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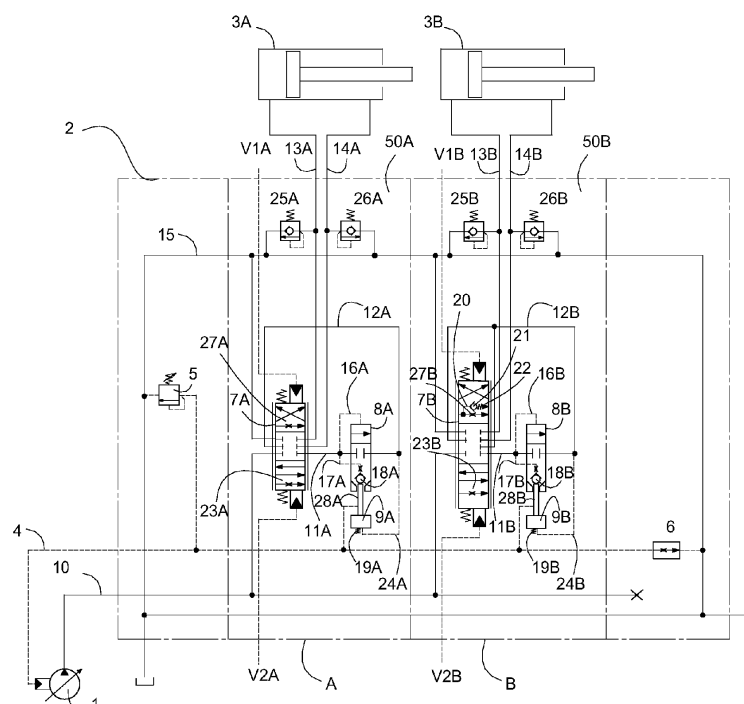
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(54) **Hydraulic distributor having a connection parallel to the recesses adjusting the flow rate of the slide and to the local compensator**

(57) In an hydraulic distributor (2) having one or more operative portions having slides (7A,7B) adjusting the flow rate to the utilization and the oil backpressure at the inlet and local pressure compensators (8A,8B) controlling the pressure drop at the ends of recesses adjusting the slide flow rate, the slide, according to its position, opens a connection (20) between a channel receiving

the oil from the pump (1) and the channel delivering oil to the actuator (3A,3B) through a shutter having a spring (22) adjusted so that the pressure for opening the shutter, is greater than "LS ΔP" set by the LS regulator of the pump. Said connection is parallel to the oil path through the adjusting recesses of the slide flow rate and local compensator.

Fig. 1



Description

FIELD OF THE INVENTION

[0001] In recent years, for saving energy and reducing the pollutant emissions in the field of the earth moving machines, such as the small-sized excavators, there is a progressive evolution of the hydraulic circuit so that, besides the traditional circuits with pumps or variable displacement pumps, there are now circuits commonly known as "load sensing".

[0002] In many load sensing circuits, the pump is a variable displacement pump and supplies only the flow rate effectively required by the actuators. The control of the pump displacement is performed by a feedback of the pressure signal of the greater among the loads, called load sensing signal, or LS, from the distributor to the pump. The hydraulic distributor is also of the load sensing type.

[0003] The pump adjusts its displacement by a regulator of the LS signal so that to keep constant the pressure differential between the delivery and the load sensing signal, or LS; such pressure differential will be called "LS ΔP ". In a load sensing distributor, the flow rate delivered to an actuator is adjusted as a function of the position of a movable slide by exploiting the drop pressure at the ends of recesses adjusting the flow rate which is kept constant independently from the load.

[0004] Generally, in the field of the small-sized excavators load sensing distributors are used for adjusting the flow rate independently from the load for proportionally reducing the flow rates in active sections in case the flow rate required by the actuators is greater than the maximum one supplied by the pump.

[0005] In each operative section, it is present a local pressure compensator which sets the pressure differential at the flow rate adjusting recesses equal to said LS ΔP in each operative section when the operation of two or more operative sections are driven also when the LS ΔP drops below the value set by the pump LS regulator.

[0006] On the variable displacement pump, there is a device for limiting the power absorbed by the pump itself for preventing the engine from turning off. The device operates as follows: when the delivery pressure increases, the maximum flow rate delivered from the pump is decreased by approximating a hyperbolic curve at constant power in the flow rate-pressure plane. When the power regulator is operated, it overcomes the LS regulator which keeps constant LS ΔP , as a consequence LS ΔP is reduced with respect to the value at which the LS regulator was adjusted.

