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(54) Title: CONTROL OF SUPPLY OF AIR TO A PNEUMATIC VALVE ACTUATOR

(57) Abstract: A technology is disclosed for controlling the function of a pneumatic valve actuator (14). The piston (22) of the valve actuator (14) is biased to be in first state (44) and move to a second state (46) when pressurized. A conduit (28) connects the pressure side (24) and non-pressure sides (26) of the valve actuator (14) for supplying the non-pressure side (26) of the valve actuator (14) with gas from the pressure side (24) of the valve actuator (14). A control valve (30) is connected to the conduit (28) for controlling a release of gas from the pressure side (24) of the valve actuator (14). The valve controller (14) also has pressure-relief valve (32) connected to the conduit (28) between the control valve (30) and the non-pressure side (26) of the valve actuator (14) for reducing the pressure in the conduit (28).

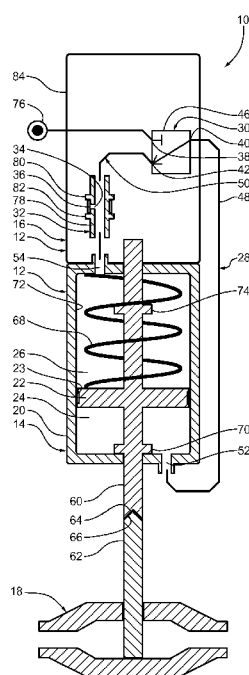


Fig. 1a



CONTROL OF SUPPLY OF AIR TO A PNEUMATIC VALVE ACTUATOR

Technical Field

The invention relates to the control of pneumatic valve actuators that are biased to be in a de-energized state. In particular, it relates to a control of the supply and discharge of gas of the pressure and non-pressure sides of such a valve actuator.

5

Background Art

Automated valve systems are commonly used today in great variety of applications. In many of these, the valve is controlled by a pneumatically operated valve actuator having a cylinder and a piston that moves inside the cylinder, wherein the piston is biased to be in a de-energized or resting state. Typically, this is achieved by mechanical means, for example by a coil spring located inside the cylinder and acting on the piston. Compressed air enters the pressure side of the actuator and moves the piston to an energized or activated state. At the same time, air on the non-pressure side of the actuator escapes from the cylinder to prevent pressure from building up on the non-pressure side. When the pressure is released on the pressure side, the compressed air escapes and the piston moves from the energized state to the de-energized state. At the same time, air enters the non-pressure side.

In the described actuators, the piston typically has a gasket preventing pressurized gas from leaking from the pressure side to the non-pressure side inside the cylinder. Air enters the non-pressure side from the surrounding atmosphere. However, the air typically contains particles and dust that also enters the non-pressure side and that accumulate inside the cylinder, which results in wear on the gasket that reduces the service lifetime of the valve actuator. This is considered being one of the more common reasons for gasket failure.

Many existing valves and actuators are installed in tight spaces with little room for retrofitting, such as additional tubing or extra components. Thus, there is a need for a solution located close the valve actuators and that requires as little space as possible.

30 Summary

It is an object of the invention to at least partly overcome one or more of the above-identified limitations of known techniques. In particular, it is an object to prevent air of the surrounding atmosphere from entering the non-pressure side of a valve actuator. It also an object to provide a solution at the valve actuator that requires little

or no additional space, and that can be installed in close proximity to the valve actuator. It is also an object to provide a solution that is suitable for retrofitting.

To meet the above objects, an assembly comprising a valve actuator and an actuator controller for controlling the function of the valve actuator is provided. The valve actuator is pneumatically operated, configured for being operatively connected to a valve, and comprises a cylinder and a piston movable inside the cylinder. The valve actuator has a pressure side and a non-pressure side separated by the piston, and the piston is biased to be in a first position and is configured to move to a second position at a pressure increase on the pressure side of the valve actuator.

10 The actuator controller comprises a conduit connecting the pressure and non-pressure sides of the valve actuator for supplying the non-pressure side of the valve actuator with gas from the pressure side of the valve actuator. The actuator controller also comprises a control valve connected to the conduit between the pressure and non-pressure sides for controlling a release of gas from the pressure side of the valve actuator into the conduit. Additionally, the actuator controller also comprises a pressure-relief valve connected to the conduit between the control valve and the non-pressure-side of the valve actuator for reducing the pressure in the conduit.

The conduit has the effect that clean air from the pressure side of the actuator enters the non-pressure side when the piston moves from the second position to the first position. Typically, the displaced volume of gas is the same on the pressure side and the non-pressure side when the piston moves between the two states, but with an increase on one side and a decrease on the other side. The pressure is higher on the pressure side, which means that no additional source of gas, such as the surrounding atmosphere, is necessary for filling the non-pressure side when the piston moves from the second position to the first position. Thus, particles and dust from the surrounding atmosphere, or any other source of gas, are prevented from entering the cylinder of the valve actuator.

The pressure-relief valve reduces the pressure in the conduit so that the non-pressure side can have a lower pressure. This way, the conduit will have little or no effect on the function of the valve actuator, which means that the valve actuator can be constructed without taking the conduit into account. Thus, the actuator controller is suitable for a retrofitting, as described below.

The actuator controller may be located at the valve actuator. This is possible since the conduit is required only to stretch from the pressure side to the non-pressure side and a pressure relief valve can be made small. Thus, no centralized control or

extended piping system is required. The conduit may have a length of the same order of magnitude as the length of cylinder of the valve actuator. For example, the length of the conduit may be less than two times the length of the cylinder, four times the length of the cylinder, six times the length of the cylinder, or eight times the length of the
5 cylinder. Thus, the space required by the conduit is limited.

The control valve may comprise: an inlet for being connected to and receive a pressurized gas from a pressure source, a combined inlet and outlet, and an outlet. The control valve further has a first state in which it can lead pressurized gas from the inlet to the combined inlet and outlet and a second state in which it can lead
10 pressurized gas from the combined inlet and outlet to the outlet. The conduit may further comprise: a first conduit section connecting the combined inlet and outlet of the control valve to the pressure side of the valve actuator, and a second conduit section connecting the outlet of the control valve and to the non-pressure side of the valve actuator, wherein the pressure-relief valve forms part of the second conduit section.
15 This means that the supplying of gas from the pressure side to the non-pressure side can be controlled by the same control valve that controls the function of the valve actuator. Thus, no additional control valve is required, which would have required space at the valve actuator.

