

Dec. 2, 1969

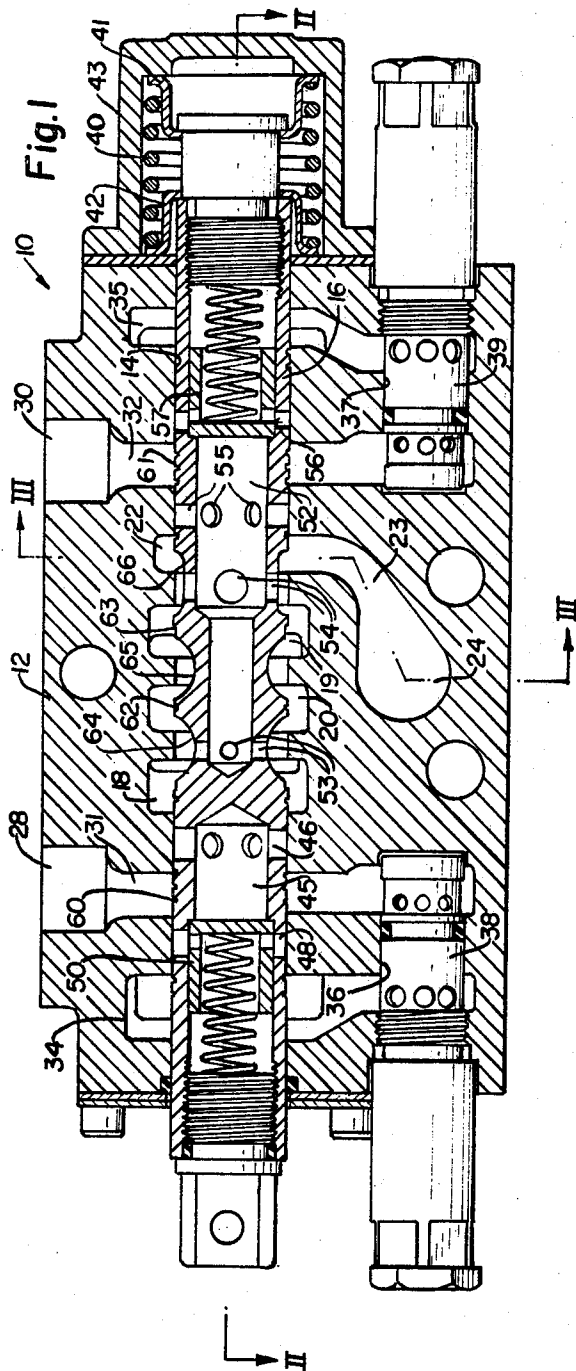
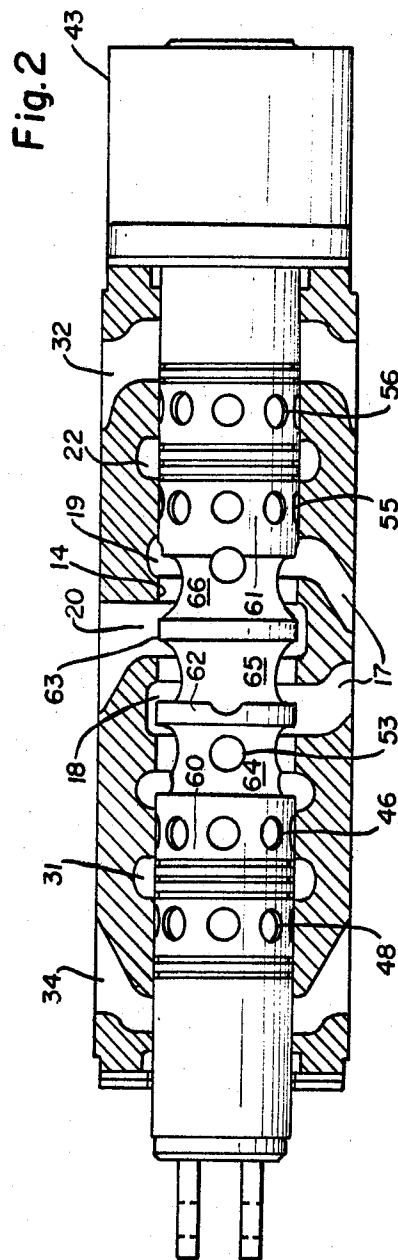
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3,481,364

HYDRAULIC VALVES.

