



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
05.03.2008 Bulletin 2008/10

(51) Int Cl.:
F15B 13/02 (2006.01)

(21) Application number: **06425615.9**

(22) Date of filing: **04.09.2006**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK YU

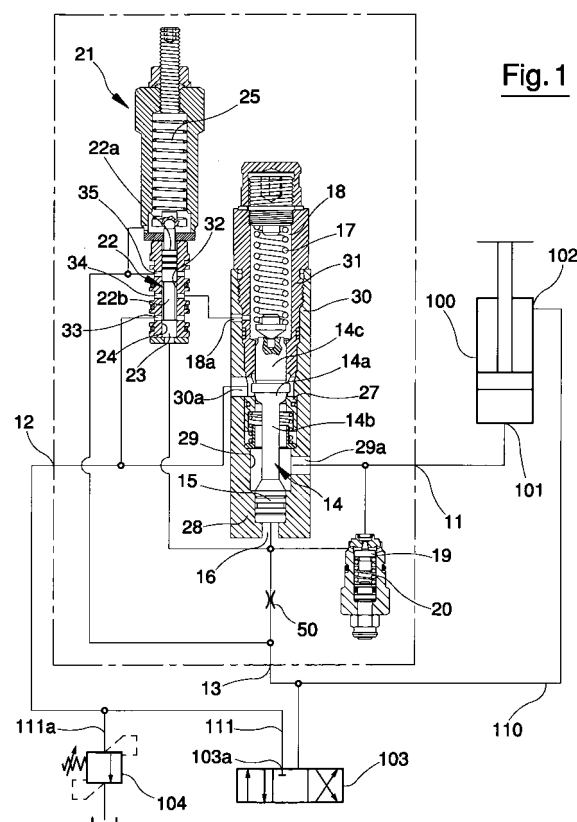
(72) Inventor: **Storci, Andrea**
41015 Nonantola (Modena) (IT)

(74) Representative: **Gotra, Stefano**
BUGNION S.p.A.
Via Vellani Marchi, 20
41100 Modena (IT)

(71) Applicant: **OIL CONTROL S.p.A.**
20122 Milano (IT)

(54) **A high pressure relief and control valve assembly**

(57) The valve comprises: at least a first opening (11), at least a second opening (12) and at least a third opening (13); a first obturator (14), mobile between at least a first position thereof, in which it prevents a connection between the first opening (11) and the second opening (12), and at least a second position, in which it places the first opening (11) and the second opening (12) in communication. The first obturator (14) is mobile from the first position to the second position by effect of a pilot pressure which acts in opposition to a force exerted by elastic means (17) operating inside a chamber (18), which tend to push the first obturator (14) from the second position towards the first position thereof. A second obturator (19) is mobile between at least a first position, in which it prevents a connection between the first opening (11) and a pilot chamber (16), and at least a second position, in which it places the first opening (11) in communication with the pilot chamber (16). The second obturator (19) is mobile from the first position towards the second position by effect of a thrust exerted by the pressure at the first opening (11) directed in opposition to elastic means (20) which tend to push the second obturator (19) from the second position towards the first position. A distributor (21) selectively places the chamber (18) in communication with the second opening (12) or with the third opening (13).



Description

[0001] The prior art includes high pressure and control valves for hydraulic actuators which are predisposed to be inserted in an activation circuit of a double-acting hydraulic actuator. As is known, the actuator is generally provided with a first opening, through which pressurised fluid can be sent to the actuator to determine a displacement in opposition to an external load, and a second opening, through which pressurised fluid can be sent to the actuator to determine a displacement which in agreement with the direction of the external load. The circuit further comprises a four-way three-position distributor which in a central position has at least one closed way which is predisposed to connect to the first opening of the actuator. The presence of the closed central way contributes to guaranteeing that under normal actuator rest conditions, the load is maintained in a stationary position, in particular in a case where the hydraulic actuator is constituted by a double-acting cylinder used to raise and lower a load of a determined weight. In a rest condition of the actuator, in which the distributor is in the central position, the first actuator opening is connected to the closed way of the distributor so that the load is thus maintained in a stationary position. A safety valve is generally connected to the closed way of the distributor:

[0002] Valves of known type usually comprise at least a first opening, connected to the first opening of the actuator, at least a second opening, which in the central position of the actuator is connected to the closed way of the actuator, and at least a third opening, connected to the second opening of the actuator and to the distributor.

