

(19)



(11)

EP 2 345 815 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:

20.07.2011 Bulletin 2011/29

(51) Int Cl.:

F15B 13/01 (2006.01)(21) Application number: **10425006.3**(22) Date of filing: **14.01.2010**

(84) Designated Contracting States:

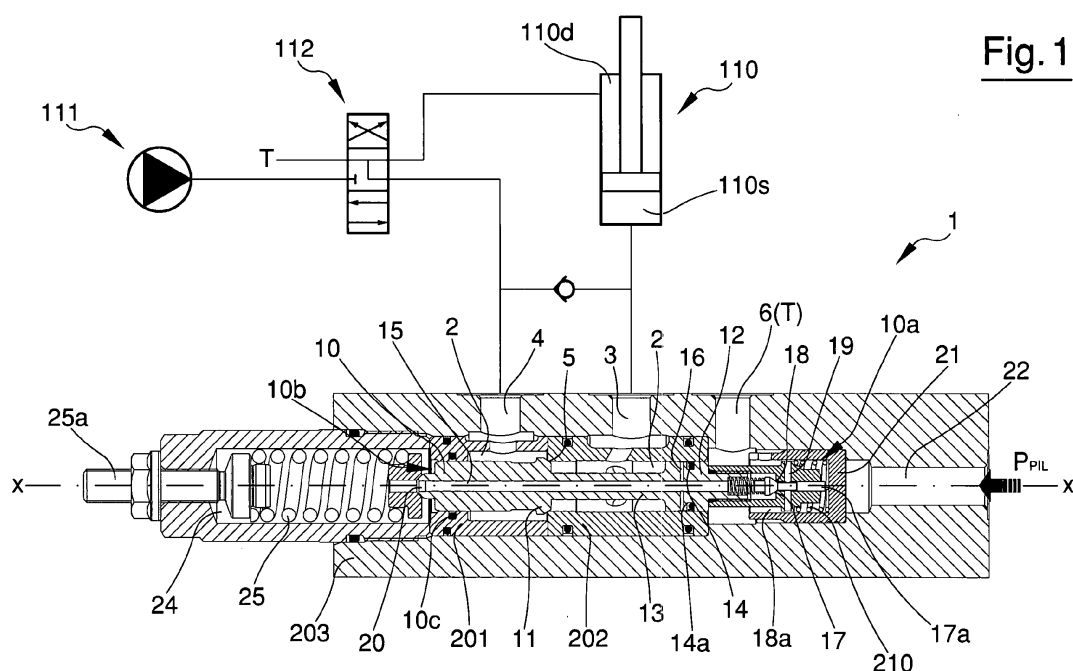
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL
PT RO SE SI SK SM TR**

Designated Extension States:

AL BA RS(72) Inventor: **Storci, Andrea****41015 Nonantola (Modena) (IT)**(74) Representative: **Colò, Chiara et al****Bugnion S.p.A.****Via Vellani Marchi, 20****41124 Modena (IT)**(71) Applicant: **Bosch Rexroth Oil Control S.p.A.****20149 Milano (IT)****(54) A hydraulic valve for supporting and controlling descent of a load**

(57) A hydraulic valve for supporting and controlling a descent, comprising: a conduit (2) for passage of a fluid, provided with a first opening (3) and a second opening (4) and a seal seating (5), arranged in an intermediate position between the first opening (3) and the second opening (4); an obturator (10), mobile between a closed position, in which a first seal portion (11) of the obturator is in contact with the seal seating (5) and the first opening (3) and the second opening (4) are not in communication with one another, and at least an open position, in which

the first seal portion (11) is distant from the seal seating (5) and the first opening (3) and the second opening (4) are in communication with one another; a second seal portion (12), sealedly slidable along an internal wall of the conduit (2); a gasket (14), interposed between an external surface of the second seal portion (12), which gasket (14) is housed internally of an annular seating (14a); discharge means (15, 16, 17, 18) predisposed to enable a fluid communication between the annular seating (14a) and a discharge opening (6) of the valve.

**Fig. 1****EP 2 345 815 A1**

Description

[0001] The invention relates to a hydraulic valve for supporting and controlling descent of a load.

[0002] These valves are commonly used in hydraulic circuits for activating mechanical lift arms, lift trucks and other machinery predisposed for moving a load along at least a vertical component.

[0003] The above-described activating circuits for machinery generally comprise at least a hydraulic actuator which is supplied with a fluid for determining the raising or descent of the load. In particular, in the case of a linear actuator in the form of a cylinder, generally the supply of fluid to the base of the cylinder determines extraction of the stem and the raising of the load, while the supply of fluid to the chamber of the stem causes retraction of the stem and the descent of the load.

[0004] The above-described activating circuits comprise a support and control valve of the descent which is normally interposed between the source of fluid supply and the base of the linear actuator, or more generally between the pressurised fluid source and the supply point to the actuator for the raising of the load. The function of the valve is to enable the load to be maintained in position, in the absence of fluid supply to the actuator, and in the presence of fluid supply for the load descent, to enable control of the descent of the load.