Filed Nov. 30, 1967

3 Sheets-Sheet 1



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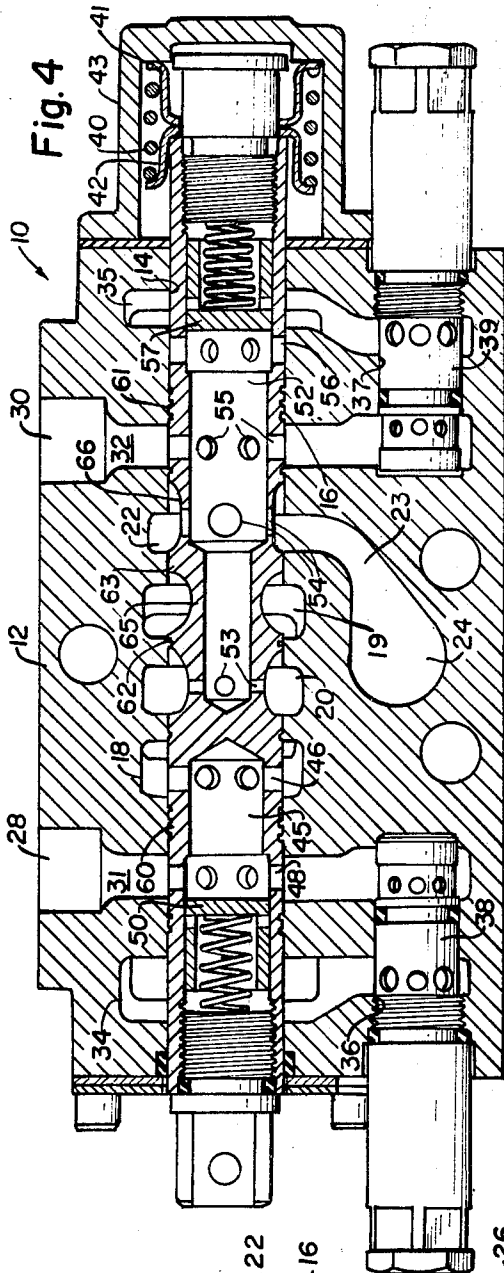
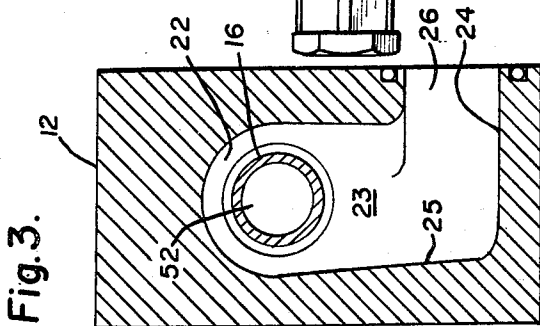
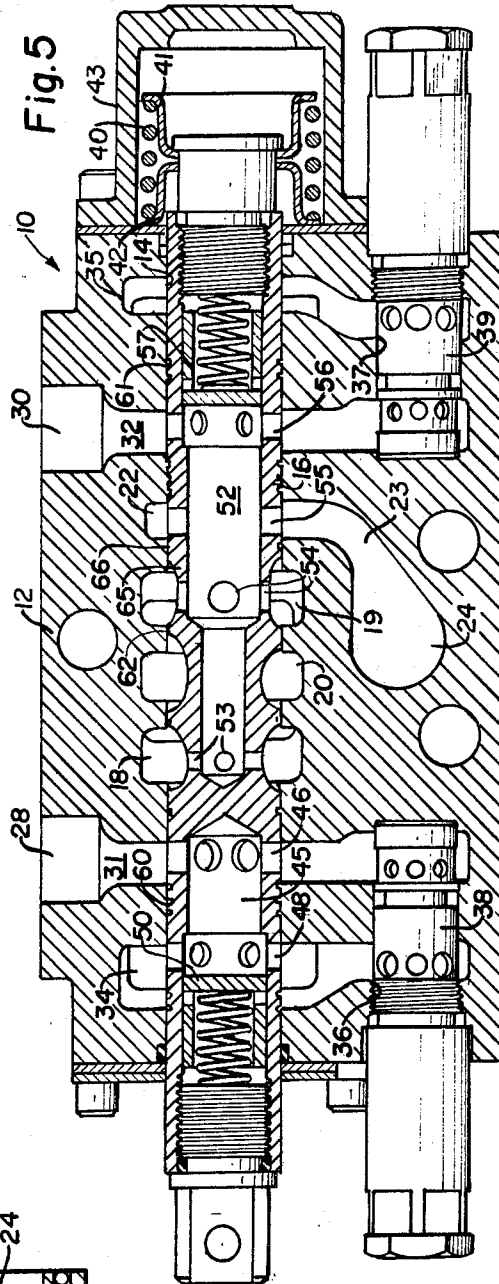
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3,481,364