[0003] The prior-art valves comprise a first obturator, mobile between at least a first position, in which the obturator prevents a connection between the first opening and the second opening of the valve, and at least a second position, in which it places the first and second valve openings in communication. The first obturator is solidly provided with a pilot piston which is mobile within a pilot chamber by effect of a pilot pressure which pushes the first obturator from the first towards the second position, acting against elastic means which operate inside a chamber, which elastic means push the first obturator from the second towards the first position. The pilot chamber of the first obturator is connected to the third opening of the valve. In this way, when pressurised fluid is sent to the second opening of the actuator, the first obturator receives the pilot pressure via the third opening of the valve and is placed in the second position. In the second position the first opening and the second opening of the valve are connected and enable a discharging of the fluid from the actuator.

[0004] The displacement of the first obturator from the first towards the second position requires the chamber containing the elastic means to be depressurised. This is generally done either by ventilating the chamber towards the outside or by connecting the chamber to a low-

pressure reservoir.

[0005] Both the solutions have drawbacks: the ventilation of the chamber towards the atmosphere, thanks to possible faults in the sealing gaskets acting on the first obturator, might determine losses of oil towards the outside; the connection of the chamber to the low-pressure reservoir causes plant complications which are often decisively important. There have also been cases in which, for functional reasons, the chamber in which the elastic means operate must be pressurised in certain circumstances and depressurised in others. Requirements of this type make the above-described solutions unsuitable.

[0006] The main aim of the present invention is to provide a high-pressure and control valve which overcomes the drawbacks in valves of known type.

[0007] An advantage of the valve of the present invention is that it enables a depressurisation of the chamber in which the elastic means operate, which elastic means act on the first obturator without there being any need to ventilate the chamber to the outside and without any need to provide connection conduits between the chamber and a low-pressure reservoir. A further advantage of the valve of the invention is to enable control of the chamber depressurisation.

[0008] Further characteristics and advantages of the invention will better emerge from the detailed description that follows, made with reference to the accompanying figures of the drawings, given by way of non-limiting example, and in which:

- figure 1 is a schematic view of a valve of the present invention in combination with a circuit for activation of a double-acting hydraulic actuator;
- figure 2 is a schematic representation of the valve of figure 1 in a different operational configuration.

[0009] In a preferred but not exclusive use, the valve of the present invention is inserted in an activation circuit for a double-acting hydraulic actuator 100 provided with a first opening 101, through which pressurised fluid can be sent to the actuator to cause a displacement in opposition to an external load, and a second opening 102, through which pressurised fluid can be sent to the actuator to cause a displacement in agreement with the external load. The circuit comprises a four-way three-position distributor 103, which in the central position thereof exhibits at least a way 103a which is closed and predisposed to connect to the first opening 101 of the actuator 100. A first conduit 110 connects the distributor 103 to the first opening 101 of the actuator 100, while a second conduit 111 connects the distributor 103 to a valve according to the present invention. A safety valve 104 is connected to the closed way 103a of the distributor 103 by a branch 111a of the second conduit 111.

[0010] The valve of the invention comprises at least a first opening 11, at least a second opening 12 and at least a third opening 13. In the preferred use the valve is connected to the closed way 103a of the distributor 103 and

to the safety valve 104 at the second opening 12. At the first opening 11 the valve can be connected to the first opening 101 of the actuator 100, while at the third opening 13 it can be connected to the second opening 102 of the actuator 100 and the distributor 103.

