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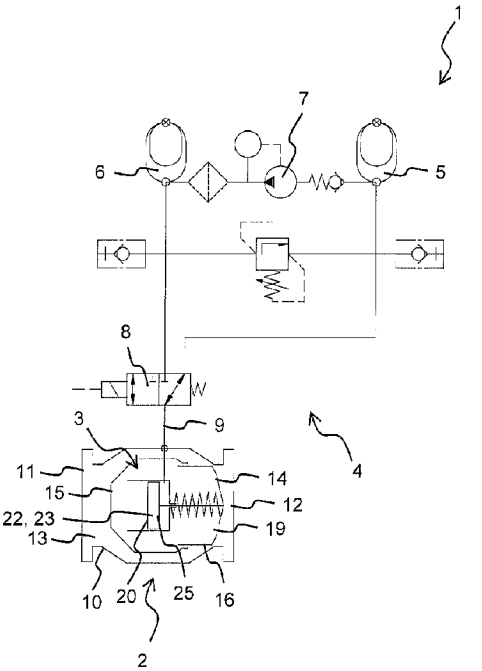
(54) Titre : SYSTEME DE PROTECTION DE PRESSION A INTEGRITE ELEVEE (HIPPS) POUR UNE CONDUITE DE FLUIDE

(54) Title: HIGH INTEGRITY PRESSURE PROTECTING SYSTEM (HIPPS) FOR A FLUID LINE



(57) Abrégé/Abstract:
The invention relates to a High Integrity Pressure Protecting Systems (HIPPS), comprising an ON/OFF valve having a housing, comprising a closure member, and a control element fixed to the closure member, and a switchable hydraulic supply unit supplying a control face of the control element with a pressure in an active state, and releases the pressure from the control face in a passive state. A logic solver compares the pressure to a critical value, and switches the unit to the active state so the closure member stays open, whenever the pressure is below the critical value, and switches the unit to the passive state so the closure member closes, whenever the pressure exceeds the critical value. A face of the control element, opposite to the control face, is exposed to the downstream pressure of the fluid, so that the downstream pressure of the fluid pushes the closure member to close.

ABSTRACT

The invention relates to a High Integrity Pressure Protecting Systems (HIPPS), comprising an ON/OFF valve having a housing, comprising a closure member, and a control element fixed to the closure member, and a switchable hydraulic supply unit supplying a control face of the control element with a pressure in an active state, and releases the pressure from the control face in a passive state. A logic solver compares the pressure to a critical value, and switches the unit to the active state so the closure member stays open, whenever the pressure is below the critical value, and switches the unit to the passive state so the closure member closes, whenever the pressure exceeds the critical value. A face of the control element, opposite to the control face, is exposed to the downstream pressure of the fluid, so that the downstream pressure of the fluid pushes the closure member to close.

TITLE OF INVENTION

High Integrity Pressure Protecting System (HIPPS) for a fluid line

TECHNICAL FIELD

The invention relates in general to High Integrity Pressure Protecting Systems (HIPPS) and in particular to such HIPPS, wherein the HIPPS has an ON/OFF-valve, with a housing, wherein the housing has an inlet and an outlet, and a conduit for passage of a fluid from the inlet to the outlet, and with a closure member, that is axially movable in a direction from the inlet to the outlet from an open position to a closing position, wherein in the open position the closure member opens the conduit for allowing the passage, and in the closing position the closure member closes the conduit for inhibiting the passage, and a hydraulic actuator, having a control element that is kinematically fixed to the closure member, and a switchable hydraulic supply unit, which in an active state supplies a control face of the control element with a control pressure, and in a passive state releases the control pressure from the control face, a sensor measuring a downstream pressure of the fluid, downstream of the outlet, and a logic solver that compares the downstream pressure to a critical value, that switches the hydraulic supply unit to the active state for allowing the closure member to stay in the open position, whenever the downstream pressure is below the critical value, and that switches the hydraulic supply unit to the passive state for allowing the closure member to move into, or to stay in the closing position, whenever the downstream pressure exceeds the critical value. For safety reasons, HIPPS systems always require a manual action for opening.

BACKGROUND ART

High Integrity Pressure Protection Systems (HIPPS) are commonly known Safety Instrumented Systems (SIS) for preventing unsafe conditions caused by downstream pressure rising in a pipeline. HIPPS valves require high reliability figures and shall be designed to close the pipeline at any condition when required.

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When a critical downstream pressure is sensed, the final element (valve) is closed to prevent further pressurization of the downstream pipeline. The known HIPPS valve have an external actuator, these actuators often use springs/hydraulics and are very large to ensure sufficient safety to be able to close the valve at any condition. These external actuators could fail resulting in a loss of actuation force.

In technological background of the invention, DE 25 17 730 A1 suggests an ON/OFF-valve to be closed by upstream pressure. However, this known valve is not usable for including into an HIPPS without substantial modifications, in particular to the valve seat and to the sealing element, as enhancement for the typically high pressure levels in a pipeline.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a valve in which the actuation force is inherently present when the valve has to close.

According to an aspect of the present invention, there is provided a High Integrity Pressure Protecting System (HIPPS) for a fluid line, wherein the HIPPS has

a. an ON/OFF-valve, with a housing, wherein the housing has an inlet and an outlet, and a conduit for passage of a fluid from the inlet to the outlet, and with a closure member, that is axially movable in a direction from the inlet to the outlet from an open position to a closing position, wherein in the open position the closure member opens the conduit for allowing the passage, and in a closing position the closure member closes the conduit for inhibiting the passage, and
b. a hydraulic actuator, having a control element that is kinematically fixed to the closure member, and
c. a switchable hydraulic supply unit, which in an active state supplies a control face of the control element with a control pressure, and in a passive state releases the control pressure from the control face,
d. a sensor measuring a downstream pressure of the fluid, downstream of the outlet,

e. and a logic solver
   i. that compares the downstream pressure to a critical value,
   ii. that switches the hydraulic supply unit to the active state for allowing the closure member to move into, or to stay in the open position, whenever the downstream pressure is below the critical value, and
   iii. that switches the hydraulic supply unit to the passive state for allowing the closure member to stay in the closing position, whenever the downstream pressure exceeds the critical value,

wherein a face of the control element, opposite to the control face is exposed to the downstream pressure of the fluid, so that the downstream pressure of the fluid pushes the closure member into the closing position.

