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(54) **System for controlling a hydraulic actuator for the rise and descent of a load**

(57) The present invention relates to system (1) for controlling a hydraulic actuator (2) for the rise and descent of a load, comprising a directional valve (6) for distributing a pressurized working fluid, from which the following branch out: a first working duct (7) associated with a first chamber (4) of the actuator (2) adapted to actuate the descent of the load if supplied and a second working duct (8) associated with a second chamber (5) of the actuator which is adapted to actuate the rise of the load if supplied, and a descent control valve (9) for controlling the descent of the load which is arranged along the second working duct (8), is normally closed in the discharge direction and can be opened in the direction for supplying the second chamber (5) and is driven hydraulically to open in the direction for discharge of the second chamber during descent of the load.

The control system comprises a line (10) for driving the descent control valve (9) which is in fluid connection with the second chamber (5) and is flow controlled by a downstream pressure control valve (11), which is normally closed hermetically and is switched to open by actuation means (12), operable by an operator to obtain a preset pressure reduction, and has at least one inlet (13) associated with the second chamber (5) and at least one outlet (14) associated with the descent control valve (9) to drive opening of the valve (9).

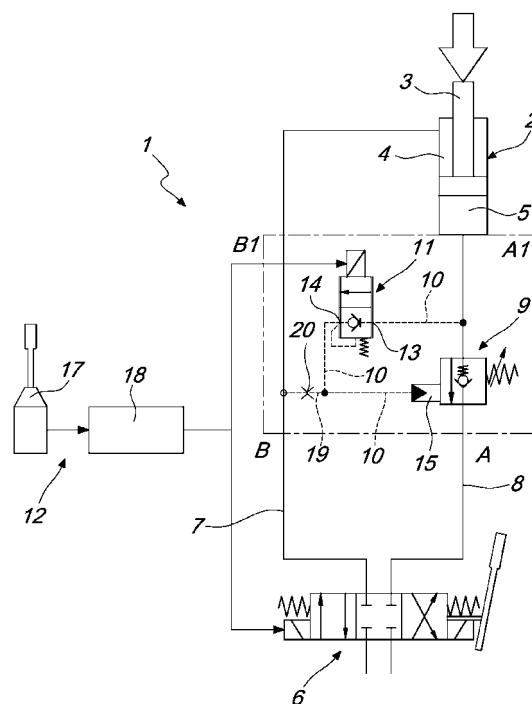


Fig. 1

Description

[0001] The present invention relates to a system for controlling a hydraulic actuator for the rise and descent of a load.

[0002] It is known that in the field of machines for moving loads, a hydraulic circuit is generally used for controlling a cylinder provided with a stem connected to the load to be moved, with a first chamber which if supplied causes the rise of the load and with a second chamber which if supplied causes the descent of the load.

[0003] This circuit includes a directional valve, with 4 ways and 3 positions, which is connected to the descent and rise chambers through a first and a second working duct. The second working duct, in particular, is flow controlled by an over-center valve, which is normally closed and driven to open in order to allow the discharge of the rise chamber, which prevents the accidental lowering of the load.

[0004] The systems for driving the known type of over-center valve to open generally use pressure taken from the first working duct, or they use pressure from external sources of supply.

[0005] In the first case, pressurization of the circuit is required in order to actuate the opening of the over-center valve with consequent energy consumption even to execute manoeuvres to lower the load, which if suitably controlled could occur spontaneously as a result of the force of gravity.

[0006] In the second case, hydraulic or electro-hydraulic drives are required that use an external pressure source in order to actuate the opening of the over-center valve, which in this type of application is generally referred to as the descent control valve. However, the lack of an independent driving line has limited the application of this system on lifting apparatuses as well. Moreover, systems that use electro-hydraulic drives exhibit the problem linked to the fact that, in the event of an outage of the electrical system, they do not allow manoeuvres to be executed to lower the load in an emergency in order to return the apparatus to a rest condition.

[0007] The aim of the present invention is to eliminate the above-mentioned drawbacks in the background art by providing a system for controlling a hydraulic actuator for the rise and descent of a load that makes it possible to reduce the energy consumption of the apparatus on which it is installed for the execution of manoeuvres to lower the load, and also to ensure that these manoeuvres can be executed correctly and in total safety even in the event of an outage of the system, thus making it possible to return the apparatus to a rest condition.

[0008] Within this aim, another object of the present invention is that of not requiring changes in the general architecture of hydraulic circuits, and therefore being capable of being installed both on newly-built machines and on existing machines.

[0009] Another object of the present invention is to provide a simple structure, that is relatively easy and prac-

tical to implement, safe to use and effective in operation, and relatively low-cost.

[0010] This aim and these objects are all achieved by the present system for controlling a hydraulic actuator for the rise and descent of a load, comprising a directional valve for distributing a pressurized working fluid, from which the following branch out: a first working duct associated with a first chamber of said actuator adapted to actuate the descent of the load if supplied and a second working duct associated with a second chamber of said actuator which is adapted to actuate the rise of the load if supplied and a descent control valve for controlling the descent of the load which is arranged along said second working duct, is normally closed in the discharge direction and can be opened in the direction for supplying said second chamber and is driven hydraulically to open in the direction for discharge of said second chamber during descent of the load, characterized in that it comprises a line for driving said descent control valve which is in fluid connection with said second chamber and is flow controlled by a downstream pressure control valve, which is normally closed hermetically and is switched to open by actuation means, operable by an operator to obtain a preset pressure reduction, and has at least one inlet associated with said second chamber and at least one outlet associated with said descent control valve to drive the opening of said valve.

[0011] Further characteristics and advantages of the present invention will become more apparent from the detailed description of some preferred, but not exclusive, embodiments of a system for controlling a hydraulic actuator for the rise and descent of a load, illustrated for the purposes of non-limiting example in the accompanying drawings wherein:

Figure 1 is a schematic circuit diagram of a first embodiment of the control system according to the invention;

Figure 2 is a schematic sectional view of a possible constructive implementation of an assembly comprising the descent control valve and the pressure control valve in Figure 1;

Figure 3 is a schematic circuit diagram of a second embodiment of the control system according to the invention;

Figure 4 is a schematic circuit diagram of a first variation of the control system in Figure 1;

Figure 5 is a schematic circuit diagram of a second variation of the control system in Figure 1;

Figure 6 is a schematic sectional view of a possible constructive implementation of an assembly comprising the descent control valve and the pressure control valve in Figure 5;

Figure 7 is a schematic circuit diagram of a third variation of the control system in Figure 1.