[0011] The valve further comprises a first obturator 14, mobile between at least a first position, in which it prevents a connection between the first opening 11 and the second opening 12, and at least a second position, in which it places the first opening 11 and the second opening 12 in communication. The first obturator 14 is provided with a pilot piston 15 solidly connected thereto which is mobile in a pilot chamber 16 by effect of a pilot pressure which pushes the first obturator from the first towards the second position. The pilot chamber 16 is connected to the third opening 13 of the valve, preferably through a choke 50, the function of which will be more fully explained herein below. Elastic means 17, preferably constituted by a calibratable helix spring, operate inside a chamber 18 and push the first obturator from the second position towards the first position, antagonistically to the action of the pilot pressure.

[0012] The valve further comprises a second obturator 19 which is mobile between at least a first position, in which it prevents a connection between the first opening 11 and the pilot chamber 16, and at least a second position, in which it places the first opening 11 in communication with the pilot chamber 16. The second obturator is mobile from the first position towards the second position by effect of the thrust exerted thereon by the pressure present at the first opening 11, which pressure acts against the elastic means 20, preferably constituted by a calibratable helix spring, which push the second obturator 19 from the second position towards the first position.

[0013] A basic aspect of the valve is constituted by the presence of a distributor 21 which alternatively places the chamber 18, in which the elastic means 17 act, in communication with the second opening 12 or with the third opening 13. The presence of the distributor 21 constitutes the main development with respect to valves of known type.

[0014] The distributor 21 comprises a third obturator 22, mobile between at least a first position, in which it places the chamber 18 in communication with the second opening 12 of the valve, and at least a second position, in which it places the vane 18 in communication with the third opening 13 of the valve.

[0015] The third obturator 22 comprises a first end portion provided with a pilot surface 23 which is mobile inside a pilot chamber 24 for effecting a pilot pressure which pushes the third obturator 22 from the first towards the second position, in opposition to the elastic means 25, preferably constituted by a calibratable helix spring, which elastic means 25 push the third obturator from the second towards the first position.

[0016] The pilot chamber 24 of the third obturator 22 is in communication with the third opening 13 of the valve,

preferably through a choke 50. In particular the pilot chamber 16 of the first obturator 14 and the pilot chamber 24 of the third obturator 22 are in communication with the third opening 13 through the same choke 50. Both the pilot chambers 16, 24 can further be set in communication with the first opening 11 of the valve thanks to the second obturator 19, specifically when the second obturator 19 is in the second position thereof.

[0017] The valve of the present invention operates as follows.

[0018] Supposing a situation in which the hydraulic actuator 100 is constituted by a double-acting cylinder used for raising and lowering a weight of a determined amount, and that an initial condition exists, illustrated in figure 1, in which the distributor 103 is in the central position, the actuator 100 in this position is still, as no pressurised fluid is sent to the actuator and the first opening 101 of the actuator is connected to the closed way 103a of the distributor. The load is thus maintained in a stationary condition.

[0019] If the distributor is now activated, bringing it into a position in which pressurised oil is supplied to the second opening 102 of the actuator 100 (figure 2), the supply of pressurised fluid to the second opening 102 causes a displacement of the actuator in the same direction as the resistant weight, in this case, for example, leading to a lowering of the weight.

[0020] The pressurised fluid, through the third opening 13 of the valve of the invention, reaches the pilot chamber 16 of the first obturator 14, which by effect of the thrust received from the pilot piston 15 moves from the first position towards the second position, placing the first opening 11 and the second opening 12 of the valve in communication.

[0021] If during the descent of the load the distributor 103 is very rapidly brought back into the central position, for example in a case of rapid arrest of the lowering operation, the pressure at the third opening 13 of the valve drops brusquely. The presence of the choke 50 interposed between the pilot chamber 16 of the first obturator 14 and the pilot chamber 24 of the third obturator 22 determines, however, a certain delay in the pressure drop within the pilot chambers 16, 24, enabling the fluid present in the actuator to discharge through the second opening 12 of the valve. Any inertia-caused pressure peaks on load arrest can be discharged via the safety valve 104 connected to the second opening 12 of the valve.