According to another aspect of the present invention, there is provided a method for operating an High Integrity Pressure Protecting System (HIPPS) in a fluid line, the HIPPS having an ON/OFF-valve, with a housing, wherein the housing has an inlet and an outlet, and a conduit for passage of a fluid from the inlet to the outlet, and with a closure member, that is axially movable in a direction from the inlet to the outlet from an open position to a closing position, wherein in the open position the closure member opens the conduit for allowing the passage, and in a closing position the closure member closes the conduit for inhibiting the passage, and having a hydraulic actuator with a control element that is kinematically fixed to the closure member, comprising the steps of

a. supplying a control face of the control element with a control pressure, in an active state, and releasing the control pressure from the control face, in a passive state,
b. measuring a downstream pressure of the fluid, downstream of the outlet,
c. comparing the downstream pressure to a critical value,
d. switching the hydraulic actuator to the active state so as to hold the closure member in the open position, whenever the downstream pressure is below the critical value, and
e. switching the hydraulic actuator to the passive state so as to move the closure member into, or to hold the same in the closing

position, whenever the downstream pressure exceeds the critical value,

further comprising exposing a face of the control element, opposite to the control face, to the downstream pressure, so that the downstream pressure of the fluid pushes the closure member into the closing position.

The invention suggests that an opposite face of the control element, opposite to the control face is exposed to the downstream pressure of the fluid, so that the downstream pressure of the fluid pushes the closure member into the closing position. In an HIPPS according to the invention, the rising downstream pressure of the fluid itself is the acting means, that closes the ON/OFF-valve.

In a preferred HIPPS according to the invention, the actuator is arranged inside the housing. In such HIPPS, the actuator is protected from pressure and other impact from the environment, in particular in sub-sea, and in seabed applications. Alternatively, e.g. in globe valves, the actuator may be arranged outside the housing.

In such HIPPS, the conduit preferably surrounds the actuator. With the conduit surrounding the actuator, inside an inner housing, the ON/OFF-valve is basically pressure balanced. Alternatively, the conduit may be formed alongside the actuator, to avoid wear of the inner housing.

In a further preferred HIPPS according to the invention, the control element is a piston of the hydraulic actuator. Such HIPPS is preferred in particular for large diameters.

In an alternatively preferred HIPPS according to the invention, the control element is a cylinder barrel of the hydraulic actuator. Such HIPPS is preferred in particular for smaller diameters.

In a further preferred HIPPS according to the invention, a spring pushes the closure member into the closing position. Such additional springs are suggested by common standards for HIPPS, to assist closing of the valve.

In a further preferred HIPPS according to the invention, at least one sensor identifies a position of the closure member. Including a sensor into the ON/OFF-valve provides for monitoring the status of the HIPPS.

In a further preferred HIPPS according to the invention, the closure member has an orifice, giving way to the fluid from the outlet through the closure member to the back face of the control element. An orifice formed in the closure member provides the most simple connection from the outlet of the valve, to the inside of the inner housing.

The invention further suggests a method for operating such HIPPS in a fluid line, wherein an opposite face of the control element, opposite to the control face, is exposed to the pressure, so that the downstream pressure of the fluid pushes the closure member into the closing position. The method according to the invention may be executed using the HIPPS described supra, and features the same advantages.

BEST MODE FOR CARRYING OUT THE INVENTION

The apparatus according to the invention and the associated method are subsequently described in more detail with reference to preferred embodiments illustrated in the drawing figures.

Fig. 1 schematically shows a first HIPPS according to the invention,

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Fig. 2 schematically shows the ON/OFF-valve of this HIPPS, and

Fig. 3a/b schematically shows this ON/OFF-valve in open and closed positions,

Fig. 4a/b shows an ON/OFF-valve of a second HIPPS according to the invention in these positions, and

Fig. 5 shows an engineering detail of this ON/OFF-valve,

Fig. 6a/b shows an ON/OFF-valve of a third HIPPS according to the invention in these positions, and

Fig. 7 shows an engineering detail of this ON/OFF-valve.

A first HIPPS 1 according to the invention is shown in Fig. 1: The first HIPPS 1 has an ON/OFF-valve 2 for application into a fluid line, a hydraulic actuator 3 integrated into the ON/OFF-valve 2, and a hydraulic supply unit 4. Further commonly known elements of the first HIPPS 1, namely a sensor measuring a downstream pressure of a fluid flowing through the ON/OFF-valve 2, and a logic solver for interpreting data from the sensor, are not shown.

The hydraulic supply unit 4 has a low pressure reservoir 5 and a high pressure reservoir 6 for a hydraulic fluid, a pump 7 for the hydraulic fluid between the low pressure reservoir 5 and the high pressure reservoir 6, and a 3/2-valve 8 connecting either the low pressure reservoir 5 or the high pressure reservoir 6 to the hydraulic actuator 3 through an hydraulic line 9. The 3/2-valve 8 is driven by the logic solver.

The ON/OFF-valve 2, in detail shown in Fig. 2, has a housing 10, the housing 10 having an inlet 11 and an outlet 12, and a conduit 13 for passage of the fluid from the inlet 11 to the outlet 12.

And the ON/OFF-valve 2 has a cup-shaped closure member 14, that is axially movable in a direction from the inlet 11 to the outlet 12 from an open position to a closing position. The closure member 14 forms part of an inner housing 15 inside the housing 10, that encloses the hydraulic actuator 3, and is surrounded by the conduit 13.

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A cylindrical side wall 16 of the closure member 14 is dynamically sealed to seats 17 both in the inner housing 15, and in the housing 10. A base 18 of the closure member 14 has an orifice 19 that gives way to the fluid from the outlet 12 through the closure member 14 to a back face 20 of the control element.

A cylinder barrel 21 of the hydraulic actuator 3 is fixed to the inner housing 15, while a movable piston 22 – forming a control element 23 – inside the cylinder barrel 21 is connected to the closure member 14 by a connecting rod 24. The control element 23 has a control face 25, that faces a cylinder cap 26 of the hydraulic actuator 3.

The ON/OFF-valve 2 further has a spring 27 supported between the cylinder cap 26 of the hydraulic actuator 3, and the closure member 14.

In active state of the hydraulic supply unit 4, the inside of the hydraulic actuator 3 is supplied with a control pressure, that generates a control force upon the control face 25, pulling the closure member 14 to the open position, as shown in fig. 3a: The conduit 13 is open from the inlet 11 to the outlet 12, permitting passage of the fluid through the fluid line.

Inside the inner housing 15, the downstream pressure of the fluid, downstream of the outlet 12, generates a closing force to the back face 20 of the control element 23. More precisely, the closing force is proportional to the excess area of visible faces of the movable parts – i.e. the control element 23 and the closing member – viewed from the inlet 11 over the visible faces of the same, viewed from the outlet 12.

Whenever this closing force, added to the spring force, exceeds the control force, it pushes the closure to the closing position, as shown in fig. 3b: The control element 23 closes the conduit 13, and inhibits passage of the fluid through the fluid line.