[0012] With particular reference to the figures, the reference numeral 1 generally designates a system for con-

trolling a hydraulic actuator 2 for the rise and descent of a load, not shown, of the type that is conventionally used on fixed and self-propelled lifting apparatuses.

[0013] More specifically, the actuator 2 is generally of the linear type and is constituted by a conventional cylinder whose stem 3 is associated with the load and which is provided with a first chamber 4 that, if supplied with a pressurized working fluid of the type of hydraulic oil, actuates the descent of the load and with a second chamber 5 that, if supplied, actuates the rise of the load.

[0014] In an alternative embodiment, not shown, the actuator 2 could be of the rotating type, such as a hydraulic engine.

[0015] The system 1 comprises a conventional directional valve 6, of the type with 4 ways and 3 positions, not described in detail, whose corresponding ports are connected to a device for supplying oil under pressure (not shown), a discharge device (also not shown) and to the chambers 4 and 5 of the actuator 2.

[0016] More specifically, the system 1 comprises a first working duct 7 and a second working duct 8 for the connection of corresponding ports of the directional valve 6, respectively, to the first chamber 4 and to the second chamber 5.

[0017] The system 1 comprises, moreover, a descent control valve 9 for controlling the descent of the load which is arranged along the second working duct 8. The descent control valve 9 is normally closed in the discharge direction and can be opened in the direction for supplying the second chamber 5 and is hydraulically driven to open in the direction for discharge of the second chamber during descent of the load.

[0018] The system 1 comprises a line 10 for driving the descent control valve 9, which is in fluid connection with the second chamber 5 and is flow controlled by a downstream pressure control valve 11, which is normally closed hermetically and is switched to open by actuation means 12, operable by an operator to obtain a preset pressure reduction, for example in the order of magnitude of 25-30 bar independently of the pressure acting in the second chamber 5. The pressure control valve 11 is provided with at least one inlet 13 associated with the second chamber 5 and at least one outlet 14 associated with the descent control valve 9 for driving the opening of the valve 9.

[0019] In particular the driving line 10 branches out from the second working duct 8.

[0020] The descent control valve 9 is provided with a movable piston 16 in a corresponding seat and with at least one working chamber 15 for driving opening of the piston 16. Moreover, means are provided for the discharge of the working chamber 15 so as to allow the restoration of the closed condition of the descent control valve 9 once the step of lowering the load is concluded.

[0021] In this way, through the pressure control valve 11, the pressure induced in the second chamber 5 as a result of the load weighing on the stem 3 and on the corresponding piston, following a suitable reduction, is

supplied to the working chamber 15 of the piston 16 so as to activate the opening of the descent control valve 9 and, therefore, the descent of the load itself without the need to supply pressurized working fluid along the first working duct 7 and, therefore, reducing the energy consumption required for the activation of the descent of the load to a minimum.

[0022] The pressure control valve 11 is preferably of the proportional type. Alternatively, it can be of the fixed-setting or adjustable type.

[0023] The actuation means 12 can be, for example, of the electrical, mechanical, hydraulic or pneumatic type, depending on the nature of the actuation of the pressure control valve 11.

[0024] The actuation means 12 are provided with a conventional joystick 17 or other element operable by an operator.

[0025] Moreover, the actuation means 12 can also be controlled by the actuation of the directional valve 6, or they can be dedicated to the pressure control valve 11.

[0026] Specifically, Figures 1 and 3-7 exemplify embodiments of the system 1 with actuation means 12 of the electrical type, in which the joystick 17 is associated with an electronic controller 18 that manages the supply of electric current for the actuation to open the pressure control valve 11, which is of the spool type, and the directional valve 6.

[0027] Figure 2 shows an embodiment of the system 1 with actuation means 12 of the hydraulic type, in which the joystick 17 manages the supply of pressurized working fluid for the actuation of the pressure control valve 11 and of the directional valve 6.

[0028] Advantageously, the system 1 comprises means for supplying the working chamber 15 in an emergency which comprise a connection branch 19 interposed between the chamber and the first working duct 7.

[0029] In a possible embodiment (Figures 1-4) the descent control valve 9 is provided with a single working chamber 15 and the connection branch 19 merges along the driving line 10 downstream of the outlet 14 in the direction for passing through during descent of the load.

[0030] According to this embodiment the discharge means coincide with the emergency supplying means and the connection branch 19 is flow controlled by at least one choke 20.

[0031] In the step of supplying the driving line 10, the choke 20 offers resistance to the passage of the oil along the connection branch 19, thus enabling the working chamber 15 to be pressurized.

[0032] The connection branch 19, in fact, serves to enable the discharge of the working chamber 15 when the descent step of the load has been concluded, and to restore the closed configuration of the descent control valve 9. Likewise, in the event of an outage of the pressure control valve 11 or of the actuation means 12 or if the load acting on the actuator 2 changes direction, through the connection branch 19 it is possible to achieve the opening of the descent control valve 9, and thus the low-

ering of the load, by pressurizing the working chamber 15 by means of oil under pressure derived from the first working duct 7, which is also supplied with oil under pressure, through the connection branch 19 and the corresponding choke 20.

[0033] It is not excluded, however, that the supply means and the discharge means could be implemented separately, if for example the discharge means are adapted to evacuate the working fluid into a separate tank.

[0034] In a further embodiment (Figures 5-7) the descent control valve 9 is provided with a first working chamber 15a, which operates on a first driving area of the piston 16, which is supplied by means of the driving line 10, and a second working chamber 15b, which operates on a second driving area of the piston 16, which has a smaller extension than the first one and is supplied through the connection branch 19.

[0035] In this case the discharge means coincide with the connection branch 19 to discharge the second working chamber 15b and comprise a connecting portion 35, which is interposed between the driving line 10 and the connection branch and is flow controlled by at least one choke 20 for discharging the first working chamber 15a.

