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(54) BELLOWS VALVE

BALGVENTIL

SOUPAPE À SOUFFLET

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Description

[0001] The present invention relates to a valve, a method and use of this valve for controlling a differentially-controlled gas lift valve in a well.

[0002] In several applications there is a need for a pressure-controlled valve, which as a consequence of pressure differences round the valve opens and/or closes the valve automatically. There is also a need for a valve which can be controlled in such a manner that it is opened or closed for a given pressure difference and may otherwise be closed. An example of a typical use of such a valve will be in connection with control of gas lift valves in a well, for example during a start-up phase where there is completion fluid in both the annulus and the production tubing. In order to start production in such a well, the completion fluid has to be displaced from the annulus, usually through one or more pressure-controlled valves and up to the surface through the tubing or after closing down a well where at least parts of the annulus are filled with fluid or where production fluid has been lying for some time and gas has migrated to the surface and the production pressure in the tubing is too low to permit the well to begin producing without receiving pressure support from gas injection. This start-up activity is undertaken to enable the gas injections to be achieved through the deepest-mounted valve.

[0003] US 3.014.500 which is considered the closest prior art describes a valve assembly in which a variable volume sealed chamber afforded by a hollow housing and where a movable bellows wall is subdivided into a liquid filled chamber part adjacent the bellows and another chamber part charged with pressure gas acting on the liquid in opposition to valve opening movement and wherein the subdivision is afforded by a partition comprising a pair of tubular walls sleeved on one another and sealed at opposite ends and one wall being imperforate and flexible for deflection radially in response to fluid pressure on opposite faces thereof and the other wall being rigid and perforated for connecting the space between adjoining faces of the walls with the chamber space on the other side of the rigid wall.

[0004] US 5.707.214 describes a gas flow control device for injecting gas into a production string for recovering and reducing frictional losses, so that critical flow can be reached at lower pressure drops and higher production pressure. The device comprises a nozzle having first and second ends, and a flow path therebetween, and a Venturi having first and second ends, and a flow path therebetween. The first end of the Venturi portion is disposed adjacent to the second end of the nozzle. The Venturi flow path is coaxially aligned with the nozzle flow path to provide a continuous flow path through the device.

[0005] The object of the present invention is to provide a valve which can be opened or closed when there is a given pressure difference between two fluids. It is also an object to provide a valve which can be employed for controlling a gas lift valve in a well. It is also an object to provide a valve which takes up little space in a radial direction while at the same time providing good control of the valve where the control is dependent on pressure differences between different fluids.

[0006] These objects are achieved with a valve, method and uses as indicated in the following independent claims where further features of the invention will be apparent from dependent claims and the description below.

[0007] The present invention relates to a valve device comprising an external structure with a longitudinal axis and a valve seat, and a valve body, where the valve body, when it is in abutment with the valve seat in the external structure, will shut off an access between an inlet and an outlet of the valve device. An inlet of the valve is generally connected to a fluid source, which may, for example, be an annulus in a well, where the outlet of the valve is connected to a second fluid-filled space, for example an internal cavity of a tubing in a well. In one variant the outlet will also be connected to a second valve, for example a gas lift valve introducing gas into the tubing in a well.

[0008] According to the invention a first bellows device is mounted inside the external structure. This first bellows device is permitted to be moved in a substantially radial direction, and is in fluid connection with a first fluid outside the structure, where the pressure of this first fluid influences the position of the first bellows device. The first bellows device is furthermore hydraulically connected to a second bellows device, where this second bellows device is permitted to be moved in a substantially axial direction. A change of pressure in the fluid outside the first bellows device will be transmitted to the second bellows device via the hydraulic coupling, which may mean that a space between the two bellows is filled with a substantially incompressible fluid. The second bellows device is exposed to a second fluid, and it is the pressure difference between this first and second fluid which controls the movement of the bellows devices. The second bellows device is further connected to a first part piston with the result that movement of the second bellows device influences the position of the first part piston relative to the external structure. In an embodiment the movement of the first part piston may be substantially in the same direction as the second bellows device. The first part piston cooperates with a second part piston, in such a way that the second part piston is given an oppositely-directed movement relative to the first part piston, and where the movement of the second part piston thereby operates the valve body relative to the valve seat in order to open and close the valve respectively.