[0022] In presence of an overload, i.e. when there is an overpressure at the first opening 101 of the actuator 100, the ready displacement of the first obturator 14 and the third obturator 22 is guaranteed by the rapid opening of the second obturator 19 which, owing to the increase of pressure at the first opening 11 of the valve, displaces from the first position towards the second position, placing the first opening 11 in communication with the pilot chambers 16, 24 of the first and third obturators. The elastic means 20 which act on the second obturator 19

exert a thrust on the second obturator 19 which is such that the pressure needed to determine the displacement of the second obturator 19 from the first position towards the second position is less than (or equal to) the pressure needed to cause a displacement of the first obturator 14 from the first position towards the second position.

[0023] The chamber 18 in which the elastic means 17 of the first obturator operate is rapidly depressurised as the elastic means 25 which act on the third obturator 22 exert thereon a thrust which is such that the pressure needed to determine the displacement of the third obturator 22 from the first towards the second position is decidedly lower than the pressure needed to determine the displacement of the first obturator 14 from the first towards the second position.

[0024] From a constructional point of view, the valve preferably comprises a main body, denoted only schematically by the broken line surrounding the three obturators 14, 19, 22, internally of which the sliding seats of the various obturators are afforded, as well as the connecting conduits between the various openings of the valve and between the obturators. In particular, the first conduit 110 which connects the distributor 103 to the first opening 101 of the actuator 100 can be afforded partially internally of the main body of the valve. Alternatively, as illustrated in figure 1, the first conduit 110 can be external of the main body of the valve with a connection to the third opening 13 of the valve.

[0025] The first obturator 14 is cylindrical and comprises at least a shaped portion 14a predisposed to position strikingly against a mobile seating 27 at the first position of the first obturator 14, and a stem 14b which conjoins the shaped portion 14a to the pilot piston 15. The seating 27 is elastically mobile by effect of a positive pressure difference between the second opening 12 and the first opening 11 of the valve, which allows a fluid flow from the second opening 12 towards the first opening 11 of the valve. The shaped portion 14a is arranged between the stem 14b and an end portion 14c on which the elastic means 17 of the first obturator 14 act.

[0026] The first obturator 14 is slidable in a seating which comprises a first tract 28, in which the pilot piston 15 of the first obturator 14 sealedly slides, which first tract delimits the pilot piston 16 of the first obturator 14. A second tract 29, consecutive to the first tract 28, unsealedly houses at least a portion of the stem 14b. This second tract internally comprises the mobile seating 27, at an opposite end with respect to the first tract. The mobile seating 27 is constituted by a ring pushed by a spring in the direction of the shaped portion 14a of the first obturator 22. A third tract 30 of the seating of the first obturator 14, consecutive to the second tract 29, internally houses a tubular element 31 in which the end portion 14c of the first obturator 14 slides. The tubular element 31 delimits the chamber 18 in which the elastic means 17 acting on the first obturator 14 act. The chamber 18 is provided with a breather opening 18a.

[0027] At least a first opening 29a of the sliding seat

of the first obturator 14 opens into the inside of the second tract 29 of the seat itself. The first opening 29a is connected to the first opening 11 of the valve of the invention. At least a second opening 30a of the sliding seat of the first obturator 14 opens into the third tract 30 of the seat and is connected to the second opening 12 of the valve.

[0028] The presence of the mobile seat 27, as already mentioned, allows the fluid flow from the second opening 12 to the first opening 11 of the valve. This flow, in the illustrated embodiment, occurs when the distributor 103 is displaced into the position in which the pressurised fluid is sent to the second opening 12 of the valve in order to determine the raising of the load, or more generally a displacement of the actuator in an opposite direction to the resistant weight. In these conditions, not illustrated in detail as the positions of the various obturators are the same as the positions illustrated in figure 1 except for that of the obturator in the mobile seat 27 which is however easily imaginable, the first obturator 14 is in the first position thereof as it does not receive any pilot pressure. The pressure at the second opening 12 of the valve determines the displacement of the mobile seat 27 which distances from the shaped portion 14a of the first obturator 14, enabling fluid to pass.