HYDRAULIC VALVES.

Filed Nov. 30, 1967

3 Sheets-Sheet 2



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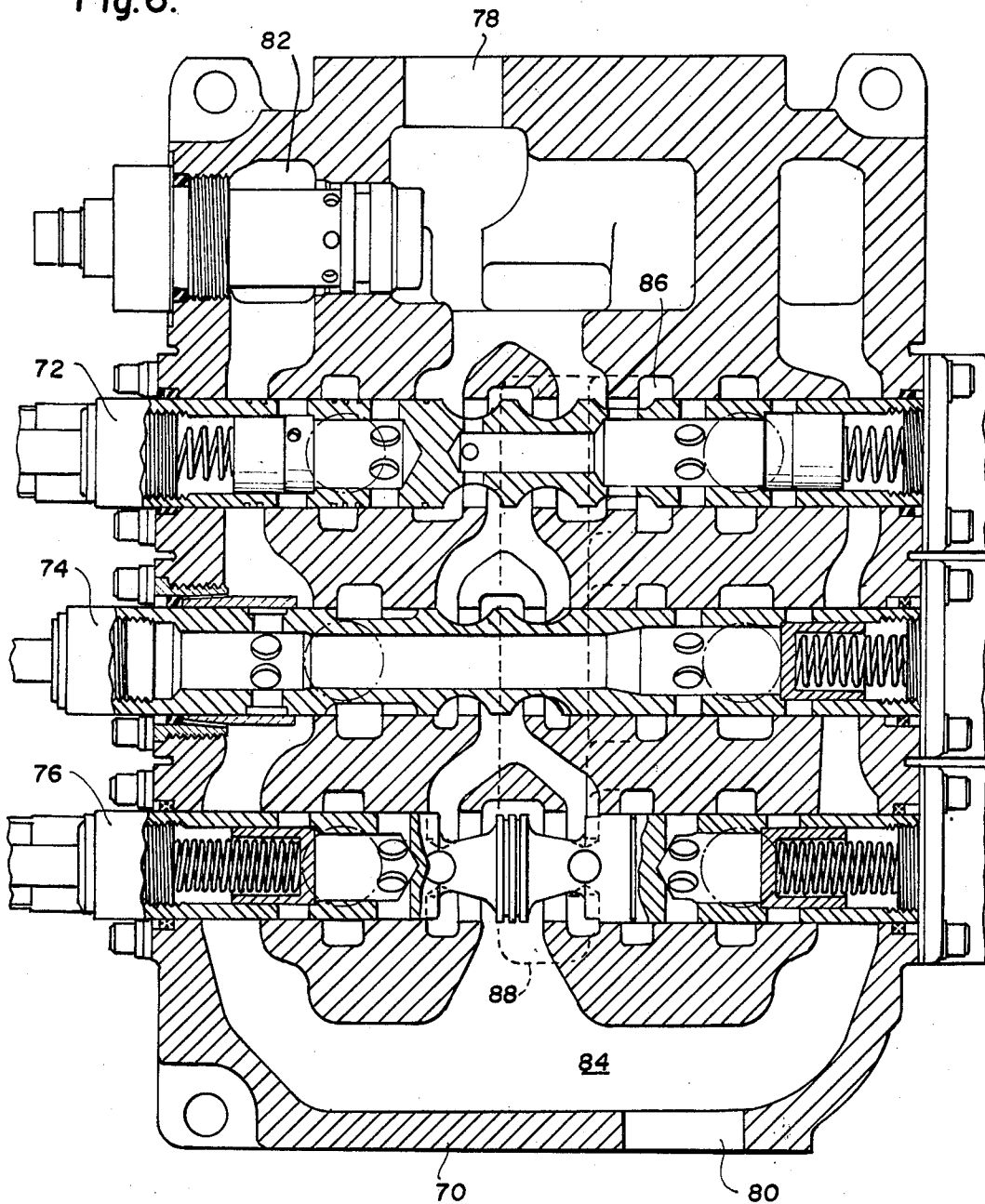
3,481,364

HYDRAULIC VALVES.