The closure member 14 is thus pushed to the closing position, when in passive state of the hydraulic supply unit 4, the control pressure is released from the control face 25. Furthermore, the closure member 14 is also pushed to the closing

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position with the control face 25 under control pressure, when the downstream pressure exceeds an emergency closing level defined by the control pressure of the hydraulic supply unit 4, and by the spring force.

Figs. 4a and 4b show a second ON/OFF-valve 28 of another HIPPS according to the invention. The second ON/OFF-valve 28 basically has all features of the first ON/OFF-valve 2 described supra, and has a flange size of 48 *inch*. The base 29 of the closure member 30 forms a spoked wheel and is screwed to the cylindrical side wall 31. Fig. 4a shows the second ON/OFF-valve 28 in the open position, fig. 4b in the closing position. Fig. 5 in detail shows the hydraulic actuator 32 and the closure member 30 of the second ON/OFF-valve 28.

Figs. 6a and 6b show a third ON/OFF-valve 33 of yet another HIPPS according to the invention. The third ON/OFF-valve 33 in principle resembles the second ON/OFF-valve 28, but has a flange size of 6 *inch*, only. Other HIPPS's according to the invention may of course have ON/OFF-valves with any flange size between these two extreme values. Fig. 6a shows the third ON/OFF-valve 33 in the open position, fig. 6b in the closing position. Fig. 7 in detail shows the hydraulic actuator 34 and the closure member 35 of the third ON/OFF-valve 33:

In the third ON/OFF-valve 33, a piston 36 of the hydraulic actuator 34 is fixed to the inner housing 37, and the hydraulic line 38 thus integrated into the piston rod 39. A cylinder barrel 40 – forming a control element 41 – is movable, and screwed to the cylindrical side wall 42 of the closure member 35. The spring 43 is supported between the piston rod 39, and the closure member 35.

The third ON/OFF-valve 33 further has a permanent magnet 44 attached to the closure member 35, and two sensing heads 45 for detecting the position of permanent magnet 44, and thus the closure member 35.

The drawings are simplified and in particular seals are not shown.

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In the figures are

1 HIPPS
2 ON/OFF-valve
3 hydraulic actuator
4 hydraulic supply unit
5 low pressure reservoir
6 high pressure reservoir
7 pump
8 3/2-valve
9 hydraulic line
10 housing
11 inlet
12 outlet
13 conduit
14 closure member
15 inner housing
16 side wall
17 seat
18 base
19 orifice
20 back face
21 cylinder barrel
22 piston
23 control element
24 connecting rod
25 control face
26 cylinder cap
27 spring
28 ON/OFF-valve
29 base
30 closure member

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31 side wall
32 hydraulic actuator
33 ON/OFF-valve
34 hydraulic actuator
35 closure member
36 piston
37 inner housing
38 hydraulic line
39 piston rod
40 cylinder barrel
41 control element
42 side wall
43 spring
44 permanent magnet
45 sensing head

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The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A High Integrity Pressure Protecting System (HIPPS) for a fluid line, wherein the HIPPS has

a. an ON/OFF-valve, with a housing, wherein the housing has an inlet and an outlet, and a conduit for passage of a fluid from the inlet to the outlet, and with a closure member, that is axially movable in a direction from the inlet to the outlet from an open position to a closing position, wherein in the open position the closure member opens the conduit for allowing the passage, and in the closing position the closure member closes the conduit for inhibiting the passage, and

b. a hydraulic actuator, having a control element that is kinematically fixed to the closure member, and

c. a switchable hydraulic supply unit, which in an active state supplies a control face of the control element with a control pressure, and in a passive state releases the control pressure from the control face,

d. a sensor measuring a downstream pressure of the fluid, downstream of the outlet,

e. and a logic solver

i. that compares the downstream pressure to a critical value,

ii. that switches the hydraulic supply unit to the active state for allowing the closure member to move into, or to stay in the open position, whenever the downstream pressure is below the critical value, and

iii. that switches the hydraulic supply unit to the passive state for allowing the closure member to stay in the closing position, whenever the downstream pressure exceeds the critical value,

wherein a face of the control element, opposite to the control face is exposed to the downstream pressure of the fluid, so that the downstream pressure of the fluid pushes the closure member into the closing position.

2. The HIPPS according to claim 1, wherein the actuator is arranged inside the housing.

3. The HIPPS according to claim 1 or 2, wherein the conduit surrounds the actuator.

4. The HIPPS according to any one of claims 1 to 3, wherein the control element is a piston of the hydraulic actuator.

5. The HIPPS according to any one of claims 1 to 3, wherein the control element is a cylinder barrel of the hydraulic actuator.

6. The HIPPS according to any one of claims 1 to 5, further comprising a spring that pushes the closure member into the closing position.

7. The HIPPS according to any one of claims 1 to 6, further comprising at least one sensor for identifying one of the positions of the closure member.

8. The HIPPS according to any one of claims 1 to 7, wherein the closure member has an orifice, giving way to the fluid from the outlet through the closure member to a back face of the control element.

9. A method for operating an High Integrity Pressure Protecting System (HIPPS) in a fluid line, the HIPPS having an ON/OFF-valve, with a housing, wherein the housing has an inlet and an outlet, and a conduit for passage of a fluid from the inlet to the outlet, and with a closure member, that is axially movable in a direction from the inlet to the outlet from an open position to a closing position, wherein in the open position the closure member opens the conduit for allowing the passage, and in a closing position the closure member closes the conduit for inhibiting the passage, and having a hydraulic actuator with a control element that is kinematically fixed to the closure member, comprising the steps of

a. supplying a control face of the control element with a control pressure, in an active state, and releasing the control pressure from the control face, in a passive state,

b. measuring a downstream pressure of the fluid, downstream of the outlet,

c. comparing the downstream pressure to a critical value,

d. switching the hydraulic actuator to the active state so as to hold the closure member in the open position, whenever the downstream pressure is below the critical value, and

e. switching the hydraulic actuator to the passive state so as to move the closure member into, or to hold the same in the closing position, whenever the downstream pressure exceeds the critical value,

further comprising exposing a face of the control element, opposite to the control face, to the downstream pressure, so that the downstream pressure of the fluid pushes the closure member into the closing position.

