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(71) Applicant: **KAYABA INDUSTRY CO., LTD.**
Sekai Boeki Center Bldg.,
2-4-1, Hamamatsu-cho
Minato-Ku,
Tokyo 105 (JP)

(72) Inventor: **Koiwai, Hideshi**
2-27-15 Kami-Toda
Toda-shi,
Saitama-ken (JP)
Inventor: **Naito, Hisato**
C-202 Shimokuzawa,
Sagamihara-shi
Kanagawa-ken (JP)
Inventor: **Yonekubo, Yoshitake**
2-15-15 Tamagawa
Setagaya-ku,
Tokyo (JP)
Inventor: **Nishiumi, Kenichi**
1-19-7-304 Terao-Dai
Tama-ku,
Kawasaki-shi,
Kanagawa-ken (JP)
Inventor: **Hasegawa, Yoshimi**
8-22-7 Nishi,
Yachiyo-Dai
Yachiyo-Shi,
Chiba-ken (JP)

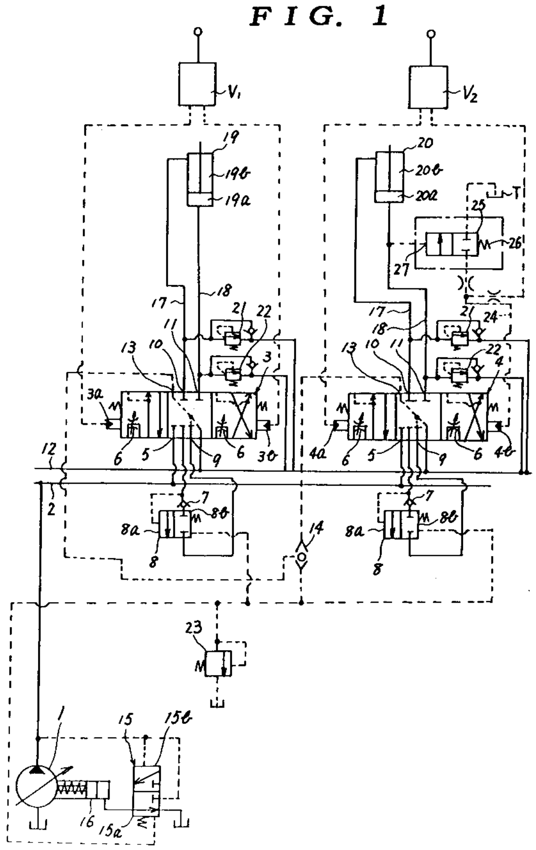
(74) Representative: **Carpmael, John William Maurice**
CARPMAELS & RANSFORD
43 Bloomsbury Square
London, WC1A 2RA (GB)

(54) **Load-sensing active hydraulic control device.**

(57) A load-sensing active hydraulic control device is disclosed in which a plurality of cylinders (19,20) are connected in parallel and fed with hydraulic fluid from a variable discharge pump (1), thereby to control the variable discharge pump depending on horsepower constant control characteristics and which is capable of preventing, when one cylinder (20) is increased in load pressure, actuation of the other cylinder (19) from being stopped due to a decrease in the amount of hydraulic fluid discharged from the pump. A pilot valve (25) is provided which is changed over by a pressure actuation of a passage (18) of the one cylinder (20). The pilot valve is open to communicate a pilot chamber (4b) of a change-over valve (4) with a tank (T) when a pressure in the passage approaches a set pressure of an overload relief valve (22) of the passage. This results in a degree of opening of a variable orifice (6) of the change-over valve being reduced to decrease the amount of hydraulic fluid fed to the cylinder (20), thereby to ensure feeding of hydraulic fluid to the cylinder (19) correspondingly.

EP 0 684 387 A2

F I G. 1



This invention relates to a load-sensing active hydraulic control device, and more particularly to a load-sensing active hydraulic control device for detecting a load pressure of a plurality of hydraulic actuators to keep an output of a pump constant.

Such hydraulic control devices are known, but they suffer from the disadvantage that if one actuator is operated at maximum power sufficient to operate an associated overload relief valve, another cylinder which has to be operated at a lower power may not be operable at all.