Filed Nov. 30, 1967

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Fig. 6.



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HYDRAULIC VALVES

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Filed Nov. 30, 1967, Ser. No. 686,948

Int. Cl. F16k 31/12

U.S. Cl. 137—596

6 Claims

ABSTRACT OF THE DISCLOSURE

A hydraulic series-parallel valve including a body having a longitudinal bore, intercommunicating inlet and outlet chambers, a pair of work port chambers, a pair of exhaust chambers and a branch port chamber communicating with the inlet and outlet chambers. A slidable valve element is received in the longitudinal bore and is shiftable from a neutral position to one of two work positions. The valve element has a pair of hollow portions and various openings communicating with the respective hollow portions. When the valve element is in one work position fluid will flow in series through one work port chamber and the branch port chamber, and when the valve element is in the other work position fluid will flow in parallel to the other work port chamber and the branch port chamber.

This invention relates to hydraulic valves and particularly to hollow spool valves having selective series or parallel flow capability.

There are various operations of multiple hydraulic cylinders or motors where it is desirable that they operate in series or in parallel with each other. During series operation more than one of the cylinders or motors can function concurrently. On the other hand, during parallel operation the cylinders or motors ordinarily function sequentially. For example, in parallel operation two valves in a multiple valve configuration could be operated together and in such case the first cylinder or motor would operate until it reaches a mechanical stop at which time the pump would build up enough pressure to actuate the second cylinder or motor. Such a parallel multiple valve arrangement could be made to actuate the cylinders or motors simultaneously but would necessitate metering of the input supply with consequent diminishing of circuit efficiency. Although the series arrangement would permit simultaneous operation of the cylinders or motors one disadvantage when operating a bank of valves is the necessity of large cylinders or motors to obtain a desired work output during operation of more than one of such valves.

There are various apparatus whose functioning requires the use of a combined series-parallel circuit in that the operation of the series circuit is used in one instance while the parallel circuit is used in another instance. Such a combination circuit would be used in the operation of a hydraulic loader or shovel, for example. The parallel circuit would be used for rolling back of the bucket and lifting the boom. The bucket pressure requirement is lower than that of the boom. Accordingly, the bucket would roll back until it reached a mechanical stop at which stage the pump would build up the fluid pressure to enable the boom to move up to a stable half stroke position. The loading machine would be moved to a truck or carrier where the operator would activate the boom valve to raise the boom to a higher position for unloading the bucket into the carrier. At the same time as the activating of the boom valve, the bucket valve would be activated to place it in series with the boom valve. Accordingly, the lifting and dumping operations will occur substantially simultaneously. The dump-

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ing of the bucket will require a lesser pressure than the rolling back thereof since the weight of the bucket and load will assist the dumping movement. After the bucket is dumped the operator will return the loading machine to perform another digging operation. Ordinarily the above operation would require a complex hydraulic valve and circuit arrangement for providing the parallel and series flows. We overcome the necessity of such complex circuitry by providing a unitary hydraulic valve section which will permit parallel circuit flow with the valve element thereof in one work position and series circuit flow with the valve element in the other work position, thus permitting a simple hydraulic circuit for performing work functions such as those illustrated above. In our preferred embodiment we provide such a combination series and parallel circuit double acting control valve, described in sectional form but not limited thereto, comprising a body having a longitudinal bore, inlet means, and outlet means, an inlet chamber intersecting the bore and communicating with the inlet means; and outlet chamber intersecting the bore spaced from the inlet chamber and communicating with the outlet chamber; a passage in the body beginning intermediate the sides of the body and extending to the outlet side transverse to the bore in a plane generally parallel to and spaced from the plane of the inlet and outlet chambers and the bore; first and second work port chambers intersecting the bore, one on each side of the inlet and outlet chambers; a branch chamber between the first work port chamber and the inlet chamber and communicating with the passage; at least one exhaust passage means intersecting the bore adjacent the second work port chamber; a valve element selectively shiftable longitudinally of the bore from a neutral position in which fluid entering the inlet chamber passes to the outlet chamber through the bore around a reduced portion of the valve element to one of two work positions, the valve element having a first hollow portion extending substantially in the direction of the first work port chamber to adjacent one end portion thereof, the valve element has a second hollow portion at the other end portion thereof, the valve element being adapted when in one work position to block direct communication through the bore between the inlet and outlet chambers while connecting the inlet chamber with the branch chamber and the first work port chamber, respectively, through first openings in the valve element communicating with the first hollow portion and connecting the second work port chamber with the exhaust chamber, and the valve element is further adapted when in the other work position to block direct communication between the inlet and the outlet chambers while connecting the second work port chamber with the inlet chamber through second openings in said valve element communicating with the second hollow portion and connecting the first work port chamber with the branch chamber and the outlet chamber through the first openings in the valve element.