Fig. 1

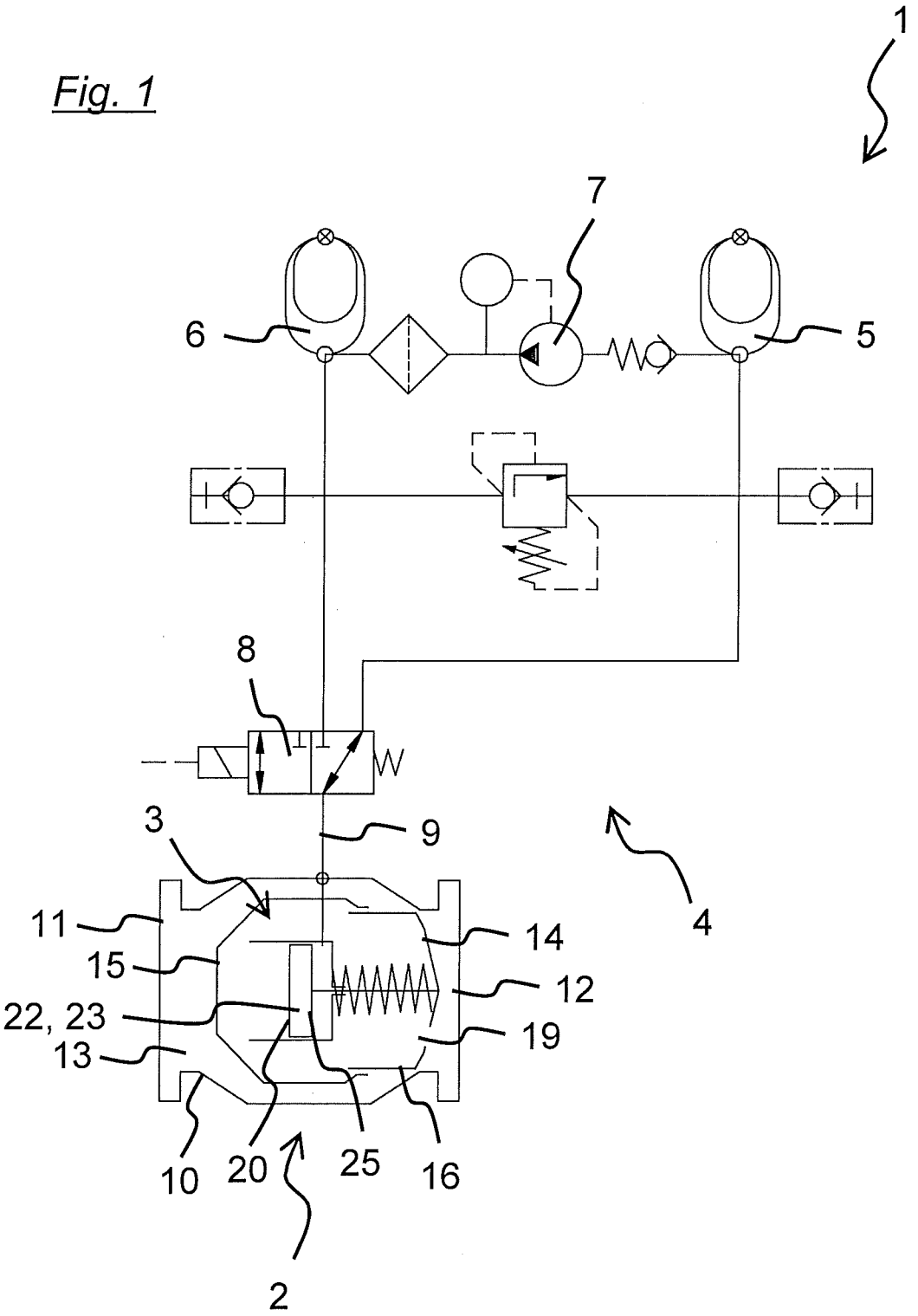

Fig. 2

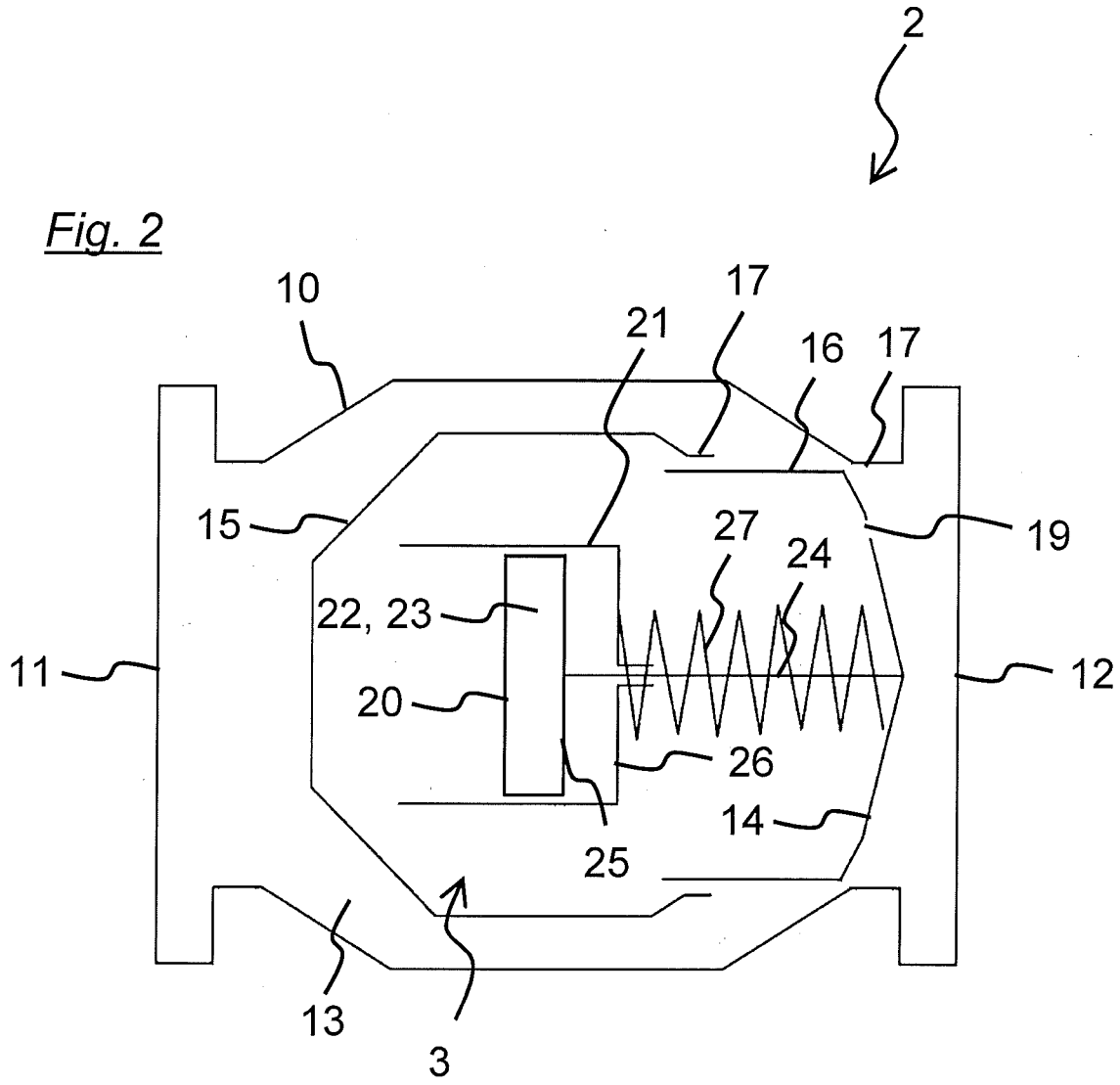

Fig. 3a

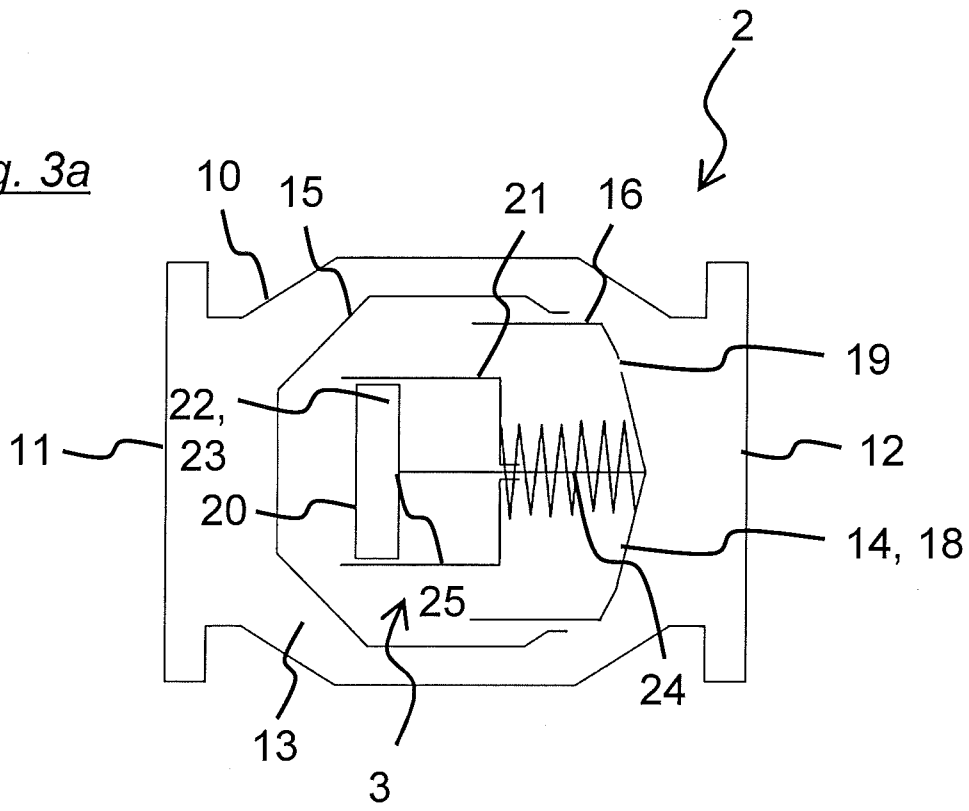