[0036] Here too, the choke 20 offers resistance to the passage of the oil along the connecting portion 35 in the step of supplying the driving line 10, thus enabling the first working chamber 15a to be pressurized.

[0037] In particular, the connecting portion 35 branches off the driving line 10 downstream of the outlet 14 in the direction for passing through of the working fluid during descent of the load.

[0038] According to this embodiment, the driving to open the descent control valve 9 occurs by means of the pressurization of the second working chamber 15b through the connection branch 19 with the oil under pressure derived from the first working duct 7, which is also under pressure, in the event of an outage of the pressure control valve 11 or of the actuation means 12 or if the load acting on the actuator 2 changes direction.

[0039] In a possible variation (Figures 4 and 7) the system 1 can be provided with a pressure reduction valve 34 arranged along the driving line 10 upstream of the inlet 13 in the direction for passing through during descent of the load.

[0040] This reduction valve 34 makes it possible to reduce phenomena of hysteresis thanks to a lower pressurization of the dynamic gaskets associated with the supply pressure.

[0041] Moreover, the system 1 can be provided with a conventional flow control valve, which is normally closed and can be opened during descent of the load, and is arranged along the driving line 10 upstream of the inlet 13 in the direction for passing through during descent of the load. This flow control valve can be provided in addition to or as a substitution of the reduction valve 34 and it ensures the maintaining of the load applied to the stem 3.

[0042] The flow control valve could be constituted by a two-way solenoid valve actuated, again, by the actuation means 12.

[0043] Figure 2 shows a possible constructive embodiment of an assembly 21 that incorporates the electrically-actuated pressure control valve 11 and the descent control valve 9 with a single working chamber 15 according to the circuit diagram in Figure 1.

[0044] The assembly 21 comprises a monolithic body 22 in which the following are formed: sections of the first and of the second working duct, respectively, 7 and 8, the driving line 10, the connection branch 19 with the corresponding choke 20 and the accommodation seats of the descent control valve 9 and of the pressure control valve 11.

[0045] In the descent control valve 9, the piston 16 is provided in a single body and has a first end 16a directed toward the working chamber 15 and a second end 16b, opposite to the first, on which a first compression spring 24 operates for maintaining the closed configuration in the direction for discharge of the second chamber 5.

[0046] The first end 16a forms the driving area upon which the pressure supplied in the working chamber 15 acts.

[0047] The piston 16 is provided with a contoured median portion 16c, which abuts hermetically against a sleeve 25 which is kept pressed against the median portion and against a fixed abutment element 26 by a second compression spring 27 accommodated within the seat of the descent control valve 9. The median portion 16c, the sleeve 25 and the second spring 27 provide the one-way valve incorporated in the descent control valve 9.

[0048] If the second chamber 5 needs to be supplied, the pressure in the second working duct 8 at the gate A causes the movement to the right, with reference to the figure, of the sleeve 25 in contrast to the resistance offered by the second spring 27 and, therefore, the passage of oil, the piston 16 remaining stationary within its seat.

[0049] By contrast, in order to drive the opening of the descent control valve 9 in the descent step, the pressure acting in the working chamber 15 on the first end 16a causes the movement to the left, with reference to the figure, of the piston 16 with consequent opening of the gap formed between the median portion 16c and the sleeve 25 which is prevented from moving to the left by the fixed abutment element 26.

[0050] The pressure control valve 11 is of the electrically actuated type and is provided with a spool 28 coupled to an electromagnetic core 29 which, through a stem 30, operates on a conical plug 31.

[0051] The force of a third compression spring 33 accommodated in the seat of the pressure control valve 11 and the pressure along the driving line 10 act on the head of the plug 31, for closing against the corresponding seat.

[0052] The pressure control valve 11 is, therefore, normally kept hermetically closed.

[0053] The difference between the electromagnetic force that opens the pressure control valve 11 and the

reaction of the third spring 33 determines the extent of the pressurization of the driving chamber 15.

[0054] In the event of excitement of the spool 28, the core 29 moves, as a result of the induced electromagnetic field, upward, with reference to the figure, causing the movement of the plug 31 and, therefore, the opening of the pressure control valve 11.

[0055] Figure 6 shows a possible embodiment of the assembly 21 in Figure 2, of which the same reference numerals are used and to the description of which the reader is referred, in which the descent control valve 9 is provided with two working chambers 15a and 15b and the piston 16 with corresponding driving areas, according to the circuit diagram in Figure 5.

[0056] The piston 16 is provided at its first end 16a with a slave cylinder 36 the free end 36a of which forms the first driving area exposed to the pressure supplied in the first working chamber 15a through the pressure control valve 11.

[0057] The first end 16a, directed toward the slave cylinder 36, forms the second driving area exposed to the pressure supplied in the second working chamber 15b through the connection branch 19.

[0058] In practice it has been found that the invention described achieves the intended aim and objects and, in particular, attention is drawn to the fact that under normal operating conditions the system according to the invention makes it possible to minimize the consumption of energy required to activate the manoeuvre of lowering the load. Nonetheless, in emergency situations the system according to the invention makes it possible to automatically and safely manage the descent manoeuvre of the load.

[0059] Moreover, the system according to the invention does not involve burdensome changes in the architecture and in the components of traditional circuits.

[0060] The invention, thus conceived, is susceptible of numerous modifications and variations, all of which are within the scope of the appended claims.

[0061] Moreover, all the details may be substituted by other, technically equivalent elements.

[0062] In practice the materials employed, as well as the contingent dimensions and shapes, may be any according to requirements but without for this reason extending beyond the scope of protection of the following claims.

[0063] The disclosures in Italian Patent Application No. MO2010A000253 from which this application claims priority are incorporated herein by reference.

[0064] Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly, such reference signs do not have any limiting effect on the interpretation of each element identified by way of example by such reference signs.

