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[54] **DIRECTIONAL CONTROL VALVE ASSEMBLY**
18 Claims, 4 Drawing Figs.

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60/52, 60/97: 137/596.17
[51] **Int. Cl.** **F15b 13/06**
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411(A), 411(A1); 60/97(E), 52(US), 52(HE),
97(H); 137/596.17 (Inquired)

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ABSTRACT: A directional control valve assembly for actuating a pair of fluid motors (or pairs of fluid motors) characterized in that duplicate directional control valves have duplicate motor ports adapted to be connected to the respective fluid motors and have duplicate inlet ports adapted to be connected to duplicate pumps, said inlet ports and/or the respective motor ports of said valves being cross-connected thus to equalize the fluid pressures in said inlet ports and/or in said motor ports to provide substantially equalized flow of fluid to the respective motors.

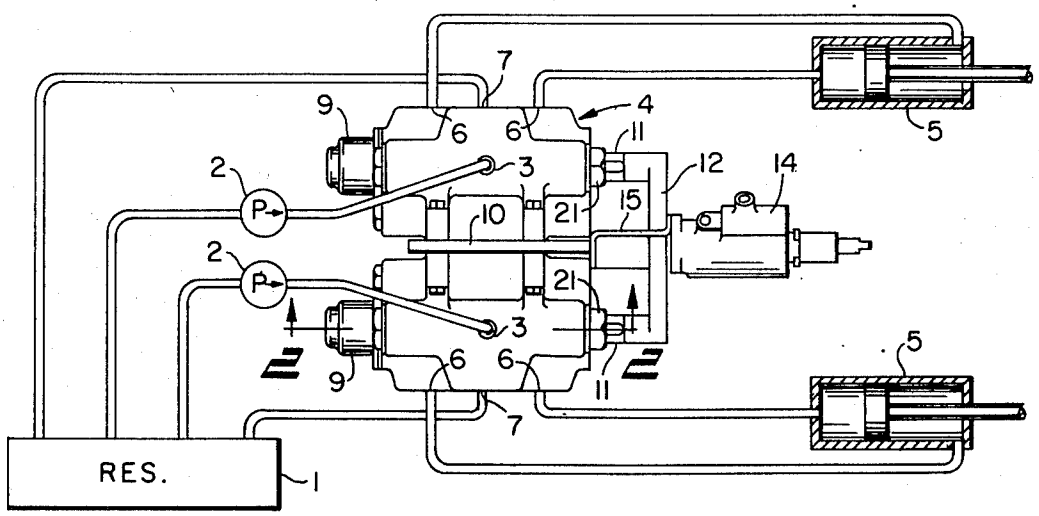


Fig. 1

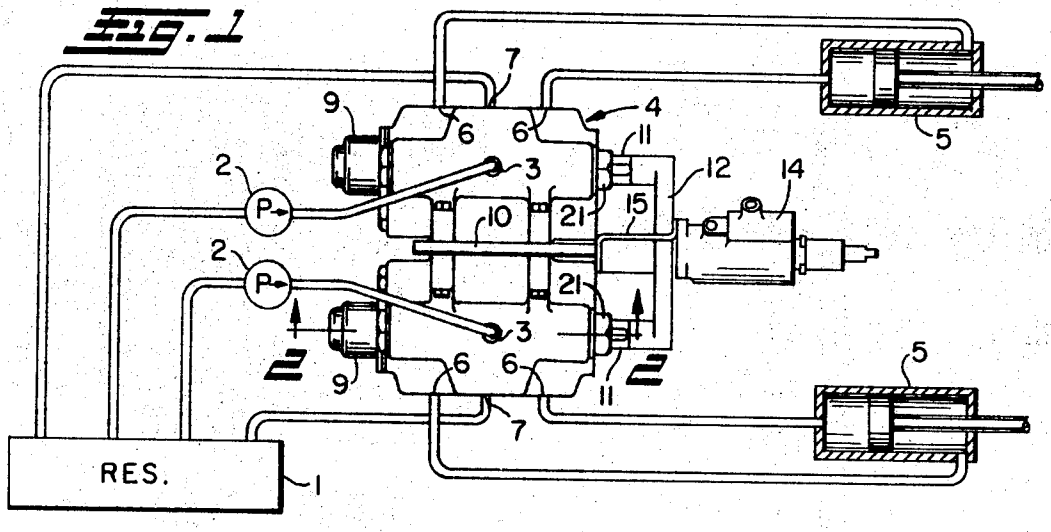
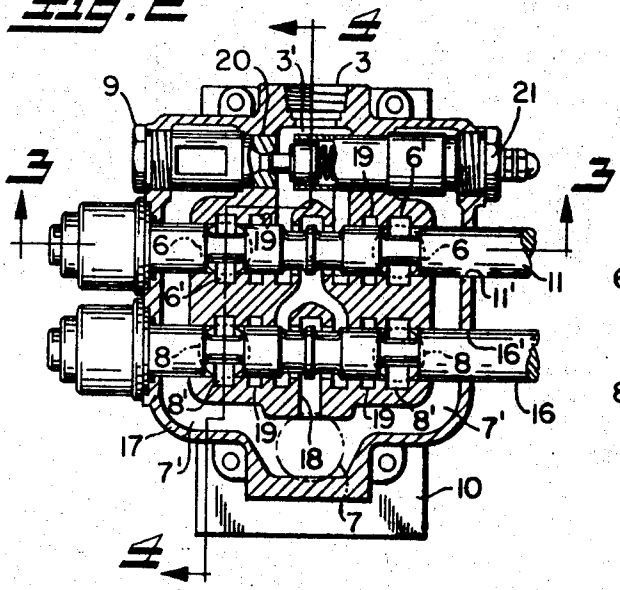


Fig. 2



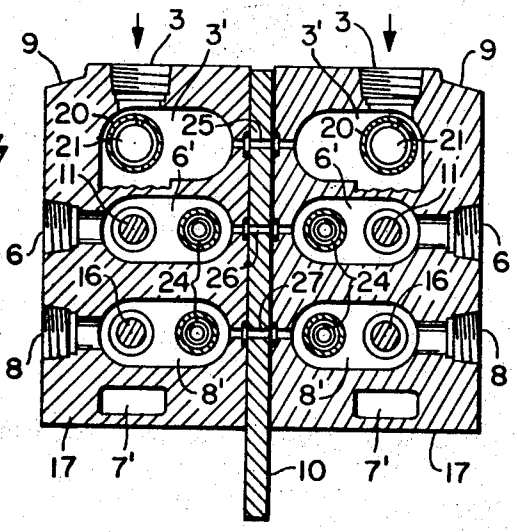


Fig. 4

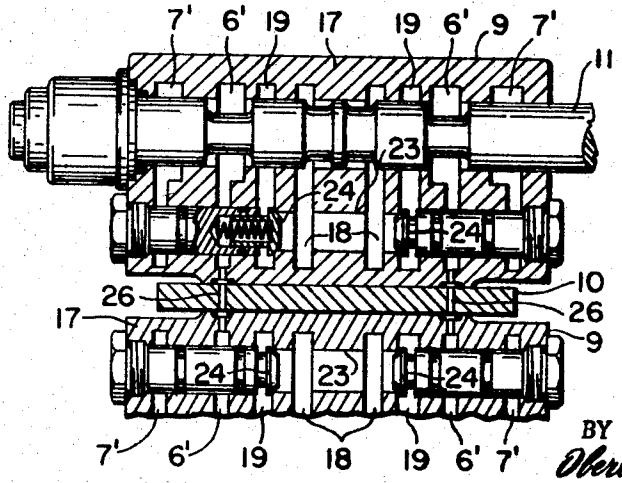


Fig. 3

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DIRECTIONAL CONTROL VALVE ASSEMBLY