[0005] Zero-leakage valves of known type comprise an obturator provided with a first seal portion destined to enter into contact with a seal seating arranged along a passage conduit for the fluid. The obturator is mobile between a closed position, in which the first seal portion is in contact with the seal seating and the conduit is closed to fluid passage, and an open position, in which the seal portion is not in contact with the seal seating and the fluid can transit along the conduit via the seal seating. The first sealing portion must be shaped such that in displacing from the closed position towards the open position, the area of the section which is free for the passage of the fluid is initially small, such that the fluid flow which can transit initially is limited and the descent of the load begins at very low velocity, and then grows more sharply following the initial instants of the descent.

[0006] The obturators of the known-type valves, for a reason which will be made clearer herein below in the description, are normally configured in the following way.

[0007] The first seal portion is associated to an end of a stem, the section of which is smaller than the area surrounded by the seal seating and the internal section of the fluid passage conduit. At the opposite end of the stem there is a second seal portion which runs sealedly along the fluid passage conduit. The second seal portion is provided in general with a seating in which a seal ring is housed which ring realises a watertight seal between the obturator and the fluid passage conduit. On the second seal portion, at a surface facing towards the outside of the fluid passage conduit, a piloting pressure acts which on command pushes the obturator towards the open po-

sition.

[0008] During the descent of the load, the operator fluid is supplied to the valve in a zone comprised between the two seal portions, in the annular space comprised between the fluid passage conduit and the obturator stem. The seal ring the second seal portion is provided with prevents the fluid from exiting the conduit, such that when the obturator displaces towards the open position the fluid can transit only through the seal seating.

[0009] The configuration of the above-described obturator has a very precise function. In work machines (e.g. excavator arms, crane arms, etc.), during the lowering movement of the load, the relative angle between the activating cylinder and the arm can change considerably, and consequently the pressure induced internally of the cylinder changes. In these conditions, the oil flow could considerably change, and thus also the lowering velocity, even if the operator keeps the descent command in the same position, for example a command lever of a distributor. This might cause relative movements which are difficult to control.

[0010] The position of the two seal portions and the operator fluid supply in an intermediate zone between them provides a better intrinsic stability in dynamic control. When the static pressure in the cylinder increases, the obturator naturally tends to displace towards the closure position thereof. This happens due to the fact that the obturator is in the open position and consequently the static pressure in proximity of the first seal position tends to drop. This means that the axial thrust which the fluid exerts on the second seal portion remains the same, while the thrust exerted by the fluid towards the first seal portion diminishes. When the cylinder pressure increases, an obturator made in this way thus tends to displace towards the closed position thereof, reducing the passage hole for the fluid through the seal seating of the valve. Consequently the fluid flow does not increase the descent velocity of the load, or increases it only to a small extent.

[0011] The tendency to close the obturator is however not sufficient to realise total closure, but for the rest closure a further mechanical thrust obtained through the spring is necessary, which spring, for this purpose, has to be realised with very reliable safety criteria.

[0012] A drawback of the valves of known type is given by the fact that the gasket or seal ring present on the second seal portion is subjected to the high pressure induced by the load bearing down on the actuator. By effect of the high pressure it is subject to, the seal gasket deforms considerably, adhering with force to the internal wall of the fluid passage conduit. Thus a considerable friction is created between the gasket and the internal wall of the conduit, especially in the first instants of obturator movement, even if the gasket is made of anti-friction materials, such as, for example, based on teflon. The result is to delay the start of opening when the piloting pressure is applied, i.e. when a force sufficient to overcome the static friction is realised. The opening is sub-

sequently done with an excessive transitory motion as soon as the sliding of the rod begins and the friction, from static, becomes dynamic, i.e. much less strong. This phenomenon is also known as stick-slip and the effect thereof is such as to reduce the operator's sensitivity in control of the start of movement or for fine movements.

[0013] The aim of the present invention is to provide a support and descent control valve which obviates the drawbacks of the valves of known type.

[0014] The main advantage of the valve is that it considerably limits the friction between the gasket seal associated to the second seal portion and the internal wall of the fluid passage conduit.

[0015] A further advantage of the valve is that the obturator, in the absence of a piloting pressure, can autonomously move into the closed position by effect of the pressure exerted by the load.

[0016] Further characteristics and advantages of the present invention will better emerge from the following non-limiting description of a preferred but not exclusive embodiment of the invention, as illustrated in the accompanying figures of the drawings, in which:

figure 1 is a schematic view of a valve of the present invention in a closed configuration of load support;
figure 2 is the valve of figure 1, in which the cursor 17 is in an open position;
figure 3 is the valve of figure 2 in which the obturator 10 is in the open position;
figures 4 and 5 show two relative enlarged views of two alternative constructional solutions for the obturator 10.

[0017] The valve of the present invention, denoted in its entirety by 1, can be used in a circuit comprising an actuator 110 predisposed to actuate displacement of a load along at least a vertical motion component. In the illustrated example the actuator is constituted by a hydraulic cylinder, but a linear actuator of a different type could be used, or a rotary actuator. A pressurised fluid is sent by a pump 111 through a distributor valve 112 to a lift chamber 110s or a descent chamber 110d of the actuator 110 such as to cause a corresponding lifting or descent of the load. In the cylinder illustrated in figure 1, the raising of the load is determined by supplying pressurised fluid to the base of the cylinder while the descent of the load can be commanded by supplying the fluid to the chamber of the piston stem, as long as the valve 1 has been opened; in an alternative solution, the opposite could apply.