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Fig. 3b

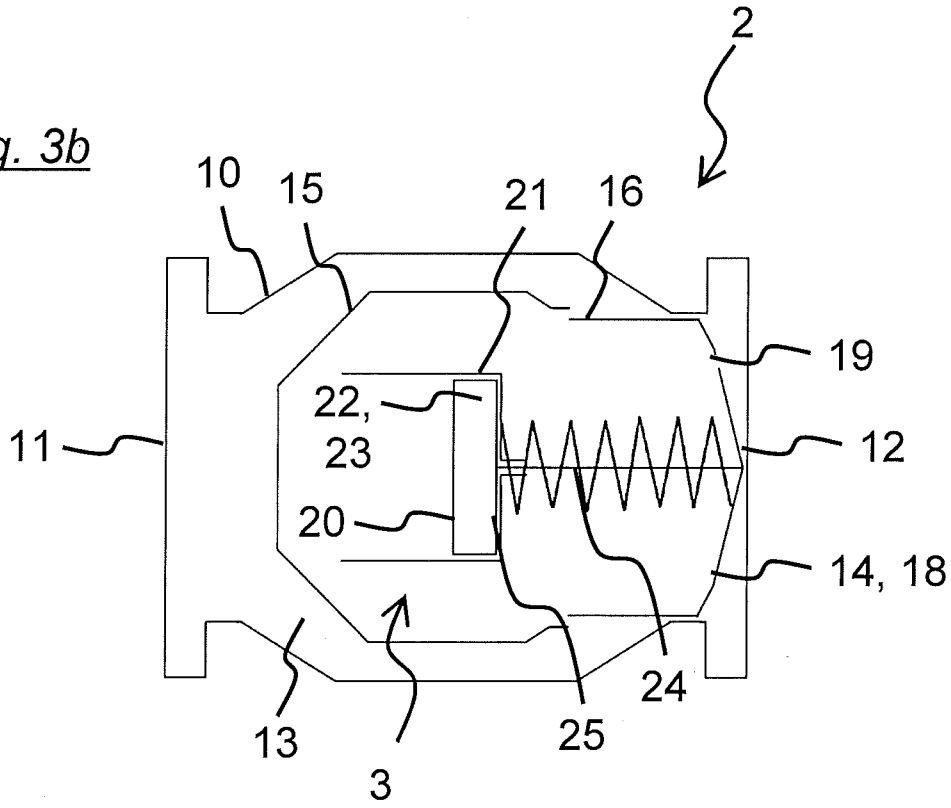
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Fig. 4a

