



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:  
**17.01.2018 Bulletin 2018/03**

(51) Int Cl.:  
**F04B 17/06** <sup>(2006.01)</sup> **F04B 49/035** <sup>(2006.01)</sup>  
**F04B 53/10** <sup>(2006.01)</sup> **F04B 53/16** <sup>(2006.01)</sup>

(21) Application number: **17180434.7**

(22) Date of filing: **10.07.2017**

(84) Designated Contracting States:  
**AL 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 RS SE SI SK SM TR**  
 Designated Extension States:  
**BA ME**  
 Designated Validation States:  
**MA MD**

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(30) Priority: **11.07.2016 IT 201600072149**

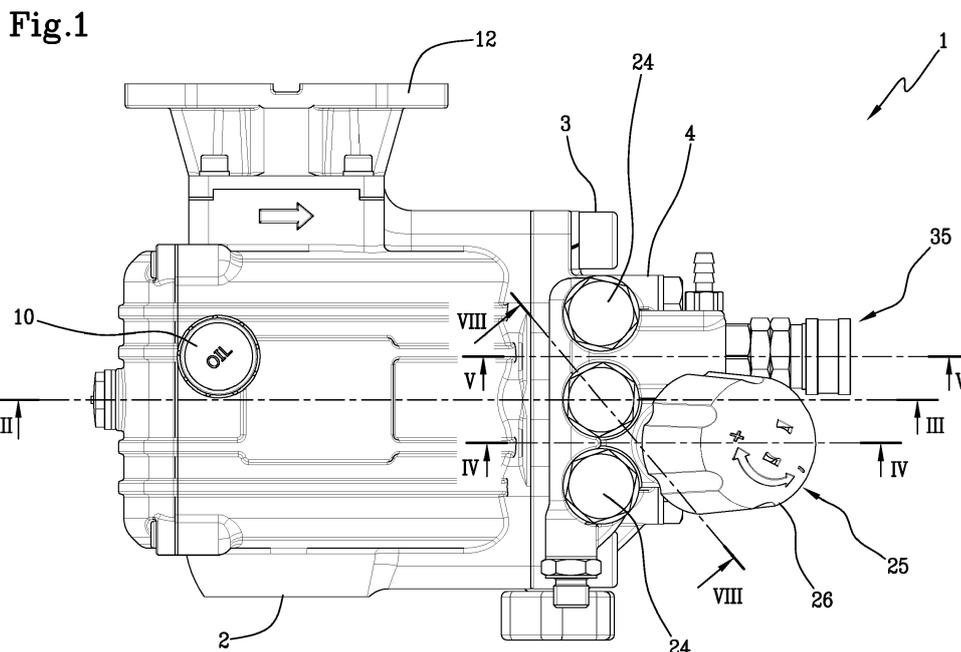
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(54) **A PUMP FOR DISPENSING A LIQUID**

(57) A pump comprises:  
 - a plurality of pistons (5) each of which is slidable inside a cylinder so as to vary volume of a corresponding chamber (6),  
 - a plurality of suction valves (16), each of which is associated with a chamber (6) and is operable to allow a liquid to enter the chamber (6), the suction valves (16) being arranged in a first sequence,  
 - a plurality of delivery valves (17), each of which is as-

sociated with a chamber (6) and is operable to allow said liquid to exit from the chamber (6), the delivery valves (17) being arranged in a second sequence,  
 - an adjusting valve (25) for adjusting pressure of the liquid exiting from the pump (1).

The adjusting valve (25) is interposed between two consecutive valves of a sequence chosen from said first sequence and said second sequence.



## Description

**[0001]** The invention relates to a pump for dispensing a liquid in a desired environment, particularly for dispensing water, to which one or more additional substances can be added. The pump according to the invention is particularly suitable for processing a cleaning liquid, such as water, possibly with the addition of detergent substances, by sending such liquid onto a surface to be cleaned. The pump according to the invention may be for example used in a high pressure water jet machine.

**[0002]** Piston pumps are known comprising a plurality of pistons that are movable inside respective cylinders in order to increase or decrease the volume of corresponding chambers, so as to cause suction of water into each chamber, or exit of the water from the chamber. Each chamber is provided with a suction valve, through which the water can enter the chamber, and with a delivery valve, through which the water can exit from the chamber. The pistons, each of which can be made as a single piece, or be formed by various components, are usually partially housed inside a casing or case of the pump, which also contains a driving device arranged to move the pistons forwards or backwards inside the respective cylinders. The delivery valves and the suction valves are instead housed inside a head of the pump, which is fixed to the casing for example through screws.

**[0003]** In particular, the suction valves may be positioned along a row and extend along respective axes that define a plane. The delivery valves can also be positioned along a row, and their axes usually define a plane that is perpendicular to the plane defined by the axes of the suction valves. Known pumps may also comprise a pressure adjusting valve on which an operator may act manually for adjusting the flow rate, and consequently the pressure, of the water exiting from the pump. The pressure adjusting valve is normally positioned in a lateral region of the head, next to the row of delivery valves.

**[0004]** The pressure adjusting valve normally extends along an axis parallel to the axes of the delivery valves and therefore perpendicular to the plane defined by the axes of the suction valves.

**[0005]** A drawback of the pumps described above is that they are rather bulky. The pressure adjusting valve is supported by a lateral appendage that projects next to the row of delivery valves. This appendage significantly increases the overall dimensions of the pump.

**[0006]** Furthermore, providing a lateral appendage that supports the pressure adjusting valve implies an increase in the amount of material, particularly metal material, that needs to be used for manufacturing the pump. This determines an increase in the pump cost.

**[0007]** Finally, due to its positioning, the pressure adjusting valve of known pumps cannot be easily accessible by the operator, when the latter wishes to change pressure of the liquid at the outlet from the pump.

**[0008]** An object of the invention is to improve the pumps of known type, particularly the pumps intended

to process a liquid, for example water, to be dispensed on a surface or in an environment.

**[0009]** A further object is to reduce the overall dimensions of known pumps, particularly of pumps equipped with an adjusting valve that allows the flow rate, and consequently the pressure, of the liquid exiting from the pump to be adjusted.

**[0010]** Another object is to reduce costs of known pumps, particularly pumps equipped with an adjusting valve of the type mentioned above.

**[0011]** A further object is to provide a pump equipped with an adjusting valve that allows the flow rate, and consequently the pressure, of a liquid exiting from the pump to be adjusted, in which the operator can easily access the adjusting valve.

**[0012]** According to the invention, there is provided a pump comprising:

- a plurality of pistons each of which is slidable inside a cylinder so as to vary volume of a corresponding chamber,
- a plurality of suction valves, each of which is associated with a chamber and is operable to allow a liquid to enter the chamber, the suction valves being arranged in a first sequence,
- a plurality of delivery valves, each of which is associated with a chamber and is operable to allow said liquid to exit from the chamber, the delivery valves being arranged in a second sequence,
- an adjusting valve for adjusting pressure of the liquid exiting from the pump,

characterised in that the adjusting valve is interposed between two consecutive valves of a sequence chosen from said first sequence and said second sequence.