Accordingly, it is an object of the present invention to provide a load-sensing active hydraulic control device which is capable of preventing the amount of hydraulic fluid discharged from a variable discharge pump from being extremely reduced even when a load pressure of any one of the actuators is increased to a set pressure of an overload relief valve, thereby to ensure actuation of the remaining actuators.

In accordance with the present invention, there is provided a load-sensing active hydraulic control device which comprises a tank, a plurality of actuators provided with change-over valves connected in parallel, respectively, pilot chambers provided on both sides of each of the change-over valves which are provided with variable orifices of which a degree of opening is controlled depending on a pressure in the pilot chambers, a pressure compensating valve provided on a downstream side of the variable orifices of each of the change-over valves for keeping a pressure difference between a load pressure and a pressure on the downstream side of the variable orifices constant, overload relief valves connected to the downstream side of each of said switching valves for setting a maximum pressure of each of said actuators, and a pump output control mechanism arranged so as to keep an output of a pump constant in response to a load pressure of each of the actuators.

The load-sensing active hydraulic control device of the present invention thus generally constructed is characterized in that a pilot valve is provided so as to permit the pilot chambers of each of the change-over valves to communicate with the tank when the load pressure of each of the actuators is equal to or approaches a set pressure of the overload relief valve.

In the present invention constructed as described above, when a load pressure of any one of the actuators is increased to a level equal to or approaching a set pressure of the overload relief valve, the pressure causes the pilot valve to be open, thereby to permit the pilot chambers of the change-over valve to communicate with the tank. Such communication between the pilot chambers and the tank causes the change-over valve to return to the neutral position or a position approaching the neutral position, resulting in a degree of opening of the variable orifices being reduced. This permits a degree of opening of the variable orifices of the change-over valve connected to the one actuator to be increased as compared with a degree of opening of the variable orifices of the change-over valve connected to the other actuator. Thus, the ratio between both degrees of opening is increased, so that the amount of hydraulic fluid distributed to the other actuator is increased, even when the amount of hydraulic fluid discharged from the variable discharge pump is constant, resulting in feeding of hydraulic fluid to the other actuator being ensured.

A preferred embodiment of the present invention is now described by way of example with reference to the accompanying drawings, in which like reference characters designate like or corresponding parts throughout, wherein:-

FIGURE 1 is a circuit diagram showing an embodiment of a load-sensing active hydraulic control device according to the present invention;

FIGURE 2 is a circuit diagram showing a conventional load-sensing active hydraulic control device; and

FIGURE 3 is a graphical representation showing control characteristics of keeping a power of a variable discharge pump constant.

A load-sensing active hydraulic control device which has been conventionally known in the art will now be described hereinafter with reference to Figure 2. In the conventional device shown in Figure 2, a variable discharge pump 1 is connected on a discharge side thereof to a high pressure passage 2 and then connected through the high pressure passage 2 to an inlet port 5 of each of a first change-over valve 3 and a second change-over valve 4. The first change-over valve 3 is provided on each side thereof with a respective pilot chamber 3a, 3b and the second change-over valve 4 is likewise provided on each side thereof with a respective pilot chamber 4a, 4b. The pilot chambers 3a and 3b are connected to a pilot operating valve V1 and likewise the pilot chambers 4a and 4b are connected to a pilot operating valve V2. The pilot operating valves V1 and V2 are each adapted to control an output pilot pressure depending on the amount of operation thereof.

Each change-over valve 3, 4 when at a neutral position as shown in Figure 1, has its inlet port 5 closed. When it is changed over to either a left-side position or a right-side position, a variable orifice 6 is rendered open and the degree of opening of the variable orifice 6 is controlled depending on the amount of changing-over of the valve.

The variable orifice 6 is connected on a downstream side thereof through a check valve 7 to a pressure compensating valve 8. Further, the pressure compensating valve 8 is arranged so as to communicate on a downstream side thereof with a feed port 9 of each of the change-over valves 3 and 4. The feed ports 9 are kept closed when the corresponding change-over valve 3 or 4 is at a neutral position and permitted to communicate with any one of actuator ports 10 and 11 when the change-over valves 3 and 4 are changed over to either a left-side position or a right-side position. At this time, the other of the actuator ports 10 and 11 is kept communicating with a tank passage 12.