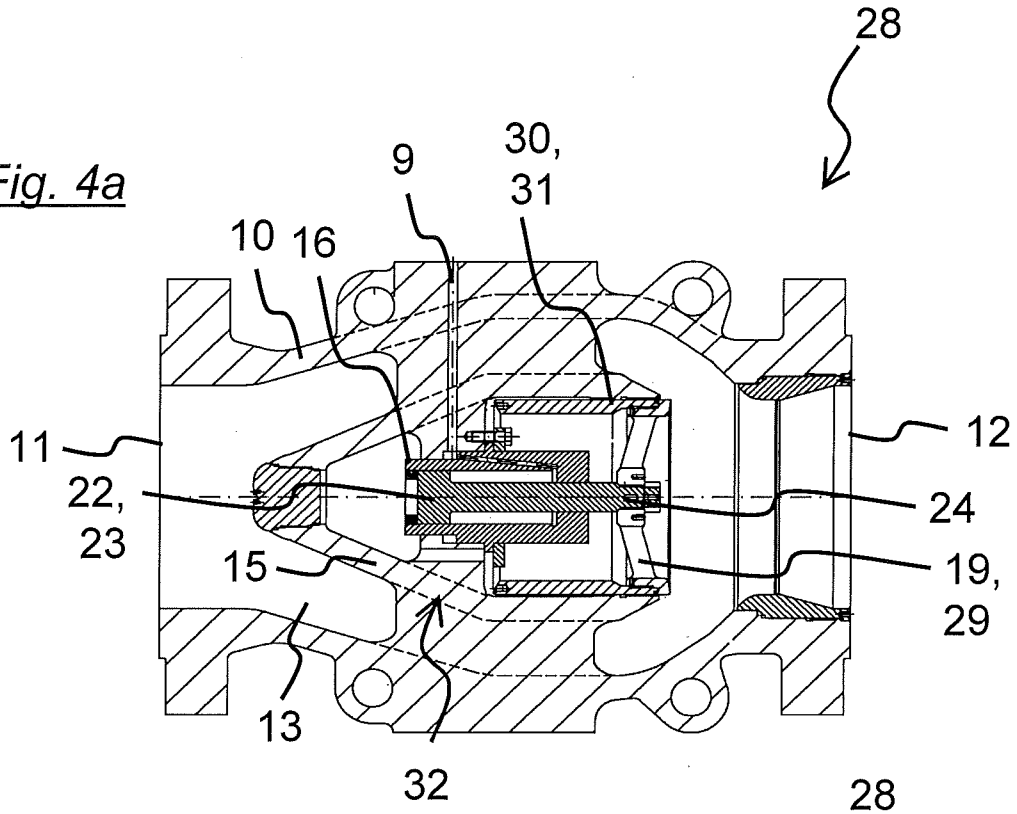
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Fig. 4b

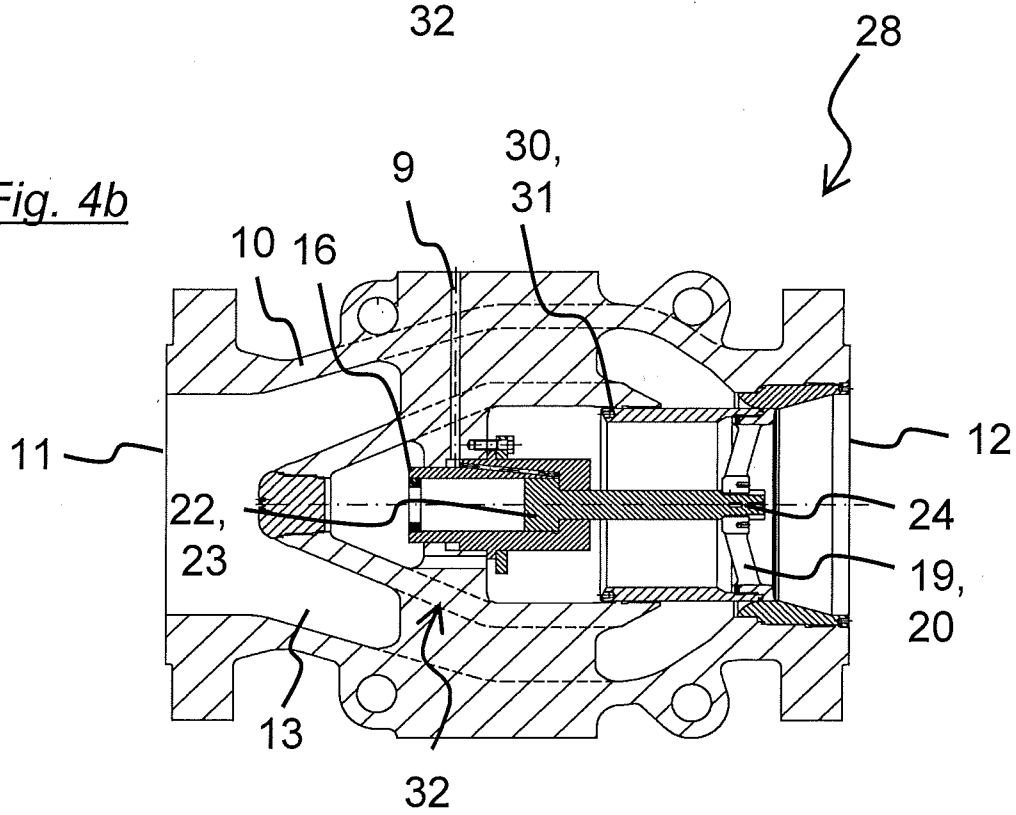
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Fig. 5