The valve actuator may further comprise: a first combined inlet and outlet for
20 allowing gas to enter and escape the pressure side of the valve actuator, wherein the first combined inlet and outlet is connected to the first conduit section. It may also further comprise: a second combined inlet and outlet for allowing gas to enter and escape the non-pressure side of the valve actuator, wherein the second combined inlet and outlet is connected to the second conduit section. For valve actuators of the
25 specified type, the proposed first and second conduit sections minimizes the number of conduit parts required for supplying gas from the pressure side to the non-pressure side, thus also minimizing the required space.

The above objects are also met by an actuator controller for controlling the function of a valve actuator. The valve actuator is pneumatically operated, configured
30 for being operatively connected to a valve, and comprises a cylinder and a piston movable inside the cylinder. The valve actuator further has a pressure side and a non-pressure side separated by the piston, and the piston is biased to be in a first position and is configured to move to a second position at a pressure increase on the pressure side of the valve actuator.

The actuator controller comprises: a conduit configured for connecting the pressure and non-pressure sides of the valve actuator for supplying the non-pressure side of the valve actuator with gas from the pressure side of the valve actuator. The actuator further comprises: a control valve connected to the conduit between the
5 pressure and non-pressure sides for controlling a release of gas from the pressure side of the valve actuator into the conduit. Additionally, the actuator controller comprises: a pressure-relief valve connected to the conduit between the control valve and the non-pressure-side of the valve actuator and configured for reducing the pressure in the conduit.

10 The described features of the actuator controller have the same effects as the corresponding features described above in relation to the assembly.

The control valve of the actuator controller may comprise: an inlet for being connected to and receive a pressurized gas from a pressure source, a combined inlet and outlet, and an outlet. The control valve further has a first state in which it can lead
15 pressurized gas from the inlet to the combined inlet and outlet and a second state in which it can lead pressurized gas from the combined inlet and outlet to the outlet. Additionally, the conduit may comprise: a first conduit section configured for connecting the combined inlet and outlet of the control valve to the pressure side of the actuator, and a second conduit section configured for connecting the outlet of the control valve
20 and to the non-pressure side of the valve actuator, wherein the pressure-relief valve forms part of the second conduit section. Thus, no additional control valve is required for supplying gas from the pressure side to the none-pressure side, as described above, and the actuator controller can be made smaller.

The valve actuator may further comprise: a first combined inlet and outlet for
25 allowing gas to enter and escape the pressure side of the valve actuator, and the first conduit section may be configured for being connected to the first combined inlet and outlet. Additionally, the valve actuator may further comprises: a second combined inlet and outlet for allowing gas to enter and escape the non-pressure side of the valve actuator, and the second conduit section may be configured for being connected to the
30 second combined inlet and outlet. As described above, this contributes to minimizing the required space for the supply of gas from the pressure side to the non-pressure side of the valve actuator.

To meet the above objects, a valve system is also provided comprising a valve and the assembly described above operatively connected to the valve.

The above objects are also met by a method of retrofitting a pressure-relief valve in an assembly comprising a valve actuator and an actuator controller for controlling the function of the valve actuator. The valve actuator is pneumatically operated, configured for being operatively connected to a valve, and comprises a
5 cylinder and a piston movable inside the cylinder. The valve actuator further has a pressure side and a non-pressure side separated by the piston, and the piston is biased to be in a first position and is configured to move to a second position at a pressure increase on the pressure side of the valve actuator.

The actuator controller comprises a control valve for controlling a release of gas
10 from the pressure side of the valve actuator, wherein the control valve comprises an inlet for being connected to and receive a pressurized gas from a pressure source, a combined inlet and outlet, and an outlet. The control valve has a first state in which it can lead pressurized gas from the inlet to the combined inlet and outlet and a second state in which it can lead pressurized gas from the combined inlet and outlet to the
15 outlet. The assembly further comprises a first conduit section connecting the combined inlet and outlet of the control valve to the pressure side of the actuator.

The method comprises: providing second conduit section and a pressure-relief valve forming part of the second conduit section, and establishing a connection
20 between the outlet of the control valve and the non-pressure side of the valve actuator with the second conduit section. The first conduit section, the control valve, the second conduit section, and the pressure-relief valve form parts of a conduit connecting the pressure and non-pressure sides of the valve actuator for supplying the non-pressure side of the valve actuator with gas from the pressure side of the valve actuator. The pressure-relief valve is further configured for reducing the pressure in the second
25 conduit section. The pressure-relief valve may form a part of the second conduit section.

The described method results in a pressure-relief valve being connected to the conduit between the control valve and the non-pressure-side of the valve actuator. The method also results in the control valve being connected to the conduit between the
30 pressure and non-pressure sides of the valve actuator, thereby allowing for a controlling of a release of gas from the pressure side of the valve actuator into the conduit. Thus, the described method of retrofitting a pressure relief valve results in an actuator controller as described above prior to the method.

The valve actuator in the described method may comprise a first combined inlet
35 and outlet for allowing gas to enter and escape the pressure side of the valve actuator

and a second combined inlet and outlet for allowing gas to enter and escape the non-pressure side of the valve actuator. The first combined inlet and outlet may be connected to the first conduit section, and the method may further comprise: establishing a connection between the outlet of the control valve and the second
5 combined inlet and outlet with the second conduit section. This contributes to minimizing the required space for the supply of gas from the pressure side to the non-pressure side of the valve actuator, as described above.

In the different aspects of the proposed technology above, i.e. the described assembly, actuator controller, valve system, and method of retrofitting, the pressure-
10 relief valve may be a non-return valve configured to prevent air from the surrounding atmosphere from entering the conduit. In the event pressure equilibrium is reached between the pressure side and the non-pressure side before the piston reaches the first position when moving from the second position, the non-return valve prevents air from the surrounding atmosphere, thus also dust and particles, from entering the
15 conduit and the cylinder of the valve actuator.

The pressure-relief valve may further be configured to reduce the pressure in the conduit to a pressure level at the pressure level of the surrounding atmosphere. This way, the pressure on the non-pressure side will not raise significantly above the ambient pressure, either when supplied with air from the pressure side, or when the
20 piston moves from the first state to the second state and the volume on the non-pressure side is reduced. This means that the conduit will not influence the function of a valve actuator originally constructed for receiving air from the surrounding atmosphere from the surroundings on the non-pressure side, or for that matter constructed for expelling gas from the non-pressure side to the surrounding
25 atmosphere. Thus, the described pressure relief valve is suitable for a retrofitting on this kind of valve actuators

In the different aspects of the proposed technology, the pressure-relief valve may comprise an aperture for allowing gas to be released from the conduit to the surrounding atmosphere and a flexible membrane covering and pressing against the
30 aperture for preventing air from the surrounding atmosphere from entering the conduit. This pressure-relief valve has the advantage that they require little space.