[0009] According to a first aspect of the invention the first bellows device is mounted between two stop devices which restrict the radial movement of a bellows element in the first bellows device. A first stop device may be composed of the external structure. In a variant the external structure may be in the form of a sleeve with only a few through-going openings for fluid connection between the first bellows device and a first fluid outside the external structure. Alternatively, at least a portion of the

external structure may be more in the form of a grid structure which will act as a first stop device, while at the same time providing good communication between the first bellows device and the first fluid round the external structure. The first stop device may also be composed of a stop element mounted inside the external structure. The fluid connection for the first fluid may also be arranged so that this fluid is conveyed to the fluid connection through the external structure via a second element, thereby providing a solution where the first fluid does not surround the external structure but is introduced into the first bellows device through the external structure. In an embodiment a second stop device may be composed of a radial internal element in the valve device where a bellows element of the first bellows device is mounted at least partly encircling this internal element, the internal stop device. This internal element may be a hollow tube structure, a solid rod or other suitable element. In a variant the second stop device may be composed of a second portion of the external structure, mounted on the opposite side of the bellows element in the first bellows device relative to the portion of the external structure forming the first bellows device.

[0010] According to an aspect of the invention a bellows element in the first bellows device may be supported at its axial ends so that a first cavity is formed between the bellows element and the internal stopper element, which first cavity is separated from a fluid on the other side of the bellows element.

[0011] According to an aspect of the invention the bellows element in the first bellows device is mounted enclosing an internal stopper element. In a section across the longitudinal direction, this bellows element will have a shape which may be oval, polygonal, curved, but preferably not circular, in order to facilitate deformation of the bellows element as a consequence of altered pressure ratio round the bellows element. In order to achieve the necessary displacement volume in the first bellows device for operation of the valve, the length of the bellows in the direction of the longitudinal axis for the valve may be adjusted.

[0012] According to an aspect of the invention the first cavity in the first bellows device, which is preferably filled with an incompressible fluid, is in fluid connection with the second bellows device and a change of the position of the first bellows element will directly influence the position of the second bellows device since a side of a second bellows element in the second bellows device is directly influenced by the fluid in the first cavity. When influenced, this second bellows element is given a movement in a substantially axial direction with the result that with this hydraulic coupling, a transition from a substantially radial movement to a substantially axial movement has been achieved. A variant may also be envisaged where the second bellows device is replaced by a dynamic piston which is moved by the fluid in the first cavity. This can be achieved by having a dynamic piston as the first part piston. In such an arrangement a transition is still obtained between an axial displacement and a radial displacement of the elements influenced by the pressure differential across the elements.

[0013] According to an aspect of the invention the valve device comprises a delay device, which delay device, on operation of the valve device, will delay the hydraulic incompressible fluid which is displaced between the first and the second bellows device. The delay device is advantageously mounted in the hydraulic coupling (hydraulic fluid connection) between the first and the second bellows device. The delay device comprises an element which at least in a portion of the fluid connection reduces the fluid through-flow area between the first and the second bellows device. In a variant the delay device may be at least one plate which is arranged in a suitable manner inside the space or the fluid connection connecting the first and the second bellows device. The plate comprises one or more through-going holes, where the hole or holes have a total cross sectional area which is smaller that the cross sectional area of the space. Alternatively, the plate may be envisaged provided with a diameter which is smaller than the internal diameter of the space or the fluid connection, whereby when the plate is mounted in the space, a gap will be formed between the external circumference of the plate and the internal circumference of the space. The plate can therefore be mounted in such a manner that the area is oriented across a fluid flow direction through the hydraulic fluid connection. As a result of pressure differences across the bellows devices, the through-flow over the plate of the incompressible fluid displaced between the first and the second bellows device will then be delayed. With the knowledge of pressure differences across the bellows devices, fluid volume and cross sectional area of the space/hole or holes, the delay can be exactly calculated, with the result that the valve device can be designed to be opened/closed after a specific time interval.

[0014] The hole or holes in the plate may be provided with the same or different diameters. They may, moreover, have the same or different cross sections over the plate's thickness etc. A person skilled in the art will know how this can be done and it will therefore not be discussed further here.

[0015] According to a further aspect of the invention the first part piston is in connection with a prestressing device, which attempts to position the first part piston in a first position. Where the valve is employed in connection with a gas injection valve in a well, this first position will be a closed position of the valve. An opposite variant may of course be envisaged here. In a variant the prestressing device may comprise an elastic element such as, for example, a spring located between an abutment surface of the first part piston and an abutment shoulder which during use is kept at rest relative to the external structure.