[0018] The valve 1 comprises a conduit 2 for fluid passage in a longitudinal direction x, a first opening 3, predisposed to be connected to the lift chamber of the actuator 110, and a second opening 4, predisposed to be connected to the distributor valve 112. A seal seating 5 is located at an intermediate point of the conduit for fluid passage, which seal seating 5 is destined to enter into contact with a first seal portion 11 of an obturator 10.

From a constructional point of view, the conduit 2 can be defined by two tubular inserts 201, 202 position internally of a body 203, as illustrated in the figures, but equivalently it could be afforded directly in the body 203. In the example represented in the figures, the seal seating 5 is defined by an end edge of a tubular insert 202.

[0019] The obturator 10, inserted coaxially in the conduit 2, comprises the first seal portion 11 and a second seal portion 12. The seal portions are arranged at ends of a stem 13, the diameter of which is lower than the internal diameter of the conduit 2. In this way, an annular chamber is defined between the stem 13 and the internal surface of the conduit 2, in communication with the second opening 3, in which the operator fluid can run.

[0020] As already mentioned, the first seal portion 11 is predisposed to enter into contact with the seal seating 5 such as to occlude the seating itself and prevent the fluid flow between the first opening 2 and the second opening 3. In particular, the obturator 10 is mobile along the longitudinal axis x between a closed position, in which the first seal portion 11 is in contact with the seal seating 5 and occludes the seal seating itself, such that the first opening 2 and the second opening 3 are not in mutual communication, and an open position, in which the first seal portion 11 is not in contact with the seal seating 5 and the first opening 2 and the second opening 3 are in mutual communication. The first seal portion 11 preferably exhibits a tapered conformation, for example truncated conical, with the apex portion facing towards the seal seating 5.

[0021] The second seal portion 12 is arranged sealedly in contact with the internal wall of the conduit 2. In particular, a gasket 14 is interposed between the second seal portion 12 and the internal wall of the conduit 2, such as to prevent leakage of fluid from one side to the other of the gasket 14. The gasket 14 is housed internally of an annular seating 14a which, preferably, is afforded on the external surface of the external surface of the second seal portion 12. Alternatively, the annular seating 14a could be afforded on the internal wall of the conduit 2.

[0022] The obturator 10 is further provided with a passing axial conduit 15 which extends along the whole longitudinal development of the obturator 10 and exhibits a first opening 19 and a second opening 20 arranged at the end portions 10a, 10b of the obturator 10. The axial conduit 15 is placed in communication with the annular seating 14a by means of at least a transversal hole 16. The transversal hole 16 extends preferably between the axial conduit 15 and a circular space 16a, interposed between the external surface of the second seal portion 12 and the internal wall of the conduit 2, which opens into the annular seating 14a. Alternatively, the transversal hole 16 might extend directly between the annular seating 14a and the axial conduit 15.

[0023] A cursor 17 is also internally operative in the axial conduit 15, which cursor 17 is predisposed to interact with a seal seating 18. In particular, the cursor 17 is mobile between a closed position, in which it is in contact

with the seal seating 18 and the seal seating 18 itself is occluded to passage of fluid, and an open position, in which the cursor 17 is removed from the seal seating 18 which is open to fluid passage. The seal seating 18 is located in an intermediate position between the transversal hole 16 and a first outlet 19 of the through conduit 15, located in a first end portion 10a of the obturator 10. A second outlet 20 of the through conduit 15 is arranged at an opposite end of the obturator 10. The first outlet 19 of the axial conduit 15 is placed in communication with a discharge opening 6 of the valve. The discharge opening 6 is in communication with a low-pressure or atmospheric environment, for example it can be connected to the circuit reservoir tank.

[0024] The seal seating 18 of the axial conduit 15 is defined by an internal radial abutment of an end element 18a, connected to the obturator 10, which defines a first end portion 10a of the obturator. An elastic means 18b, for example a spring, is interposed between the obturator 11 and the cursor 17 to push the cursor 17 into contact with the seal seating 18. The first outlet 19 of the axial conduit 15 is afforded in the end element 18a and is orientated along a perpendicular direction with respect to the longitudinal development of the conduit 15 itself.

[0025] The cursor 17 and the obturator 10 are mobile from the closed positions thereof towards the open positions thereof by effect of the thrust produced by a piloting pressure. In particular the obturator 10 and the cursor 17 are structured such that, when the piloting pressure is applied to the piston 21 to cause displacement of the obturator 10 from the closed position towards the open position, the cursor 17 is displaced from the closed position to the open position and sets the axial conduit 15 in communication with the discharge opening 6 of the valve. As can be seen in figure 2, this means that the annular seating 14a too, through the transversal hole 16, is set in communication with the discharge opening 6 of the valve. In this way, in the very first instants of application of piloting pressure to cause displacement of the obturator 10 towards the open position, the annular seating 14a is placed in communication with a low-pressure environment, such that the gasket 14 is unloaded from the pressure induced by the load, thus considerably reducing the friction on the internal wall of the conduit 2. From the moment in which the annular seating 14a is set in communication with the discharge opening 6, the sliding of the obturator 10 towards the open position (figure 3) is thus considerably facilitated by the notable reduction of friction between the gasket 14 and the internal wall of the conduit 2.