The piston may be mechanically biased to be in a first position. Further, the valve actuator may comprise a coil spring located inside the actuator and on the non-pressure side of the actuator, wherein the coil spring engages the piston for biasing the
35 piston in the first position. The piston may comprise a slidable gasket for preventing

pressurized air on the pressure side to leak into the non-pressure side inside the cylinder. This is different from linear membrane actuators that do not rely on piston moving inside a cylinder. In the different aspects described above, the control valve may constitute a part of the conduit. Similarly, the pressure-relief valve may constitute
5 a part of the conduit.

Still other objectives, features, aspects and advantages of the invention will appear from the following detailed description as well as from the drawings.

Brief Description of the Drawings

10 Embodiments of the invention will now be described, by way of example, with reference to the accompanying schematic drawings, in which

Fig.1a is a schematic cross-sectional view of a valve system having a valve actuator in a first position corresponding to a de-energized state,

15 Fig.1b is schematic cross-sectional view of the valve system shown in Fig.1a, but with the valve actuator in a second position corresponding to an energized state,

Fig.2a is a schematic cross-sectional view of a valve system without a pressure-relief valve and having a valve actuator in a first position corresponding to a de-energized state,

20 Fig.2b is schematic cross-sectional view of the valve system shown in Fig.2a, but with the valve actuator, and being in a second position corresponding to an energized state,

Fig.3a is a schematic cross-sectional view of the valve system shown in Fig.2a with a retrofitted pressure-relief valve and having a valve actuator in a first position corresponding to a de-energized state, and

25 Fig.3b is schematic cross-sectional view of the valve system shown in Fig.3a, but with the valve actuator in a second position corresponding to an energized state.

Detailed description

A schematic view of a valve system 10 is shown in Figs. 1a and 1b. The valve
30 system 10 has valve 18 and an assembly 12 composed of a valve actuator 14 and an actuator controller 16. The valve actuator 14 has a cylinder 20 and a piston 22 separating the valve actuator 14 into a pressure side 24 and a non-pressure side 26. The piston has a slidable gasket 23 engaging the wall 72 of the cylinder 20 and that prevents pressurized gas from leaking from the pressure side 24 to the non-pressure
35 side 26 inside the cylinder 20.

The piston 22 has a piston rod 60 connected to a valve stem 62 of the valve 18, and when the piston moves the stem opens and closes the valve 18, as shown in Figs.1a and 1b. The piston rod 60 has a threaded bore 64 and the valve stem 62 has a cooperating threaded end 66 that is screwed into the threaded bore 64, thereby
5 operatively connecting the piston 22 to the valve 18.

A coil spring 68 is located inside the cylinder on the non-pressure side 26 and acting on the wall 72 of the cylinder 14 and on the piston 22, as illustrated in Fig.1a showing the valve actuator 14 in the de-energized state. The piston rod 60 has a lower disc 70 inside the cylinder 20 that rests on the wall 72 of the cylinder 20 and prevents
10 the piston 22 from moving further. Thus, the piston 22 is biased to be in a first position. The piston rod 60 also has an upper disc 74 inside the cylinder. When the pressure is increased on the pressure side 24 of the actuator 14 and the force of the coil spring 68 acting on the piston 22 is surpassed, the piston 22 moves from the first position until the upper disc 74 reaches the wall 72 of the cylinder 20, thus preventing any further
15 movement of the piston 22. Thus, the valve actuator 14 is energized and the piston 22 has moved and reached a second position. At the same time, the piston rod 60 has pulled the valve stem 62 and opened the valve 18.

The valve actuator 14 has a first combined inlet and outlet 52 that allows gas to enter and escape the cylinder 20 on the pressure side 24 of the valve actuator 14.
20 Similarly, the valve actuator 14 has a second combined inlet and outlet 54 that allows gas to enter and escape the cylinder 20 on the non-pressure side 26 of the valve actuator 14.

The actuator controller 16 has a control valve 30 in the form of a solenoid valve that controls the function of the valve actuator 14. The control valve 30 has an inlet 38
25 connected to an external source 76 of compressed air not forming part of the valve system 10. The control valve 30 further has a combined inlet and outlet 40 that is connected to the first combined inlet and outlet 52 of the valve actuator 14 by a first conduit section 48, thus also connecting the combined inlet and outlet 40 to the pressure side 24 of the valve actuator 14. The control valve 30 also has an outlet 42
30 that is connected to the second combined inlet and outlet 54 of the valve actuator 14 by a second conduit section 50, thereby connecting the outlet 42 to the non-pressure side 24 of the valve actuator 14.

The control valve 30 has a first state 44, which is schematically illustrated in Fig.1b, and a second state, which is schematically illustrated in Fig.1a. In the first state,
35 the control valve 30 leads compressed air from the inlet 38 to the combined inlet and

outlet 40, thus increasing the pressure on the pressure 24 side of the actuator 14, which causes the piston 22 to move from the first position illustrated in Fig.1a to its second position illustrated in Fig.1b. When switched to its second state 46, the control valve leads the compressed air on the pressure side 24 from its combined inlet and outlet 40 to its outlet 42. The pressure on the pressure side 24 of the actuator then decreases, thus causing the piston 22 to move from the second position illustrated in Fig.1b to its first position illustrated in Fig.1a.

A pressure-relief valve 32 is located between the control valve 30 and the non-pressure-side 26 side of the valve actuator 14 and constitutes a part of the second conduit section 50, as shown in Figs.1a and 1b. The pressure-relief valve 32 has an aperture 34 that releases some of the compressed air from the control valve 30 to the surrounding atmosphere, thus reducing the pressure in the second conduit section 50. Additionally, when the piston 22 moves from the first position shown in Fig.1a to the second position shown in Fig.1b, the gas on the non-pressure side 26 is vented through the aperture 34 of the pressure-relief valve 32.

The pressure-relief valve 32 has a circular symmetric cylindrical hollow body 78 with two outward facing annular ridges 80 and 82 on either side of the aperture 34. An annular flexible membrane 36 in the form of a ring-shaped rubber band is positioned between and held in place by the ridges 80 and 82. The flexible membrane 36 has a circumference that is slightly smaller than the circumference of the body 78, thus covering and pressing against the aperture 34 so that air from the surrounding atmosphere is prevented from entering the second conduit section 50. This means that the pressure-relief valve 32 has the function of non-return valve. The flexible membrane 36 has a flexibility that allows for the pressure inside the second conduit section 50 to reach the pressure of the surrounding atmosphere, or a slightly higher pressure.