[0029] From a constructional point of view, the third obturator 22 is cylindrical and comprises a first end portion on which the pilot surface 23 is arranged. The third obturator 22 further comprises a second end portion 22a and a central portion 22b having a smaller section. The two end portions are slidable sealedly internally of a seat 32 which, on the side of the pilot surface 23, delimits the pilot chamber 24.

[0030] The seat 32 of the third obturator 22 is provided with a first opening 33, connected to the second opening 12 of the valve 12, a second opening 34, connected to the breather opening 18a of the chamber 18, and a third opening 35, connected with the third opening 13 of the valve. The openings of the seat 32 of the third obturator 22 are positioned in such a way that when the third obturator 22 is in the first position, the first opening 33 and

[0031] the second opening 34 at least partially face the central portion 22b of the third obturator 22 and are connected to one another, while when the third obturator 22 is in the second position the second opening 34 and the third opening 35 at least partially face the central portion 22b of the third obturator 22 and are connected to one another.

[0032] In the absence of pilot pressure acting on the pilot surface 23, the third obturator 22 goes into the first position thereof by effect of the thrust exerted by the elastic means 25. In the first position of the third obturator 22, the breather opening 18a of the chamber 18 in which the elastic means 17 operating on the first obturator 14 are housed is connected to the second opening of the valve 12 through a path comprising the second opening 34, an annular chamber defined around the central portion 22b of the third obturator 22 and the first opening 33 of the seat 32. In the presence of pilot pressure acting

on the pilot surface 23, the third obturator 22 goes into the second position thereof. In the second position of the third obturator, the breather opening 18a of the chamber 18 in which the elastic means 17 operating on the first obturator 14 are housed is connected to the third opening 13 of the valve through a path which comprises the second opening 34, the annular chamber defined around the central portion 22b of the third obturator 22 and the third opening 35 of the seat 32.