[0016] According to yet another aspect the prestressing device comprises devices for adjusting the prestressing against the first part piston. A possible variant is where

the abutment shoulder against which the elastic element abuts is movable in the axial direction of the valve device, thereby permitting adjustment of the available space wherein the elastic element is mounted. This abutment shoulder may be in the form of a sleeve element arranged axially movably inside the external structure, where a fastening device is further mounted in order to prevent axial movement of the sleeve element when the desired prestressing has been achieved in the valve device. In a variant the adjusting devices may be arranged so as to be accessible from the outside of the external structure, for example by having fastening screws for an internal sleeve element and an adjusting element for adjusting the positioning of the internal sleeve element accessible via openings in the external structure and/or extending to an external surface of the external structure. A variant may also be envisaged where the fastening screws and the adjusting element are one and the same element. In an embodiment static seals are mounted between the prestressing device and the external structure, since during use of the valve device the prestressing device is given a prestressing and this prestressing is set before use of the valve device and as such is not a dynamic element in the valve device, even though the possibility exists of adjusting the prestressing.

[0017] According to an aspect the first part piston is connected to the second part piston by a hinge device. In a variant the hinge device comprises an axis of rotation and transfers a linear motion between the part pistons. In an embodiment the axis of rotation for the hinge device may be substantially transverse to the longitudinal axis of the valve device. In a variant it may intersect the longitudinal axis or be arranged eccentrically in the valve device. An axis of rotation may also be envisaged which is not transverse but forms another angle with the longitudinal axis of the valve device. In an embodiment the hinge device may comprise a pivot arranged rotatingly about its own longitudinal axis, thereby forming the axis of rotation for the hinge device, which axis of rotation is arranged substantially transversely to the longitudinal axis of the valve device. The pivot is arranged rotatingly relative to the external structure and further comprises two engagement portions on two opposite sides of the pivot, which engagement portions are engaged with a notch in each part piston.

[0018] The first and second part pistons have a shape which enables them to slide in the external structure and yet do not impede movement of the part pistons. In an embodiment a part piston in a portion at an end of the part piston facing away from the second part piston may therefore be designed so that it substantially fills up the whole of the internal cross section of the external structure, but at an opposite end facing the second part piston it may be designed so as to fill up only a portion of the internal cross section, thereby making room for the second part piston to fill up a portion of the same internal cross section.

[0019] In an embodiment the second part piston may be connected to a valve body by a connecting rod so as to enable the valve body to be mounted at a distance from the portion of the second part piston which substantially fills up the whole of the internal cross section of the external structure. The part pistons fill up the internal cross section of the external structure, but there is still fluid connection across the part pistons. This may also be achieved by making notches in the surface of the part pistons and/or in the internal surface of the external structure.

[0020] According to an aspect an inlet to the valve seat is provided on one side of at least one area of the external structure adapted for sealing against a second encircling element and an outlet is provided on the opposite side of the same area. This area of the external structure is usually an external surface of the external structure which is treated in order to obtain a good seal. The external surface may also be specially adapted for cooperation with packer seals. Furthermore, in an embodiment the external structure may further comprise at least one second area adapted for sealing against a second encircling element, mounted between the inlet and the first fluid connection acting on the first bellows device. In an embodiment the inlet of the valve device may be connected to a first fluid, and the outlet of the valve device and the fluid inlet connected to a second fluid, where the valve is in an open position with a small pressure difference between the first and the second fluid and is in a closed position with a large pressure difference between the first and the second fluid. The closed position is also independent of whether the greatest pressure round the valve exists at the inlet or the outlet of the valve, but where it is the actual pressure difference which controls the valve. In a variant the first fluid may be composed of a fluid in the annulus in a well and a second fluid may be a fluid in the tubing.

[0021] According to an aspect of the invention the outlet of the valve device may be connected to a barrier valve between the first and the second fluid, such as, for example, a gas injection valve.

[0022] The invention also relates to a method for operation of a valve, comprising an external structure with a longitudinal axis and a valve seat and a valve body, where a first external fluid influences a first bellows device, which in the event of a movement in the radial direction displaces a hydraulic fluid relative to a second bellows device which is thereby moved in an axial direction, influencing a first part piston to move in one direction, which part piston cooperates with a second part piston, giving the second part piston a movement in the opposite direction in order thereby to operate the valve body relative to the valve seat between a closed and open position respectively of the valve device.

