conduit **13** is connected to the left end portion of the cylinder **11** and another conduit **14** is connected to the right end portion of said cylinder. A hydraulic pump **15** driven by an electric motor **16** supplies hydraulic fluid

from a reservoir **17** to a main distributing valve **18** by way of a conduit **19**. Hydraulic fluid is returned from the main distributing valve **18** to the reservoir **17** by a return conduit **20** connected to the distributing valve **18** respectively at **21** and **22**. A reversing valve **23** is employed, in a manner presently to be described, to reciprocate the core **24** of the main distributing valve **18**, the reversing valve **23** operating because of the action of a pair of spring-loaded pressure-responsive impulse valves **25** and **26** whose construction and operation will also be presently described.

The motor **16** is energized from a pair of supply wires **27** and **28** through a conventional double-pole, single-throw master control switch **29**.

The schematic illustration of FIGURE 7 differs somewhat from the embodiment shown in FIGURES 1 to 6 in that it shows the return connections **21** and **22** as communicating with a fluid return line **20**, whereas in the preferred embodiment illustrated in FIGURES 1 to 6, the main distributing valve **18** is shown connected directly to the hydraulic fluid reservoir **17** by means of the conduit connections **21** and **22**, said conduit connections extending through the top wall **30** of reservoir **17**. This slight structural difference does not in any way change the mode of operation of the device.

As shown in FIGURES 1 and 2, the pump **15** is mounted on the top wall **30** of the reservoir **17**, and the inlet conduit **31** of the pump extends through said top wall and its open bottom end is located near the bottom wall of the reservoir. The outlet conduit **19** of the pump is connected to the intermediate portion of the longitudinal bore **32** of the elongated main block **33** of the distributing valve **18**, said block being provided with respective end cover plates **34** and **35** having respective conduit fittings **36** and **37** mounted in their intermediate portions and communicating with the respective ends of the valve bore **32**.

As shown in FIGURE 5, the core **24** is formed with a relatively long intermediate annular groove **38** and with respective shorter annular grooves **39** and **40** located near the ends of the core. In the rightward position of the core **24** shown in FIGURE 5, the groove **38** provides communication between the pressure fluid conduit **19** and the working cylinder conduit **14**, so that pressure fluid is admitted into the right end of the cylinder **11**, as viewed in FIGURE 7, whereas the short groove **39** provides communication between the conduit **13** and the valve connection leading to the return conduit element **21**. This position of core **24** causes leftward extension of the piston rod **12**, as viewed in FIGURE 7.

In the leftward position of valve core **24**, shown in FIGURE 3, the long intermediate groove **38** of core **24** provides communication between the pressure fluid supply conduit **19** and the working cylinder pressure fluid conduit **13**, causing hydraulic fluid under pressure to be admitted into the left end of the cylinder **11**, whereas the short groove **40** provides communication between the conduit **14** and the hydraulic fluid return conduit element **22**, causing the piston rod **12** to be moved rightward, as viewed in FIGURE 7, namely, towards its retracted position. As the pressure fluid enters the left end portion of cylinder **11** through the conduit **13**, the hydraulic fluid in the right end portion of the cylinder is allowed to discharge therefrom through the conduit **14**.

The reciprocating control valve **23** comprises an elongated horizontal main block **40** mounted above and extending parallel to the block **33** of the main valve **18**, the block **40** having a longitudinal bore **41** containing a sliding core **42**. The core **42** is provided with the relatively long intermediate groove **43** and with the relatively short grooves **44** and **45** located near the core ends. The end portions of core **42** are formed with passages **46** and

47 connecting the respective grooves 44 and 45 to the opposite ends of the core. In the extreme rightward position of the core 42, shown in FIGURE 4, the groove 44 registers with a conduit fitting 48 connected to the block 40 and also connected by a conduit 49 to the conduit fitting 37. In the extreme leftward position of the core 42, shown in FIGURE 3, the groove 45 registers with a conduit connection 50 connected to block 40 and which is also connected by a conduit 51 to the conduit fitting 36.

