

[54] **HYDRAULIC CONTROL CIRCUITS AND APPARATUS**

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[58] Field of Search **91/414; 60/52 HE, 52 R, 97 P**

[56] **References Cited**

UNITED STATES PATENTS

2,445,781	7/1948	Hrdlicka	91/414 X
3,146,593	9/1964	Stacey	60/52 HE
3,208,221	9/1965	Schuetz	91/414 X
3,303,753	2/1967	McCay	91/414

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[57] **ABSTRACT**

A fluid circuit is provided for operation of multiple motors which comprises a pair of sources of high pressure fluid, two groups of directional control valves, each group containing at least two directional control valves separated by a signal block, each directional control valve operatively connected to deliver fluid to a fluid motor, one of said groups of valves being connected on opposite sides of a first signal block to each of said pumps through a pressure compensating valve, the other of said groups of valves being connected on opposite sides of a second signal block to each of said pumps through a pressure relieved inlet section, said second signal block in said other group including a pair of pressure operated spools regulating the flow of fluid from the two pumps to the directional control valves in said other group whereby the valves on either side of the second signal block can receive fluid from both pumps so long as only valves on one side or the other of the signal block are operative and receive fluid only from one pump at each side of the second block when valves on both sides are operative and shuttle valve means in connections between the signal blocks of each group whereby valves in each group may be simultaneously operated without starving the highest pressure motor.