Also, the change-over valves 3 and 4 are each formed with a load detecting port 13, which is arranged so as to communicate with the actuator port on a high pressure side.

The above-described pressure compensating valve 8 functions to introduce a pressure on an upstream side of the check valve 7 into a pilot chamber 8a, as well as a pressure on a side of the load detecting port 13 into a pilot chamber 8b. For this purpose, a plurality of shuttle valves 14 are arranged so as to select a maximum load pressure of the actuators controlled by the change-over valves 3 and 4 to introduce it to the pilot chambers 8b.

Control by the pressure compensating valve 8 thus constructed is carried out in such a manner that a pressure on a downstream side of the variable orifice 6 is kept increased by a predetermined level as compared with the maximum load pressure.

The maximum load pressure selected by the shuttle valves 14 is fed to one pilot chamber 15a of a control valve 15. The other pilot valve 15b of the control valve 15 is fed with a pressure in the above-described high pressure passage 2 or a discharge pressure of the variable discharge pump 1. Thus, operation of the control valve 15 is carried out depending on a relative difference between the discharge pressure of the variable discharge pump 1 and the maximum load pressure. Such operation of the control valve 15 causes a control cylinder 16 constituting a pump output control mechanism for keeping an output of the variable discharge pump 1 constant to be operated, thereby to ensure that the discharge pressure of the variable discharge pump 1 is kept constantly increased by a predetermined level as compared with the maximum load pressure.

The above-described change-over valves 3 and 4 are connected at the actuator ports 10 and 11 thereof through passages 17 and 18 to overload relief valves 21 and 22, respectively. Reference numeral 23 designates a main relief valve.

In the conventional control device constructed as described above, operation of the pilot operating valves V1 and V1 causes the pilot pressure to act on any one of the pilot chambers 3b and 4b of the change-over valves 3 and 4. Supposing that the valves are operated to cause the pilot pressure to act on the pilot chambers 3b and 4b, the change-over valves 3 and 4 are changed over to the right-side position.

A degree of opening of each of the variable orifices 6 is set depending on the amount of changing-over of each of the change-over valves 3 and 4 and hydraulic oil or fluid discharged from the variable discharge pump 1 is distributed depending on a ratio of a degree of opening of the variable orifice 6 of the change-over valve 3 to that of the change-over valve 4. Thus, hydraulic fluid is fed to bottom-side chambers 19a and 20a of the cylinders 19 and 20 through passages 18 depending on a degree of opening of the change-over valves 3 and 4. Hydraulic fluid on a side upper or rod-side chambers 19b and 20b of the cylinders 19 and 20 is returned via passages 17 through the change-over valves 3 and 4 to the tank passage 12.

The maximum load pressure of the actuators acts on the control cylinder 16 to control the amount of hydraulic fluid discharged from the pump 1. More particularly, the control is carried out so as to permit a product of Q x P to be fixed as shown in Figure 3, wherein P is a pressure of the variable discharge pump 1 and Q is the amount of hydraulic fluid discharged from the variable discharge pump 1. Therefore, the more the maximum load pressure is increased, the more the amount of hydraulic fluid discharged from the variable discharge pump 1 is decreased. Hydraulic fluid of which the amount is thus reduced is distributed depending on a ratio between a degree of opening of the variable orifice 6 of the change-over valve 3 and that of the change-over valve 4.

The conventional device, as described above, is adapted to control a discharge pressure of the variable discharge pump 1 by the action of the maximum one of load pressures of a plurality of actuators, resulting in often failing to actuate the actuators.

More particularly, for example, when a full stroke of the cylinder 20 is carried out while keeping a degree of opening of the variable orifice 6 of the change-over valve 3 minimum and a degree of opening of the variable orifice 6 of the change-over valve 4 maximum, load is increased to cause any one of the overload relief valves 21 and 22 connected to the cylinder 20 to be actuated. When a circuit pressure is thus increased to a degree sufficient to cause the overload relief valve to be actuated, the amount of hydraulic fluid discharged from the variable discharge pump 1 is reduced along a horsepower constant curve shown in Figure 3. Such a decrease in the amount of hydraulic fluid discharged substantially prevents feed of hydraulic fluid to the side of the change-over valve 3 operated in a slight amount, thereby to cause actuation of the cylinder 19 to be stopped in the worst case.