PRIOR ART

[0007] Among the different load sensing distributor arrangements, patent EP1628018 (B1), in the name of the same Applicant, discloses an arrangement wherein the local compensator is downstream the flow rate adjusting

recesses of the slide, and in the same lapped hole two components, a local compensator having a selector and a piston with a pushing device, slide.

[0008] In the section having a greater load, the group formed by the local compensator with selector and piston with pushing device, forms a non-return valve selector; the selector generates the load sensing signal LS: the selector, kept opened by the pushing device, connects the signal downstream the flow rate adjusting recesses of the slide to the signal LS channel. The signal LS arrives at the pump regulator LS, then it acts between the local compensator with a selector and the piston with the pushing device of the other sections.

[0009] In the active sections at smaller load, the piston with the pushing device abuts a plug and compresses a spring, while the local compensator chokes the flow passage directed to the utilisation by making equal the pressure downstream the flow rate adjusting recesses to the LS pressure in channel 4. The selector is closed.

[0010] A small-sized excavator comprising:

- a load sensing hydraulic circuit with a load sensing distributor as the one described in patent EP1628018,
 - a variable displacement path with a LS regulator and a power regulator,
- in determined operative conditions, shows a behaviour uncomfortable to the operator.

[0011] It is assumed an operative condition wherein the two translation engines are supplied by respective sections of the distributor and that, while the machine is translating, a third actuator arrives to its limit stop: at this point, the machine markedly slows; in other words the section supplying the actuator at limit stop operates the pressure relief valve on the load sensing signal LS, and consequently the power limiter reduces the maximum flow rate supplied by the pump; the translation speed of the excavator can be abruptly halved.

[0012] Patent EP2184495 (A1) of the same Applicant discloses a method for limiting the maximum power required by the hydraulic circuit and different methods for obtaining this object. The method consists of providing a connection between the upstream and downstream channels of the local compensator in the sections of the translation. The connection must be suitable sized so that when a third actuator arrives at its limit stop, the power delivered from the pump (which is supplied to the two translation engines and which flows through the two connections) does not increase the pressure besides a limit at which the power limiter operates. In this way, it is not reduced the machine translation speed.

[0013] The different ways for making the connection in the above mentioned patent are:

- on the slide, by providing a recess adapted to connect the upstream channel of the local compensator to the downstream one when the slide is at its limit

- stop,
- in the element, by forming a hole connecting the upstream channel of the local compensator to the downstream channel,
- on the local compensator, by preventing it from closing.

PROBLEM TO BE SOLVED

[0014] Since the arrangement of the load sensing distributor of patent EP1628018 (B1) provides that the local compensator of the element acts as a non-return valve, by introducing the connection as disclosed by patent EP2184485 (A1), the function as non-return valve is absent in the section wherein the connection is present.

[0015] This is not a problem in the sections of trailers, since on the translation engines there is a balancing valve acting as a non-return valve.

[0016] However, there are other operative sections wherein there is the above mentioned behaviour uncomfortable for the operator, for example when a turret is rotating and at the same time a second actuator arrives at its limit stop: the turret abruptly slows down. Analogously, an inadmissible reduction of the cycle time can occur when the first arm is going up, or when the second

[0017] In the slides of this portion, it should be possible to use the connection as shown in patent EP2184495 (A1) by using non-return valves, inside the slide, between the U-bolt and the delivery use.

[0018] However, this solution has the disadvantage of introducing an additional load loss always present in the power line and has the inconvenient of do not enable to have a back pressure along all the sensibility curve of the slide due to overlapping between the slide and the distributor present in the distributor of the same Applicant.

[0019] In order to solve this problems, it is presented the following invention.

OBJECT AND ADVANTAGES OF THE INVENTION

[0020] The invention consists in an hydraulic distributor having an inlet channel from the pump, an output channel connected to a tank, a plurality of operative portions adapted to supply the actuators through corresponding utilisations by inner slides capable of diverting the flows to channels inside the distributor; local pressure compensators capable of controlling the pressure drop at the ends of the recesses adjusting the flow rate of the slide, so that the flow rate supplied by the slide is independent from the load, wherein it is present a connection between the channel receiving the oil from the pump and the channel delivering the oil to the actuator, closed in a central position of the slide, and that opens as a function of the position of the slide itself, such connection being parallel to the flow path through the recesses adjusting

the flow rate of the slide and the local compensator.