Claims

1. A high pressure relief and control valve, comprising: at least a first opening (11), at least a second opening (12) and at least a third opening (13); also comprising a first obturator (14), mobile between at least a first position thereof, in which the first obturator (14) prevents a connection between the first opening (11) and the second opening (12), and at least a second position thereof, in which the first obturator (14) places the first opening (11) and the second opening (12) in communication; the first obturator (14) being mobile between the first position and the second position thereof by effect of a pilot pressure which pushes the first obturator (14) from the first position towards the second position thereof, in opposition to a force exerted by elastic means (17) operating inside a chamber (18), which elastic means (17) tend to push the first obturator (14) from the second position thereof towards the first position thereof; a second obturator (19), mobile between at least a first position thereof, in which the second obturator (19) prevents a connection between the first opening (11) and a pilot chamber (16), and at least a second position thereof, in which the second obturator (19) places the first opening (11) in communication with the pilot chamber (16), the second obturator (19) being mobile from the first position thereof towards the second position thereof by effect of a thrust exerted by the pressure at the first opening (11) directed in opposition to elastic means (20) which tend to push the second obturator (19) from the second position towards the first position thereof; **characterised in that** it comprises a distributor (21) which selectively places the chamber (18) in communication with the second opening (12) or with the third opening (13).
2. The valve of claim 1, wherein the distributor (21) comprises a third obturator (22), mobile between at least a first position, in which the chamber (18) is placed in communication with the second opening (12), and at least a second position, in which the chamber (18) is placed in communication with the third opening (13).
3. The valve of claim 2, wherein the third obturator (22) is provided with a pilot surface (23) which is mobile inside a pilot chamber (24) by effect of a pilot pressure which pushes the third obturator (22) from the first position thereof towards the second position thereof in opposition to elastic means (25) which push the third obturator from the second position thereof towards the first position thereof.
4. The valve of claims 2 or 3, wherein the pilot chamber (24) of the third obturator (22) is set in communication with the first opening (11) via the second obturator (19), when the second obturator (19) is in the second position thereof.
5. The valve of claim 4, wherein the first obturator (14) is solidly provided with a pilot piston (15) which is mobile inside a pilot chamber (16), which pilot chamber (16) is in communication with the third opening (13) via a choke (50).
6. The valve of claim 4, wherein the pilot chamber (23) of the third obturator (22) is in communication with third opening (13) via a choke (50).
7. The valve of claim 5 or 6, wherein the pilot chamber (16) of the first obturator (14) and the pilot chamber (24) of the third obturator (22) are in communication with the third opening (13) via the choke (50).
8. The valve of claim 7, wherein the elastic means (20) acting on the second obturator (19) exert thereon a thrust which is such that a pressure needed for determining a displacement of the second obturator (19) from the first position towards the second position thereof is less than a pressure needed for determining a displacement of the first obturator (14) from the first position towards the second position.
9. The valve of claim 7, wherein the elastic means (25) which act on the third obturator (22) exert thereon a thrust which is such that a pressure needed for determining a displacement of the third obturator (22) from the first position towards the second position thereof is less than a pressure needed for determining a displacement of the first obturator (14) from the first position towards the second position thereof.
10. An activation circuit for a double-acting hydraulic actuator (100) provided with a first opening (101), through which pressurised fluid can be sent to the actuator in order to cause a displacement thereof in opposition to an external load, and a second opening (102), through which pressurised fluid can be sent to the actuator to determine a displacement in agreement with an external load, comprising: a four-way three-position distributor (103) which in a central position thereof exhibits at least a way (103a) which is closed and predisposed to connect to the first opening (101) of the actuator (100); a safety valve (104),

connected to the closed way (103a) of the distributor (103); **characterised in that** it comprises a high-pressure and control valve as in at least one of the preceding claims, which is connected to the closed way (103a) of the distributor (103) and to the safety valve (104) at the second opening (12) thereof, the high-pressure and control valve being predisposed to connect to the first opening (101) of the actuator (100) at the first opening (11) thereof, and to the second opening (102) of the actuator (100) and to the distributor (103) at the third opening (13) thereof.