A load-sensing active hydraulic control device according to the present invention will now be described hereinafter with reference to Figure 1 of the drawings.

In the load-sensing active hydraulic control device of the illustrated embodiment, one pilot chamber 4b of a change-over valve 4 is connected to a tank T through a pilot valve 25 connected to a pilot passage 24 from chamber 4b. The pilot valve 25 is so constructed that elastic force of a spring 26 acts on one side of the pilot valve 25 and a pressure in the passage 18 acts on a pilot chamber 27 provided on the other side of the pilot valve 25. The pilot valve 25 thus constructed is rendered open when the pressure in the passage 18 or a load pressure of a cylinder 20 approaches a set pressure of an overload relief valve 22.

When the pilot valve 25 is at a normal position shown in Figure 1, it closes the pilot passage 24. Changing-over of the pilot valve 25 causes the pilot chamber 4b of the change-over valve 4 to communicate with the tank.

The remaining part of the illustrated embodiment may be constructed in substantially the same manner as the conventional device described above.

Now, the manner of operation of the load-sensing active hydraulic control device of the illustrated embodiment constructed as described above will be described, supposing that the change-over valve 4 is changed over to a right-side position while keeping a degree of opening of a variable orifice 6 of a change-over valve 3 minimum.

Under such conditions, a full stroke of the cylinder 20 causes an increase in load, thereby to generate a pressure, which causes the pilot valve 25 to be open. Such opening of the pilot valve 25 causes the pilot chamber 4b of the change-over valve 4 to communicate with the tank T, resulting in the action by the pressure being decreased, so that the change-over valve 4 is changed over toward a neutral position correspondingly. Thus, a degree of opening of the variable orifice 6 of the change-over valve 4 is reduced to decrease the amount of hydraulic fluid fed to the cylinder 20 correspondingly. For example, when a degree of opening of the variable orifice 6 of the change-over valve 4 is low as compared with that of the variable orifice 6 of the change-over valve 3, hydraulic fluid discharged from the variable discharge pump 1 is distributed depending on a ratio between both degrees of opening, resulting in hydraulic fluid being fed to the cylinder 19 connected to the change-over valve 3 as well.

In the illustrated embodiment, the pilot valve 25 is connected to only the passage 18 connected to a bottom-side chamber 20a of the cylinder 20. Alternatively, the pilot valve 25 may be connected to only a passage 17 or to both passages 27 and 18.

The device of the illustrated embodiment constructed as described above ensures feed of hydraulic fluid to the other cylinder 19 even when a load pressure on the side of the cylinder 20 is increased to a level approaching a set pressure of the overload relief valve, thereby to prevent actuation of the cylinder 19 from being stopped.

As can be seen from the foregoing, the load-sensing active hydraulic control device of the present invention effectively prevents, even when a load pressure of any one of the actuators is increased to a level equal to or approaching the set pressure of the overload relief valve, the amount of hydraulic fluid fed to the other actuator from being extremely reduced. This eliminates such a problem as encountered with the prior art that actuation of the outer actuator is stopped.