[0023] According to an aspect of the invention this method may be employed for displacement of fluid in an annulus in a well, where, when there is fluid both in the tubing and the annulus, the valve device is in an open position and the valve inlet is in contact with the annulus

and the outlet in contact with the tubing, where gas is injected into the annulus, thereby increasing pressure in the annulus and fluid and gas are displaced through the valve until the pressure of the fluid at the inlet relative to the fluid inlet pressure and the prestressing over the valve are reduced, thereby closing the valve.

[0024] The valve device according to the invention may be employed, for example, in connection with fluid displacement in connection with start-up and in connection with gas injection.

[0025] The invention will now be explained in connection with an embodiment and with reference to the attached figures, in which:

Fig. 1 is a longitudinal cross section through the valve device,

Fig. 2 is a longitudinal cross section through an alternative valve device,

Fig. 3 is a cross section through the valve device at I-I in fig. 1,

Fig. 4 is a cross section through the valve device at II-II in fig. 1,

Fig. 5 is a cross section through the valve device at III-III in fig. 1, and

Fig. 6 illustrates the valve located in connection with a well.

Figures 1 to 4 illustrate an embodiment of a valve device according to the invention.

[0026] The valve device comprises an external structure 1, which external structure 1 in the illustrated embodiment is composed of a plurality of segments 101, 102, 103, 104, which are joined so as to form the external structure. The external structure 1 has an internal cavity. At one end of the external structure 1 it is provided with an internal valve seat 2 for cooperation with a valve body 3, which is mounted in a relatively movable fashion inside the external structure 1. On movement of the valve body 3, the state of the valve device can be changed from a closed state where the valve body 3 is in abutment against the valve seat 2, as illustrated in the figure, where the valve body thereby shuts off a fluid connection between an inlet 4 of the valve to an outlet 5, to a position where the valve body 3 is not in abutment against the valve seat 2, which is an open state of the valve device. The inlet 4 of the valve is composed of a plurality of through-going holes through the external structure to a point inside the external structure 1 located on one side of the valve seat 2. In the illustrated embodiment the outlet 5 is an axial outlet at the end of the external structure 1 at a relative second side of the valve seat 2. The valve body 3 is moved between its two positions as a consequence of the pressure difference between two fluids: a first fluid and the fluid which has access to the inside of the valve through the inlet 4. The device which reacts to the pressure difference will now be explained. A first bellows device 6 comprising a first bellows element 9 is mounted inside the external structure 1. The first bellows element 6 is mounted so as to permit a substantially radial movement, which movement is restricted by an external first stopper element 12 and an internal second stopper element 13. The bellows element 6 is attached at its axial ends by a first fastening device 10 and a second fastening device 11 and is otherwise mounted enclosing the second stopper element 13. The first and/or second fastening device 10, 11 may be flexible or fixed, permitting or preventing angular change of the bellows element 9 relative to the fastening device 10, 11 at the attachment point. With such a configuration the first internal cavity 14 is formed between the bellows element 9 and the internal second stopper element 13. An external side of this bellows element 9, opposite the internal cavity 14, is in contact with a first fluid 8 via fluid connections 7.

[0027] The internal cavity 14 is in hydraulic fluid connection 15 with a second bellows device 16. This second bellows device 16 comprises a second bellows element 17 which is permitted to be moved in an axial direction by the valve device. This second bellows element 17 may, for example, be provided with an accordion-shaped portion, which provides substantial movement in the axial direction of an end of the second bellows element 17. The fluid in the first cavity 14 and the fluid connection 15, which is a substantially incompressible, relatively temperature-independent fluid, will thereby be restricted by the first and second bellows elements 9, 17, and any pressure differences on opposite sides of the two bellows elements 9, 17 will be transmitted via this fluid and move the bellows elements 9, 17. The second bellows element 17 is also in contact with a first part piston 26 and changing the position of the second bellows element 17 will influence the position of the first part piston 26. The first part piston is also influenced by an adjustable prestressing device 19. This prestressing device comprises an elastic element 20 in the form of a spring element mounted round a portion of the second bellows element 17. The elastic element 20 is mounted between an abutment surface 25 composed of the first part piston 26 and abutment shoulder 21, composed of an adjusting sleeve 22, mounted inside the external structure 1. The adjusting sleeve 22 is secured relative to the external structure 1 by means of fastening screws 23, extending from the adjusting sleeve 22 out through the external structure 1 to an outside thereof, thus enabling the fastening screws to be removed from an outside of the external structure 1. The prestressing device 19 further comprises an adjusting element 24 for adjusting the position of the adjusting sleeve 22 relative to the external structure 1 when the fastening screws 23 are loosened. In this way the prestressing in the prestressing device 19 can be adjusted.