**[0013]** Owing to the invention, it is possible to reduce the overall dimensions of the pump. By inserting the regulating valve in an intermediate position in the sequence of the suction valves or in the sequence of the delivery valves, it is no longer necessary to provide a lateral appendage specifically dedicated to support the adjusting valve. Therefore, the overall dimensions of the pump are reduced.

**[0014]** For the same reason, it is also possible to reduce the cost of the pump, since the material is saved which, in known pumps, was necessary for manufacturing the lateral appendage.

**[0015]** In an embodiment, the adjusting valve is interposed between two consecutive delivery valves of said second sequence.

**[0016]** The delivery valves extend along respective axes that may be mutually parallel.

**[0017]** In an embodiment, the adjusting valve extends along an axis which is oblique with respect to the axes of the delivery valves.

**[0018]** This allows an operator to access the adjusting valve more easily. By orienting the adjusting valve so that its axis is oblique with respect to the axes of the delivery

valves, it is possible to position the adjusting valve so that it is facing the operator, thereby increasing ergonomics and ease of grip of the adjusting valve.

**[0019]** In an embodiment, the adjusting valve is configured to vary the flow rate of the liquid exiting from the pump by selectively putting a delivery of the pump in fluid communication with a suction of the pump, so that a desired quantity of liquid may be recirculated from the delivery to the suction. Thus, the quantity of liquid that flows from the suction towards the delivery is reduced, i.e. the flow rate of the liquid at the outlet of the pump is reduced.

**[0020]** This indirectly allows pressure of the liquid exiting from the pump to be varied.

**[0021]** In an embodiment, the pump comprises an outlet conduit arranged downstream of the delivery valves.

**[0022]** In an embodiment, the outlet conduit is provided with a shutter device, the shutter device being openable to allow the liquid coming from the delivery valves to exit from the pump through a delivery tube, the shutter device being closable when the delivery tube is closed.

**[0023]** In an embodiment, the pump further comprises a connecting hole for connecting a portion of the outlet conduit arranged downstream of the shutter device with the adjusting valve, so as to generate an additional force.

**[0024]** The additional force maintains the adjusting valve open.

**[0025]** The invention can be better understood and carried out with reference to the accompanying drawings, which illustrate a non-limiting and exemplary embodiment thereof, in which:

Figure 1 is a view from above of a piston pump;

Figure 2 is a lateral view of the pump of Figure 1, taken from the right side of Figure 1;

Figure 3 is a section taken along plane III-III of Figure 1;

Figure 4 is an interrupted section, taken along plane IV-IV of Figure 1;

Figure 5 is an interrupted section, taken along plane V-V of Figure 1;

Figure 6 is an interrupted section, taken along plane VI-VI of Figure 2;

Figure 7 is an interrupted section, taken along plane VII-VII of Figure 4;

Figure 8 is an interrupted section, taken along plane VIII-VIII of Figure 1.

Figures 1 and 2 show a pump 1 for processing a liquid, particularly water, for example intended to be sent to a surface for being used as a washing liquid. Pump 1 is a piston pump of the volumetric type.

**[0026]** The pump 1 comprises a casing 2 or case inside which a driving device is housed for driving the pistons of the pump 1. A head 4 is fixed to the casing 2 through fastening elements comprising for example a plurality of screws 3. The casing 2 may be made for example of aluminium, while the head 4 may be made of brass.

**[0027]** The pump 1 comprises a plurality of pistons 5,

one of which is visible in Figure 3. Each piston 5 is slidable inside a corresponding cylinder so as to vary the volume of a chamber 6, provided in the head 4 at one end of the piston 5.

**[0028]** In the example depicted, three pistons 5 are provided. However, it is also possible to use a number of pistons 5 different from three.

**[0029]** The pistons 5 are aligned with each other, i.e. arranged so that their axes lie on a common plane.

**[0030]** In an alternative embodiment, the pistons may be arranged so that their axes do not lie on a common plane, but are staggered between each other.

**[0031]** As shown in Figure 3, the driving device arranged for driving the pistons 5 comprises an eccentric shaft 7, rotatably housed inside the casing 2. Each piston 5 is driven by the eccentric shaft 7 by means of a corresponding connecting rod 8 fixed to the eccentric shaft 7.

**[0032]** The eccentric shaft 7 is arranged inside a cavity 9 made in the casing 2. In normal operating conditions, within the cavity 9 there is a quantity of lubricating oil, which can be introduced into the casing 2 through an inlet hole that is closable by means of a plug 10.

**[0033]** The casing 2 is provided with a flange 12 which allows the pump 1 to be fixed to a motor, not depicted, the motor being suitable for rotating the eccentric shaft 7. The motor is provided with a motor shaft that can be coupled to the eccentric shaft 7 through a tongue or another coupling system that allows the eccentric shaft 7 to rotate together with the motor.

**[0034]** When the eccentric shaft 7 rotates, each piston 5 is moved forwards and backwards while sliding along a movement direction A. In this way, the piston 5 causes the volume of the chamber 6 to alternately increase or decrease.

**[0035]** Each piston 5 has a first end 11 that delimits the chamber 6 and a second end, opposite the first end 11, hinged to the connecting rod 8.

**[0036]** Each piston 5 extends along a longitudinal axis Z.

**[0037]** As shown in Figure 3, inside the casing 2, near the head 4, a gasket 13 is housed. The gasket 13 has an annular conformation and is provided with a hole through which the piston 5 passes. The gasket 13 has an inner lip in contact with which the piston 5 slides. In this way, the gasket 13 prevents any losses of oil from the cavity 9 towards the head 4. The gasket 13 therefore behaves like an oil seal.

**[0038]** Sealing means are housed in the head 4, the sealing means being suitable for preventing the liquid contained in the chamber 6 from exiting. The sealing means may comprise a first sealing element 14 arranged in a closer position to the chamber 6, and a second sealing element 15, arranged in a more distant position from the chamber 6. The first sealing element 14 can also be considered as a high pressure gasket, while the second sealing element 15 can be considered as a low pressure gasket. This is due to the fact that the first sealing element 14 works with a liquid having a pressure higher than pres-

sure of the liquid with which the second sealing element 15 works. Indeed, the first sealing element 14 interacts with the liquid coming directly from the chamber 6, which therefore has a relatively high pressure. The second sealing element 15, on the other hand, interacts with a liquid whose pressure is lower.