Other details, objects and advantages of the invention will become apparent as the following description of a present preferred embodiment thereof proceeds.

In the accompanying drawings we have shown a present preferred embodiment of the invention in which:

FIGURE 1 is a longitudinal sectional view through a double acting series-parallel hydraulic valve embodying our invention and showing the valve element in a neutral position;

FIGURE 2 is a view taken along the line II—II of FIGURE 1;

FIGURE 3 is a view taken along the line III—III of FIGURE 1;

FIGURE 4 is a longitudinal sectional view through the valve of FIGURE 1 showing the valve element in one work position;

FIGURE 5 is a longitudinal sectional view through the valve of FIGURE 1 showing the valve element in a second work position; and

FIGURE 6 is a sectional view through a multiple valve assembly having a single cast valve housing showing one application of the valve of this invention.

Referring now to the drawings wherein like reference numerals refer to like parts throughout the various figures 10 generally designates a double acting series-parallel hydraulic valve section, including an elongated body 12 adapted to be attached with the other hydraulic valve body sections by nuts and bolts, for example to form a desired multi-valve arrangement. Such arrangements are well known as typified by the series-parallel-priority valve arrangement disclosed in U.S. Patent No. 3,329,169, granted July 3, 1967. Body 12 has a longitudinal bore 14 extending therethrough with a double acting sliding valve element 16 being suitably received therein. A bifurcated inlet passage 17 having chamber 18 and 19 intersecting bore 14 receives high pressure fluid from a source, not shown, through an inlet section, also not shown but well known in the art. An outlet chamber 20 intersects bore 14 between inlet chambers 18 and 19. A branch 22 intersects bore 14 adjacent inlet chamber 19 and communicates through passage 23 with a passage 24 lying in a plane spaced beneath and generally parallel to the plane of the inlet and outlet chambers. Passage 24 also has one end 25 thereof closed while extending transversely of the lateral faces of body 12, as viewed in FIGURE 3, to an open end 26. Work ports 28 and 30 open out of body 12 and communicate with chambers 31 and 32 intersecting bore 14 on opposite sides of inlet chamber 18 and branch chamber 22, respectively. Exhaust chambers 34 and 35 intersect bore 14 on opposite sides of work chamber 31 and 32, respectively, and communicate with the respective work chambers through passages 36 and 37. Identical pressure relief valves 28 and 39 are suitably received in passages 36 and 37, respectively.

Valve element 16 is shown in the neutral position and can be shifted into one of two work positions by any well known means, as by suitable linkages, for example, connected to the left side of the valve element 16, as viewed in FIGURE 1. Valve element 16 is urged into its neutral position by a helical coil spring 40 urging a force on either collar member 41 or 42 suitably arranged on valve element 16, with the direction of the force depending on the longitudinal position of the valve element. A hollow housing 43 suitably fixed to body 12 encloses spring 40, collar members 41 and 42, and the right side of valve element 16. Valve element 16 has a hollow portion 45 extending from the left end portion thereof to an intermediate position of the valve element. A plurality of circumferentially spaced openings 46 communicate with the right hand terminal portion of hollow portion 45 while another series of circumferentially spaced openings 48 communicate with an intermediate portion of hollow portion 45. A spring urged check valve 50 suitably arranged in hollow portion 45 separates the hollow portion 45 into two sections and is disposed rightwardly adjacent intermediate openings 48. Valve element 16 also has another hollow portion 52 extending from the right end portion thereof to an intermediate position, left of center, of valve element 16. Hollow portions 45 and 52 are, therefore, separated from each other. Circumferentially spaced first openings 53 communicate with the left terminal portion of hollow portion 52, and circumferentially spaced second openings 54 communicate with an intermediate portion thereof. A plurality of circumferentially spaced openings 55 communicates to the right of openings 54 with an intermediate portion of hollow portion 52 while another plurality of circumferentially spaced openings 56 communicates to the right of openings 55 with another section