In the rightward position of core 42 shown in FIGURE 4, the long intermediate groove 43 of said core establishes communication between the conduit fitting 50 and a connection to a conduit 52 leading to the intermediate portion of the main valve 18 and connected by a passage 53 therein to the port 54 to which the pressure fluid supply conduit 19 is connected, as shown in FIGURE 5. Thus, in the rightward position of valve core 42, shown in FIGURE 4, fluid under pressure is admitted through the conduit 51 into the left end of bore 32, this fluid being effective to move the core 24 to the rightward position thereof shown in FIGURE 4. Similarly, when the core 42 is in its leftward position, shown in FIGURE 3, groove 43 connects conduit 52 to conduit 49, allowing pressure fluid to enter the right end of bore 32, the pressure fluid being effective to move the core 24 to the leftward position thereof shown in FIGURE 3.

Pressure responsive valve 25 is suitably mounted above main valve 18 and has a fluid inlet passage 60 connected by a conduit 61 to a passage in block 33 in communication with the working fluid conduit 13. Valve 25 is also provided with a passage 63 connected by a conduit 64 to the left end of the bore 41 of valve block 40 of the control valve 23. An upwardly opening spring-biased ball check valve 65 is provided in the valve 25 between the top end of passage 60 and the ball valve chamber which communicates by a passage 66 with the passage 63. The lower end of passage 63 is provided with a downwardly opening spring-biased ball check valve 67 whose chamber is connected by a passage 68 with the passage 60. When a build up of pressure occurs in the passage 60, as a result of being placed in communication with pressure fluid admitted into the conduit 13, the ball valve 65 opens, allowing the pressure fluid to pass upwardly and through the passages 66 and 63 into the conduit 64 whereby the pressure fluid is admitted into the left end of the bore 41 of the control valve 23, causing the core 42 to be moved to the right, as above described.

The valve 26 is similar in construction to the valve 25, having a passage 70 connected by a conduit 71 to the connection in valve block 33 to conduit 14. Valve 26 has a passage 76 connected through an upwardly opening pressure-responsive ball check valve 75 to the passage 70, the passage 76 being connected to a passage 73 which in turn is connected by a conduit 74 to the right end of valve 23, the lower end of passage 73 being provided with a downwardly opening pressure-responsive ball check valve 77 whose chamber communicates by a passage 78 with the passage 70. When a pressure build up in passage 70 occurs as a result of being placed in communication with fluid under pressure admitted into the conduit 14, ball check valve 75 opens, admitting pressure fluid to the passage 76 and the conduit 74 into the right end of valve 23, causing core 42 to be shifted to its leftward position, shown in FIGURE 3. When the core 42 moves leftward from the position of FIGURE 4 toward the position of FIGURE 3, the fluid in the left end of bore 41 is forced back through conduit 64 into passage 63 where its pressure causes ball check valve 67 to open and allow the fluid to pass back through passage 68, passage 60 and conduit 61 to the conduit 13 which is in communication with the return conduit element 21 through the core recess 39, as shown in FIGURE 4. As above mentioned, when the core 42 is moved to the leftward position of FIGURE 3, fluid under pressure is admitted into conduit 49 from the conduit 52, causing the core 24 of the main reciprocating valve 18 to be moved to the leftward position thereof, shown in FIGURE 3. Fluid trapped in the left end of block 33 is forced through the conduit 51 and conduit fitting 50 into the registering core recess 45 and thence through passage 47 into the right end portion of valve 23, passing through the conduit 74 into the passage 73 and causing ball valve 77 to open, whereby the compressed fluid flows through passage 78 and conduit 71 to the space in bore 32 registering with the valve recess 40, which is in communication with the fluid return conduit element 22, thereby allowing the fluid to return to the reservoir 17.