[0026] The piloting pressure P_{pil} is applied to the cursor 17 and the obturator 10 by means of a piston 21. The piston 21 is cup-shaped and houses internally thereof the first end portion 10a of the obturator 10, the end element 18a and the first outlet 19 of the axial conduit 15. The piston 21 is sealedly slidable in at least a tract of a piloting conduit 22 through which the piston 21 receives the piloting pressure P_{pil} . The cursor 17 is provided with

an axial appendage 17a which projects at least partially externally of the axial conduit 15 and the obturator 10. In particular, the axial appendage 17a is slidably housed internally of a through-hole of the end element 18a and projects axially from the end element 18a itself. The axial appendage 17a is destined to enter into contact with the bottom wall of the piston 21 when the piston 21 receives the piloting pressure P_{pil} . In particular, the piston 21 is mobile, by effect of the thrust produced by the pressure P_{pil} , between a non-operative position (figure 1), in which it is not in contact with the axial appendage 17a and the obturator 10, and an operative position, in which it is in contact with the axial appendage 17a and the obturator 10 and pushes the obturator 10 from the closed position thereof towards the open position thereof. As illustrated in figure 2, before entering into contact with the obturator 10 the piston 21 enters into contact with the axial appendage 17a of the cursor 17, thus pushing the cursor 17 from the closed position towards the open position. This places the annular seating 14a in communication with the discharge opening 6 and the consequent lowering of the pressure on the gasket 14. Preferably an elastic means 210 is interposed between the piston 21 and the obturator 10 to push the two elements apart from one another. In the non-operative position, the piston 21 is maintained in contact with an abutment of the piloting conduit 22 by the elastic means 210.

[0027] The obturator 10 is further provided with a passage 23 predisposed to place the axial conduit 15 in communication with the conduit 2, in particular with the space surrounding the obturator 10 which is in communication with the first opening 3. In a first embodiment, visible in figure 4, the passage 23 is constituted by a circumferential space, interposed between the external surface of the second seal portion 12 and the internal wall of the conduit 2, and extends between an end portion of the second seal portion 12 facing towards the stem 13 and the transversal hole 16. In a second embodiment, shown in figure 5, the passage 23 is constituted by a hole which sets the axial conduit 15 in communication and the external surface of the stem 13 of the obturator 10.

[0028] The passage 23 enables the first opening 23 to be placed in communication with the second outlet 20 of the axial conduit 15. As can be seen in figure 1, the second outlet 20 is in communication with a thrust chamber 24 in which a spring 25 can be housed, which spring 25 is predisposed to push the obturator 10 towards the closed position. The thrust chamber 24 is associated to the body 203 of the valve from the side of the end surface 10b of the obturator 10. The end surface 10b faces the thrust chamber 24 and receives the pressure present in the thrust chamber. A gasket 10c, positioned coaxially to the obturator 10 in proximity of the end surface 10b, is interposed between the thrust chamber 24 and the conduit 2. Through the passage 23 which, as mentioned, sets the first opening 3 in communication with the thrust chamber 24, the pressure present in the lift chamber 24 of the actuator 110 spreads also into the thrust chamber

24. In a stationary condition of the load, the pressure pushes the obturator 10 towards the closed position also without the aid of the spring 25. In this way, when the load is stationary, the obturator 10 is pushed and maintained in the closed position thereof by the thrust generated by the load, via the operator fluid. In stationary conditions, the presence of the spring 25 is thus substantially superfluous. The presence of the spring 25 is useful only during the descent of the load in order to push the obturator 10 towards the closed position, such as to control the descent of the load. The thrust exerted by the spring 25 can be regulated by means of a regulating screw 25a.

[0029] The functioning of the valve is as follows, starting from the closed position of the valve, shown in figure 1, in which the obturator 10 and the cursor 17 are in the closed position. In this configuration, the fluid present in the lift chamber 100s of the actuator 100 cannot discharge, as in the absence of a piloting pressure Ppil applied to the obturator 10, the obturator 10 is in the closed position by effect of the pressure present in the lift chamber 100s of the actuator, a pressure which is transmitted to the thrust surface 10b of the obturator 10 through the passage 23, the axial conduit 15 and the second outlet 10 of the axial conduit 15.

[0030] In order to command the descent of the load it is necessary to send the piloting pressure Ppil to the valve. The piloting pressure is sent, through the piloting conduit 22, to the piston 21 which displaces from its non-operative position towards its operative position in contact with the first end portion 10a of the obturator 10. Before entering into contact with the obturator 10, the piston 21 enters into contact with the axial appendage 17a of the cursor 17, displacing the cursor 17 towards the open position thereof, as illustrated in figure 2. In the configuration of figure 2, in which the cursor 17 is in the open position, the annular seating 14a is in communication with the discharge opening 6 of the valve and the gasket 14 housed in the annular seating 14a is consequently freed from the pressure present in the lift chamber 110s of the actuator 110.