6 Claims, 5 Drawing Figures

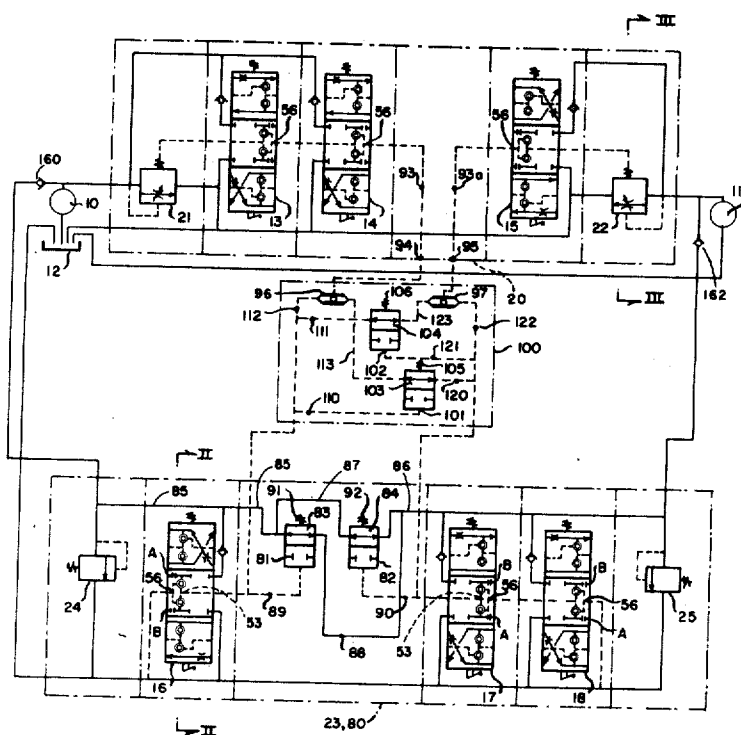
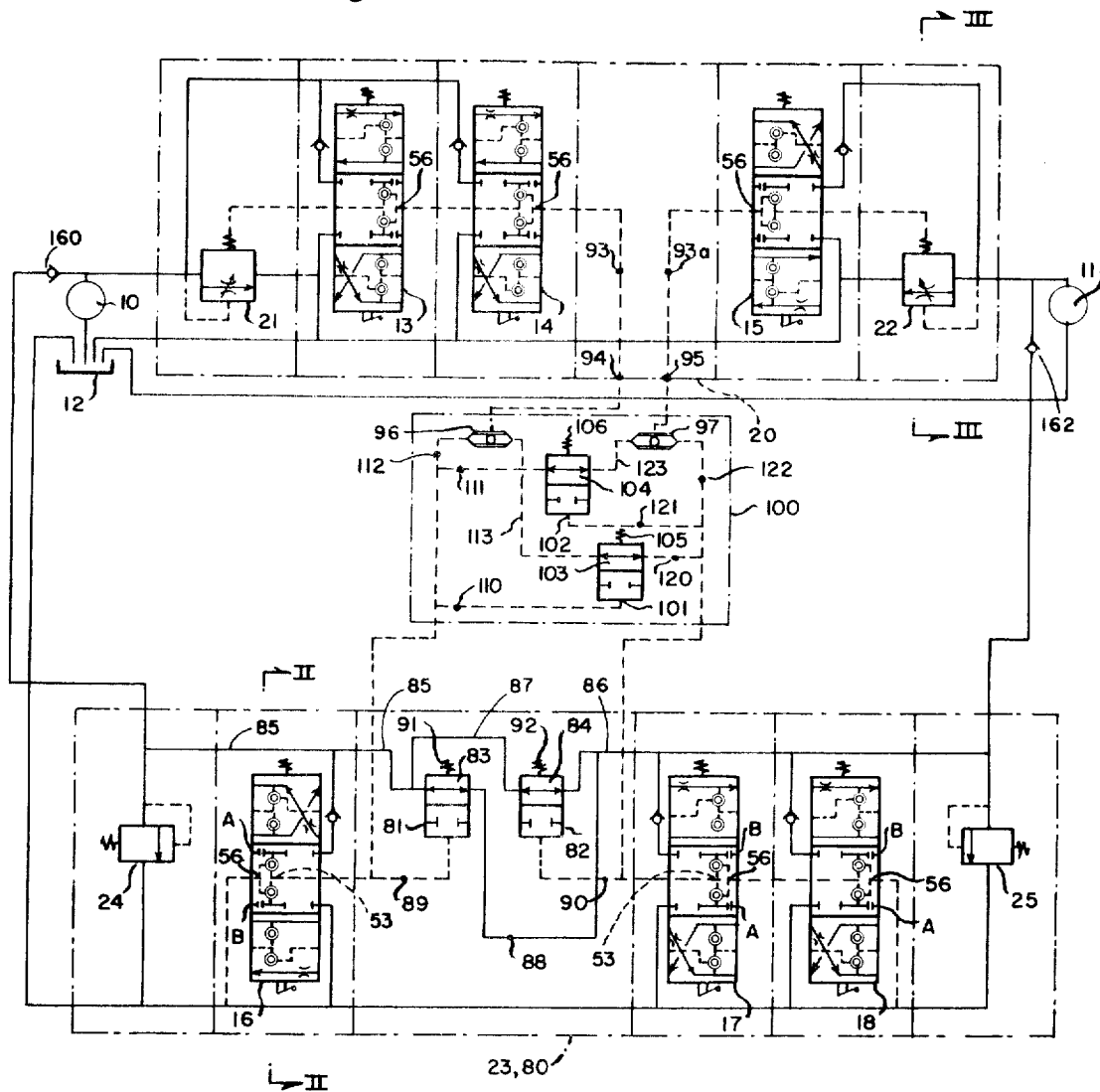


Fig. 1.



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Fig. 2.