**[0039]** Each chamber 6 is associated with a suction valve 16 and a delivery valve 17. When the suction valve 16 is open, the delivery valve 17 is closed and the liquid to be pumped can enter into the chamber 6. This happens during a suction step that occurs while the piston 5 withdraws so as to gradually increase the volume of the chamber 6. When, instead, the delivery valve 17 is open, the suction valve 16 is closed and the liquid is pumped out of the chamber 6. This happens during a delivery step that occurs while the piston 5 advances so as to gradually reduce the volume of the chamber 6. The liquid to be pumped reaches the suction valve 16 through an inlet manifold 18 shaped like a hole, particularly rectilinear, made inside the head 4. The inlet manifold 18 allows the liquid for pumping to be sent to each suction valve 16 associated with a piston 5. The inlet manifold 18 can be connected to a source of liquid, not depicted, through a respective inlet.

**[0040]** In an embodiment not illustrated, the inlet manifold 18 may be provided in a position different from that described above, for example in the casing 2. The pump 1 further comprises an outlet manifold 19 for collecting the liquid coming out of the chambers 6 and for sending such liquid towards a point of use, through a corresponding outlet.

**[0041]** The outlet manifold 19 is in fluid communication with the supply valves 17 associated with all the pistons 5, so as to collect the liquid coming out from all the chambers 6.

**[0042]** As shown in Figure 3, both the suction valve 16 and the delivery valve 17 may comprise a containment body 20, for example shaped like a cup, inside which a spring 21 and a shutter 22 are housed. The spring 21 acts on the shutter 22 to keep the latter in a pre-fixed position, for example in a closed position.

**[0043]** Each suction valve 16 and each delivery valve 17 is housed inside a valve seat provided in the head 4. Each suction valve 16 can be kept in the desired position inside the respective valve seat through a plug 23. Likewise, each delivery valve 17 can be kept in the desired position inside the respective valve seat by means of a further plug 24.

**[0044]** The suction valves 16 may be the same as the delivery valves 17, i.e. made with the same components. The plugs 23 can also be the same as the further plugs 24.

**[0045]** The inside of the containment body 20 of each suction valve 16 is in fluid communication with the inlet manifold 18. The pressure of the fluid contained in the chamber 6 also acts on such containment body 20. When, due to the backward movement of the piston 5, the pressure in the chamber 6 becomes lower than the pressure in the inlet manifold 18, the shutter 22 of the

corresponding suction valve 16 opens, thereby putting the inlet manifold 18 in fluid communication with the chamber 6.

**[0046]** Also the inside of the containment body 20 of each delivery valve 17 is in fluid communication with the corresponding chamber 6. The pressure of the fluid contained in the outlet manifold 19 also acts on such containment body 20. When, due to the forwards movement of the piston 5, the pressure of the liquid contained in the chamber 6 exceeds the pressure of the liquid contained in the outlet manifold 19, the shutter 22 of the corresponding delivery valve 17 opens, thereby putting the chamber 6 in fluid communication with the corresponding outlet manifold 19.

**[0047]** The suction valves 16 are arranged in a first sequence. In the example depicted, the first sequence along which the suction valves 16 are arranged is conformed as a rectilinear row. The suction valves 16 extend along respective axes X, shown in Figure 3, which may be mutually parallel and which, in the example depicted, lie on a common plane. In the example of Figure 3, such plane is horizontal.

**[0048]** The delivery valves 17 are arranged along a second sequence which, in the example depicted, is defined by a rectilinear row. The delivery valves 17 extend along respective axes Y, shown in Figure 3, which may be mutually parallel and possibly lie on a common plane. In the example shown in Figure 3, such plane is vertical.

**[0049]** More generally, the common plane defined by the axes X of the suction valves 16 may be perpendicular to the common plane defined by the axes Y of the delivery valves 17.

**[0050]** However, other arrangements of the delivery valves 17 and/or of the suction valves 16 are also possible. In particular, the first sequence along which the suction valves 16 are arranged, and/or the second sequence along which the delivery valves 17 are arranged, may be non-rectilinear.

**[0051]** The pump 1 further comprises an adjusting valve 25, for adjusting the flow rate, and therefore the pressure, of the liquid that exits from the pump 1.

**[0052]** As shown in Figures 1 to 3, the adjusting valve 25 is arranged in an intermediate position along the sequence of valves defined by the delivery valves 17. In other words, the adjusting valve 25 is interposed between two consecutive valves of the sequence of valves defined by the delivery valves 17. In the example shown in Figure 1, the adjusting valve 25 is interposed between the first and the second delivery valve 17, from the bottom upwards.

**[0053]** Alternatively, the adjusting valve 25 could be interposed between the second and the third delivery valve 17, from the bottom upwards in the view of Figure 1.

**[0054]** By interposing the adjusting valve 25 between two adjacent delivery valves 17, instead of positioning the adjusting valve 25 at an end of the sequence defined by the delivery valves 17, it is possible to limit the dimensions of the pump 1. In particular, it is neither necessary

to increase the length of the outlet manifold 19 with respect to known pumps, nor is it necessary to provide voluminous appendages at the end of the sequence of delivery valves 17 to support the adjusting valve 25.

**[0055]** The adjusting valve 25 extends along an axis Y1, shown in Figures 3 and 4, which is inclined with respect to the axes X of the suction valves 16 and to the axes Y of the delivery valves 17. In other words, the axis Y1 of the adjusting valve 25 is oblique, i.e. neither perpendicular nor parallel, with respect to the axes X of the suction valves 16 and with respect to the axes Y of the delivery valves 17.

**[0056]** In the case in which the axes X of the suction valves 16 are arranged on a common plane, the axis Y1 of the adjusting valve 25 is oblique with respect to such plane.

**[0057]** In the case in which the axes Y of the delivery valves 17 are arranged on a common plane, the axis Y1 of the adjusting valve 25 is oblique with respect to such plane.

**[0058]** By positioning the axis Y1 of the adjusting valve 25 in an oblique direction with respect to the axes X of the suction valves 16 and/or the axes Y of the delivery valves 17, it is possible to make the adjusting valve 25 easily accessible to the operator. This is particularly true in the case in which, as often happens, the pump 1 is installed in the low part of a high pressure water jet cleaner or another dispensing machine. In this way, owing to the inclination of the axis Y1, the adjusting valve 25 faces towards the operator, who can easily intervene on such valve to perform the desired adjustments.

**[0059]** Furthermore, by inclining the axis Y1 of the adjusting valve 25 with respect to the axes X of the suction valves 16 and/or the axes Y of the delivery valves 17, it is not necessary to increase the distance between two consecutive suction valves 16 and/or between two consecutive delivery valves 17 to house the adjusting valve 25. This allows the dimensions of the pump 1 to be kept limited.

**[0060]** As shown in Figure 4, the adjusting valve 25 comprises a control element, shaped for example like a knob 26, by acting on which the user can increase or reduce the pressure of the liquid dispensed by the pump 1. In particular, by rotating the knob 26 in a first rotation direction, for example clockwise, the pressure of the liquid dispensed by the pump 1 is increased, whereas by rotating the knob 26 in a second rotation direction, opposite the first rotation direction (for example anti-clockwise), the aforesaid pressure is reduced.