[0028] In an alternative embodiment of the valve device according to the invention at least one plate 40 is further provided in the hydraulic fluid connection 15 connecting the first bellows device 6 with the second bellows device 16. The plate 40 may be a separate unit, which is non-movably attached to the inside of the hydraulic fluid connection 15 by means of suitable fastening devices (not shown), or alternatively the plate 40 may be provided integrated in the fluid connection 15. The plate 40 is further provided with one or more through-going holes 41, where the total cross sectional area of the hole/holes is less than the hydraulic fluid connection's 15 internal cross sectional area. In the illustrated embodiment the through-going hole 41 is provided with a constant cross section over the plate's 40 thickness, but it should also be understood that the hole 41 may have a cross section which varies over the plate's 40 thickness. If the plate 40 is provided with several holes 41, the holes 41 may have different diameters and/or different cross sections.

[0029] The first part piston 26 comprises a first end portion 27 comprising the abutment surface 25. This first end portion 27 is depicted in such a manner that a cross section of this end portion 27 fills almost the whole of the internal cavity of the external structure 1. Furthermore, the first part piston 26 comprises a second end portion 28 facing away from the first end portion 27, which second end portion 28 fills only a part of the internal cavity of the external structure 1. This second end portion 28 is also connected to a hinge device 30 comprising a pivot 31 and a first engagement portion 32 located in a notch 29 in the second end portion of the first part piston 26. The hinge device 30 further comprises a second engagement portion 33 extending from the pivot 31 on an opposite side relative to the first engagement portion 32. This second engagement portion 33 is located in a notch 37 in a second end portion 36 of a second part piston 34. The movement of the first part piston 26 is transferred to the second part piston 34 which is moved in an oppositely directed direction, i.e. substantially in an axial direction of the valve device. The second end portion 36 of the second part piston 34 also has a smaller area in a cross section than the cavity of the external structure 1, thereby making room for the hinge device 30 and movement of the part pistons 26, 34. A first end portion 35 of the second part piston 34, facing away from the first part piston 26, covers substantially the whole cross section of the internal cavity in the external structure. To the end of this first end portion 35 is secured a connecting rod 38 to which the valve body 3 is secured. A movement of the second part piston 34 will thereby move the valve body 3 relative to the valve seat 2. Pressure differences in the fluid acting on the first bellows device and the second bellows device will influence the positioning of the valve body relative to the valve seat and open and/or close the valve. These pressure changes must also counteract the prestressing put on the first part piston.

[0030] The external structure also comprises a first area 39 provided at an external surface of the external structure 1 which is adapted for cooperation with a second element in order to form a sealed connection with this second element (not shown). This first area is arranged so that it is positioned between the inlet 4 and the outlet 5 of the valve device. Furthermore, the external structure also comprises a second area 40 adapted for forming a sealed connection with a second element, where this second area 40 is located between the inlet 4 and the fluid connection 7 in towards the first bellows device.

[0031] In fig. 5 the valve device is shown located in a well with a production tubing 51 and casing 50, where the fluid connection 7 and the outlet 5 are placed in connection with a fluid inside the tubing 51 and the inlet 4 is placed in connection with a fluid in an annulus on the outside of the tubing 51 and inside the casing 50. The tubing 51 further comprises a side pocket 52 comprising a holding element 53 for placing the valve with the external structure 1, comprising the first fluid connection 7 arranged in connection with a second inlet 55 through the wall of the side pocket 52 into the inside of the tubing 51, and where the inlet 4 to the valve is provided in connection with a first inlet 54 extending from the side pocket 52 out to the annulus between the tubing 51 and the casing 50. The side pocket 52 also comprises internal sealing surfaces cooperating with the first and second sealing areas 39, 40 of the external structure 1 in order to form a seal between the external structure 1 of the valve and the side pocket 52.