of hollow portion 52. A spring urged check valve 57 suitably arranged in hollow portion 52 separates the hollow portion into two sections and is disposed leftwardly adjacent openings 56. Valve element 16 has a left land 60, right land 61, central land 62, and intermediate land 63 disposed between the central and right lands. Grooves 64 and 65 are disposed on the opposite sides of central land 62 with groove 65 being disposed leftwardly of intermediate land 63. Another groove 66 is disposed rightwardly of intermediate land 63. With valve element in neutral position as shown, fluid will flow through bore 14 between inlet chambers 18 and 19, outlet chamber 20, and branch chamber 22.

In operation of the valve assembly 10, with the valve element 16 in neutral, as shown in FIGURE 1, the work chambers 31 and 32 are blocked and pressurized fluid entering body 12 through inlet chambers 18 and 19 flow to outlet chamber 20 and branch chamber 22, as well as entering openings 53 in valve element 16 to flow through hollow portion 52 and outwardly of opening 54 and into branch chamber 22. When the valve element is moved rightwardly to the position shown in FIGURE 4 the fluid flow circuit is in series. Direct flow through bore 14 between inlet chambers 18 and 19 and outlet chamber 20 is blocked. Likewise, direct flow through bore 14 between inlet chamber 19 and branch chamber 22 is blocked. The fluid will, accordingly, flow through openings 46 into hollow portion 45, will urge a leftwardly directed force on check valve 50, flow past check valve 50 through openings 48 into work chamber 31 and outwardly of port 28 into a cylinder or the like. Return flow from a cylinder will enter body 12 through work port 30 into work chamber 32 through openings 55 into hollow portion 52 where, depending on the position of other downstream valves, it will pass either through openings 54 into branch chamber 22 or through openings 53 into outlet chamber 20. If the outlet chamber 20 is blocked all of the flow will be through branch chamber 22, and vice versa.

When valve element 16 is shifted to the position shown in FIGURE 5 the fluid flow circuit is parallel. Direct flow of fluid through bore 14 between inlet chambers 18 and 19 is blocked, as well as it is between the inlet chambers and work chamber 31. Fluid thus flows from inlet chamber 18 into hollow portion 52 through opening 53, urges a rightwardly directed force on check valve 57, flows past check valve 57 through openings 56 to work chamber 32 and out of work port 30 to a cylinder or the like. Fluid will also flow from inlet chamber 19 through opening 54 into hollow portion 52. Fluid in hollow portion 52 will flow out of openings 55 into branch chamber 22 to provided, together with flow out of work port 30, parallel downstream flow outwardly of body 12. Return flow from a cylinder enters work port 28 into chamber 31, causes 48 into exhaust passage 34 and outwardly of body 12 to check valve 50 to open, and then flows through openings reservoir.

It should now be apparent that the illustrative example of a series-parallel fluid flow application described in the introductory portion of this description can be achieved by using the apparatus described herein.

The series-parallel valve of this invention has been described hereinabove as being of a familiar valve section type adapted to be connected with other valve sections to form a bank of multiple valves. As is shown in FIGURE 6, however, valve 10 of the earlier description may be incorporated as part of a bank of valves combined in a single cast housing 70. As shown in FIGURE 6 the series-parallel valve 72 of this invention is combined with a float spool valve 74 of the type fully described and claimed in copending U.S. Patent application Ser. No. 668,760, filed Sept. 19, 1967, and with a double acting valve 76 of the type fully described and claimed in U.S. Patent 3,329,169, granted July 4, 1967. Since the elements of valves 72, 74, and 76 have already been fully described structurally and functionally, it is deemed unnecessary to repeat any detailed descriptions thereof. Briefly, the valve

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bank of FIGURE 6 has an inlet means 78, and outlet means 80, and exhaust chambers 82 and 84, respectively. The series-parallel valve 72 has a branch chamber 86, corresponding in position to branch chamber 22 of the earlier description, communicating with a branch passage 88 shown in dashed outline in FIGURE 6. Branch passage 88 is open for downstream flow of fluid to valves 74 and 76 when these valves are appropriately positioned in their respective bores. Many other applications of the series-parallel valve of this invention can be readily envisioned by those skilled in this particular valve art.