Assuming the starting position to be that shown in FIGURE 3, in operation hydraulic fluid from conduit 19 will travel through recess 38 and conduit 61 to passage 60 and cause ball check valve 65 to open after the pressure in passage 60 has built up sufficiently, whereby the pressure fluid will travel through passage 66 and passage 63 to conduit 64, being thus admitted into the left end of valve 23. This occurs while hydraulic fluid under pressure is admitted by means of conduit 13 into the left end of the working cylinder 11, causing the piston rod 12 to be retracted.

The admission of the hydraulic fluid into the left end of valve 23 moves the core 42 rightward, as above described, to the position thereof shown in FIGURE 4. Pressure fluid is then admitted via conduit 52 and recess 43 into conduit 51 and thus into the left end of block 33, causing core 24 to be moved to the rightward position thereof shown in FIGURE 4. This connects the supply conduit 19 to the conduit 14, whereby to admit working fluid under pressure into the right end of the operating cylinder 11, as above described, causing the piston rod 12 to be extended in a working stroke. The space 70 of valve 26 is now in communication with the working fluid in conduit 14, whereby after a short period of time pressure builds up sufficiently to open ball valve 75, causing the pressure fluid to pass through passages 76 and 73 and conduit 74 into the right end of valve 23, shifting the core 42 to the leftward position thereof shown in FIGURE 3, wherein fluid under pressure is admitted into the conduit 49 and thence into the right end of block 33, restoring the core 24 to the leftward position thereof shown in FIGURE 3, namely, to the starting position. This again connects conduit 13 to the supply conduit 19, whereupon the previously described cycle is repeated. The core 24 of the main distributing valve 18 will thus reciprocate continuously, whereby pressure fluid is admitted alternately to the opposite ends of the working cylinder 11, causing corresponding reciprocation of the piston rod 12. This action continues as long the pump motor 16 remains energized. The apparatus is thus controlled by means of the main control switch 29.

While a specific embodiment of an improved reciprocating hydraulic control valve assembly has been disclosed in the foregoing description, it will be understood that various modifications within the spirit of the invention may occur to those skilled in the art. Therefore, it is intended that no limitations be placed on the invention except as defined by the scope of the appended claims.

What is claimed is:

1. In combination, a hydraulic cylinder having a piston rod, a source of hydraulic fluid, a drain means, a main distributing valve having an inlet connected to the source and having a first set of outlets connected respectively to the opposite ends of the cylinder and a second set of outlets connected to said drain means, said main distributing valve having a slidable core movable between two positions, means on the core to simultaneously connect the valve inlet to one of the first set of outlets and to connect the other of said first set of outlets to one of the second set of outlets when the core is in one of said positions, and to simultaneously connect the valve inlet to the other of said first set of outlets and to connect said one of the first set of outlets to the other of the

second set of outlets when the core is in its other position, whereby to reciprocate said piston rod, a further two-position distributing valve having a slidable core movable between two positions, respective pressure-responsive impulse valves connected between the first set of outlets and the opposite ends of the second-named distributing valve each including a pressure-responsive movable valve element, respectively, pressure-responsive relief valve means connecting said pressure-responsive valves to said second set of outlets, said relief valve means each including another pressure-responsive movable valve element movable independently of the movable valve element of the associated impulse valve, whereby to reciprocate said last-named core responsive to alternate build up of fluid pressure in said pressure-responsive impulse valves, and means to reciprocate said first-named core responsive to the reciprocation of the last-named core.