**[0061]** The adjusting valve 25 further comprises a containment element 27, shaped for example like a cup, inside which a spring 28 is at least partially housed. The containment element 27 is fixed relative to the knob 26.

**[0062]** In an embodiment that is not shown, the knob 26 may be absent and the containment element 27 can be used also as a control element on which the operator acts to adjust the pressure of the liquid exiting from the pump. The spring 28 is interposed between an end wall

of the containment element 27 and an intermediate body 29, so as to push the intermediate body 29 away from the containment element 27.

**[0063]** The adjusting valve 25 further comprises a shutter 30 arranged in a fixed position with respect to the intermediate body 29. The shutter 30 is at least partially positioned inside a housing 31, which is in fluid communication with the delivery of the pump 1. In more detail, the housing 31 is in fluid communication with at least one delivery valve 17, particularly with at least one delivery valve 17 arranged in an adjacent position to the adjusting valve 25. In the example shown, the housing 31 is in fluid communication with the delivery valve 17 arranged in a central position.

**[0064]** In the example depicted, a connecting conduit 32 is provided, made in the head 4 and shown in Figures 4 and 8, which connects the delivery valve 17 with the housing 31. More precisely, the connecting conduit 32 connects the housing 31 with a delivery chamber in which the delivery valve 17 is housed. Owing to the connecting conduit 32, the liquid contained in the delivery chamber associated with the delivery valve 17 at issue can flow into the housing 31. Therefore the liquid pressurised by the pistons 5 is contained in the housing 31.

**[0065]** The shutter 30 is provided with a shutting surface suitable for engaging with a bushing 33 for opening or alternatively closing a communication conduit 34 leading into the inlet manifold 18. More generally, the communication conduit 34 is in fluid communication with the suction of the pump 1.

**[0066]** The communication conduit 34 can extend along the axis Y1.

**[0067]** In particular, the shutter 30 is movable between a closed position, shown in Figure 4, and a maximum opening position not shown. In the closed position, the shutting surface of the shutter 30 is in contact with the bushing 33 and the communication conduit 34 is isolated from the housing 31. In this position, the delivery and the suction of the pump 1 are not in fluid communication with one another through the adjusting valve 25.

**[0068]** In the maximum opening position, the shutting surface of the shutter 30 is detached from the bushing 33, so that the liquid contained in the housing 31 can flow into the communication conduit 34. The delivery of the pump 1 can thus be placed in fluid communication with the suction of the pump 1 through the adjusting valve 25. Indeed, the liquid contained in the housing 31, which comes from the delivery valve 17 communicating with the housing 31 through the connecting conduit 32, passes into the inlet manifold 18 through the communication conduit 34, thus reaching the suction of the pump 1.

**[0069]** Between the closed position and the maximum opening position of the shutter 30, it is possible to identify a plurality of intermediate positions in which the housing 31 is in fluid communication with the communication conduit 34, which allows a certain amount of liquid to pass from the delivery to the suction of the pump 1, i.e. from the delivery valves 17 towards the suction valves 16.

**[0070]** The position of the shutter 30 is determined as a function of the pressure of the liquid in the housing 31 and of the force exerted by the spring 28 on the shutter 30.

**[0071]** In particular, the spring 28 pushes the shutter 30 towards the bushing 33, i.e. it tends to close the shutter 30. The pressure of the liquid in the housing 31 tends instead to distance the shutter 30 from the bushing 33, so as to move the shutter 30 towards the maximum opening position.

**[0072]** The quantity of liquid that is recirculated from the delivery to the suction of the pump 1 through the adjusting valve 25 is maximum in the maximum opening position of the shutter 30 and decreases gradually in the intermediate positions, until it reaches zero in the closed position.

**[0073]** The flow rate of liquid exiting from the pump 1 is maximum when the shutter 30 is in the closed position, i.e. in the position shown in Figure 4, in which the housing 31 is isolated from the communication conduit 34 and there is no recirculation of liquid from the delivery to the suction of the pump 1. In such a position, as will be explained more clearly below, the pressure of the liquid dispensed by the pump 1 is also maximum.

**[0074]** When, instead, the shutter 30 is in the maximum opening position, the flow rate (and therefore the pressure) of the liquid exiting from the pump 1 is minimum, since the recirculation of liquid from the delivery to the suction of the pump 1 is maximised.

**[0075]** If the user, starting from the closed position of the shutter 30 shown in Figure 4, wishes to reduce the flow rate, and therefore the pressure, of the liquid dispensed by the pump 1, the user rotates the knob 26 in a rotation direction which, in the example depicted, is anti-clockwise. More generally, the user rotates the knob 26 so as to distance the containment element 27 from the intermediate body 29, thus reducing compression of the spring 28. In this way, the force with which the spring 28 pushes the shutter 30 towards the bushing 33 is reduced, while the force exerted on the shutter 30 due to pressure of the liquid in the housing 31 remains constant. When the force exerted on the shutter 30 as a consequence of the pressure of the liquid in the housing 31 exceeds the force exerted on the shutter 30 by the spring 28, the shutter 30 moves away from the bushing 33 and the housing 31 is placed in fluid communication with the connecting conduit 34. A certain amount of liquid processed by the pump 1 is then recirculated from the delivery to the suction, with a consequent reduction of the flow rate of liquid exiting from the pump 1 and of the relative pressure.

**[0076]** By continuing to rotate the knob 26 so as to further reduce compression of the spring 28, the shutter 30 moves further away from the bushing 33, with a consequent increase in the amount of liquid recirculated from the delivery to the suction of the pump 1 and a reduction of the flow rate of liquid exiting from the pump 1.

**[0077]** A sequence of operations opposite to that described above allows the flow rate of liquid at the outlet from the pump 1 to be increased, and therefore the pres-

sure of the liquid dispensed to be increased, starting from the maximum opening position of the shutter 30.

**[0078]** The liquid can be dispensed by the pump 1 onto the surface to be cleaned or, more generally, into the environment to be treated, by means of a dispensing device, conformed for example as a delivery gun, connected to an outlet 35 of the pump 1, for example through a delivery tube not depicted.

**[0079]** The delivery gun is provided with a nozzle inside which a narrowing is made. Owing to this narrowing, it is possible to increase pressure of the liquid in a diverging portion arranged downstream of the narrowing, with respect to the value that such pressure had upstream of the narrowing. This increase in pressure is more significant, the higher the flow rate of the liquid passing through the narrowing. This explains why the adjusting valve 25, which allows the flow rate of the liquid at the outlet from the pump 1 to be varied, also - indirectly - allows the pressure of the dispensed liquid to be varied.

**[0080]** A quick coupling fitting 49 can be associated with the outlet 35 to allow the delivery tube of the pump 1 to be quickly engaged or disengaged.

**[0081]** As shown in Figures 5 and 6, the outlet 35 is defined at the end of an outlet conduit made in a protrusion 36 that projects from the head 4.