Claims

1. A system (1) for controlling a hydraulic actuator (2) for the rise and descent of a load, comprising a directional valve (6) for distributing a pressurized working fluid, from which the following branch out: a first working duct (7) associated with a first chamber (4) of said actuator (2) adapted to actuate the descent of the load if supplied and a second working duct (8) associated with a second chamber (5) of said actuator which is adapted to actuate the rise of the load if supplied, and a descent control valve (9) for controlling the descent of the load which is arranged along said second working duct (8), is normally closed in the discharge direction and can be opened in the direction for supplying said second chamber (5) and is driven hydraulically to open in the direction for discharge of said second chamber during descent of the load,
characterized in that it comprises a line (10) for driving said descent control valve (9) which is in fluid connection with said second chamber (5) and is flow controlled by a downstream pressure control valve (11), which is normally closed hermetically and is switched to open by actuation means (12), operable by an operator to obtain a preset pressure reduction, and has at least one inlet (13) associated with said second chamber (5) and at least one outlet (14) associated with said descent control valve (9) to drive opening of said valve (9).
2. The system (1) according to claim 1, **characterized in that** said descent control valve (9) is provided with a movable piston (16) and with at least one working chamber (15; 15a, 15b) for driving the opening of said valve (9), means being further provided for discharging said at least one working chamber (15; 15a, 15b) to restore the closed condition of the descent control valve (9).
3. The system (1) according to claim 1 or 2, **characterized in that** said actuation means are of the electrical, mechanical, hydraulic or pneumatic type, depending on the nature of the actuation of said pressure control valve (11).
4. The system (1) according to one or more of the preceding claims, **characterized in that** said actuation means (12) are also controlled by the actuation of said directional valve (6).
5. The system (1) according to one or more of the preceding claims, **characterized in that** said pressure control valve (11) is of the proportional type.
6. The system (1) according to one or more of the preceding claims, **characterized in that** it comprises means for the emergency supply of said at least one

working chamber (15; 15b) which comprise a connection branch (19) interposed between said chamber and said first working duct (7).

7. The system (1) according to claim 6, **characterized in that** said descent control valve (9) is provided with a single working chamber (15) and said connection branch (19) merges along said driving line (10) downstream of the outlet (14) of said pressure control valve (11) in the direction for passing through said line for the descent of the load. 5
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8. The system (1) according to claim 6, **characterized in that** said descent control valve (9) is provided with a first working chamber (15a), which operates on a first driving area (16a) of said piston (16), which is supplied through said driving line (10), and a second working chamber (15b), which operates on a second driving area (16b) of said piston, which has a smaller extension than the first one and is supplied through said connection branch (19). 15
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9. The system (1) according to claims 2 and 7, **characterized in that** said discharge means coincide with said emergency supply means, at least one choke (20) being further provided along said connection branch (19). 25
10. The system (1) according to claims 2 and 8, **characterized in that** said discharge means coincide with said connection branch (19) to discharge the second working chamber (15b) and comprise a connecting portion (35), which is interposed between the driving line (10) and said connection branch and is flow controlled by at least one choke (20) for discharging the first working chamber (15a). 30
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11. The system (1) according to one or more of the preceding claims, **characterized in that** it comprises an additional pressure reduction valve (34) arranged along said driving line (10) upstream of the intake port (13) of said pressure control valve (11) driven in the direction for passing through said line for the descent of the load. 40
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12. The system (1) according to one or more of the preceding claims, **characterized in that** it comprises a flow control valve arranged along said driving line (10), which is normally closed and can be opened during load descent. 50