[0021] Said additional connection enables the oil to flow through a shutter, provided with a set spring, so that the opening pressure is greater than the set one of the pump regulator LS.

[0022] The connection is operative in one of the two positions of the slide or in both according to the fact if it is necessary to limit the speed of one or both the utilisations of the section.

[0023] The present invention obtains the same operations of the connection disclosed by patent EP2184495 (A1) without having the above mentioned disadvantages, in fact it is present a suitable set non-return valve along the connection and such non-return valve is not usually supplied by the power flow.

[0024] Said objects and advantages are all met by the hydraulic distributor having a connection parallel to the recesses adjusting the flow rate and to the local compensator, object of the present invention, which is characterised for what is provided in the attached claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] This and other characteristics will be better understood in the following description of some embodiments shown, in an exemplifying and non limiting way, in the attached drawings.

- Figure 1 shows an hydraulic diagram of a distributor having two portions, wherein in a portion there is a connection between the channel receiving oil from the pump and the channel delivering oil to the actuator, according to the present invention,
- Figure 2 shows an example of a preferred embodiment of the connection object of the present invention inside the slide according to the diagram of Figure 1.

DESCRIPTION OF THE INVENTION

[0026] The following example has been described with the only object of the invention, without limiting its protection, whose scope comprises the claims content.

[0027] Referring particularly to Figure 1, 2 generally indicates a load sensing distributor 2 comprising inside a channel 10 in which flows pressurized oil from a variable displacement pump 1; through said channel 10 the pressurised oil flows through suitable inner channels and can arrive to at least two portions A and B, each of them controls corresponding actuators 3A, 3B, through the channels or utilisations 13A, 14A (in the portion A) and 13B, 14B (in the portion B); the utilisations are in turn connected to the collecting tank through a canal 15.

[0028] In addition, the distributor 2 further comprises a pressure limiting valve 5 located in a load sensing signal channel 4 (LS) of the greater one among the loads and a flow rate regulating valve 6 for draining said LS signal channel 4.

[0029] Each operative portion A and B is defined by an element 50A, 50B which receives the slides, local compensators and other components necessary for implementing the invention.

[0030] Referring particularly to the element 50A of the operative portion A, the oil from the pump 1 (through channel 10) encounters a slide 7A, passes through the area of the flow rate adjusting recesses 27A (23A) when the slide 7A is driven by V1A (V2A), passes through a local compensator 8A, to the utilisation 13A (14A), and returns to the utilisation 14A (13A) and drains itself through the channel 15.

[0031] There are secondary shock-resistant and anti-cavitation valves 25A and 26A on the channels 13A and 14A.

[0032] A piston 9A with a pushing device 28A slides in the same lapped hole of the local compensator 8A. The local compensator 8A receives a selector 18A for selecting the signal LS. The local compensator is normally closed; on one of its side it is subjected to a pressure upstream present at 11A which acts when it is opened through the channel 16A, from the other side it is subjected to the signal LS 4 and to the contact force of piston 9A which act to close. Piston 9A is subjected, on one side, to the pressure of channel 4 of signal LS and to the contact force of the local compensator 8A, on the other side to the pressure downstream present at 12A through the channel 24A and to the force of a spring 19A having a negligible value.

[0033] When just the portion A is operated or when is operated with other portions and has the greatest utilisation load (portion A is predominant), the local compensator 8A is opened and contacts the piston 9A because the pressure in 16A is greater than the pressure in 24A; the group formed by the local compensator 8A and piston 9A operates as a non-return valve. Signal LS is taken by channel 11A through channel 17A and is delivered to channel 4 through the selector 18A kept opened by the pushing device 28A of piston 9A. In this instance, the pressure drop through the flow rate adjusting recesses 27A (23A) of the slide 7A between 10 and 11A is controlled by the pump and is equal to "LS Δ P", in other words the difference between the pressure in channel 10 and pressure in channel 4.