[0032] The invention has now been explained with reference to an embodiment. A person skilled in the art will appreciate that several changes and modifications may be made to the illustrated embodiment which fall within the scope of the invention as defined in the following claims. The areas for sealed connection with a second element may be provided inside the external structure or at an end of the structure. The first bellows device need not be arranged round an internal second stopper element, but may be a surface supported along its external edge. The prestressing device may be located at an opposite side of the part pistons and possibly in abutment with the second part piston. The second bellows device and the first part piston may be provided as a unit, with dynamic seals between this unit and the external structure.

Claims

1. A valve device for use in a well, comprising an external structure (1) with a longitudinal axis (1b) and a valve seat (2), and a valve body (3) mounted movably inside the external structure (1), and a first bellows device (6) permitted to be moved in a substantially radial direction, in fluid connection with a first fluid, **characterised in that** the first bellows device (6) is hydraulically connected to a second bellows

device (16) permitted to be moved in a substantially axial direction, which second bellows device (16) is connected to a first part piston (26) cooperating with a second part piston (34), thereby giving the second part piston (34) an oppositely directed movement relative to the first part piston (26), which thereby moves the valve body (3) relative to the valve seat (2).

2. A valve device according to claim 1, **characterised in that** the first bellows device (6) is mounted between two stop devices (12, 13) which restrict the radial movement.

3. A valve device according to claim 2, **characterised in that** the first bellows device (6) at least partly encloses an internal stop device (13).

4. A valve device according to claim 3, **characterised in that** a bellows element (9) in the first bellows device (6) is supported at its axial ends in such a manner that a first cavity (14) is formed between the bellows element and internal stopper element (13) separated from a first fluid (8) on the other side of the bellows element.

5. A valve device according to claim 4, **characterised in that** the first cavity (14) is in fluid connection with the second bellows device (16).

6. A valve device according to claim 1, **characterised in that** the first part piston (26) is mounted in connection with a prestressing device (19).

7. A valve device according to claim 6, **characterised in that** the prestressing device (19) comprises devices (21, 22, 23, 24) for adjusting the prestressing against the first part piston (26).

8. A valve device according to claim 7, **characterised in that** it comprises access to the devices (24) for adjusting prestressing from the outside of the external structure (1).

9. A valve device according to claim 1, **characterised in that** the first part piston (26) is connected to the second part piston (34) by a hinge device (30).

10. A valve device according to claim 1, **characterised in that** an inlet (4) to the valve seat (2) is arranged on a side of at least one area (39) of the external structure (1) adapted for sealing against a second encircling element (52) and an outlet (5) is arranged on the opposite side of the same area (39).

11. A valve device according to claim 1, **characterised in that** the external structure (1) further comprises at least one second area (40) adapted for sealing against a second encircling element (52) mounted between the inlet (4) and the fluid connection (7) for the first fluid (8).

12. A valve device according to claim 11, **characterised in that** the inlet (4) of the valve device is connected to a second fluid (41), and the outlet (5) of the valve device and the fluid inlet (7) are connected to a first fluid (8), where the valve is in an open position with a small pressure difference between the first and the second fluid and is in a closed position with a large pressure difference between the first and the second fluid.

13. A valve device according to claim 1, **characterised in that** the hydraulic connection between the first and second bellow devices (6, 16) comprises a hydraulic fluid connection (15) comprising a delay device.

14. A valve device according to claim 13, **characterised in that** the delay device in the hydraulic fluid connection (15) comprises at least one plate (40), in which plate (40) one or more throughgoing holes (41) are provided.

15. A method for operation of a valve in a well, comprising an external structure (1) with a longitudinal axis and a valve seat (2) and a valve body (3), **characterised in that** a first external fluid (8) influences a first bellows device (6), which upon a movement in the radial direction displaces a hydraulic fluid relative to a second bellows device (16) which is thereby moved in the axial direction, where the second bellows device (16) is influenced by a second fluid (41), where the second bellows device (16) influences a first part piston (26) to move in a direction, which part piston (26) cooperates with a second part piston (34), giving the second part piston (34) a movement in the opposite direction in order thereby to operate the valve body (3) relative to the valve seat (2).

16. A method for displacing fluid in an annulus in a well according to claim 15, **characterised in that** when there is fluid both in the production tubing and the annulus, the valve device is in an open position and the inlet and the second bellows device (16) of the valve device are in contact with the annulus and the outlet and the first bellows device (6) are in contact with the tubing, whereupon gas is injected into the annulus thereby increasing the pressure in the annulus and causing fluid and gas to be displaced through the valve until the pressure of the fluid at the inlet relative to the fluid inlet pressure on the first bellows device (6) and the prestressing device (19) across the valve is reduced, causing the valve to be closed.