BACKGROUND OF THE INVENTION

In hydraulic power systems for presses, machine tools, hoisting equipment, etc. it is sometimes desirable or necessary to provide a pair of fluid motors to actuate a press ram, a machine tool slide, a hoist boom, etc. rather than a single large size fluid motor. In such dual motor installations it is known to employ one large size pump (or a plurality of smaller pumps) having a capacity to supply fluid at required pressure to both motors via a single large size directional control valve assembly and large size conduits or hoses connected to the motor ports of the directional control valve, said conduits or hoses terminating at tees for splitting the flow of fluid to the respective motors.

It is also known to provide a dual directional control valve assembly for each pair of motors, but here again, a large size valve assembly is required to handle the total flow of the large size pump (or of a plurality of smaller pumps) through its inlet and return ports and through its bypass passage. Furthermore, because one valve member is upstream of the other, the simultaneous actuation of the valve members will result in the motor associated with the downstream motor port receiving a lower pressure than the motor associated with the upstream motor port due to the greater pressure drop through the valve passages leading to the downstream motor port and thus the motors tend to apply twisting or cocking strains on the guides of the component actuated thereby.

It is also well known to provide complex synchronizing means or proportional flow dividers in hydraulic systems which generally are actuated by the pistons of the respective motors to achieve synchronized operation of the motors.

SUMMARY OF THE INVENTION

With the foregoing in mind it is a principal object of this invention to provide a directional control valve assembly which has duplicate inlet ports for connection to duplicate pumps, duplicate motor ports for connection to duplicate motors, and duplicate valve members which are simultaneously actuated to open and close fluid communication between the respective inlet ports and motor ports, the ports, valve members, and conduits being of size to accommodate the fluid flow required for the respective motors. In addition, the inlet ports and/or the motor ports are cross-connected to each other to equalize the pressures in the inlet ports and/or in the motor ports whereby said motors will be operated in synchronism.

Other objects and advantages of the present invention will become apparent as the following description proceeds.

To the accomplishment of the foregoing and related ends, the invention, then, comprises the features hereinafter fully described and particularly pointed out in the claims, the following description and the annexed drawing setting forth in detail a certain illustrative embodiment of the invention, this being indicative, however, of but one of the various ways in which the principle of the invention may be employed.

BRIEF DESCRIPTION OF THE DRAWING

In the annexed drawing:

FIG. 1 is a top plan view of a directional control valve assembly embodying the present invention, the same being shown in a hydraulic system employing two pumps for synchronous operation of a pair of fluid motors connected to the respective upper pairs of motor ports of said valve assembly;

FIG. 2 is a cross-sectional view taken substantially along the line 2–2, FIG. 1;

FIG. 3 is a cross-sectional view taken substantially along the line 3–3, FIG. 2; and

FIG. 4 is a cross-sectional view taken substantially along the line 4–4, FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now in detail to the drawing, FIG. 1 illustrates a hydraulic system comprising a reservoir 1, a pair of pumps 2;2 for supplying fluid under pressure to the respective inlet ports 3;3 of a directional control valve assembly 4, and a pair of fluid motors 5;5 connected as shown to the respective upper pairs of motor ports 6;6 of said valve assembly 4. The directional control valve assembly 4 also has a pair of return ports 7;7 which are connected as shown to the reservoir 1. As evident from FIGS. 2 and 4, the directional control valve assembly 4 also has lower pairs of motor ports 8;8 adapted for connection with another pair of fluid motors (not shown).

The directional control valve assembly, 4 herein shown for purpose of illustration comprises two double-spool directional control valves 9;9 which are bolted together with a plate 10 therebetween. The upper spools 11;11 of the respective valves 9;9 are connected together for simultaneous actuation by a yoke 12 and if desired, or necessary, the yoke 12 may be actuated through a pneumatic or hydraulic power assist unit 14 which is supported on a bracket 15 attached to the valve assembly 4. The lower pair of spools 16;16 are similarly connected together by a yoke 12 actuated by a power assist unit 14.