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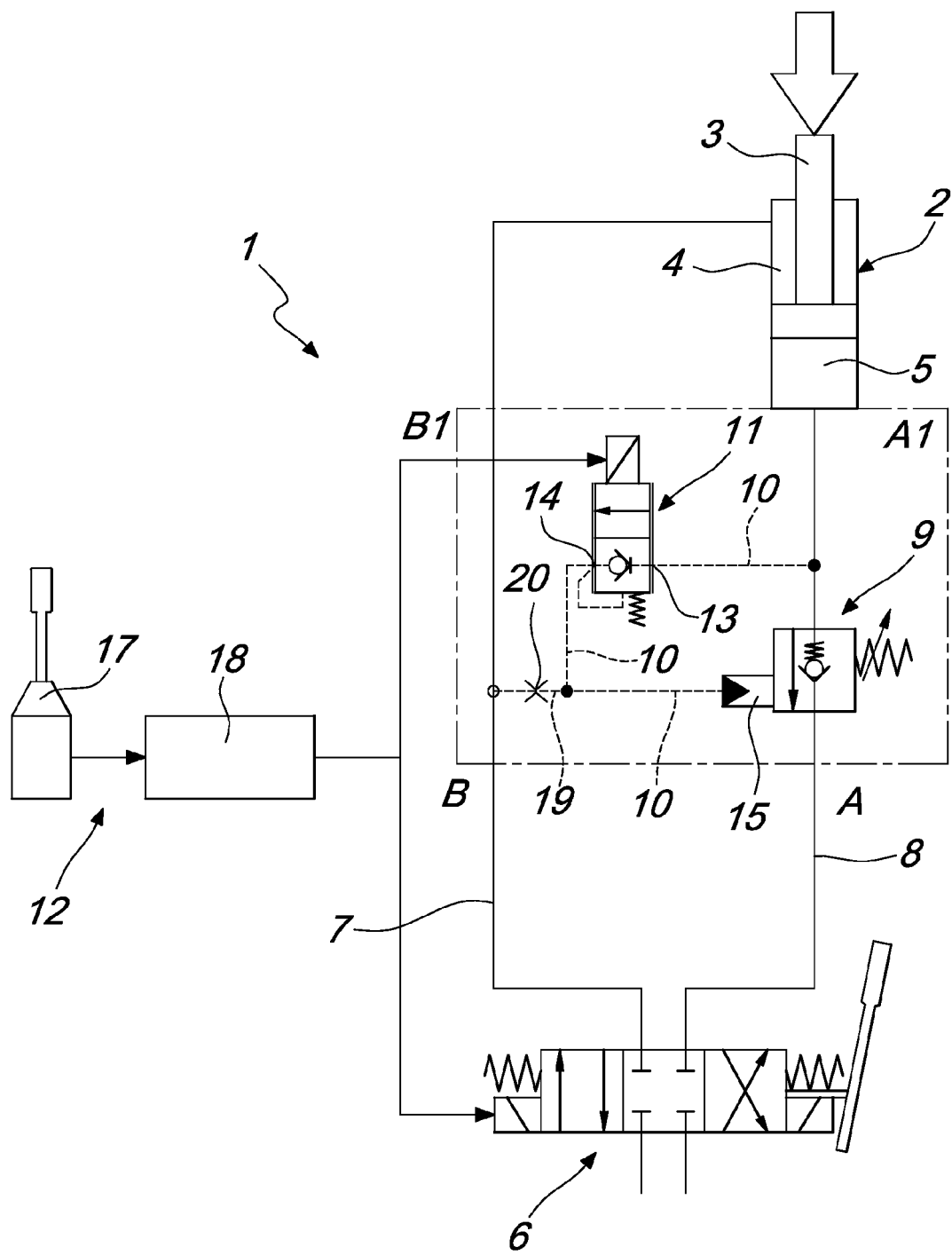
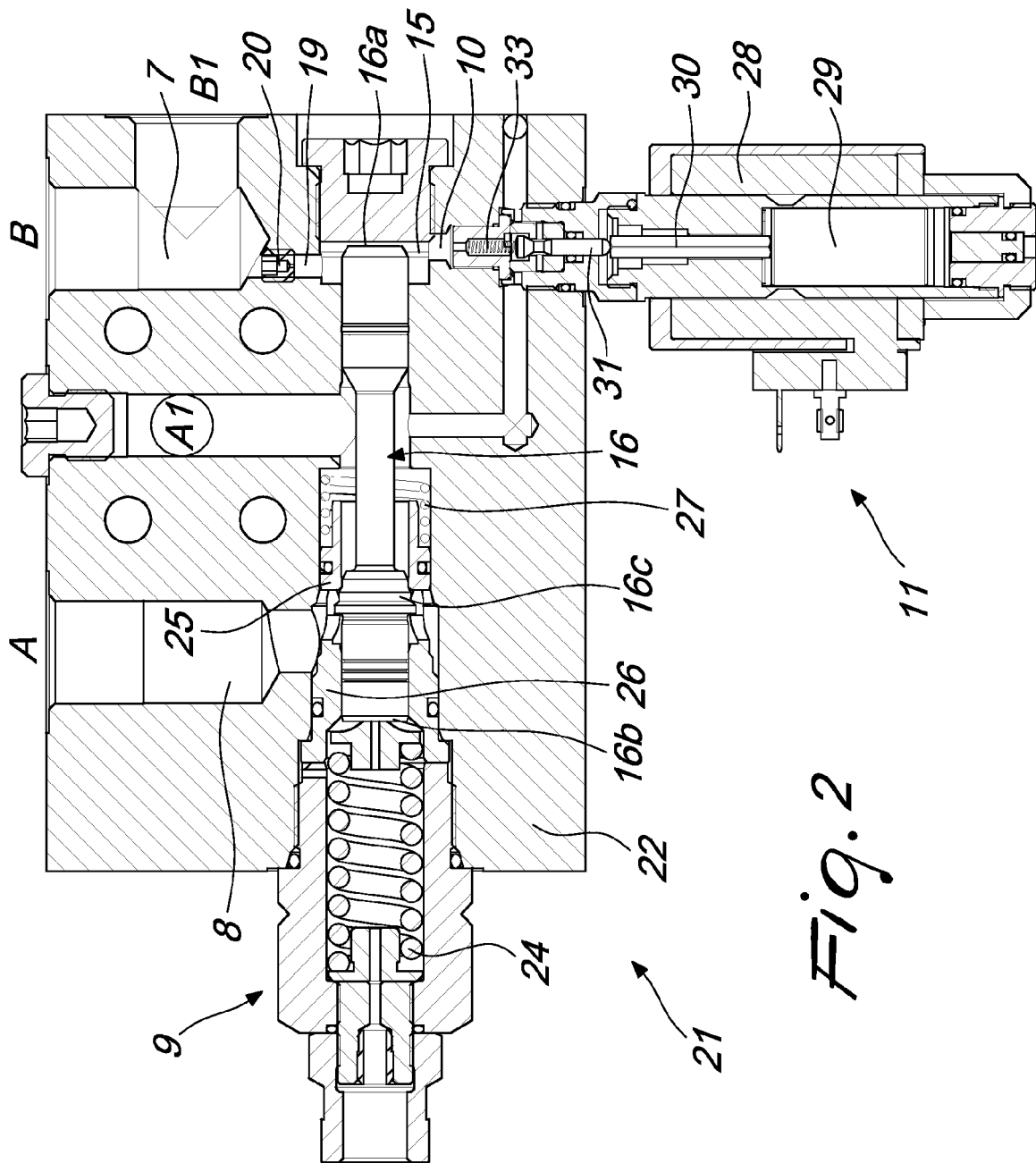