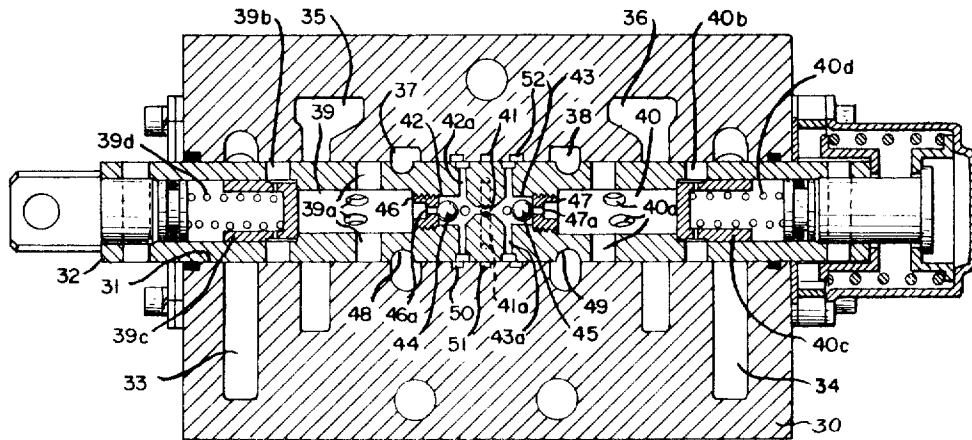
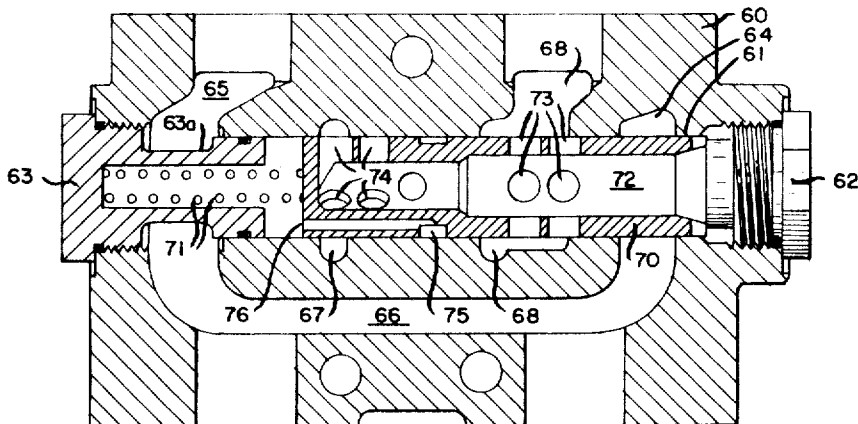


Fig. 3.



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Fig. 4.