**[0082]** The protrusion 36 is distinct from the adjusting valve 25.

**[0083]** The protrusion 36 extends along an axis X1 which may be, for example, parallel to the axes X of the suction valves 16.

**[0084]** As shown in Figures 5 and 6, the outlet conduit made in the protrusion 36 comprises an initial portion 37 that extends from the outlet manifold 19. Such outlet conduit further comprises a final portion 38 arranged near the outlet 35, particularly inside the quick coupling fitting 49.

**[0085]** A narrowing 40 having a minimum passage section and a diverging portion 41, arranged downstream of the narrowing 40, are also interposed between the initial portion 37 and the final portion 38.

**[0086]** Between the initial portion 37 and the final portion 38, a shutter device 39 is also interposed, which can be positioned upstream of the narrowing 40 with respect to an outlet direction of the liquid from the pump 1.

**[0087]** The shutter device 39 is configured to open or alternatively close the initial portion 37, so as to put the initial portion 37 in fluid communication with the final portion 38, or alternatively separate the initial portion 37 from the final portion 38.

**[0088]** In particular, the shutter device 39 is configured to put in fluid communication the initial portion 37 with the final portion 38, when the pressure of the liquid in the initial portion 37 is higher than the pressure of the liquid in the final portion 38.

**[0089]** An adding device 43 is provided for adding an additive to the liquid exiting from the pump 1, particularly a detergent substance. As shown in Figures 6 and 7, the adding device 43 comprises a connector 42, which

projects from the protrusion 36 transversely to the axis X1. The connector 42 is suitable for being connected to an additive tank not depicted. Inside the connector 42 a passage 44 is made through which the additive can flow to reach the liquid that is exiting from the pump 1. The passage 44 extends transversely, in particular, perpendicularly, to the axis X1.

**[0090]** The passage 44 can be closed by means of a closing body 45, conformed for example like a ball, on which an elastic element 46 acts, the elastic element 46 being conformed for example like a helical spring.

**[0091]** The elastic element 46 is configured to push the closing body 45 into a position such as to close the passage 44.

**[0092]** The adding device 43 is positioned near to, or at, the narrowing 40, so that the detergent substance is injected into such narrowing.

**[0093]** Finally, in the head 4 of the pump 1 a connecting hole 47 is made which, as shown in Figure 7, connects the adjusting valve 25 with a chamber in which the shutter device 39 is housed. In particular, the connecting hole 47 allows the liquid contained downstream of the shutter device 39 (i.e. in the portion of the outlet conduit interposed between the shutter device 39 and the outlet 35) to reach the adjusting valve 25.

**[0094]** When the liquid is to be dispensed onto the surface to be cleaned or in general into the environment to be treated, the delivery tube is connected to the outlet 35, the delivery gun being connected to the delivery tube. On the delivery gun there is provided an on/off type opening device, which the user can arrange in an open configuration or alternatively in a closed configuration.

**[0095]** The user positions the on/off type opening device in the open configuration and the pressure of the liquid in the initial portion 37 of the outlet conduit opens the shutter device 39, by overcoming the resistance of a spring element 48 included in the shutter device 39. The liquid can thus reach the final portion 38 and be directed towards the delivery gun through the delivery tube.

**[0096]** The speed of the liquid that flows towards the outlet 35 increases in the narrowing 40, due to the effect of the reduction of the cross section for passage of the liquid occurring in the narrowing 40. Thus, in the narrowing 40, a sort of suction is created, which acts on the closing body 45, thereby compressing the elastic element 46 and opening the passage 44.

**[0097]** The detergent substance can thus flow through the passage 44 and be mixed with the liquid exiting from the pump in the narrowing 40. In this way it is possible to dispense onto the surface to be cleaned a liquid that already has the detergent substance added to it.

**[0098]** When the user decides to interrupt dispensing of the liquid on the surface to be cleaned or into the environment to be treated, the user positions the on/off type opening device provided on the delivery gun in the closed configuration. Therefore, the liquid cannot exit through the delivery gun. The pump 1 instead continues to operate, while waiting for the user to reactivate the delivery

gun.

**[0099]** A certain amount of pressurised liquid remains in the delivery tube. This pressurised liquid cannot exit from the delivery gun due to a pressure surge (water hammer) within the protrusion 36, which generates a force directed from the final portion 38 towards the initial portion 37. This force acts on the shutter device 39 by pushing the shutter device 39 into the respective closed position, shown in Figure 6. Therefore the outlet conduit made in the protrusion 36 is closed, i.e. the fluid communication between the initial portion 37 and the final portion 38 is interrupted. Furthermore, as will be explained better below, the pressurised liquid that flows into the connecting hole 47 allows the shutter 30 to be opened. By so doing, excessive pressures in the head 4 of the pump 1 are avoided, which excessive pressures might be due to the pressurised liquid contained in the delivery tube connected to the outlet 35.

**[0100]** The pressure surge in the outlet conduit made inside the protrusion 36 further causes closing of the adding device 43, because the closing body 45 is pushed by the elastic element 46 towards the connector 42, therefore closing the passage 44. In this way, dispensing of the detergent substance through the passage 44 is interrupted.

**[0101]** Finally, through the connecting hole 47, the liquid contained in the delivery tube and more generally downstream of the shutter device 39 can reach the adjusting valve 25. Here the pressure surge due to the liquid that cannot exit from the delivery tube generates a force that detaches the shutter 30 from the bushing 33. Thus, the outlet manifold 19 is put in fluid communication with the inlet manifold 18 through the connecting conduit 32. Consequently, the liquid flows from the outlet manifold 19 towards the inlet manifold 18, thereby protecting the components of the pump 1 against any damage.

**[0102]** In this way the correct operation of the pump 1 is guaranteed, also in the transitory steps in which the delivery gun is activated or deactivated.

## Claims

1. A pump comprising:

- a plurality of pistons (5) each of which is slidable inside a cylinder for varying volume of a corresponding chamber (6),
- a plurality of suction valves (16), each of which is associated with a chamber (6) and is operable to allow a liquid to enter the chamber (6), the suction valves (16) being arranged in a first sequence,
- a plurality of delivery valves (17), each of which is associated with a chamber (6) and is operable to allow said liquid to flow out of the chamber (6), the delivery valves (17) being arranged in a second sequence,

- an adjusting valve (25) for adjusting pressure of the liquid exiting from the pump (1),

wherein the adjusting valve (25) is interposed between two consecutive valves of a sequence chosen between said first sequence and said second sequence, the pump (1) further comprising:

- an outlet conduit arranged downstream of the delivery valves (17),
- a shutter device (39) interposed between an initial portion (37) of the outlet conduit and a final portion (38) of the outlet conduit, so as to put the initial portion (37) in fluid communication with the final portion (38), or alternatively separate the initial portion (37) from the final portion (38),
- a connecting hole (47) for connecting a portion of the outlet conduit arranged downstream of the shutter device (39) with the adjusting valve (25).