Fig. 1



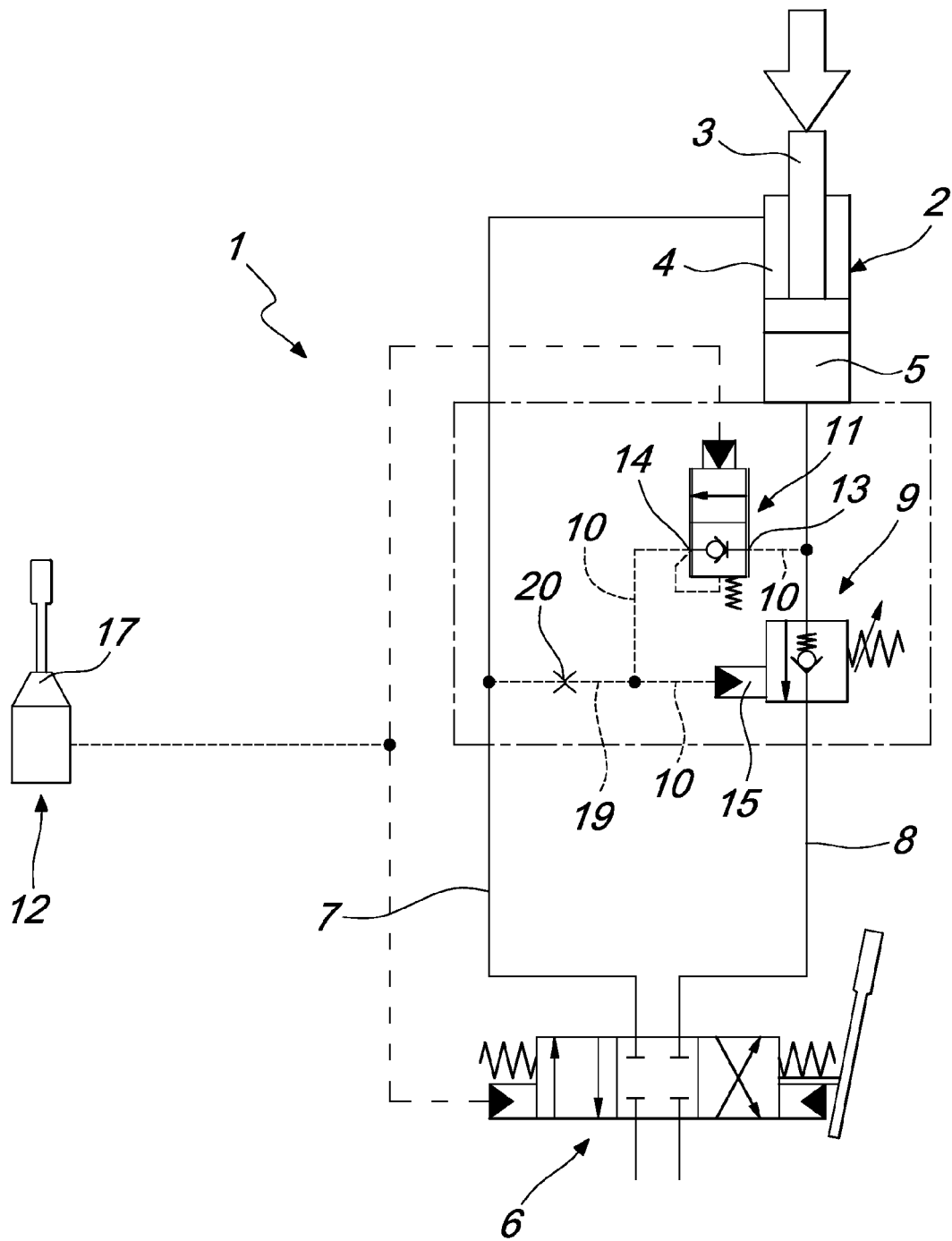


Fig. 3

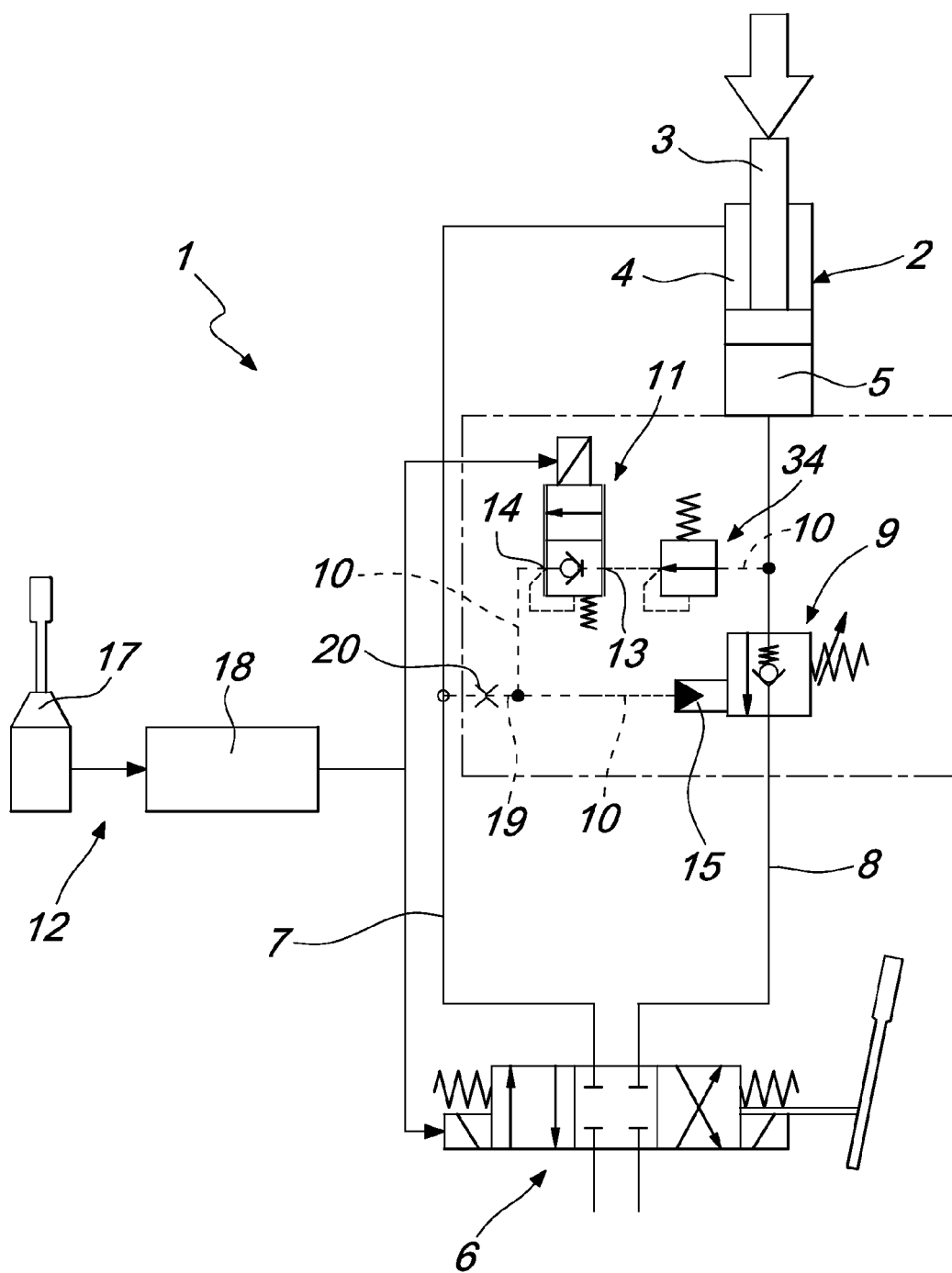