The first conduit section 48, the control valve 30, the second conduit section 50, and the pressure-relief valve 32 form parts of a conduit 28 that connects the pressure side 24 and non-pressure side 26 of the valve actuator 14 that supplies the non-pressure side 26 of the valve actuator with air from the pressure side 24 of the valve actuator 14. The conduit 28 has the effect that the non-pressure side 26 of the valve actuator 14 will be supplied with non-compressed air from the external source of compressed air 76 via the pressure side 24 of the valve actuator 14. Thus no dust or particles of the surrounding atmosphere will enter the cylinder 20 of the valve actuator 14. Thus, wear on the gasket 23 is reduced and the service lifetime of the valve

actuator 14 is increased. It should be noted that air is typically filtered when compressed in compressor and no dust or particles from the surrounding atmosphere will enter the valve actuator 14 via such a source.

5 A valve system 10' is shown in Figs.2a and 2b that is assumed to be existing. Features having the same function as in the previously described embodiment have been given the same number indexing. Features having similar or related function have also been given the same number indexing, but with a prime.

10 The actuator controller 16' has a housing 84 that is attached to the valve actuator 14 and in which the control valve 30 and the second conduit section 50 with the pressure-relief valve 32 are situated. The housing 84 is ventilated so that air in the surrounding atmosphere can enter and escape the housing 84.

15 The valve system 10' differs from the previous embodiment in that the actuator controller 16' has no second conduit section with a pressure relief valve that connects the outlet 42 of the control valve 30 to the second combined inlet and outlet of the valve actuator 54. Instead, an outlet conduit 86 is coupled to the control valve 30. The outlet conduit 86 is connected at one end to the outlet 42 of the control valve 30. Its other end is outside the housing 84 of the actuator controller 16' and opens to the surrounding atmosphere. Thus, when the control valve is in its first state 44, as shown in Fig.2a, 20 compressed air on the pressure side 24 of the valve actuator 14 is vented via the first conduit section 48, the control valve 30, and the outlet conduit 86 into the surrounding atmosphere.

25 A combined inlet and outlet conduit 88 is coupled to the valve actuator 14. At one end it is connected to the second combined inlet and outlet 54 of valve actuator 14. Its other end is outside the housing 84 of the actuator controller 16' and opens to the surrounding atmosphere. Thus, when the piston 22 moves from the first position shown in Fig.2a to the second position shown in Fig.2b, the gas on the non-pressure side 26 is vented through combined inlet and outlet conduit 88 into the surrounding atmosphere. When the piston 22 moves from the second position shown in Fig.2b to the first position shown in Fig.2a, air from the surrounding atmosphere is sucked into the cylinder 20 on the non-pressure side 26 via the combined inlet and outlet conduit 88, resulting in long term accumulation of dust and particles inside of the cylinder 20 that causes wear on the gasket 23.

35 Another embodiment of a valve system 10' is shown in Figs.3a and 3b. The valve system has all the features of the valve system 10' described above in relation in

Figs.2a and 2b. Features having the same function as in the embodiment described in relation to Figs.1a and 1b have been given the same number indexing, while features having similar or related function have been given the same number indexing, but with a prime.

5 A pressure-relief valve 32 has been connected to the outlet conduit 86 and the combined inlet and outlet conduit 88 on the outside of the housing 84 of actuator controller 16, thus constituting a retrofitting of the pressure-relief valve 32 to the valve system 10', as shown in Figs.3a and 3b. The outlet conduit 86, the pressure-relief valve 32, and the combined inlet and outlet conduit 88 forms a conduit section 50'. The
10 retrofitting thus results in a valve system 10' having all the functions of the valve system 10 described in relation to Figs.1a and 1b. Effectively, a second conduit section 50' with a pressure-relief valve 32 has been provided. Also, a connection between the outlet 42 of the control valve 30 and the second combined inlet and outlet 54 on the non-pressure side 26 of the valve actuator 14 has been established with the second
15 conduit section 50'.

From the description above follows that, although various embodiments of the invention have been described and shown, the invention is not restricted thereto, but may also be embodied in other ways within the scope of the subject-matter defined in the following claims.

20

ITEM LIST

- 10 valve system
- 12 assembly
- 14 valve actuator
- 25 16 actuator controller
- 18 valve
- 20 cylinder
- 22 piston
- 23 gasket
- 30 24 pressure side
- 26 non-pressure side
- 28 conduit
- 30 control valve
- 32 pressure-relief valve
- 35 34 aperture

- 36 flexible membrane
- 38 inlet of control valve
- 40 combined inlet and outlet of control valve
- 42 outlet of control valve
- 5 44 first state
- 46 second state
- 48 first conduit section
- 50 second conduit section
- 52 first combined inlet and outlet of valve actuator
- 10 54 second combined inlet and outlet of valve actuator
- 60 piston rod
- 62 valve stem
- 64 threaded bore
- 66 threaded end
- 15 68 coil spring
- 70 lower disc
- 72 cylinder wall
- 74 upper disc
- 76 external source of compressed air
- 20 78 body of pressure-relief valve
- 80 ridge
- 82 ridge
- 84 housing of actuator controller
- 86 outlet conduit
- 25 88 combined inlet and outlet conduit

CLAIMS

1. An assembly (12) comprising a valve actuator (14) and an actuator controller (16) for controlling the function of the valve actuator (14), wherein the valve actuator (14) is pneumatically operated, configured for being operatively connected to a valve (18), and comprises a cylinder (20) and a piston (22) movable inside the cylinder (20), the valve actuator (14) has a pressure side (24) and a non-pressure side (26) separated by the piston (22), the piston (22) is biased to be in a first position and is configured to move to a second position at a pressure increase on the pressure side (24) of the valve actuator (14), and wherein the actuator controller (16) comprises:
- a conduit (28) connecting the pressure and non-pressure sides (24, 26) of the valve actuator (14) for supplying the non-pressure side (26) of the valve actuator (14) with gas from the pressure side (24) of the valve actuator (14),
 - a control valve (30) connected to the conduit (28) between the pressure and non-pressure sides (24, 26) for controlling a release of gas from the pressure side (24) of the valve actuator (14) into the conduit (28), and
 - a pressure-relief valve (32) connected to the conduit (28) between the control valve (30) and the non-pressure side (26) of the valve actuator (14) for reducing the pressure in the conduit (28).
2. The assembly (12) according to claim 1, wherein the control valve (30) comprises:
- an inlet (38) for being connected to and receive a pressurized gas from a pressure source (76),
 - a combined inlet and outlet (40), and
 - an outlet (42),
- wherein the control valve (30) has a first state (44) in which it can lead pressurized gas from the inlet (38) to the combined inlet and outlet (40) and a second state (46) in which it can lead pressurized gas from the combined inlet and outlet (40) to the outlet (42), and wherein the conduit (28) comprises:
- a first conduit section (48) connecting the combined inlet and outlet (40) of the control valve (30) to the pressure side (24) of the valve actuator (14), and
 - a second conduit section (50) connecting the outlet (42) of the control valve (30) and to the non-pressure side (26) of the valve actuator (14), wherein the pressure-relief valve (32) forms part of the second conduit section (50).