[0034] When portion A is operated with other portions and has the utilisation load which is not the highest, the local compensator 8A chokes the passage of the flow rate directed to the actuator 3A, so that the pressure in channel 16A is equal to pressure LS in channel 4; piston 9A is pushed to contact the spring 19A side and does not contact the local compensator 8A. In this case, the pressure drop through the flow rate adjusting recesses 27A (23A) of slide 7A between 10 and 11A is controlled by the local compensator 8A and also in this case is equal to "LS Δ P".

[0035] From the above described operation modes, it is possible to understand that a distributor, having the portions as portion A, provides flow rates independent

from the load and reduces them proportionally in case the flow rate required by the actuators is greater than the maximum one supplied by the pump, because the pressure drop at the ends of the flow rate adjusting recesses is equal to "LS Δ P" in all the sections.

[0036] With particular reference to the element 50B of the operative portion B, as in portion A, the oil from pump 1 encounters the slide 7A, passes through the area of the recesses, for adjusting the flow rate 27B (23B) when the slide 7B is driven by V1B (V2B), passes through the local compensator 8B, arrives to the utilisation 13B (14B), returns to the utilisation 14B (13B) and discharges itself through channel 15.

[0037] There are shock-resistant and anti-cavitation secondary valves 25B and 25B in channels 13B and 14B.

[0038] In portion B, the group formed by the local compensator 8B having the selector 8B, piston 9B with a pushing device 28B and spring 19B, is analogous to the one of portion A, therefore the description is the same.

[0039] When the slide 7B is driven by V1B, it opens the connection 20 between channel 10 from the pump upstream the flow rate adjusting recesses 27B and the channel 12B downstream the local compensator 8B and therefore to the utilisation 13B; such connection is parallel to the flow path through the flow rate adjusting recesses 27B and the local compensator 8B. Along the connection 20 there is a shutter 21 kept in position by the closing position of a spring 22 set so that the opening pressure of the shutter 21 is greater than "LS Δ P" established by the pump regulator LS.

[0040] When the slide 7B is driven by V2B, the connection 20 remains closed, as when the slide is in a central position, so that in this case the operation of the portion is the same as the operation of the above described portion A.

[0041] It is considered the case when just the slide 7B is operated by V1B. The pressure drop at the ends of the flow rate adjusting recesses 27B, equal to the pressure in 10 minus the pressure in 11B, being the latter equal to the pressure LS in channel 4, is equal to the "LS Δ P" set by pump 1. Since portion B is the only one which is active, the group comprising the local compensator 8B and piston 9B operates as a non-return valve, therefore the pressure differential between 11B and 12B is for example equal to 7-8 bar to the maximum flow rate at the utilisation; by assuming that the regulator LS of the pump is set so that the "LS Δ P" is equal to 20 bar, the pressure differential between 10 and 12B is at the maximum equal to 28 bar. By setting the shutter 21 spring so that its pressure at the opening is 30 bar, the shutter 21 remains closed. Therefore, in this case, all the oil passes through the flow rate adjusting recesses 27B and the local compensator 8B and does not pass through the connection 20, although it is available. The portion B behaves in the same way as portion A.

[0042] In case both slides 7A and 7B are operated for example by V1A and V1B and the load on utilisation 13B is greater than the load on utilisation 13A (section B is

predominant) is still true what just described, in fact the pressure in 11 is equal to pressure LS in channel 4 and therefore the pressure differential between 10 and 12B is at the maximum equal to 28 bar, which is not enough for opening shutter 21.

[0043] In case both slides 7A and 7B are operated for example by V1A and V1B and the load on utilisation 13B is not the greatest, in other words portion B is dependent, when the pressure differential between 10 and 12B exceeds than 30 bar, the shutter 21 opens. In this case, the oil besides passing through the flow rate adjusting recesses 27B and the local compensator 8B, in other words the controlled flow rate channel, passes through the path 20 from the delivery 10 to the utilisation 13B. Such path 20 is equivalent to an adjusted path, therefore its flow rate is dependent on the pressure differential 10 and 12B. The flow rate arriving to the utilisation 13B is given by the sum of the flow rate from the flow rate adjusting recesses 27B and the one from the connection 20.