15

20

25

30

35

40

45

50

55

Fig. 1

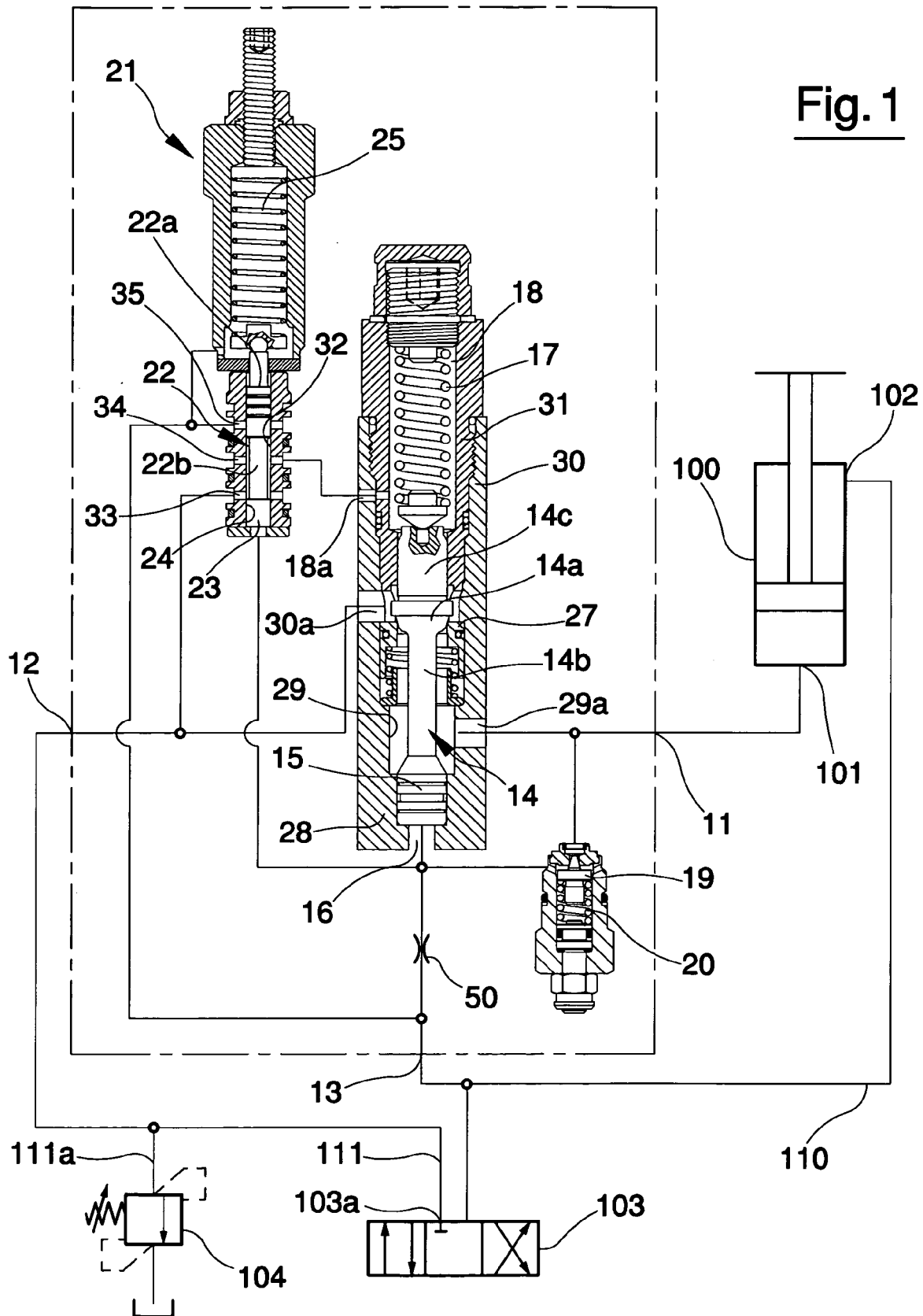
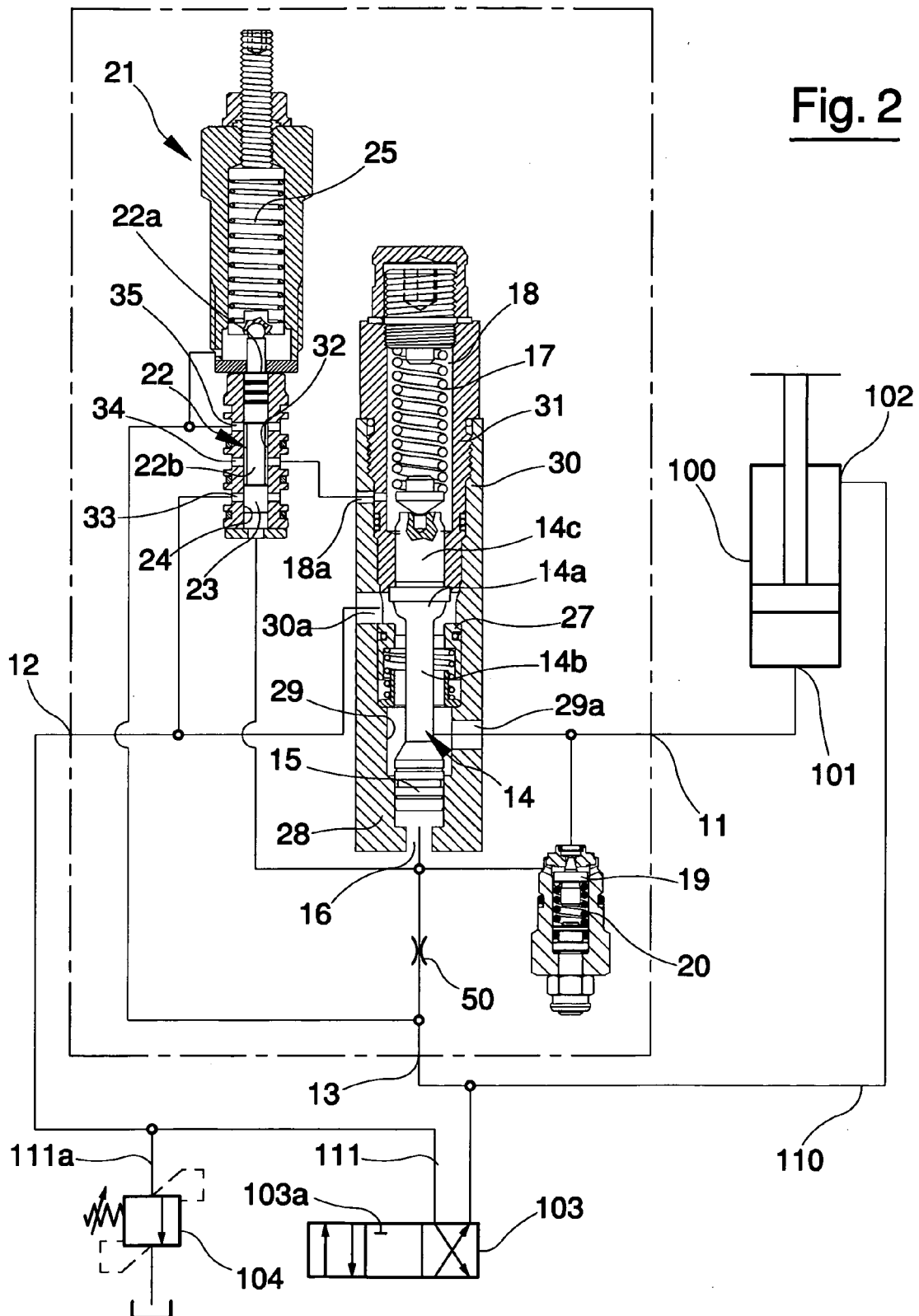