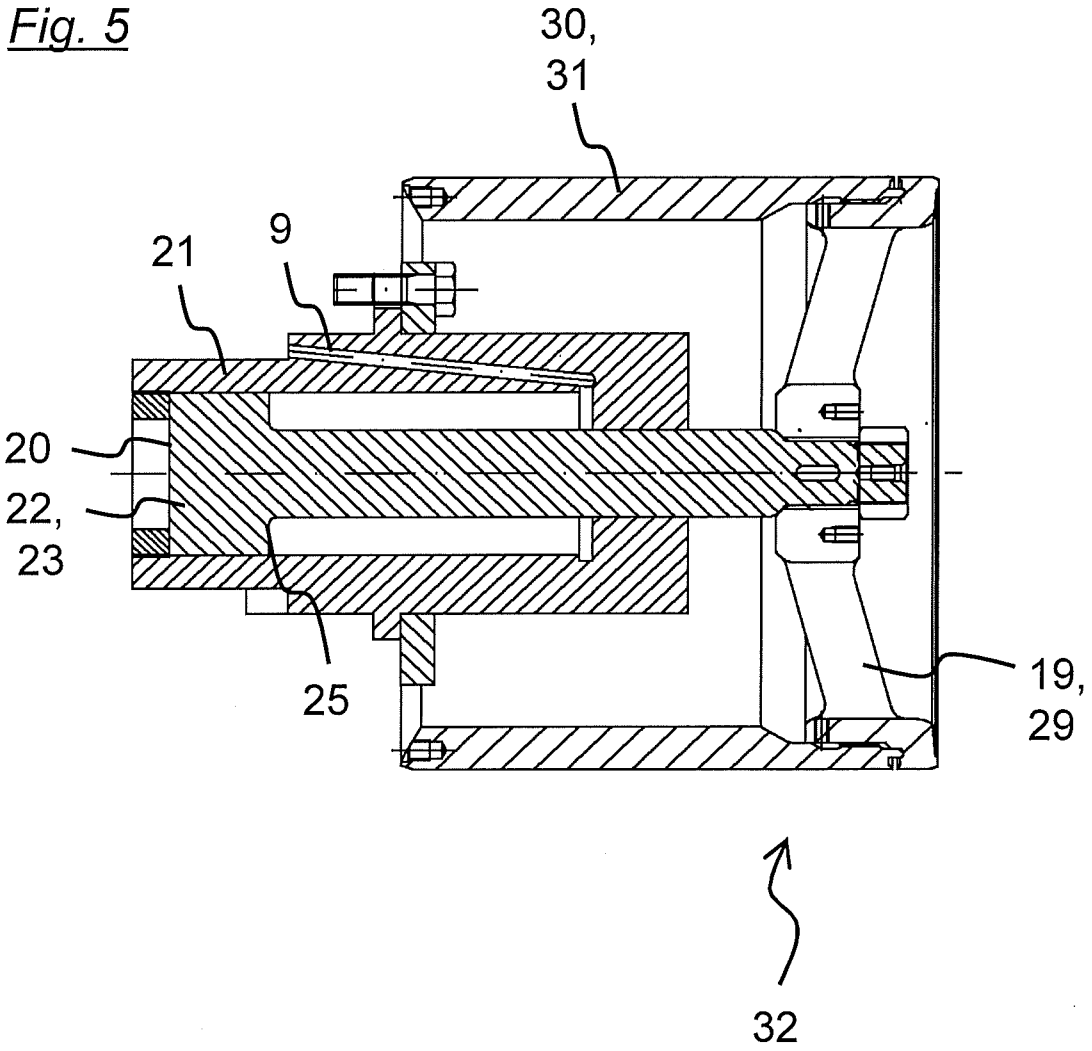

Fig. 6a

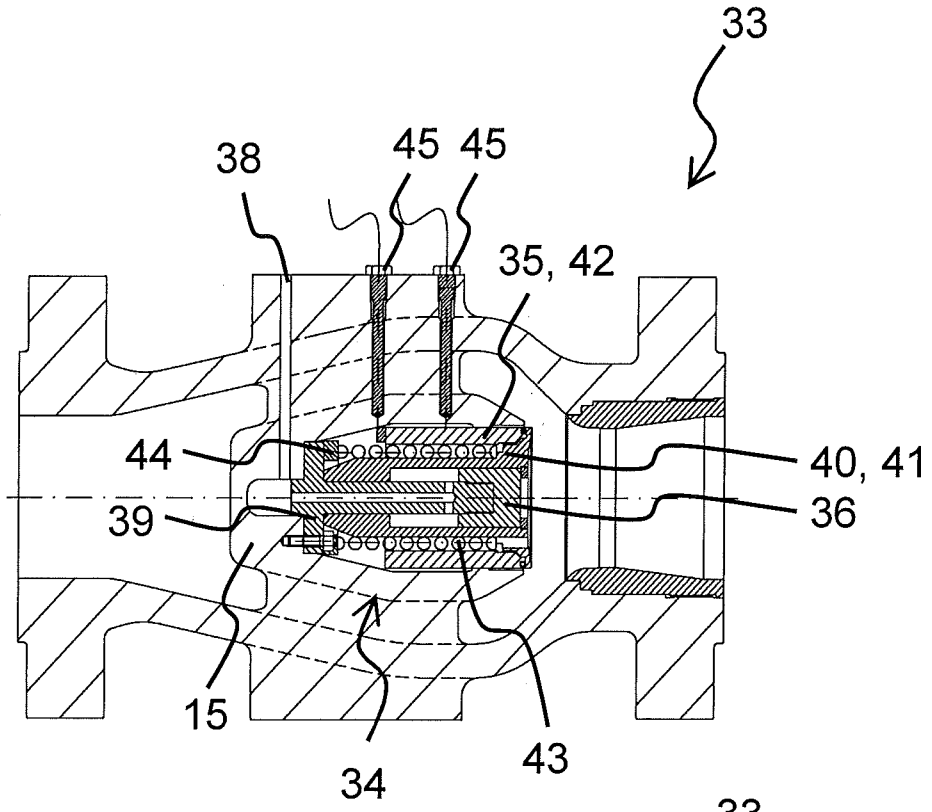
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Fig. 6b