Fig. 4

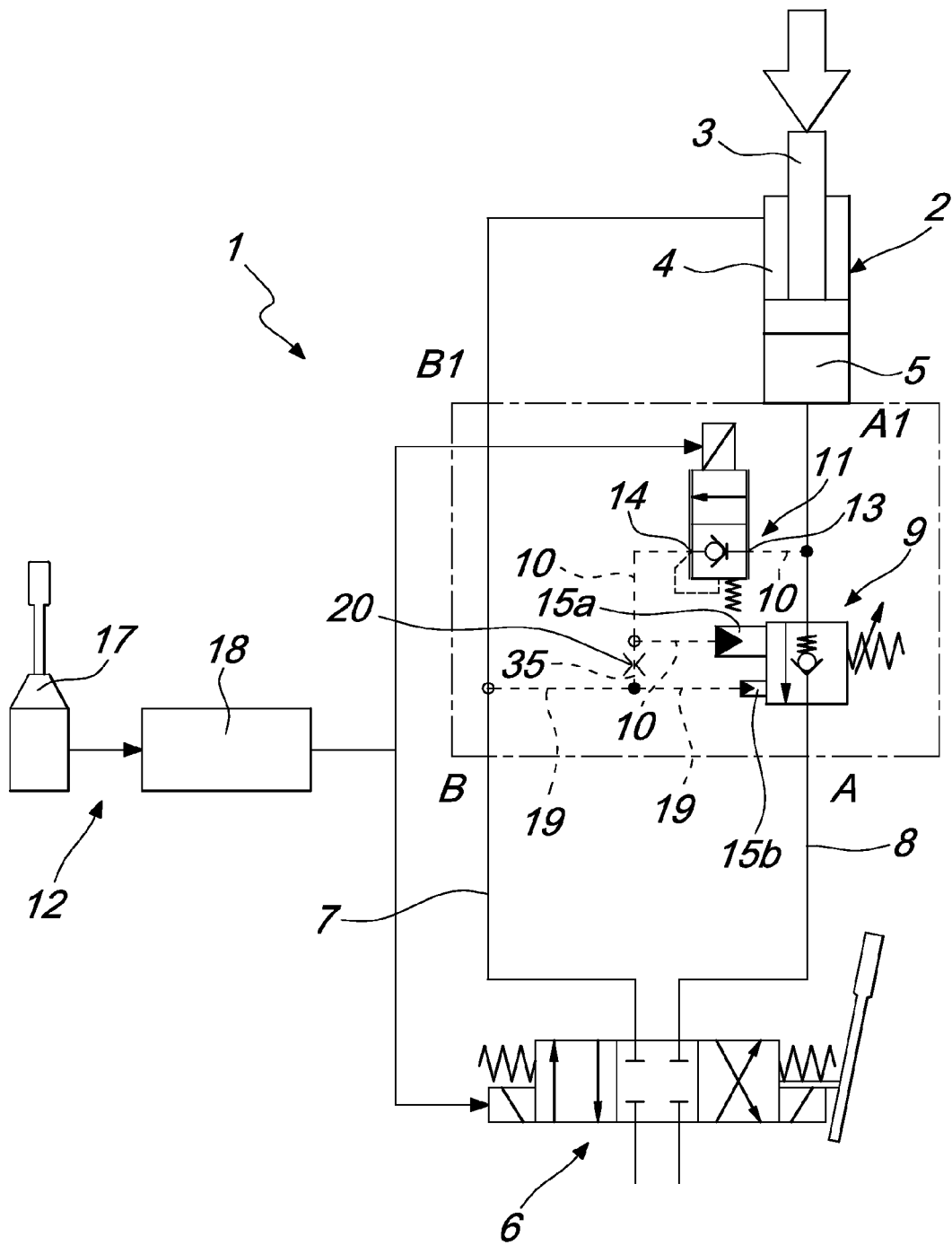
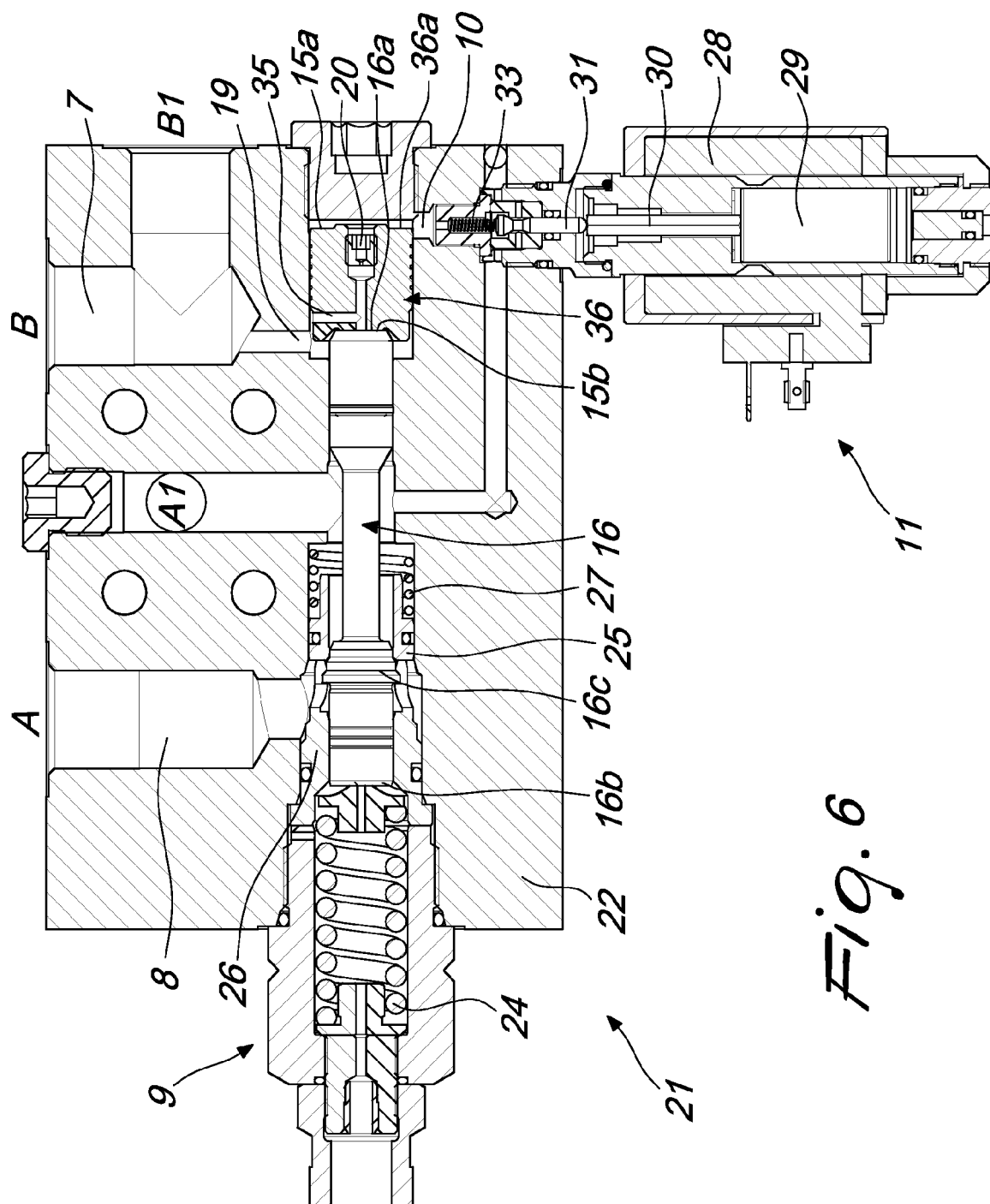