2. A pump according to claim 1, wherein the adjusting valve (25) is interposed between two consecutive delivery valves (17) of said second sequence.
3. A pump according to claim 1 or 2, wherein the suction valves (16) extend along respective axes (X), the adjusting valve (25) extending along an axis (Y1) which is oblique with respect to the axes (X) of the suction valves (16).
4. A pump according to claim 3, wherein the axes (X) along which the suction valves (16) extend are mutually parallel.
5. A pump according to any preceding claim, wherein the adjusting valve (25) is configured to selectively put a delivery of the pump (1) in fluid communication with a suction of the pump (1), so that a quantity of liquid can be recirculated from the delivery to the suction in order to vary flow rate of the liquid exiting from the pump (1).
6. A pump according to claim 5, wherein the adjusting valve (25) comprises a shutter (30) at least partially positioned in a housing (31), the pump (1) further comprising a connecting conduit (32) which connects the housing (31) to the delivery of the pump (1), the shutter (30) being configured to isolate or alternately connect the housing (31) with a communication conduit (34), the communication conduit (34) being in fluid communication with the suction of the pump (1).
7. A pump according to claim 6, wherein the connecting conduit (32) connects the housing (31) with a delivery valve (17) of said plurality of delivery valves (17), the communication conduit (34) selectively connect-

ing the housing (31) with an outlet manifold (19), the outlet manifold (19) being configured to send the liquid to the suction valves (16).

8. A pump according to claim 6 or 7, wherein the shutter (30) has a position inside the housing (31), said position being determinable as a function of the liquid pressure inside the housing (31) and of a force exerted by a spring (28) on the shutter (30), the adjusting valve (25) further comprising a control element (26; 27) operable by a user to adjust the force exerted by said spring (28).
9. A pump according to any preceding claim, wherein said outlet conduit has a narrowing (40) of its cross-section.
10. A pump according to claim 9, and further comprising an adding device (43) facing said narrowing (40), the adding device (43) being openable by virtue of a suction action generated by a flow of liquid passing through the outlet conduit, so that the adding device (43) introduces an additive into said flow of liquid.