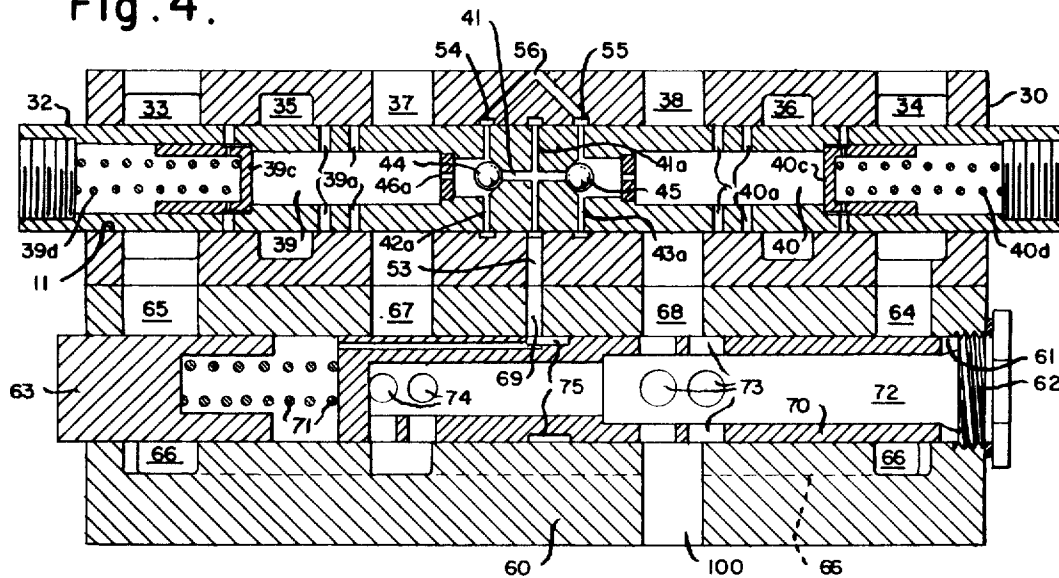
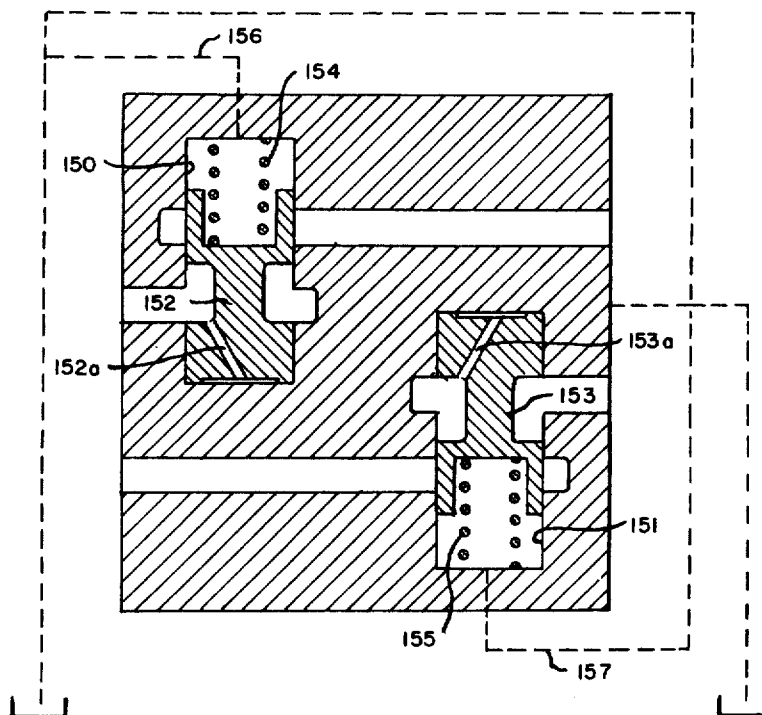


Fig. 5.



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HYDRAULIC CONTROL CIRCUITS AND APPARATUS

This invention relates to hydraulic control circuits and apparatus and particularly a control apparatus which automatically shifts hydraulic fluid from the source of fluid pressure from parallel to priority to the driven motors on a preselected place.

There are numerous situations in multiple movement hydraulic machines where it is desirable to supply hydraulic fluid from two different pumps to operate a plurality of different motors independently of one another or in parallel pairs. A typical example of such an apparatus is a hydraulic excavator having two tracks, a swing, a boom, a bucket and a dipper, each with a drive motor operated hydraulically from two hydraulic pumps so that the boom and dipper are operable independently of each other or in parallel with the tracks, the boom and swing are operable at the same time, the bucket is parallel to either the boom or dipper, the bucket is supplied from both pumps and the boom and dipper can be supplied from both pumps. In order to accomplish this a plurality of interconnected manual complicated multiple core valves have been required in the past.

We have developed a control apparatus which will accomplish all of these requirements with much less complicated coring in the control valves than the prior art and with less valve movement.

We preferably provide two pumps providing fluid under pressure, six directional control valves arranged in groups of three, each group of three being separated by a signal section, and arranged so that the two directional valves of one group and the single directional valve of the other group receive oil from one pump while the two directional valves of the other group and the single directional valve of the said one group receive oil from the other pump. One group of three valves is connected to the source of oil through a pressure compensating valve between each of the source and the control valves and the other group is connected by a standard relieved inlet port member. The signal sections of each group are connected together by a shuttle valve and the signal section in the said other group is provided with a pair of shifting spools to provide pressure shifting whereby the two directional valves on one side may be in communication with the directional valve on the other side.