Fig. 5



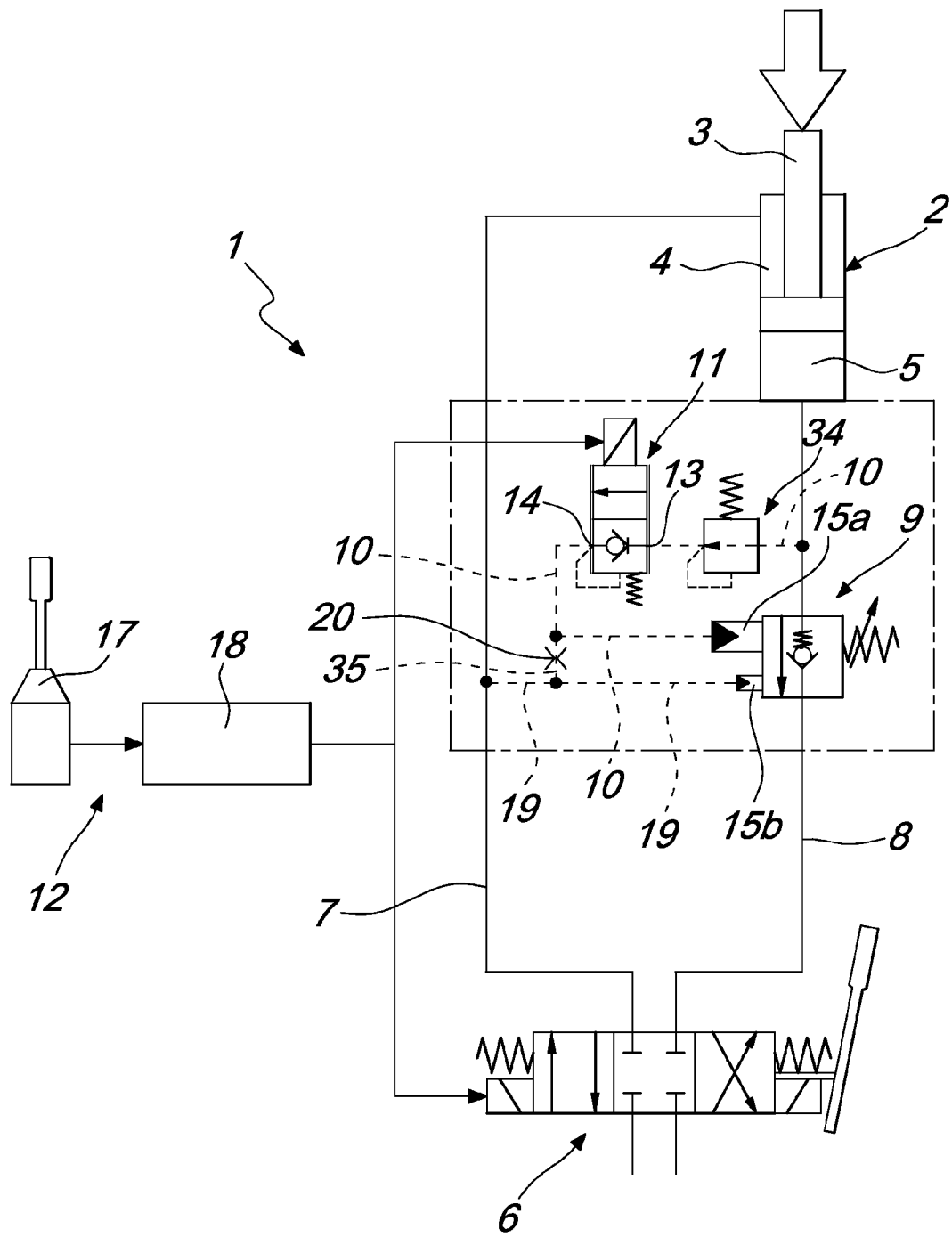


Fig. 7



EUROPEAN SEARCH REPORT

Application Number
EP 11 17 9650

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	FR 2 328 868 A1 (MONSUN TISON AB [SE]) 20 May 1977 (1977-05-20) * claims 1,3; figure 4 *	1-5,12	INV. F15B11/044
X	FR 2 459 894 A1 (POCLAIN SA) 16 January 1981 (1981-01-16) * claims 1,2; figure 1 *	1-5,11, 12	
			TECHNICAL FIELDS SEARCHED (IPC)
			F15B
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 30 September 2011	Examiner Krikorian, Olivier
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EPO FORM 1503 03.82 (P04C01)

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

EP 11 17 9650

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The members are as contained in the European Patent Office EDP file on
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30-09-2011

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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