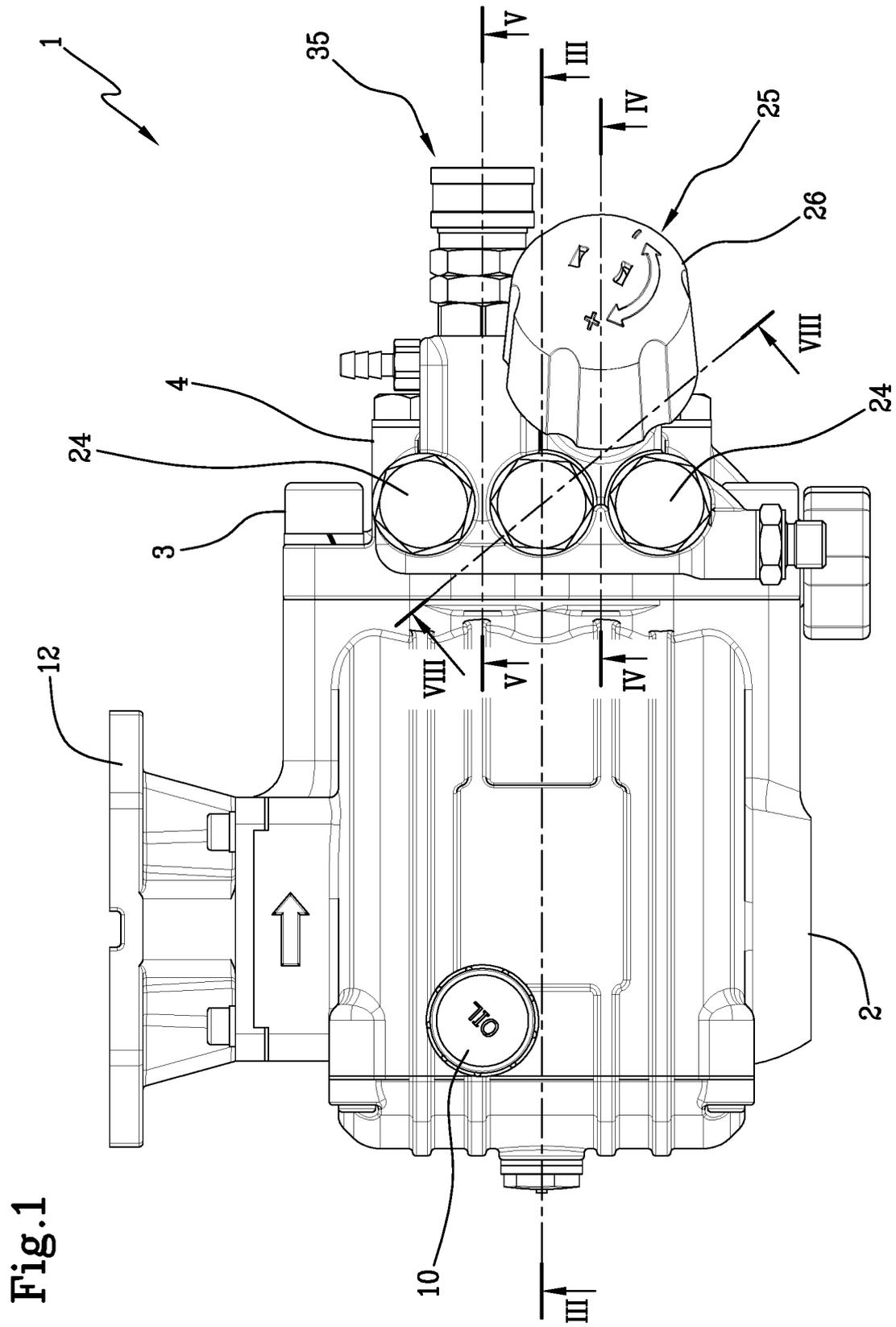


Fig.1

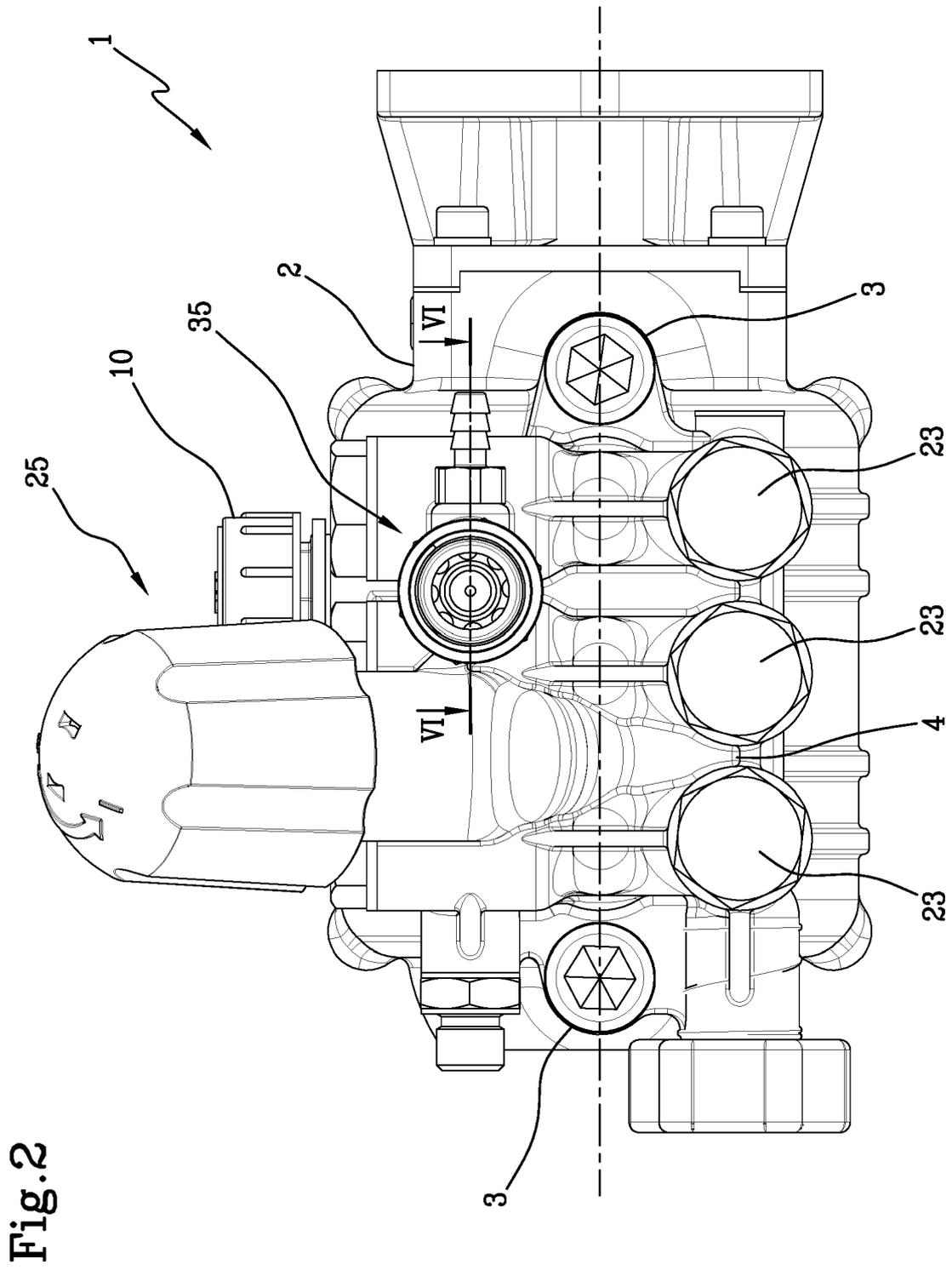
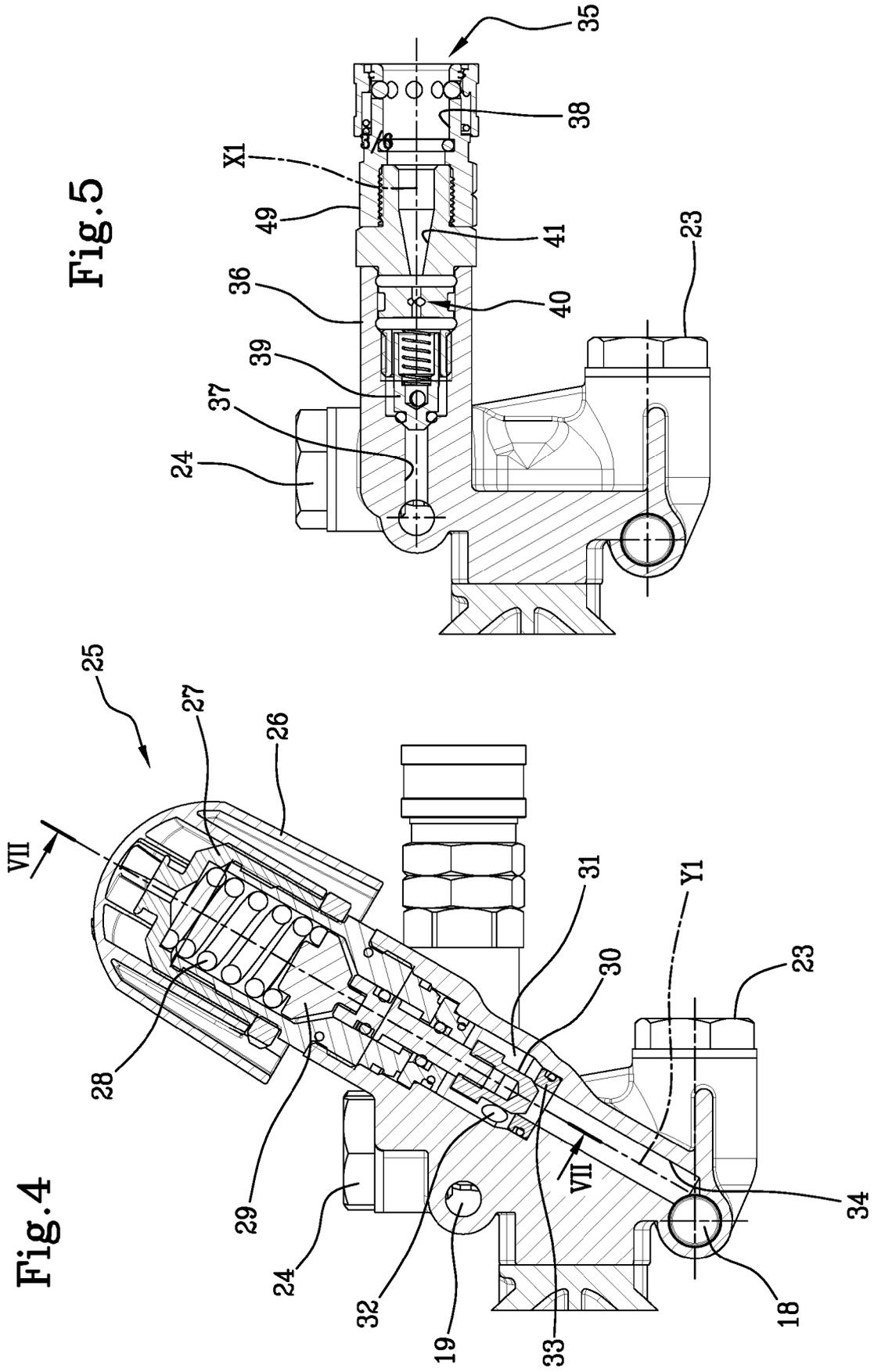
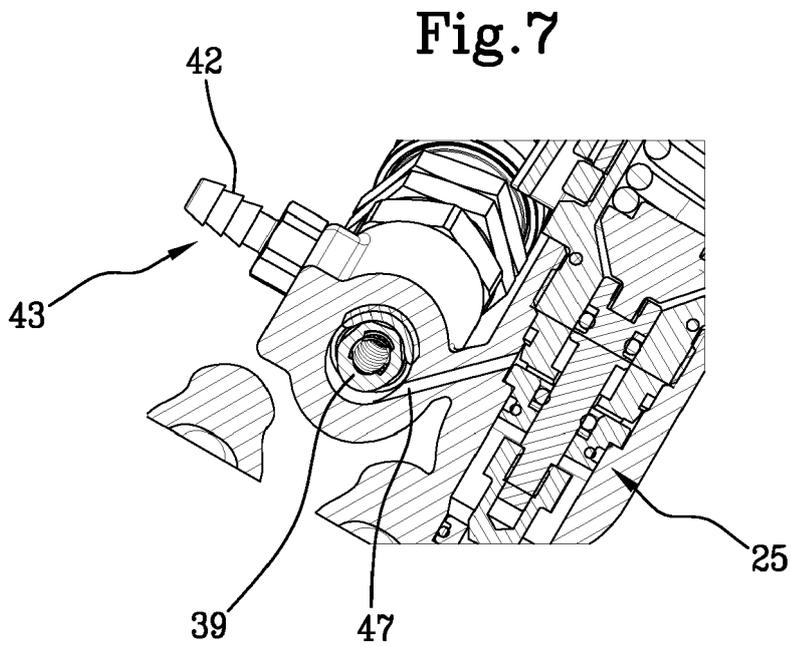
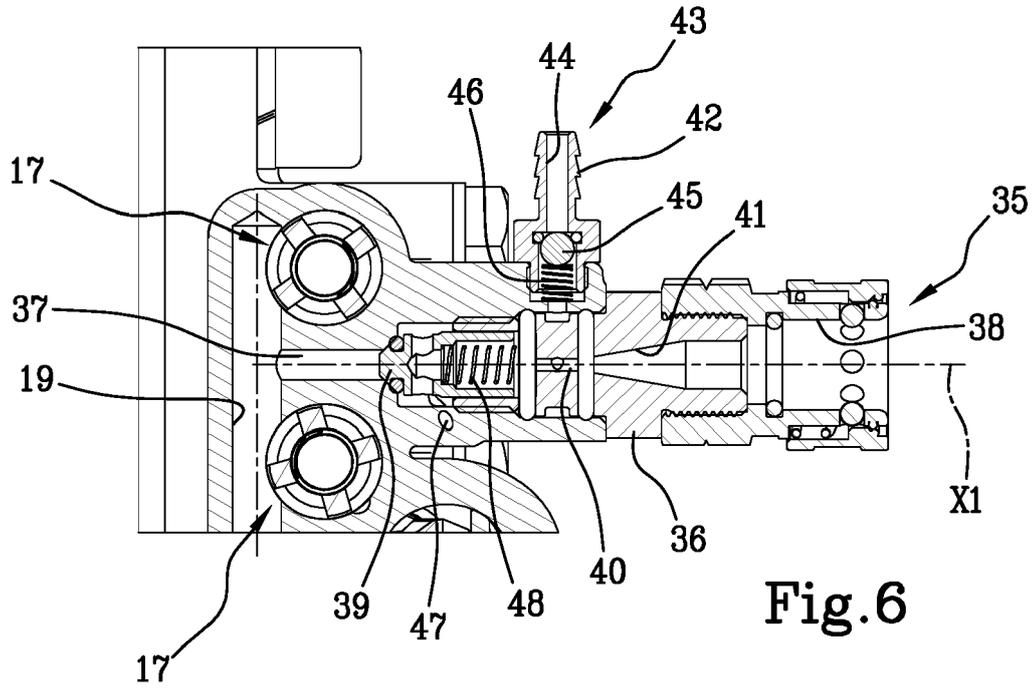