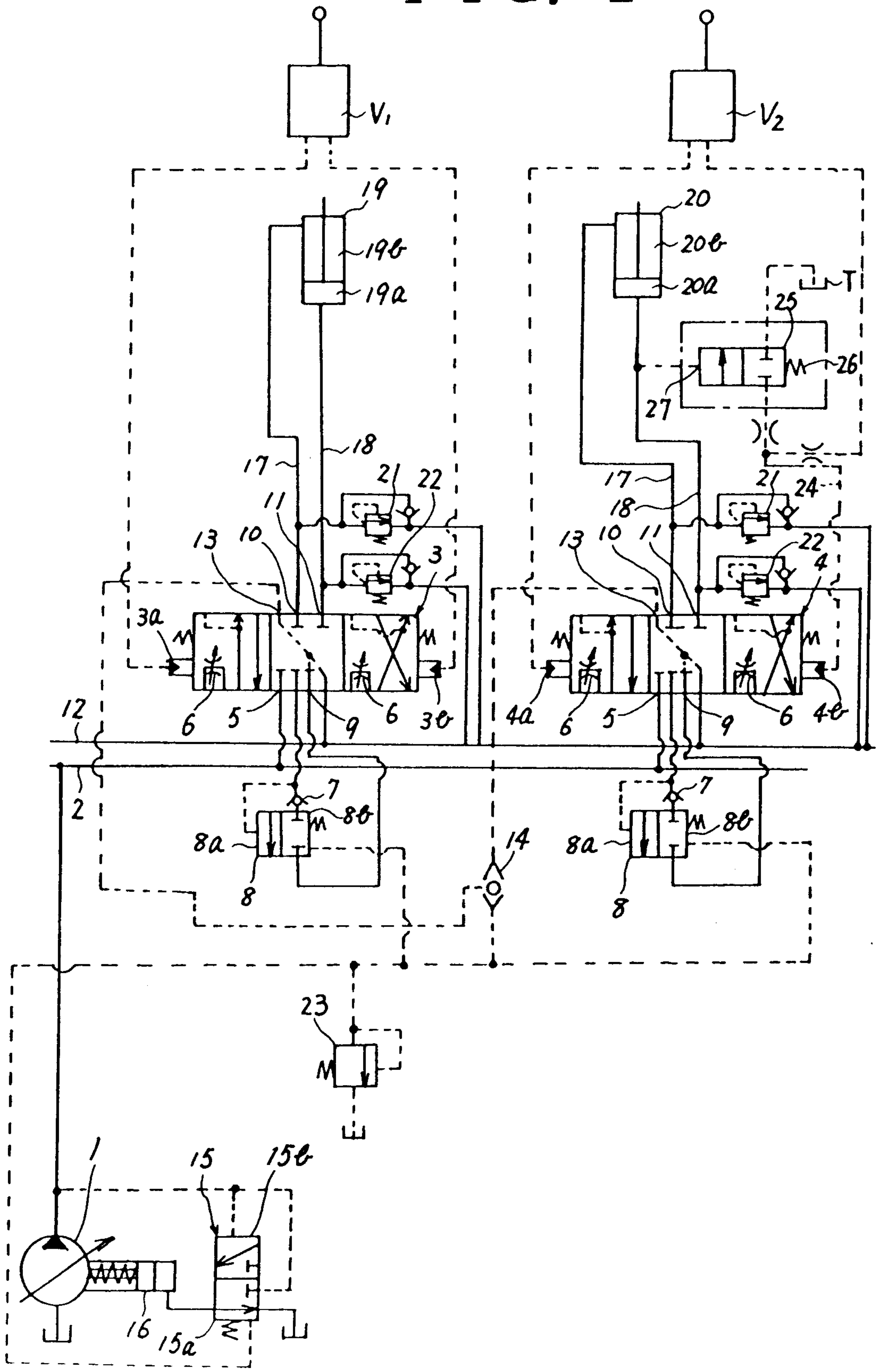
While a preferred embodiment of the invention has been described with a a certain degree of particularity with reference to the drawings, obvious modifications and variations are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practised otherwise than as specifically described.

Claims

1. A load-sensing active hydraulic control device comprising a tank (T), a plurality of actuators (19,20) provided with change-over valves (3,4) connected in parallel, pilot chambers (3a,3b,4a,4b) provided on both sides of each of the change-over valves, the change-over valves each being provided with variable orifices (6) of which a degree of opening is controlled depending on a pressure in the pilot chambers, a pressure compensating valve (8) provided on a downstream side of the variable orifices of each of the change-over valves for keeping a pressure difference between a load pressure and a pressure on the downstream side of the variable orifices constant, overload relief valves (21,22) connected to the downstream side of each of said actuators, and a pump output control mechanism arranged so as to keep an output of a pump (1) constant in response to a load pressure of each of the actuators, characterised in that a pilot valve (25) is provided so as to permit the pilot chambers of each of the change-over valves to communicate with the tank when the load pres-

sure of each of the actuators is equal to or approaches a set pressure of the overload relief valve.