[0044] It is assumed that both slides 7A and 7B are operated for example by V1A and V1B and that the actuator 3A arrives to its limit stop. If the connection 20 is not present, this operative condition will cause the opening of the pressure limiting valve 5 with the signal LS, channel 4, and will be reached the maximum pressure of the circuit, consequently the torque limiter of the pump 1 will act and, in case the flow rate required by the actuator is greater than the maximum one supplied by the pump, with the consequent reduction of the actuator 3B speed. (?) When the pressure differential between 10 and 12B increases, the presence of the connection 20 causes an increase of the flow rate passing through the connection 20. Since the oil from channel 10 to the utilisation 13A is a static column, the pressure signal at 10 passes through the flow rate adjusting recesses 27A, channel 11A, is taken by channel 17A and delivered to signal LS of channel 4; consequently, the local compensator 8B is kept closed by the pressure LS in channel 4 which is equal to pressure in channel 10 and therefore the only possible path for the oil in portion B to utilisation 13B is through passage 20.

[0045] The connection 20 makes the pressure of oil in channel 10 less than the one set by the limiting valve 5 which therefore remains closed. In this way, the pump delivers a flow rate greater than the one delivered at the pressure set by the pressure limiting valve 5 and consequently is kept the reduction of actuator 3B speed.

[0046] Figure 2 shows a preferred way for implementing the present invention according to the diagram of Figure 1. In the cross section of element 50B of the operative portion B it is possible to see the lapped hole 48 receiving the sliding slide 7B shown in a central position. Slide 7B can be actuated to the right from V1B for performing the connection 10>11B by opening the flow rate adjusting recesses 27B, 12B > 13B, by opening the overlapping 34, 14B>15, by opening the recess 36; therefore can be driven to the left of the V2B for performing the connection 10>11B by opening the flow rate adjusting recesses 23B,

12B > 14B, by opening the overlapping 35, 13B > 15 by opening the recess 36.

[0047] Specifically, it can be seen the connection 20 formed by the radial passages 40 which supply oil to the shutter 21, from the radial holes 42 discharging the oil from the shutter 21, from the axial hole 41 connecting to each other the radial holes 40 and 42. The radial holes 40 are always connected to channel 10, while radial holes 42 are overlapped in a central position and open to channel 12B and therefore to the corresponding utilisation 13B when the slide 7B is driven by the V1B side.

[0048] Between the axial hole 41 and the radial holes 42 there is the sealing seat 44 of shutter 21. Shutter 21 is seated in hole 43 with the spring 22 by which the shutter is kept in a closed position; when the shutter 21 is opened, it abuts the pin 32. The pressure at 41 and therefore at 10 acts on the shutter 21 when is opened, when the shutter is closed there is the pressure at 42 which is equal to the one at 12B, when the slide is driven by V1B, plus the spring 22 force.

Claims

1. Load sensing distributor (2), of the type comprising:

- a. a channel (10) in which a pressurized oil flows coming from a variable displacement pump (1) provided with a LS ΔP regulator;
- b. a pressurized oil discharge or exit channel (15),
- c. a channel (4) of a load sensing signal (LS) for the highest among the loads,
- d. at least two portions (A, B) having a plurality of channels or users (13A, 14A, 13B, 14B) to be connected to respective actuators (3A, 3B); each section being defined by elements (50A, 50B) in which are received respective slides (7A, 7B) comprising a plurality of flow rate regulating slots (23A, 27A; 23B, 27B) and local pressure compensators (8A; 8B) adapted to control the pressure drop at the ends of the flow rate regulating slots (23A, 27A; 23B, 27B) of the slide for making the slide delivered flow rate independent from the load,

characterized by the fact that at least one of said portions (A, B) comprises a connection (20) between the channel (10) receiving oil from the pump (1) and at least the channel (13B) delivering oil to the actuator (3B); said connection (20) being parallel to the path of the flow through the flow rate regulating slots (23B, 27B) of the respective slide (7B) and the local compensator (8B); said connection (20) being closed in a central position of the respective slide (7B) and opened when the slide (7B) is piloted by a side (V1B); in said connection (20) the oil flows through a shutter (21) normally closed by a

spring (22) adjusted so that the opening pressure is higher than the LS ΔP at which the LS pump (1) regulator LS is adjusted.

2. Hydraulic distributor (2), according to claim 1, **characterized by** the fact said connection (20) is made inside the slide (7B) through radial holes (40, 42) and axial hole (41), the shutter (21) and spring (22) being both housed in the slide (7B).