Each double-spool valve 9 comprises a housing 17 having an inlet port 3, a return port 7, and a bypass passage 18 for flow of fluid from the inlet port 3 to the return port 7 when both spools 11 and 16 are in neutral position as shown in FIG. 2.

Each housing 17 has parallel bores 11′ and 16′ in which the respective spools 11 and 16 are reciprocable, said bores being intersected by the aforesaid bypass passage 18, by pressure feed passages 19;19, motor passages 6′;6′ and 8′;8′ communicating with the respective motor ports 6;6 and 8;8 and by return passages 7′;7′ leading to the return port 7. Each housing 17 also has another bore 20 upstream of the upper spool 11 in which is contained a relief valve 21 which conducts excess pressure in the system from the inlet port 3 and inlet chamber 3′ to the return port 7 via a return passage 7′.

As shown in FIGS. 3 and 4, the bypass, pressure feed, motor, and return passages 18, 19, 6′, 8′, and 7′ of each housing 17 have lateral extensions which intersect bores 23;23 parallel to the respective spool bores 11′ and 16′, there being a pair of check valves 24;24 in each bore 23.

The spools 11;11 (and also spools 16;16) herein shown are of the four-way type for actuating the respective double-acting fluid motors 5;5 whereby when the upper spools 11 are shifted to the left from the neutral position shown in FIG. 2 through the upper yoke 12 and power assist unit 14, the right pressure feed passages 19 are communicated with the right motor passages 6′ and ports 6 thus to conduct fluid under pressure from the respective inlet ports 3 into the head ends of the respective motors 5, and the left motor passages 6′ and ports 6 are communicated with the left return passages 7′ whereby fluid displaced from the rod ends of the motors 5 is conducted to the respective return ports 7. Conversely, when the upper spools 11 are shifted to the right from FIG. 2 neutral position, the left pressure feed passages 19 are communicated with the left motor passages 6′ and ports 6 and the right motor passages 6′ and ports 6 are communicated with the right return passages 7′ whereby the fluid motors 5 will be actuated in the opposite direction by fluid under pressure entering the rod ends thereof and the displaced fluid being conducted to the reservoir 1 from the head ends thereof via the right motor ports and passages 6 and 6′ and right return passages and ports 7′ and 7.

As previously mentioned, the valves 9 containing the upper and lower spools 11 and 16 are duplicates of each other and are fastened back to back with a plate 10 therebetween. As clearly shown in FIGS. 3 and 4, the plate 10 and the respective housings 17 have registering passages 25 which intercommunicate the respective inlet ports and passages and 3 and 3′ and registering pairs of passages 26;26 and 27;27 which respec-

tively intercommunicate motor ports and passages 6;6 and 6';6' and the motor ports and passages 8;8 and 8';8'. By reason of such cross-connections, the motors 5 (or the motors associated with the lower pairs of motor ports 8;8) will be operated in synchronism because the fluid pressures are balanced or equalized in the inlet ports and passages 3 and 3' and in the motor ports and passages 6 and 6' which are then pressurized. In other words, the motors 5 receive equal actuating pressures.

From the foregoing discussion, it can now be seen that the flow paths through the directional control valves 9;9 for each pair of motors 5;5 are identical and since the pressures are equalized by cross-connections through plate 10, the respective motors 5 will operate in synchronism in the actuation of a movable component of a press, a machine tool, hoisting equipment, etc. Although it is preferred herein to employ double-spool directional control valves 9;9 each arranged for series-parallel operation wherein only one spool 11 or 16 thereof may be actuated, it is to be understood that each double-spool valve 9 may be arranged for parallel operation wherein both spools 11 and 16 may be actuated simultaneously.