3. The assembly (12) according to claim 2, wherein the valve actuator (14) comprises:

5 a first combined inlet and outlet (52) for allowing gas to enter and escape the pressure side (24) of the valve actuator (14), wherein the first combined inlet and outlet (52) is connected to the first conduit section (48), and

a second combined inlet and outlet (54) for allowing gas to enter and escape the non-pressure side (26) of the valve actuator (14), wherein the second combined inlet and outlet (54) is connected to the second conduit section (50).

10

4. The assembly (12) according to any of the claims 1-3, wherein the pressure-relief valve (32) is a non-return valve configured to prevent air from the surrounding atmosphere from entering the conduit (28).

15 5. The assembly (12) according to claim 4, wherein the pressure-relief valve (32) is configured to reduce the pressure in the conduit (28) to a pressure level at the pressure level of the surrounding atmosphere.

20 6. The assembly (12) according to any of the claims 1-5, wherein the pressure-relief valve (32) comprises an aperture (34) for allowing gas to be released from the conduit (28) to the surrounding atmosphere and a flexible membrane (36) covering and pressing against the aperture (34) for preventing air from the surrounding atmosphere from entering the conduit (28).

25 7. An actuator controller (16) for controlling the function of a valve actuator (14), wherein the valve actuator (14) is pneumatically operated, configured for being operatively connected to a valve (18), and comprises a cylinder (20) and a piston (22) movable inside the cylinder (20), the valve actuator (14) has a pressure side (24) and a non-pressure side (26) separated by the piston (22), the piston (22) is biased to be in a first position and is configured to move to a second position at a pressure increase on the pressure side (24) of the valve actuator (14), and wherein the actuator controller (16) comprises:

30

a conduit (28) configured for being connected the pressure and non-pressure sides (24, 26) of the valve actuator (14) for supplying the non-pressure side

(26) of the valve actuator (14) with gas from the pressure side (24) of the valve actuator (14),

a control valve (30) connected to the conduit (28) between the pressure and non-pressure sides (24, 26) for controlling a release of gas from the pressure side (24) of the valve actuator (14) into the conduit (28), and

a pressure-relief valve (32) connected to the conduit (28) between the control valve (30) and the non-pressure-side (26) of the valve actuator (14) and configured for reducing the pressure in the conduit (28).

8. The actuator controller (16) according to claim 7, wherein the control valve (30) comprises:

an inlet (38) configured for being connected to and receive a pressurized gas from a pressure source (76),

a combined inlet and outlet (40), and

an outlet (42),

wherein the control valve (30) has a first state (44) in which it can lead pressurized gas from the inlet (38) to the combined inlet and outlet (40) and a second state (46) in which it can lead pressurized gas from the combined inlet and outlet (40) to the outlet (42), and wherein the conduit (28) comprises:

a first conduit section (48) configured for connecting the combined inlet and outlet (40) of the control valve (30) to the pressure side (24) of the actuator (14), and

a second conduit section (50) configured for connecting the outlet (42) of the control valve (30) and to the non-pressure side (26) of the valve actuator (14), wherein the pressure-relief valve (32) forms part of the second conduit section (50).

9. The actuator controller (16) according to claim 8, wherein the valve actuator (14) comprises:

a first combined inlet and outlet (52) for allowing gas to enter and escape the pressure side (24) of the valve actuator (14), wherein the first conduit section (48)

is configured for being connected to the first combined inlet and outlet (52), and

a second combined inlet and outlet (54) for allowing gas to enter and escape the non-pressure side (26) of the valve actuator (14), wherein the second conduit section (50) is configured for being connected to the second combined inlet and outlet (54).

10. The actuator controller (16) according to any of the claims 7-9, wherein the pressure-relief valve (32) is a non-return valve configured to prevent air from the surrounding atmosphere from entering the conduit (28).
- 5 11. The actuator controller (16) according to any of the claims 7-10, wherein the pressure-relief valve (32) is configured to reduce the pressure in the conduit (28) to a pressure level at the pressure level of the surrounding atmosphere.
12. The actuator controller (16) according to any of the claims 7-11, wherein
10 the pressure-relief valve (32) comprises an aperture (34) for allowing gas to be released from the conduit (28) to the surrounding atmosphere and a flexible membrane (36) covering and pressing against the aperture (34) for preventing air from the surrounding atmosphere from entering the conduit (28).
- 15 13. A valve system (10) comprising a valve (18) and an assembly (12) according to any of the claims 1-6 operatively connected to the controlling the valve.
14. A method of retrofitting a pressure-relief valve (32) in an assembly (12) comprising a valve actuator (14) and an actuator controller (16) for controlling the
20 function of the valve actuator (14), wherein the valve actuator (14) is pneumatically operated, configured for being operatively connected to a valve, and comprises a cylinder (20) and a piston (22) movable inside the cylinder (20), wherein the valve actuator (14) has a pressure side (24) and a non-pressure side (26) separated by the piston (22), the piston (22) is biased to be in a first position and is configured to move
25 to a second position at a pressure increase on the pressure side (24) of the valve actuator (14), and wherein the actuator controller (16) comprises: a control valve (30) for controlling a release of gas from the pressure side (24) of the valve actuator (14), wherein the control valve (30) comprises an inlet (38) for being connected to and receive a pressurized gas from a pressure source (76), a combined inlet and outlet
30 (40), and an outlet (42), wherein the control valve (30) has a first state (44) in which it can lead pressurized gas from the inlet (38) to the combined inlet and outlet (40) and a second state (46) in which it can lead pressurized gas from the combined inlet and outlet (40) to the outlet (42), the assembly (12) further comprises a first conduit section (48) connecting the combined inlet and outlet (40) of the control valve (30) to the
35 pressure side (24) of the actuator (14), and wherein the method comprises:

providing second conduit section (50) and a pressure-relief valve (32) forming part of the second conduit section (50), and

establishing a connection between the outlet (42) of the control valve (30) and the non-pressure side (26) of the valve actuator (14) with the second conduit section (50),

5 wherein the first conduit section (48), the control valve (30), the second conduit section (50), and the pressure-relief valve (32) form parts of a conduit (28) connecting the pressure and non-pressure sides (24, 26) of the valve actuator (14) for supplying the non-pressure side (26) of the valve actuator (14) with gas from the pressure side (24) of the valve actuator (14), wherein the a pressure-relief valve (32) is configured for
10 reducing the pressure in the second conduit section (50).