In the foregoing general description of our invention we have set out certain objects, purposes and advantages of this invention. Other objects, purposes and advantages will be apparent from a consideration of the following description and the accompanying drawings in which:

FIG. 1 is a schematic view of a control system according to our invention;

FIG. 2 is a section on the line II—II of FIG. 1 through a directional control valve as used in our invention;

FIG. 3 is a section on the line III—III of FIG. 1 through a pressure compensating valve;

FIG. 4 is a horizontal section through a pressure compensating valve and directional control valve according to FIGS. 2 and 3; and

FIG. 5 is a schematic view of an alternative shuttle control valve assembly according to our invention.

Referring to the drawings we have illustrated a fluid control system according to our invention adapted to a

hydraulic excavator. In the drawings we provide a system having two spaced apart hydraulic pumps 10 and 11 drawing fluid from a common tank 12. The system is provided with six directional control valves 13, 14, 15, 16, 17 and 18 respectively adapted to divert fluid to a fluid motor (not shown). Each fluid motor operates some part of the excavator and is identified by name at each such valve. The directional control valves are divided into two groups of three each and each such group is divided in such a way that one control valve is separated from the remaining two in its respective group by a signal block 20. The first such group is made up of valves 13 and 14 on one side of a signal block 20 and valve 15 on the opposite side. Fluid is delivered from pump 10 through a pressure compensating valve 21 to valve 13 and 14. Fluid is delivered from pump 11 to pressure compensating valve 22 and thence to valve 15.

The second group of directional control valves includes valve 16 on one side of a signal block 23 and valves 17 and 18 on the opposite side. Fluid from pump 10 goes to valve 16 through an inlet section provided with a relief valve 24. Fluid from pump 11 goes to valves 17 and 18 through a like inlet section provided with a relief valve 25.

Each of the directional control valves 13—18 is of the form shown in detail in FIG. 2 and consists of a housing 30 having an axial bore 31 carrying a valve member 32. The housing is provided with spaced exhaust chambers 33 and 34 adjacent each end and intersecting bore 31, a pair of work chambers 35 and 36, one adjacent each exhaust chamber and each adapted to be connected to the opposite sides of a fluid motor. Between the two work chambers are spaced inlet chambers 37 and 38. The valve member 32 is hollow at each end to provide a pair of spaced internal chambers 39 and 40 extending axially of the valve member and connected by an axial passage 41 and ball chambers 42 and 43 at each end of said passage. The ball chambers are provided with freely movable balls 44 and 45 held in place by plugs 46 and 47 threaded into the ends of chambers 42 and 43 and each provided with a passage 46a and 47a respectively. Each of chambers 42 and 43 is provided with passages 42a and 43a extending radially to the periphery of the valve member. The chamber 40 is provided with two sets of radial openings 40a and 40b and chamber 39 is provided with a corresponding set of radial openings 39a and 39b. The openings 39a and 40a lie on a helical line so that their center lines are not on the same circumferential line. Openings 39b and 40b are separated from openings 39a and 40a respectively by check valves 39c and 40c within the chamber operated by springs 39d and 40d. A pair of spaced annular grooves 48 and 49 surround the valve member in alignment with inlet chambers 37 and 38 when the valve is in neutral position. When the valve is shifted to the right viewing FIG. 2 the openings 40a are one after another opened to work chamber 36 while openings 40b are open to outlet or exhaust chambers 34. At the same time, openings 39a are opened to inlet chamber 37 and openings 39b are opened to work chamber 35. As the valve is moved the openings 39a and 40a are opened to the appropriate chamber one after another to provide slowly increased flow of fluid into the corresponding chamber in a throttling manner. This fluid

then opens the corresponding check valve 39c and 40c permitting fluid in chamber 39 to flow to work chamber 35 and thence to one side of a fluid motor (not shown). In turn, the fluid in the opposite side of the fluid motor is discharged to work chamber 36 thence through openings 40a, check valve 40c and into outlet chamber 34. At the same time, the pressure in chamber 39 passes through passages 46a forcing ball 44 to close passage 41 and its corresponding radial passages 41a. Passage 43a is isolated at this point. Moving the valve in the opposite direction from neutral reverses the flow of fluid. The valve housing is provided with annular grooves 50, 51 and 52 which when the valve is in neutral are open to radial passages 42a, 41a and 43a respectively. The groove 51 is connected to a radial passage 53 which extends to the outside of housing 30. Grooves 50 and 52 are connected respectively to passages 54 and 55 which extend angularly to the outside of housing 30 and connect at the outside of the housing to a common port 56.