Fig. 2







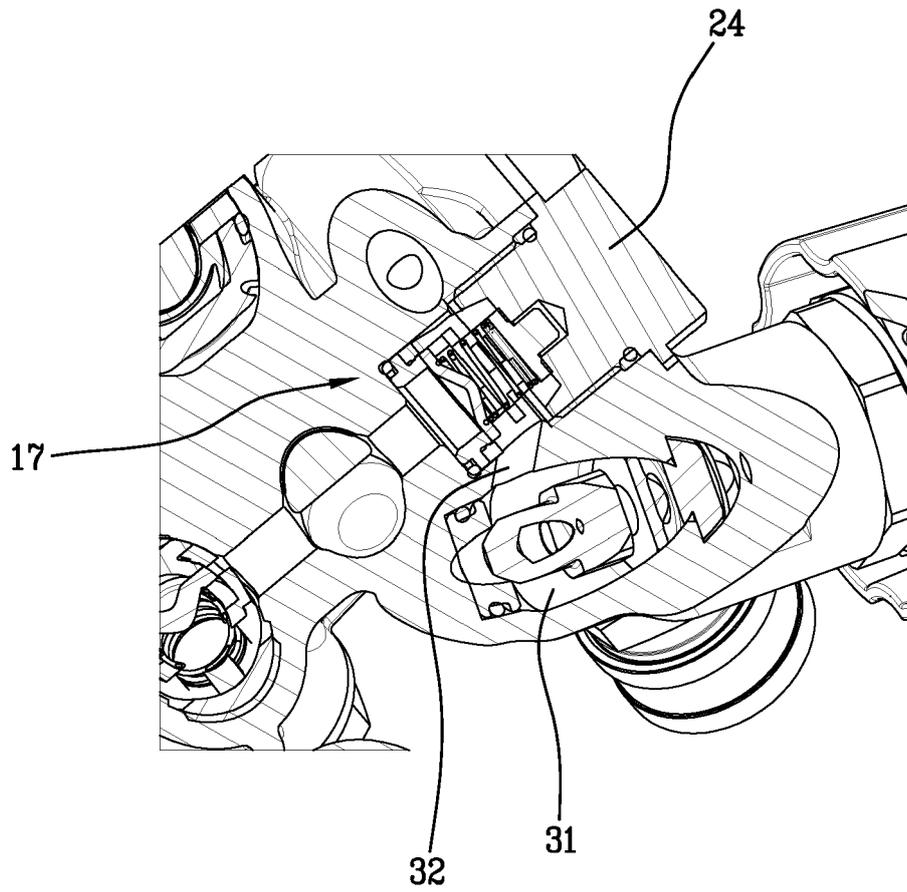


Fig.8



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Application Number  
EP 17 18 0434

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