[0031] Thereafter the piston 21, which proceeds its run towards the operative position thereof following the thrust exerted by the piloting pressure Ppil, enters into contact with the obturator 10, thrusting it towards the open position thereof, as shown in figure 3. In this configuration of the valve, the fluid present in the lift chamber 100s of the actuator 110 can discharge through the opening 2, enabling the load to descend.

[0032] The descent of the load, in a known way, can occur by force of gravity alone or with the aid of the thrust exerted by the operator fluid which can be sent to the descent chamber 100d of the actuator 110, switching the position of the distributor 112.

Claims

1. A hydraulic valve for supporting and controlling a de-

scent, comprising:

a conduit (2) for passage of a fluid, provided with a first opening (3) and a second opening (4) and a seal seating (5), arranged in an intermediate position between the first opening (3) and the second opening (4); an obturator (10), mobile between a closed position, in which a first seal portion (11) of the obturator is in contact with the seal seating (5) and the first opening (3) and the second opening (4) are not in communication with one another, and at least an open position, in which the first seal portion (11) is distant from the seal seating (5) and the first opening (3) and the second opening (4) are in communication with one another; a second seal portion (12), sealedly slidable along an internal wall of the conduit (2); a gasket (14), interposed between an external surface of the second seal portion (12), which gasket (14) is housed internally of an annular seating (14a); **characterised in that** it comprises discharge means (15, 16, 17, 18) predisposed to enable a fluid communication between the annular seating (14a) and a discharge opening (6) of the valve.

2. The valve of claim 1, wherein the discharge means (15, 16, 17, 18) comprise a seal seating (18), interposed between the annular seating (14a) and the discharge opening (6), and a cursor (17), mobile between a closed position, in which the cursor (17) is in contact with the seal seating (18) and prevents fluid communication between the annular seating (14a) and the discharge opening (6), and an open position, in which it is removed from the seal seating (18), and the annular seating (14a) and the discharge opening (6) are in communication with each other.
3. The valve of claim 2, wherein the cursor (17) and the obturator (10) are mobile from the closed positions thereof towards the open positions thereof by effect of a thrust produced by a piloting pressure (Ppil), the obturator (10) and the cursor (17) being structured such that when the piloting pressure (Ppil) is sent to cause displacement of the obturator (10) from the closed position thereof towards the open position thereof, the cursor (17) displaces from the closed position thereof to the open position thereof, placing the annular seating (14a) in communication with the discharge opening (6) of the valve.
4. The valve of claim 3, wherein the cursor (17) is provided with an axial appendage (17a) which projects axially from a first end portion (10a) of the obturator (10).
5. The valve of claim 4, comprising a piston (21) which is mobile, by effect of the thrust produced by the pi-

loting pressure (Ppil), between a non-operative position, in which it is not in contact with the axial appendage (17a) and the obturator (10), and an operative position, in which it is in contact with the obturator (10) and pushes the obturator from the closed position thereof towards the open position thereof, the piston (21) being predisposed to enter into contact with the axial appendage (17a) of the cursor (17), pushing the cursor (17) from the closed position thereof towards the open position thereof, before entering into contact with the obturator (10).

the end surface (10b) sealedly faces.

6. The valve of claim 5, wherein the piston (21) is cup-shaped and houses internally thereof the end portion of the obturator (10) from which the axial appendage (17a) of the cursor (17) axially projects.
7. The valve of one of the preceding claims, wherein the discharge means (15, 16, 17, 18) comprise an axial through-conduit (15) which extends along a whole longitudinal development of the obturator (10) and exhibits a first outlet (19) arranged at a first end portion of the obturator (10), the axial conduit (15) being placed in communication with the annular seating (14a) by means of at least a transversal hole (16), the seal seating (18) being interposed between the transversal hole (16) and the first outlet (19) along the axial conduit (15).
8. The valve of one of the preceding claims, comprising means (15, 20, 23) for placing the first opening (3) of the valve in communication with an end surface (10b) of the obturator arranged on an opposite side with respect to the first end portion (10a).
9. The valve of claims 7 and 8, wherein the means (15, 20, 23) for placing the first opening (3) of the valve in communication with an end surface (10b) of the obturator comprise a passage (23) predisposed to place the axial conduit (15) in communication with the first opening (3).
10. The valve of claim 9, wherein the passage (23) is constituted by a circumferential space, interposed between the external surface of the second seal portion (12) and the internal wall of the conduit (2), and extends from an end portion of the second seal portion (12) facing towards the stem (13) and the transversal hole (16).
11. The valve of claim 9, wherein the passage (23) is constituted by a hole which places the axial conduit (15) in communication with the external surface of the stem (13) of the obturator (10).
12. The valve of claims 10 or 11, wherein the axial conduit (15) is provided with a second outlet (20) which is in communication with a thrust chamber (24) which