The pressure compensating valve housing 60 (FIG. 3) has a bore 61 closed at one end by a cap 62 threaded into the bore at one end and by a cap 63 threaded into the bore at the opposite end. The bore 61 is intersected by outlet or exhaust chambers 64 and 65 at each end connected together by a U-shaped passage 66. Inlet or high pressure chambers 67 and 68 intersect the bore intermediate the outlet chambers. A pressure sensing passage 69 intersects the bore 61 between the inlet chambers 67 and 68. The cap 63 extends through the exhaust or outlet chamber 65 and is provided with a groove 63a which permits free movement of fluid around it in chamber 65. A valve member 70 is freely movable in bore 61 and is biased toward cap 62 by spring 71 which bears on cap 63 at one end and on the valve member 70 at the other end. The valve member is hollow from the end adjacent cap 62 to a point spaced from its opposite end to form an inner axial chamber 72. Radial openings 73 spaced axially along and through the wall of the valve member 70 connect the chamber 72 with inlet chamber 68. Similar radial openings 74 spaced axially along and through the wall of valve member 70 connect the chamber 72 with inlet chamber 67. An annular groove 75 surrounds the valve member 70 in communication with passage 69. Groove 75 is connected to the area between cap 63 and valve member 70 by an axially extending passage 76 which parallels the chamber 72.

The signal block 23 between directional valves 16 and valves 17 and 18 consists of a housing 80 having parallel bores 81 and 82 carrying spools 83 and 84 of identical configuration. Each bore 81 and 82 is connected intermediate its ends to the parallel passage 38 of the next adjacent directional control valve, i.e., 16 and 17 respectively by passages 85 and 86 respectively. Passages 85 and 86 are in turn connected to the other bore by passages 87 and 88 so that the two bores 81 and 82 are in parallel. Bore 81 is connected at one end by passage 89 to signal passage 53 of valve 16 and bore 82 is connected at one end to signal passage 53 of valve 17 by passage 90. Each of the spools 83 and 84 is biased toward the end of bores 81 and 82 which receive passages 89 and 90 by springs 91 and 92.

The signal block 20 between directional control valves 14 and 15 is provided with a pair of passages 93

and 93a which connect respectively to signal passages 56 of valves 14 and 15 and to external ports 94 and 95 which are in turn connected to ball shuttle valves 96 and 97 in intermediate signal block 100. Signal block 100 is provided with bores 101 and 102 and spools 103 and 104 therein. Spools 103 and 104 are spring biased by springs 105 and 106 precisely as the spools 83 and 84 of signal block 23. Signal passage 89 of signal block 23 is connected to the end of bore 101 by passage 110, to bore 102 by passage 111 and to one end of ball shuttle 96 by passage 112. The opposite end of ball shuttle 96 is connected to bore 101 by passage 113. Signal passage 90 is connected by passage 120 to bore 101, to the end of bore 102 by passage 121 and to one end of ball shuttle 97 by passage 122. The opposite end of ball shuttle 97 is connected to bore 102 by passage 123.