I claim:

1. A valve assembly comprising a housing having duplicate inlet and motor ports; duplicate valve members in said housing and actuating means therefor operable to simultaneously move said valve members to open and close communication between the respective inlet and motor ports; said housing having a passage therein intercommunicating said inlet ports with each other thus to substantially equalize fluid pressures in said inlet ports for substantially equalized flow of fluid to fluid motors adapted to be connected to the respective motor ports.

2. A valve assembly comprising a housing having duplicate inlet and motor ports; duplicate valve members in said housing and actuating means therefor operable to simultaneously move said valve members to open and close communication between the respective inlet and motor ports; said housing having a passage therein intercommunicating said motor ports with each other thus to substantially equalize fluid pressures in said motor ports when said valve members are moved to open communication between the respective inlet and motor ports for substantially equalized flow of fluid to fluid motors adapted to be connected to the respective motor ports.

3. A valve assembly comprising a housing having duplicate inlet and motor ports; duplicate valve members in said housing and actuating means therefor operable to simultaneously move said valve members to open and close communication between the respective inlet and motor ports; said housing having first and second passages therein respectively intercommunicating said inlet ports with each other and said motor ports with each other thus to substantially equalize fluid pressures in said inlet ports and in said motor ports for substantially equalized flow of fluid to fluid motors adapted to be connected to the respective motor ports.

4. A valve assembly comprising a housing having duplicate inlet ports, duplicate pairs of motor ports, and at least one return port; duplicate valve members in said housing and actuating means therefor operable to simultaneously move said valve members from a neutral position whereat said inlet ports are communicated with said return port to an operating position whereat one of each pair of motor ports is communicated with the respective inlet port and the other of each pair of motor ports is communicated with said return port; said housing having a passage therein intercommunicating said inlet ports with each other thus to substantially equalize fluid pressures in said inlet ports for substantially equalized flow of fluid to fluid motors adapted to be connected to the respective pairs of motor ports.

5. A valve assembly comprising a housing having duplicate inlet ports, duplicate pairs of motor ports, and at least one return port; duplicate valve members in said housing and actuating means therefor operable to simultaneously move said valve members from a neutral position whereat said inlet ports are communicated with said return port to an operating position whereat one of each pair of motor ports is communicated with the respective inlet port and the other of each pair of motor ports is communicated with said return port; said housing having a passage therein intercommunicating said one motor ports with each other to substantially equalize fluid pressures in said motor ports for substantially equalized flow of fluid to fluid motors adapted to be connected to the respective pairs of motor ports.

6. A valve assembly comprising a housing having duplicate inlet ports, duplicate pairs of motor ports, and at least one return port; duplicate valve members in said housing and actuating means therefor operable to simultaneously move said valve members from a neutral position whereat said inlet ports are communicated with said return port to an operating position whereat one of each pair of motor ports is communicated with the respective inlet port and the other of each pair of motor ports is communicated with said return port; said housing having first and second passages therein respectively intercommunicating said inlet ports and said one motor ports with each other thus to substantially equalize fluid pressures in said inlet ports and in said one motor ports for substantially equalized flow of fluid to fluid motors adapted to be connected to the respective pairs of motor ports.

7. A valve assembly comprising a housing having duplicate inlet ports, duplicate pairs of motor ports, and at least one return port; duplicate valve members in said housing and actuating means therefor operable to simultaneously move said valve members from a neutral position whereat said inlet ports are communicated with said return port to operating positions whereat the motor ports constituting each pair of motor ports are selectively communicated with the respective inlet port and said return port to control the direction of actuation of double-acting fluid motors adapted to be connected to the respective pairs of motor ports; said housing having first, second, and third passages therein respectively intercommunicating said inlet ports, one of each pair of motor ports, and the other of each pair of motor ports with each other thus to substantially equalize fluid pressures in said inlet ports, said one motor ports, and said other motor ports for substantially equalized flow of fluid to and from such fluid motors.