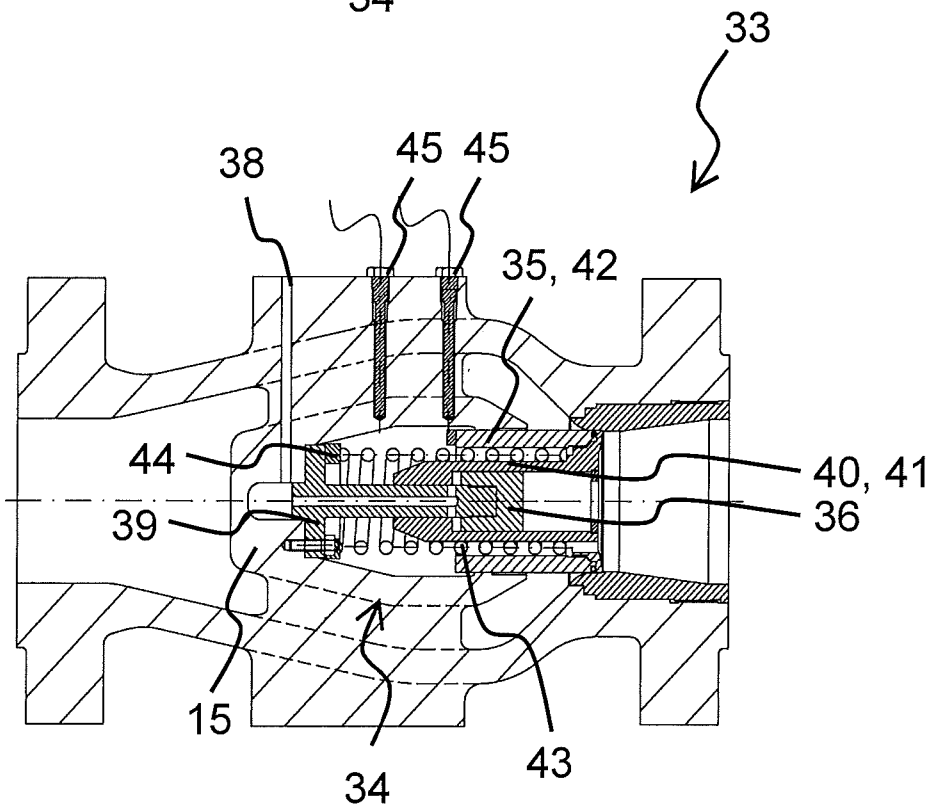
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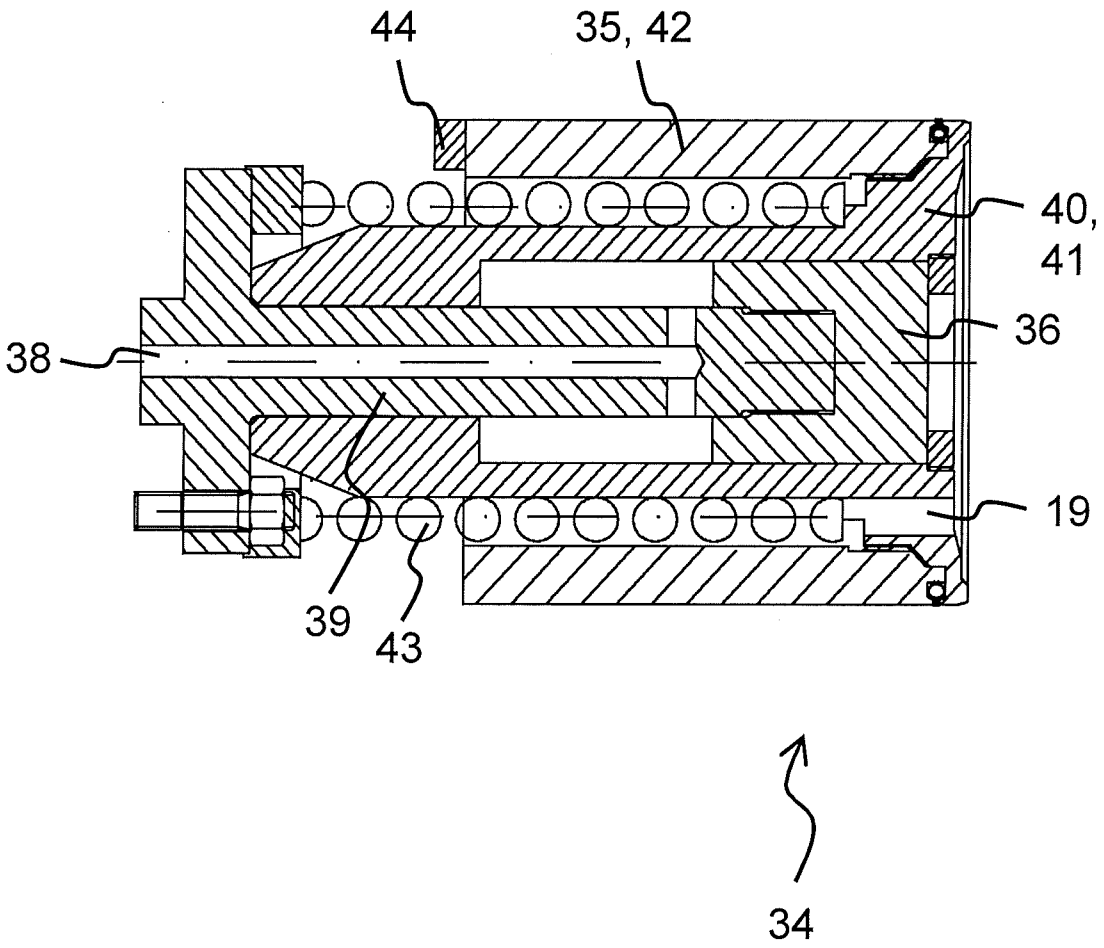
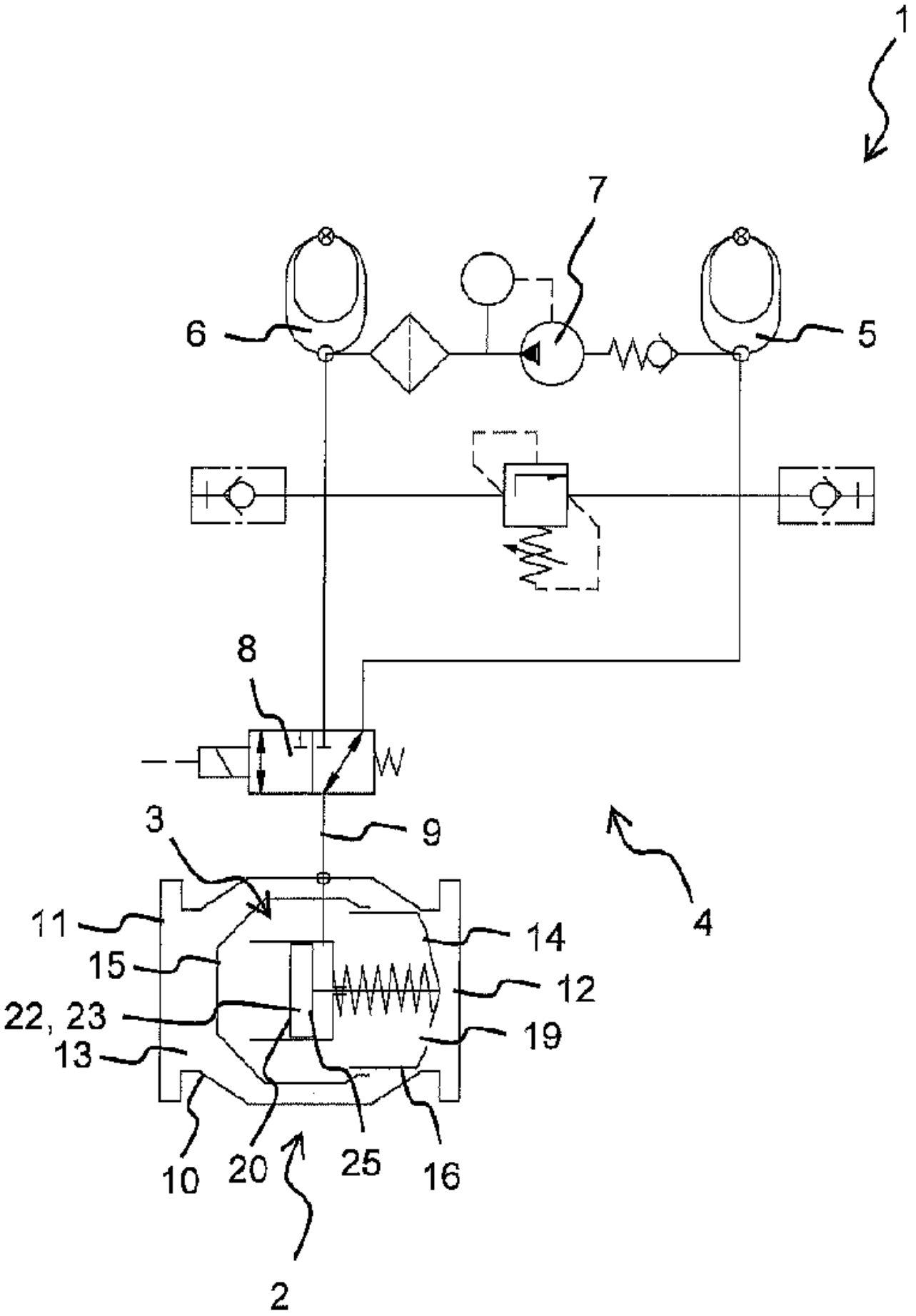
Fig. 7

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