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3. Hydraulic distributor (2), according to claim 2, **characterized by** the fact said radial holes (40) delivering oil to the shutter (21) are always connected to the channel (10), while the radial holes (42) discharging oil from the shutter (21) are covered in a central position and they are opened to the channel (12B) and therefore the respective use (13B) when the slide (7B) is piloted from one side (V1B); between the axial hole (41) and the radial holes (42) there is a sealing seat (44) of the shutter (21), while the shutter (21) is housed in the hole (43) with the spring (22) which keeps the shutter in a closed position; in an opened condition the shutter (21) abuts the pin (32); on the shutter (21) acts the opening pressure in the axial hole (41) and therefore the pressure of oil entering the pump in the channel (10), in a closed condition the pressure in the radial holes (42) is equal to the one in the user in the channel (12B), when the cursor is piloted from one side (V1B), plus the force of the spring (22).

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4. Hydraulic distributor (2), according to claim 1, **characterized by** the fact the local pressure compensators (8A; 8B) are located downstream the respective slides (7A; 7B) between the flow rate regulating slots (23A, 27A; 23B, 27B) and the users (13A, 14A; 13B, 14B).

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Fig. 1

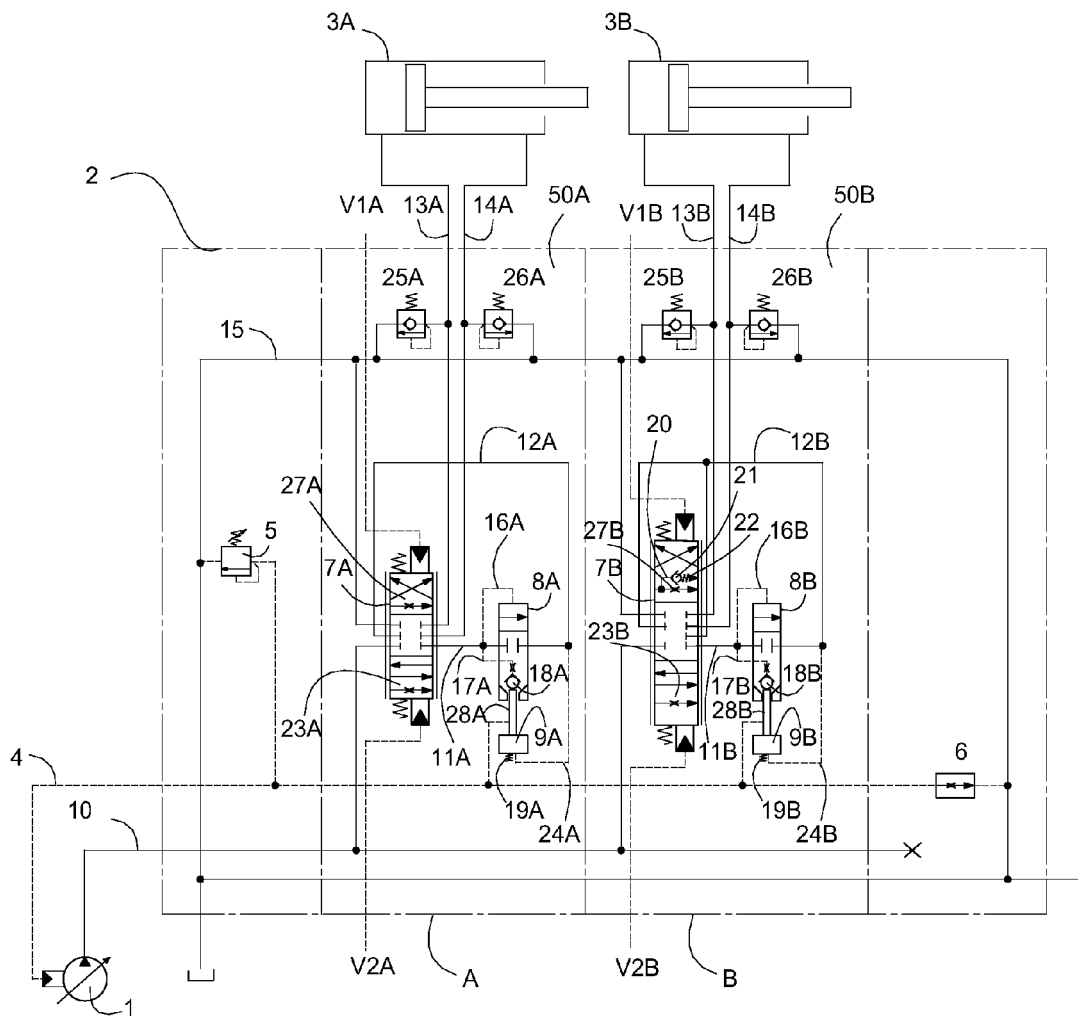
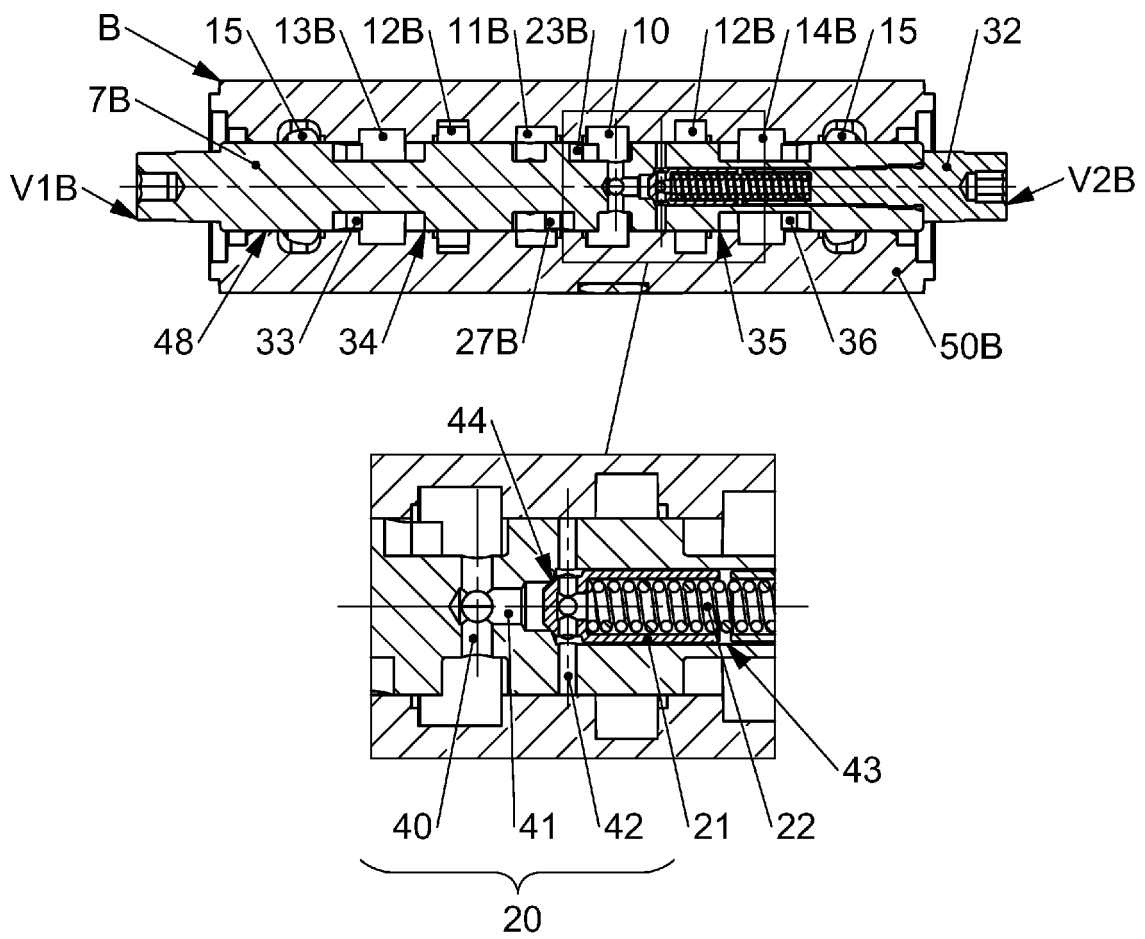


Fig.2





EUROPEAN SEARCH REPORT

Application Number
EP 12 16 7550

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 5 937 645 A (HAMAMOTO SATOSHI [JP]) 17 August 1999 (1999-08-17) * figure 2d *	1-4	INV. F15B11/16
A	US 2009/266070 A1 (PACK ANDREAS S [US] ET AL) 29 October 2009 (2009-10-29) * figure 1 *	1-4	
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The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
			F15B
Place of search		Date of completion of the search	Examiner
The Hague		4 June 2012	Regaud, Christian
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 12 16 7550

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