Fig. 2





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 06 42 5615

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	EP 0 756 089 A2 (DEERE & CO [US]) 29 January 1997 (1997-01-29) * column 3, line 23 - column 4, line 15; figure 1 *	1	INV. F15B13/02
A	GB 2 112 909 A (KOMATSU MFG CO LTD) 27 July 1983 (1983-07-27) * column 2, line 80 - line 112; figure *	1	
A	US 3 304 842 A (SHAFER HOMER J) 21 February 1967 (1967-02-21) * column 2, line 20 - column 3, line 20; figure 1 *	1	
A	EP 0 331 076 A1 (KOBE STEEL LTD [JP]) 6 September 1989 (1989-09-06) * figure 1 *	1	
A	DE 10 2004 032652 A1 (DEERE & CO [US]) 14 April 2005 (2005-04-14) * figure 1 *	1	
			TECHNICAL FIELDS SEARCHED (IPC)
			F15B F16K
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		20 February 2007	Krikorian, Olivier
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			

2

EPO FORM 1503 03.82 (P04C01)

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

EP 06 42 5615

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

20-02-2007

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0756089	A2	29-01-1997	NONE
GB 2112909	A	27-07-1983	JP 58076853 U 24-05-1983 US 4548036 A 22-10-1985
US 3304842	A	21-02-1967	NONE
EP 0331076	A1	06-09-1989	DE 68909069 D1 21-10-1993 ES 2043915 T3 01-01-1994
DE 102004032652	A1	14-04-2005	NONE