The operation of the control system of our invention is as follows: With the two pumps 10 and 11 operating, the directional control valves 13 and 14 receive oil from pump 10, the two valves being in parallel. Oil is never received from pump 11 by valves 13 and 14. Valve 15 on the other hand receives oil from pump 11 and never from pump 10. If directional control valve 16 is operated it receives oil from both pumps 10 and 11 through the check valves 160, 162 and signal block 23 around one of the normally closed spools 83 and 84. If at the same time valves 13 or 14 are indexed in operating position, they get oil from pump 10 in parallel with valve 16 while valve 16 still obtains oil from pump 11 through check valve 162 without sharing the same with valves 13 and 14 due to check valve 160. Directional control valves 17 and 18 are in parallel with each other and receive oil from pump 11 and from pump 10 through signal block 23 around one of valves 81 and 82. In the event that valves 16 and 17 or 18 are indexed at the same time, the signal block 23 through valves 81 and 82 prevents the fluid from the two pumps from crossing through block 23 so that valve 16 receives fluid only from pump 10 through check valve 160 and valves 17 and 18 receive fluid only from pump 11 through check valve 162. The control of valves 81 and 82 through passages 89 and 90 results from the flow of fluid through passage 56 of valves 16 and 17 or 18 so that if both valves 16 and 17 or 18 are operative, both valves 81 and 82 are closed. At the same time valves 101 and 102 acting through shuttle valves 96 and 97 and signal block 20 and pressure compensating valves 21 and 22 regulate the flow of fluid to valves 13 and 14 or 15 as the case may be so that when any of valves 16 or 17 and 18 are operated at the same time as valves 13 and 14 or 15, fluid will be distributed to all valves without regard to the differential pressures involved so that no valve will be starved to the advantage of others.

In FIG. 5 we have illustrated another form of valve bores 150 and 151 and spools 152 and 153 biased to the closed position by springs 154 and 155. The spools 152 and 153 are opened by pressure fluid acting through passages 152a and 153a in spools 152 and 153 on the end of the spools in opposition to springs 154 and 155 and the signal fluid in passages 156 and 157. This arrangement can be substituted for valves 81 and 82 of FIG. 1-4 to produce a like result.

In the foregoing specification we have set out certain preferred embodiments of our invention, however it will be understood that the invention may be otherwise embodied.

We claim:

1. A fluid circuit for operation of multiple fluid motors comprising a pair of sources of high pressure fluid, two groups of directional control valves, each group containing at least two directional control valves separated by a signal block, each directional control valve operatively connected to deliver fluid to a fluid motor, one of said groups of valves being connected on opposite sides of a first signal block to each of said pumps through a pressure compensating valve, the other of said groups of valves being connected on opposite sides of a second signal block to each of said pumps through a pressure relieved inlet section, said second signal block in said other group including a pair of pressure operated spools regulating the flow of fluid from the two pumps to the directional control valves in said other group whereby the valves on either side of the second signal block can receive fluid from both pumps so long as only valves on one side or the other of the signal block are operative and receive fluid only from one pump at each side of the second block when valves on both sides are operative and shuttle valve means in connections between the signal blocks of each group whereby valves in each group may be simultaneously operated without starving the highest pressure motor.

2. A fluid circuit as claimed in claim 1 wherein each of said two groups of valves includes three directional

control valves, two on one side and one on the opposite side of each signal block.

3. A fluid circuit as claimed in claim 1 wherein said first signal block includes two signal passages, one connecting the valves on one side of the block to said shuttle valve means and the other connecting the valves on the other side of the block to said shuttle valve means.

4. A fluid circuit as claimed in claim 3 wherein said shuttle valve means includes a pair of spaced shuttle valves, one connected to each of said two signal passages, each of said pair of shuttle valves being connected to the second signal block whereby pressure changes in said second signal block are reflected in changed position of the shuttle valves.

5. A fluid circuit as claimed in claim 4 wherein the second signal block includes a pair of pressure responsive valves controlling the flow of fluid between the directional valves on one side of said signal block and the directional valves on the other side of said signal block whereby the operative valves on either side of said block receive fluid from both pumps so long as no valve is operated on the other side of the block and receive fluid from only one pump when valves on both sides of said block are operative.

6. A fluid circuit as claimed in claim 1 wherein a check valve is inserted between the pumps and the inlet section.

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