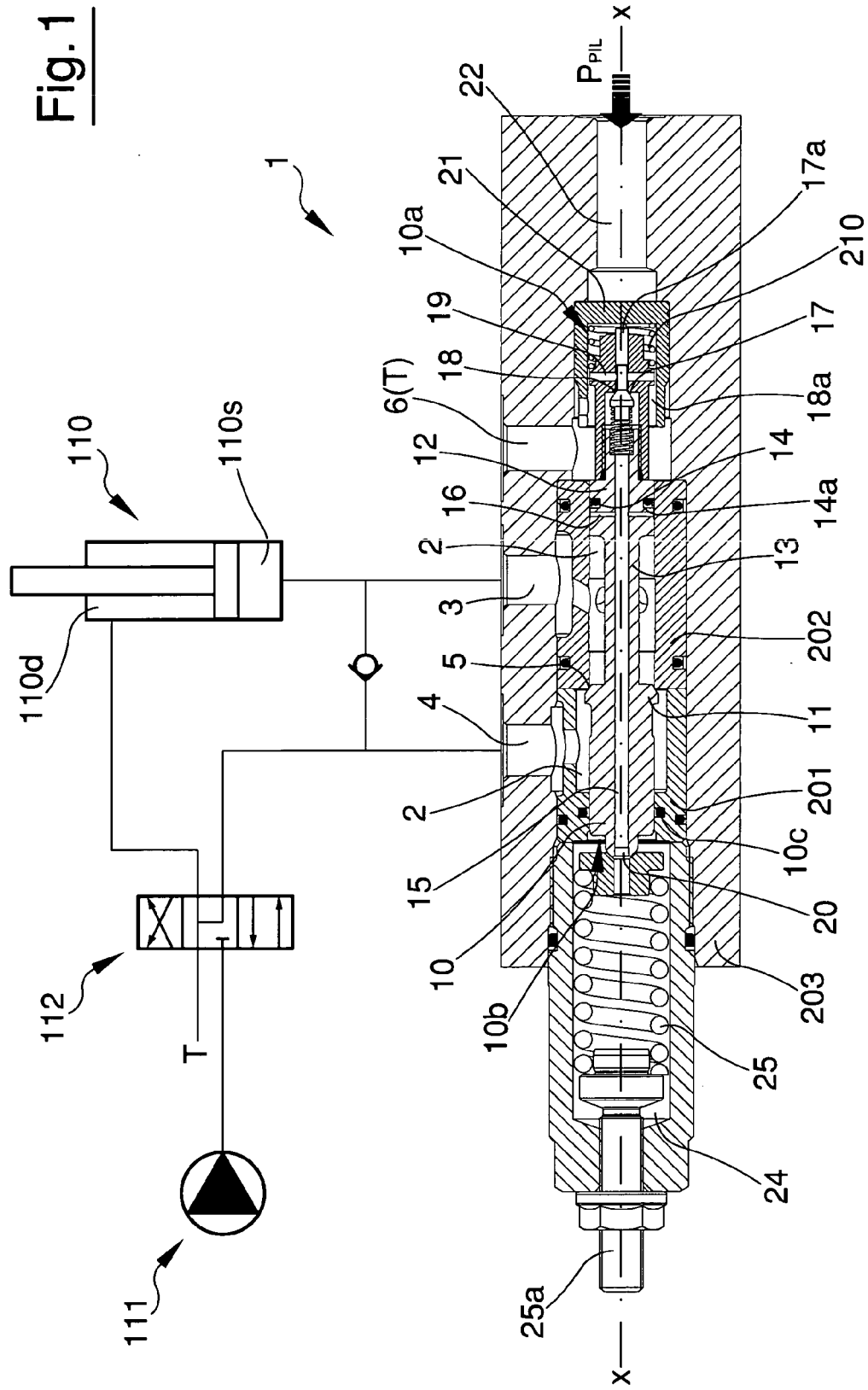


Fig. 2

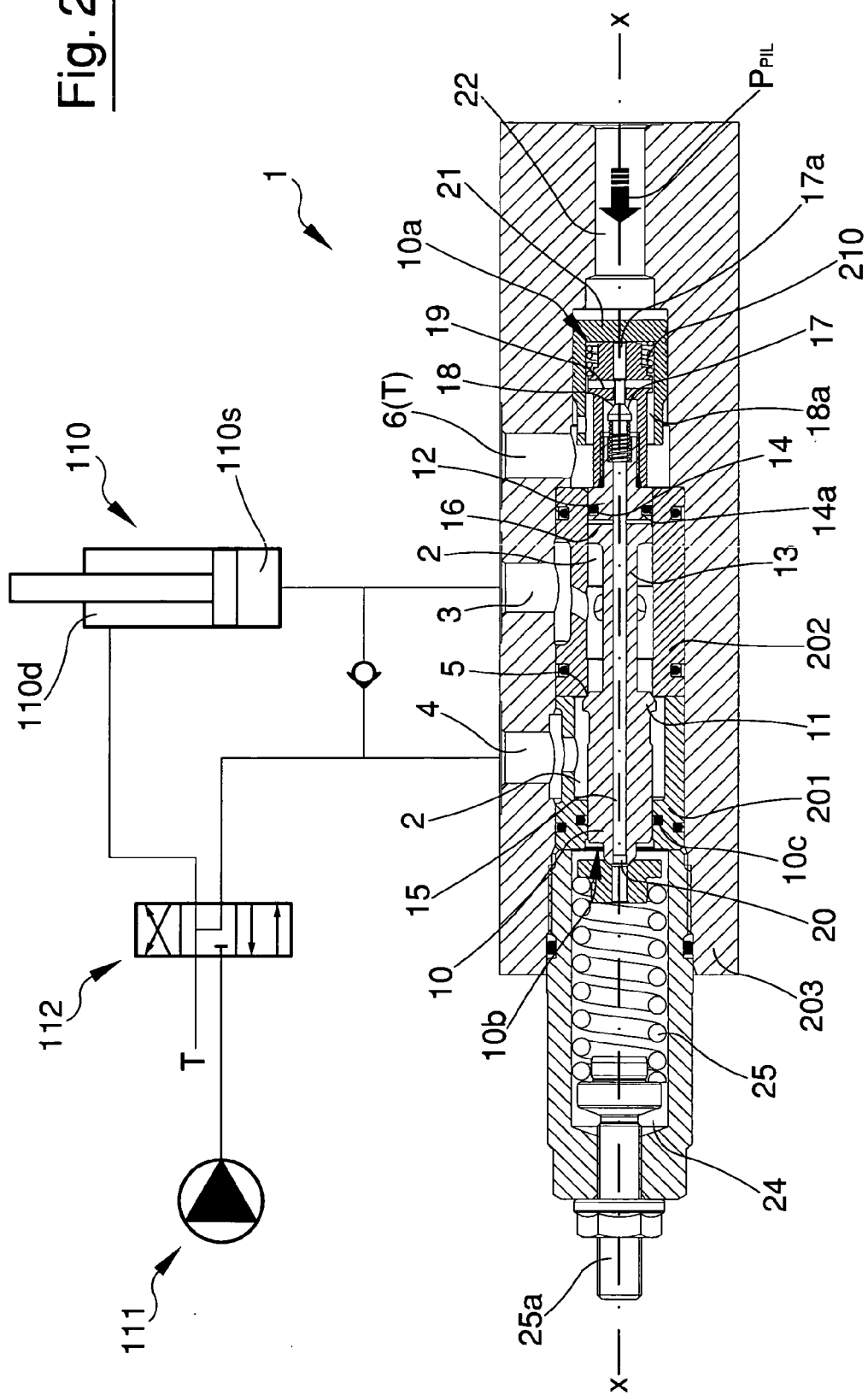


Fig. 3

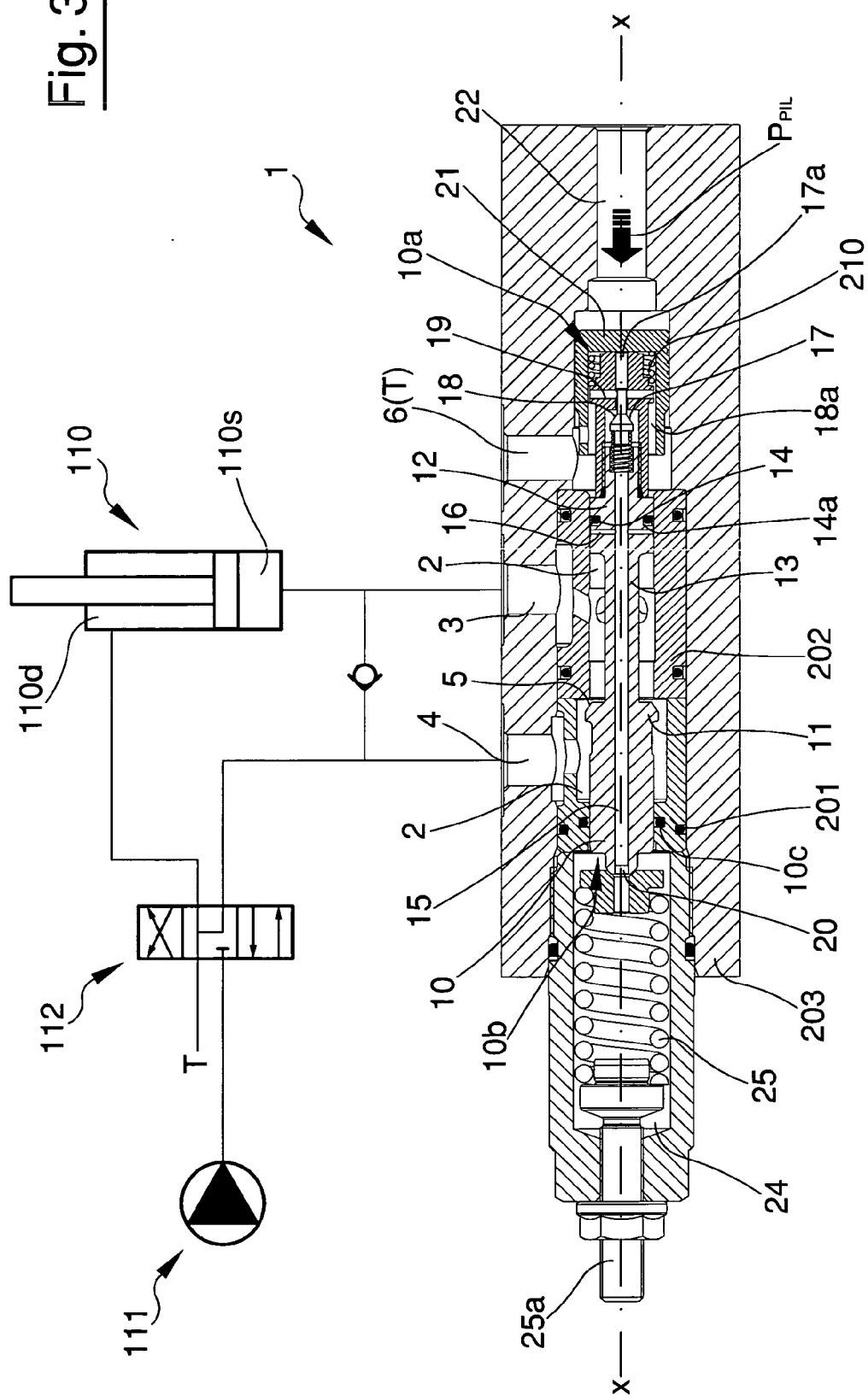


Fig. 4

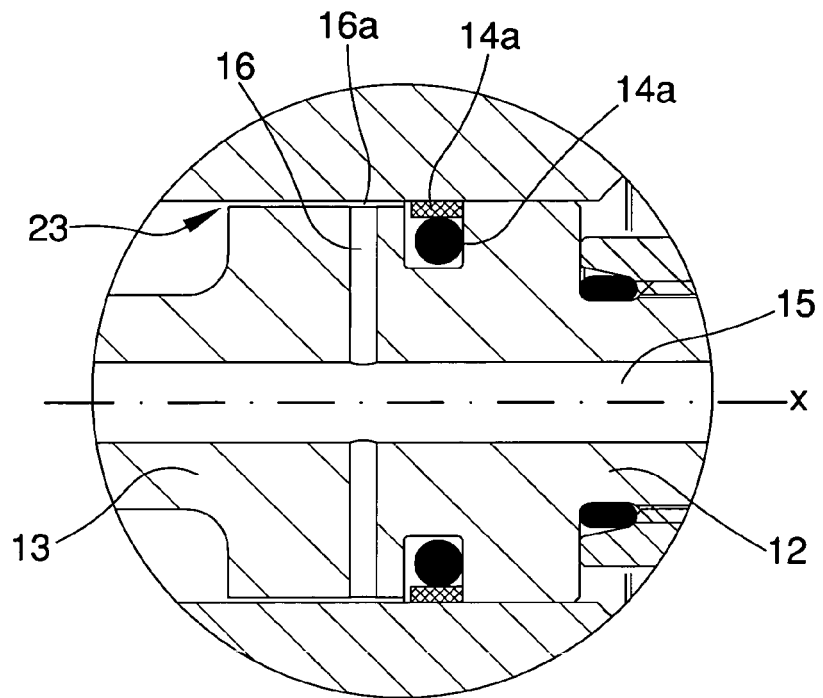
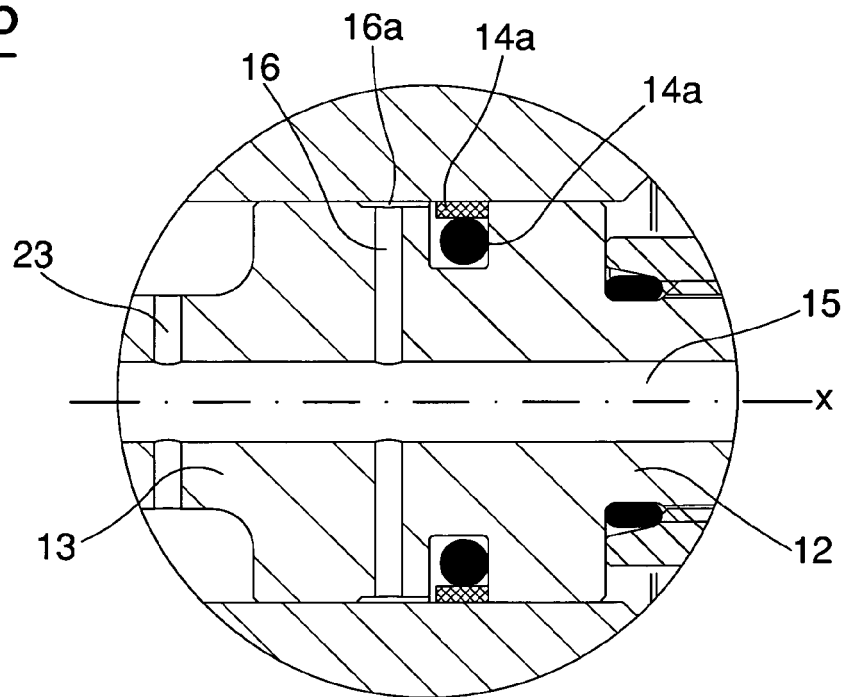


Fig. 5





EUROPEAN SEARCH REPORT

Application Number
EP 10 42 5006

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC) F15B F16K
3	Place of search Munich	Date of completion of the search 11 June 2010	Examiner Toffolo, 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			

EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 10 42 5006

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
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