FIG. 1


V1
V2
19
19b
19a
20
20b
20a
T
25
26
27
17
18
21
22
24
13
10
11
3
4
3a
3b
4a
4b
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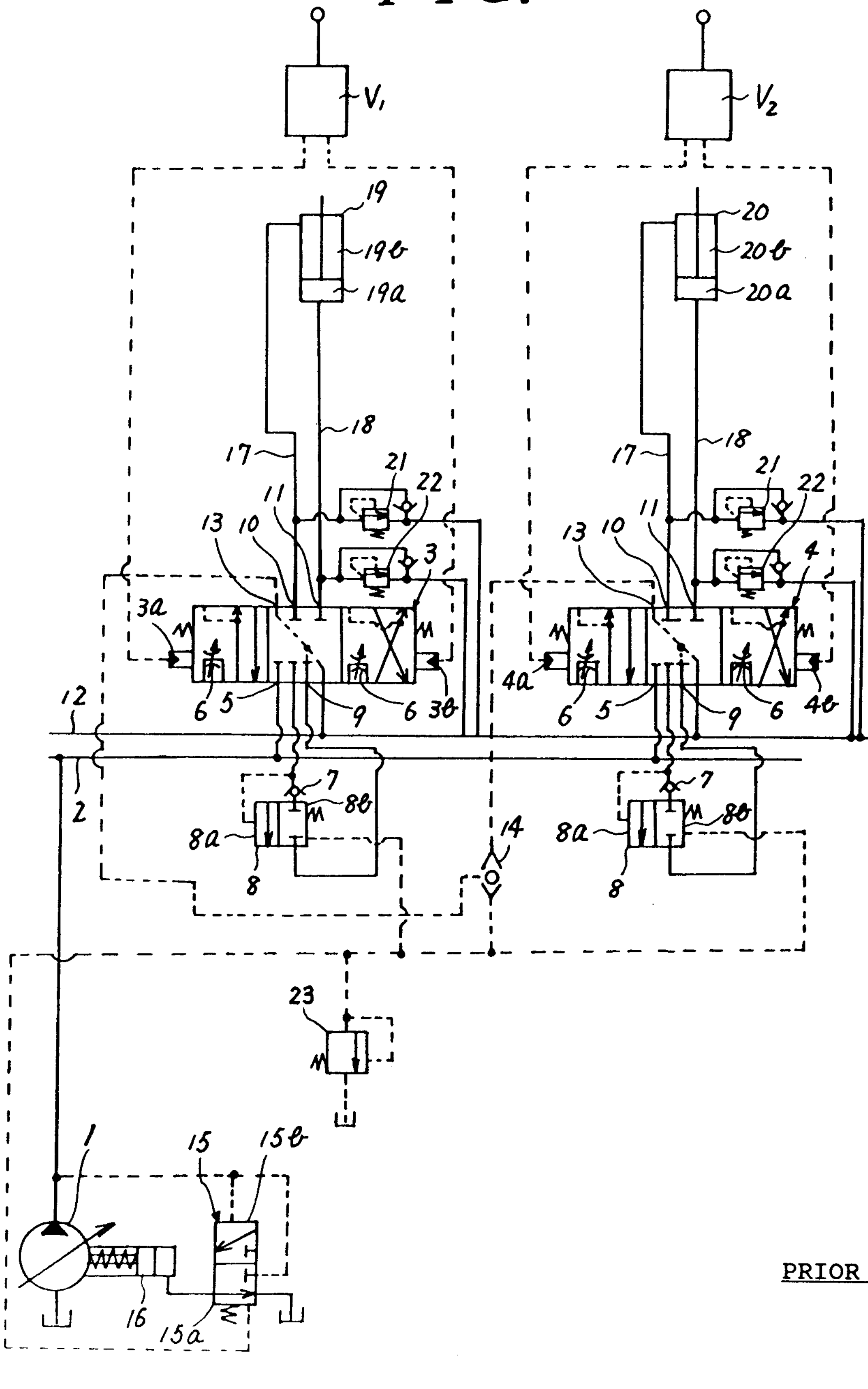
15b
16
15a

FIG. 2



PRIOR ART

FIG. 3