2. In combination, a hydraulic cylinder having a piston rod, a source of hydraulic fluid, a drain means, a main distributing valve having an inlet connected to the source and having a first set of outlets connected respectively to the opposite ends of the cylinder and a second set of outlets connected to said drain means, said main distributing valve having a slidable core movable between two positions, means on the core to simultaneously connect the valve inlet to one of the first set of outlets and to connect the other of said first set of outlets to one of the second set of outlets when the core is in one of said positions, and to simultaneously connect the valve inlet to the other of said first set of outlets and to connect said one of the first set of outlets to the other of the second set of outlets when the core is in its other position, whereby to reciprocate said piston rod, a further two position distributing valve having a slidable core movable between two positions, respective pressure-responsive impulse valves connected between the first set of outlets and the opposite ends of the second-named distributing valve and each including a first passage provided with a spring-biased ball valve opening responsive to pressure build up in the associated one of the first set of outlets and a bypass passage across said first-named ball valve and including a second spring biased ball valve opening responsive to pressure build up in the associated end of the second-named distributing valve, whereby to reciprocate said last-named core responsive to alternate build up of fluid pressure in said first set of outlets, and means to reciprocate said first-named core responsive to the reciprocation of the last-named core.

3. In combination, a hydraulic cylinder having a piston rod, a source of hydraulic fluid, a drain means, a main distributing valve having an inlet connected to the source and having a first set of outlets connected respectively to the opposite ends of the cylinder and a second set of outlets connected to said drain means, said main distributing valve having a slidable core movable between two positions, means on the core to simultaneously connect the valve inlet to one of the first set of outlets and to connect the other of said first set of outlets to one of the second set of outlets when the core is in one of said positions, and to simultaneously connect the valve inlet to the other of said first set of outlets and to connect said one of the first set of outlets to the other of the second set of outlets when the core is in its other position, whereby to reciprocate said piston rod, a further two-position distributing valve having a slidable core movable between two positions, respective pressure-responsive impulse valves connected between the first set of outlets and the opposite ends of the second-named distributing valve and each including a first passage provided with a spring-biased ball valve opening responsive to pressure build up in the associated one of the first set of outlets and a bypass passage across said first-named ball valve and including a second spring-biased ball valve opening responsive to pressure build up in the associated end of the second-named distributing valve, whereby to reciprocate said last-named core responsive to alternate build up of fluid pressure in said first set of outlets, and conduit means interconnecting said further distributing valve and the opposite ends of the main distributing valve, said last-named core being formed with grooves located relative to the connections of said conduit means so as to alternately admit hydraulic fluid to an end of the main distributing valve and to connect the opposite end of the main distributing valve to an end of the second-named distributing valve, whereby to reciprocate said first-named core responsive to the reciprocation of said last-named core.

4. In combination, a hydraulic cylinder having a piston rod, a source of hydraulic fluid, a drain means, a main distributing valve having an inlet connected to the source and having a first set of outlets connected respectively to the opposite ends of the cylinder and a second set of outlets connected to said drain means, said main distributing valve having a slidable core movable between two positions, means on the core to simultaneously connect the valve inlet to one of the first set of outlets and to connect the other of said first set of outlets to one of the second set of outlets when the core is in one of said positions, and to simultaneously connect the valve inlet to the other of said first set of outlets and to connect said one of the first set of outlets to the other of the second set of outlets when the core is in its other position, whereby to reciprocate said piston rod, a further distributing valve comprising an elongated housing containing a valve core longitudinally slidable therein between two limiting positions, respective pressure-responsive impulse valves connected between the first set of outlets and the opposite ends of said housing and each including a first passage provided with a normally closed spring biased ball valve opening responsive to pressure build up in the associated one of the first set of outlets and each including a bypass passage across the portion of said first passage containing the ball valve, said bypass passage including a second spring-biased ball valve opening responsive to pressure build up in the associated end of said elongated housing, and conduit means interconnecting said further distributing valve and the opposite ends of the main distributing valve, said last-named core being formed with annular recesses located relative to the connections of said conduit means to the housing so as to alternately admit hydraulic fluid under pressure to the opposite ends of the main distributing valve responsive to the reciprocation of said last-named core, whereby to reciprocate said first-named core, said impulse valves alternately admitting fluid under pressure to the ends of the housing, whereby to reciprocate said last-named core.

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