15. The method according to claim 14, wherein the valve actuator (14) comprises a first combined inlet and outlet (52) for allowing gas to enter and escape
15 the pressure side (24) of the valve actuator (14) and a second combined inlet and outlet (54) for allowing gas to enter and escape the non-pressure side (26) of the valve actuator (14), wherein the first combined inlet and outlet (52) is connected to the first conduit section (48), and wherein the method comprises:

establishing a connection between the outlet (42) of the control valve (30)
20 and the second combined inlet and outlet (54) with the second conduit section (50).

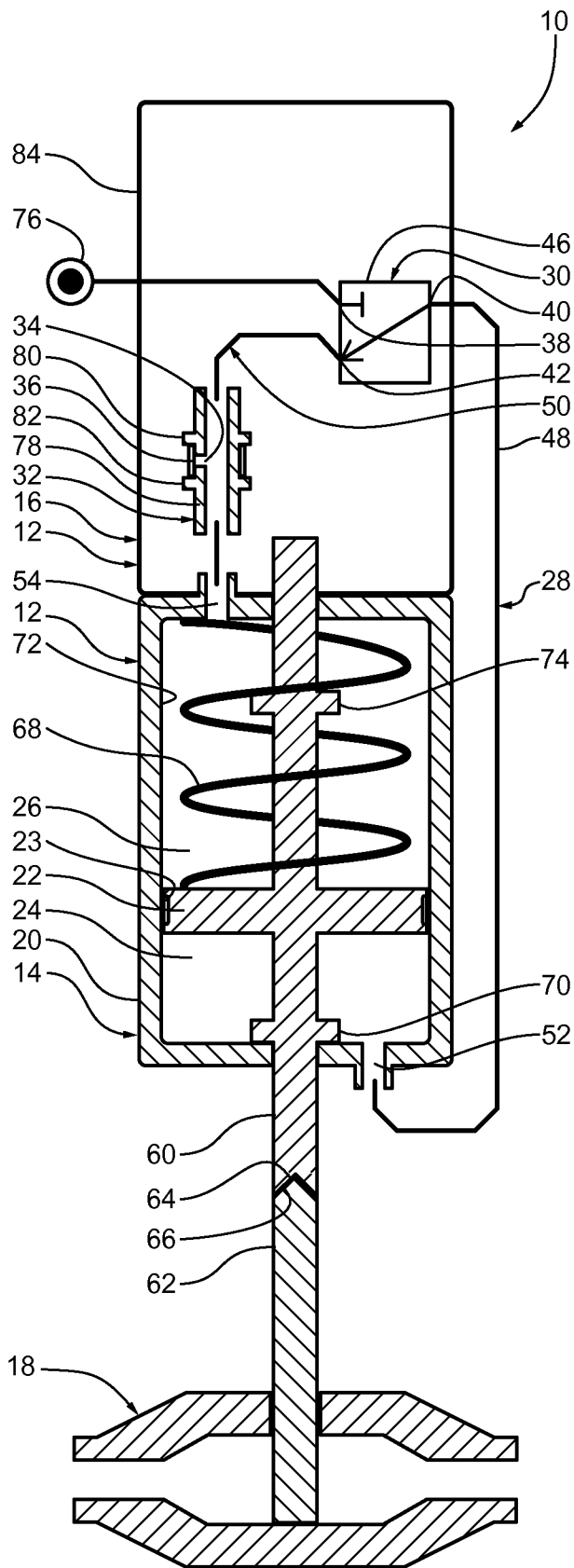


Fig.1a

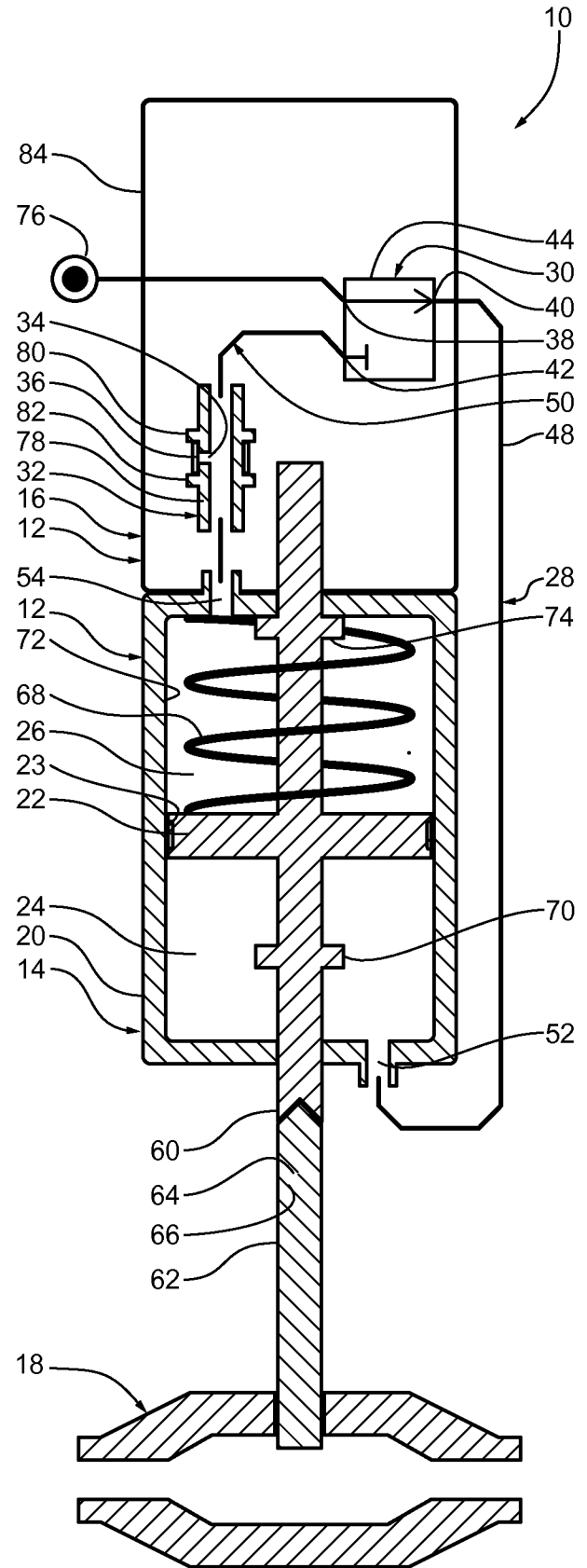


Fig.1b

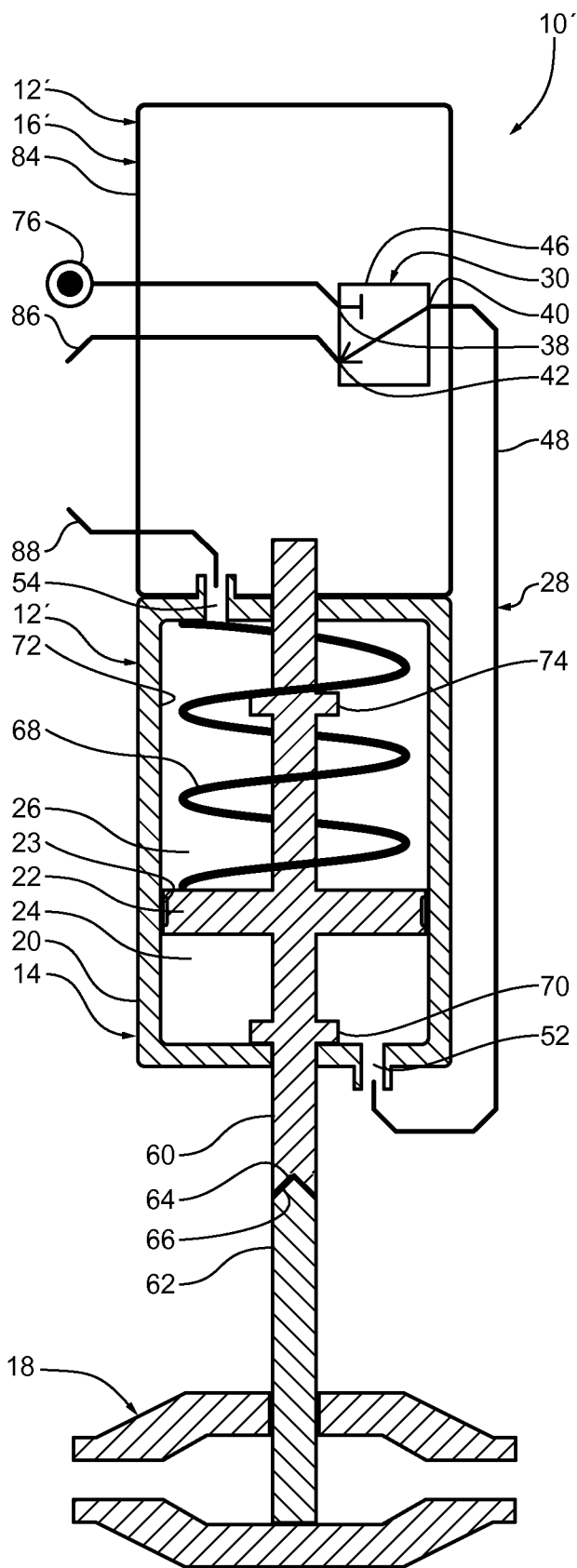


Fig.2a

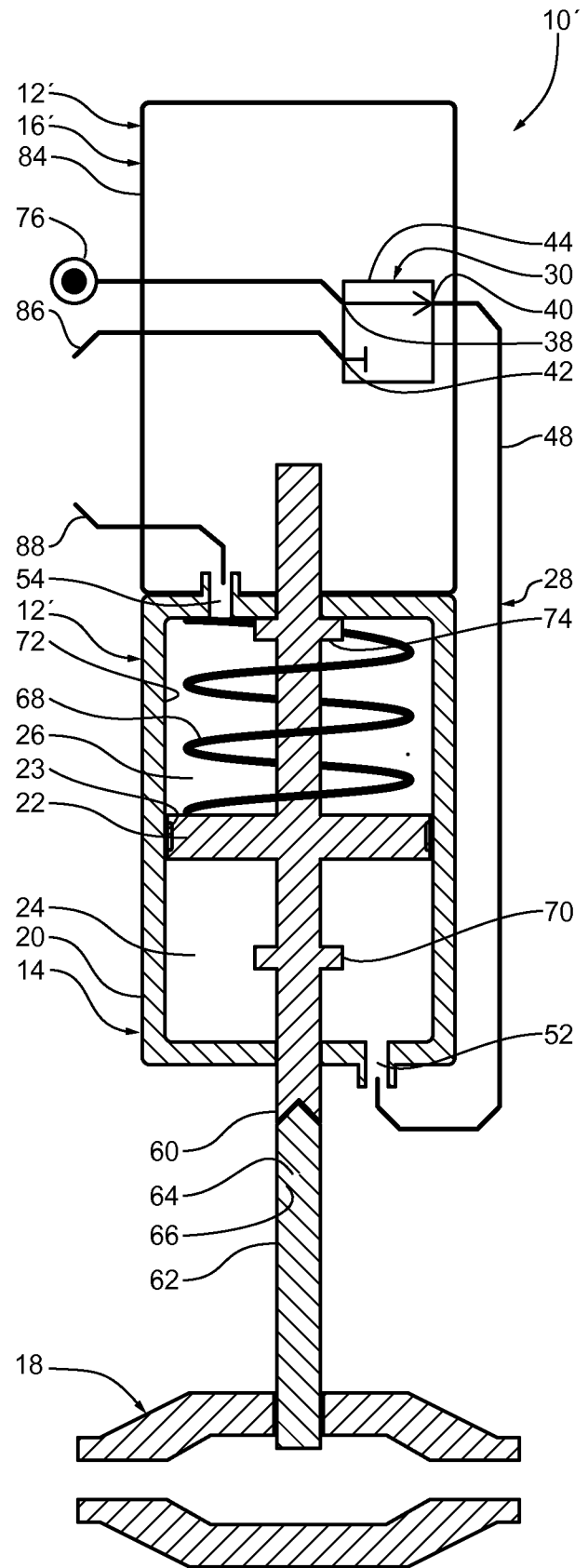


Fig.2b

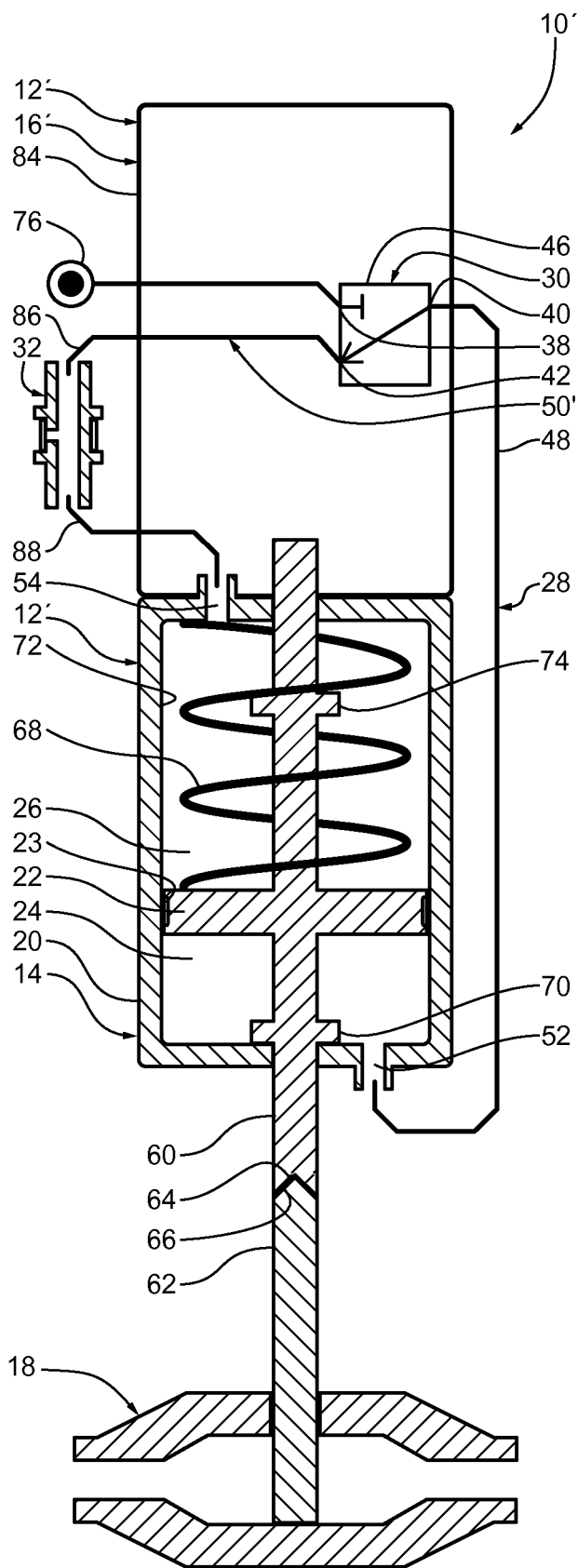


Fig.3a

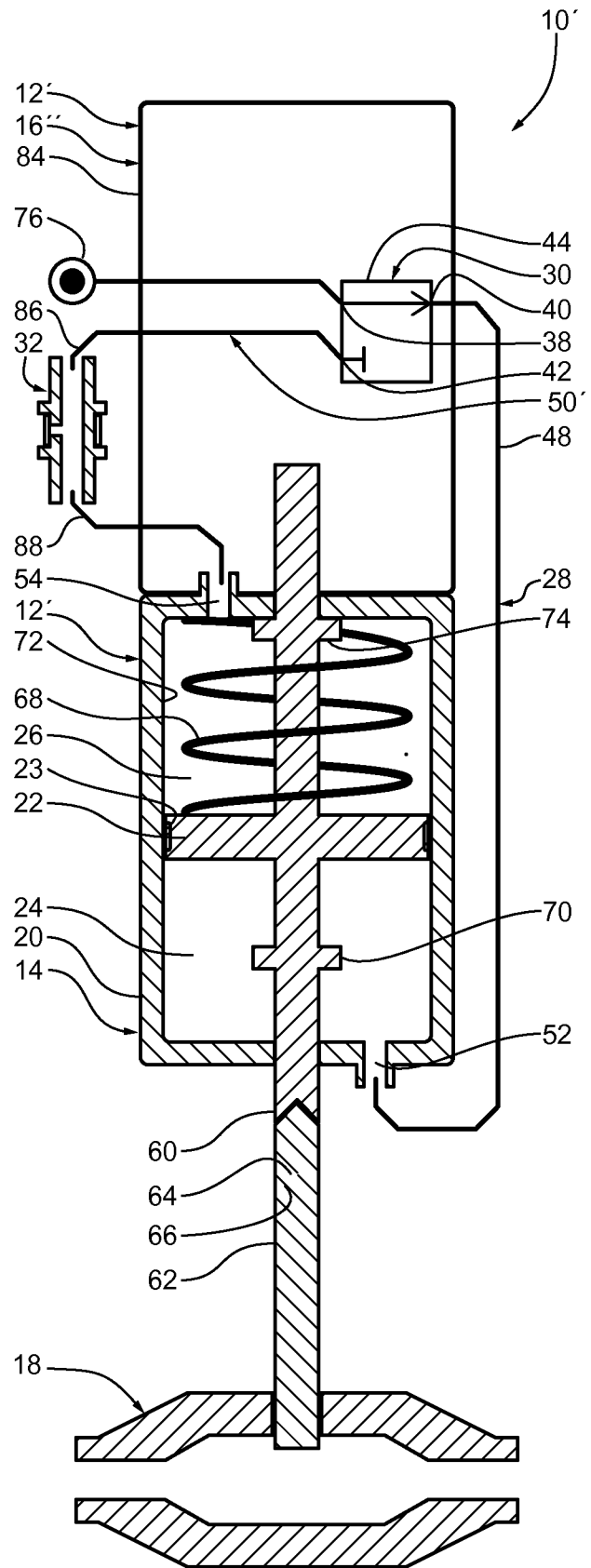


Fig.3b

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/062233

A. CLASSIFICATION OF SUBJECT MATTER
INV. F16K31/122
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F16K F15B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2005 282712 A (DAINIPPON SCREEN MFG) 13 October 2005 (2005-10-13) abstract; figures -----	1,7,14
A	US 3 456 561 A (LAIKAM WILLIAM JR) 22 July 1969 (1969-07-22) the whole document -----	1,7,14
A	DE 29 04 805 A1 (SCHROEDER WERNER) 14 August 1980 (1980-08-14) the whole document -----	1,7,14



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

13 July 2017

Date of mailing of the international search report

20/07/2017

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2017/062233

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2005282712 A	13-10-2005	JP 4364036 B2	11-11-2009
		JP 2005282712 A	13-10-2005

US 3456561 A	22-07-1969	NONE	

DE 2904805 A1	14-08-1980	NONE	