8. A valve assembly comprising a pair of housings providing duplicate inlet ports, motor ports, and return ports; duplicate valve members movable in the respective housings selectively to establish fluid communication of the respective motor ports with the respective inlet ports and with the respective return ports; actuating means operatively connected with said valve members to effect simultaneous movement of the latter; and cross-connection means associated with said housings having a first passage intercommunicating said inlet ports with each other to substantially equalize fluid pressures in said inlet ports for substantially equalized flow of fluid to fluid motors adapted to be connected to the respective motor ports.

9. The valve assembly of claim 8 wherein said cross-connection means has a second passage intercommunicating said motor ports with each other for substantially equalized flow of fluid to or from such fluid motors.

10. The valve assembly of claim 8 wherein said cross-connection means comprises a platelike member clamped between 33 said housing and having said first passage therethrough registering with passages in the respective housings leading to the respective inlet ports.

11. The valve assembly of claim 9 wherein said cross-connection means comprises a platelike member clamped between said housings and having said first and second passages therethrough respectively registering with passages in said housings leading to the respective inlet ports and motor ports.

12. A valve assembly comprising a pair of housings providing duplicate inlet ports, duplicate pairs of motor ports adapted for connection with double-acting fluid motors, and duplicate return ports; duplicate valve members movable in the respective housings selectively to establish fluid communication between the respective inlet ports, pairs of motor ports,

and return ports for actuating such fluid motors in opposite directions; actuating means operatively connected with said valve members to effect simultaneous movement of the latter; and cross-connection means associated with said housings having a first passage intercommunicating said inlet ports with each other to substantially equalize fluid pressure in said inlet ports for substantially equalized flow of fluid to such fluid motors.

13. The valve assembly of claim 12 wherein said cross-connection means has a pair of second passages intercommunicating the motor ports constituting the respective pairs of motor ports with each other for substantially equalized flow of fluid to and from such fluid motors.

14. The valve assembly of claim 12 wherein said housings have duplicate bypass passages leading from the respective inlet ports to the respective return ports; and wherein said valve members when moved as aforesaid close the respective bypass passages.

15. In a fluid pressure system, the combination of a reservoir; duplicate pumps; a valve assembly having duplicate inlet ports, duplicate pairs of motor ports, and duplicate return ports; duplicate valve members movable in said assembly and actuating means therefor operative to simultaneously move said valve members to operating positions whereat the motor ports constituting the respective pairs of motor ports are selectively communicated with the respective inlet ports and return ports; duplicate double-acting fluid motors; conduit means connecting said pumps to said reservoir and to the respective inlet ports, connecting said motors to the respective pairs of motor ports, and connecting said return ports to said reservoir whereby upon movement of said valve members said motors are actuated in desired direction; and cross-connection means providing a first passage which intercommunicates said inlet ports with each other to substantially equalize fluid pressures in said inlet ports for substantially equalized flow of fluid to the respective motors.

16. The system of claim 15 wherein said cross-connection means provides a pair of second passages which intercommunicates the respective pairs of motor ports with each other further to substantially equalize flow of fluid through said motor ports to and from the respective motors.

17. A valve assembly comprising: a pair of valve housings secured together with a plate member therebetween; each housing having a bore intersected by passages leading respectively to an inlet port, a return port, and the respective ones of a pair of motor ports; parallel valve spools reciprocable in the respective bores from a neutral position whereat said inlet ports are in fluid communication with the respective return ports to operating positions whereat said inlet ports and return ports are selectively in fluid communication with the respective pairs of motor ports; actuating means operatively connected to said valve spools to simultaneously reciprocate the same; said plate member and housings having registering passages which intercommunicate said inlet ports with each other thus to substantially equalize fluid pressures therein for substantially equalized flow of fluid to a pair of double-acting fluid motors adapted to be connected to the respective pairs of motor ports.

18. The valve assembly of claim 17 wherein said plate member and housings have additional registering passages which intercommunicate the respective pairs of motor ports with each other.