We claim:

1. A hydraulic valve comprising: an elongated body having at least one longitudinal bore, inlet means and outlet means; an inlet chamber intersecting said bore and communicating with said inlet means; an outlet chamber intersecting said bore spaced from said inlet chamber and communicating with said outlet means; a passage in said body beginning intermediate the sides of said body and extending to the outlet side transverse to said bore in a plane generally parallel to and spaced from the plane of said inlet and outlet chambers and said bore; first and second work port chambers intersecting said bore, one on each side of said inlet and outlet chamber; a branch chamber between said first work port chamber and said inlet chamber and communicating with said passage; at least one exhaust chamber intersecting said bore adjacent said second work port chamber; a valve element selectively shiftable longitudinally of said bore from a neutral position in which fluid entering said inlet chamber passes to said outlet chamber through said bore around a reduced portion of said valve element to one of two work positions, said valve element having a first hollow portion extending in the direction of said first work port chamber to adjacent one end portion thereof, said valve element having a second hollow portion at the other end portion thereof, said valve element being adapted when in one work position to block direct communication through said bore between said inlet and outlet chambers while connecting said inlet chamber with said branch chamber and said first work port chamber, respectively, through first openings in said valve element communicating with said first hollow portion and connecting said second work port chamber with said exhaust chamber, and in the other work position to block direct communication between said inlet and said outlet chambers while connecting said second work port chamber with said inlet chamber through second openings in said valve element communicating with said second hollow portion and connecting said first work port chamber with said branch chamber and said outlet chamber through said first openings in said valve element.

2. A hydraulic valve as set forth in claim 1 wherein, said said valve element is in said one work position said

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second work port chamber and said exhaust chamber are connected through said second openings.

3. A hydraulic valve as set forth in claim 1 wherein said first hollow portion extends substantially through said reduced portion of said valve element in the direction of said first work port chamber.

4. A hydraulic valve as set forth in claim 1 wherein said first opening includes a series of longitudinally separated circumferentially spaced passageways communicating with said first hollow portion; and said second openings include a series of longitudinally separated circumferentially spaced ports communicating with said second hollow portion.

5. A hydraulic valve as set forth in claim 3 wherein said first openings include longitudinally separated circumferentially spaced first, second, third and fourth passageways connected with said first hollow portion; said second openings include longitudinally separated circumferentially spaced first and second ports communicating with said second hollow portion; and wherein, when said valve element is in said one work position said second work port chamber and said exhaust chamber adjacent thereto are connected through said first and second ports, said branch chamber communicates with said third passageways and is connected to said inlet chamber through said first, second and third passageways, said inlet chamber is connected with said first work port chamber through said first, second and fourth passageways; and when said valve element is in said other work position said first work port chamber is connected with said branch chamber through said third and second passageways, said first work port chamber is connected with said outlet chamber through said third and first passageways.

6. A hydraulic valve as set forth in claim 5 including first and second pressure responsive check valve means in said first and second hollow portion, respectively, said first check valve means closing said fourth passageways, and said second check valve means closing said second ports.

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U.S. Cl. X.R.

55 137—625.68

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,481,364

December 2, 1969

Robert F. Hodgson et al.

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 3, line 19, "July 3, 1967" should read -- July 4, 1967 --; line 26, after "branch" insert -- chamber --; line 40, "28" should read -- 38 --. Column 4, line 50, "vided" should read -- vide --; lines 53 and 54, "48 into exhaust passage 34 and outwardly of body 12 to check valve 50 to open, and then flows through openings" should read -- check valve 50 to open, and then flows through opening 48 into exhaust passage 34 and outwardly of body 12 to --.

Signed and sealed this 20th day of October 1970.

(SEAL)

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Commissioner of Patents