17. The use of a valve device according to claim 1 in connection with control of gas injection in a well.

18. The use of a valve device according to claim 1 in connection with fluid displacement during start-up.

Patentansprüche

1. Ventilvorrichtung zur Verwendung in einem Bohrloch, eine Außenstruktur (1) mit einer Längsachse (1b) und einem Ventilsitz (2) und einem Ventilkörper (3), der beweglich im Inneren der Außenstruktur (1) angebracht ist, und eine erste Balgvorrichtung (6) umfassend, die in einer im Wesentlichen radialen Richtung in Fluidverbindung mit einem ersten Fluid bewegt werden kann, **dadurch gekennzeichnet, dass** die erste Balgvorrichtung (6) hydraulisch an eine zweite Balgvorrichtung (16) angeschlossen ist, die in einer im Wesentlichen axialen Richtung bewegt werden kann und an einen ersten Teilkolben (26) angeschlossen ist, der mit einem zweiten Teilkolben (34) zusammenwirkt, wodurch dem zweiten Teilkolben (34) eine entgegengesetzt gerichtete Bewegung in Bezug auf den ersten Teilkolben (26) verliehen wird, der **dadurch** den Ventilkörper (3) in Bezug auf den Ventilsitz (2) bewegt.

2. Ventilvorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** die erste Balgvorrichtung (6) zwischen zwei Anschlagvorrichtungen (12, 13) angebracht ist, die die radiale Bewegung einschränken.

3. Ventilvorrichtung nach Anspruch 2, **dadurch gekennzeichnet, dass** die erste Balgvorrichtung (6) eine innere Anschlagvorrichtung (13) zumindest teilweise umschließt.

4. Ventilvorrichtung nach Anspruch 3, **dadurch gekennzeichnet, dass** ein Balgelement (9) in der ersten Balgvorrichtung (6) an seinen axialen Enden so gelagert ist, dass ein erster Hohlraum (14) zwischen dem Balgelement und dem inneren Anschlagelement (13) getrennt von einem ersten Fluid (8) auf der anderen Seite des Balgelements gebildet ist.

5. Ventilvorrichtung nach Anspruch 4, **dadurch gekennzeichnet, dass** der erste Hohlraum (14) in Fluidverbindung mit der zweiten Balgvorrichtung (16) steht.

6. Ventilvorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** der erste Teilkolben (26) in Verbindung mit einer Vorspannungsvorrichtung (19) angebracht ist.

7. Ventilvorrichtung nach Anspruch 6, **dadurch gekennzeichnet, dass** die Vorspannungsvorrichtung (19) Vorrichtungen (21, 22, 23, 24) zum Einstellen der Vorspannung gegen den ersten Teilkolben (26) umfasst.

8. Ventilvorrichtung nach Anspruch 7, **dadurch gekennzeichnet, dass** sie einen Zugang zu den Vorrichtungen (24) zur Vorspannungseinstellung von außerhalb der Außenstruktur (1) umfasst.

9. Ventilvorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** der erste Teilkolben (26) durch eine Gelenkvorrichtung (30) an den zweiten Teilkolben (34) angeschlossen ist.

10. Ventilvorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** ein Einlass (4) zum Ventilsitz (2) auf einer Seite zumindest eines Bereichs (39) der Außenstruktur (2) angeordnet ist, der dazu ausgelegt ist, gegen ein zweites Umschließungselement (52) abzudichten, und ein Auslass (5) auf der anderen Seite desselben Bereichs (39) angeordnet ist.

11. Ventilvorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** die Außenstruktur (1) darüber hinaus mindestens einen zweiten Bereich (40) umfasst, der dazu ausgelegt ist, gegen ein zweites Umschließungselement (52) abzudichten, das zwischen dem Einlass (4) und dem Fluidanschluss (7) für das erste Fluid (8) angebracht ist.

12. Ventilvorrichtung nach Anspruch 11, **dadurch gekennzeichnet, dass** der Einlass (4) der Ventilvorrichtung mit einem zweiten Fluid (41) verbunden ist, und der Auslass (5) der Ventilvorrichtung und der Fluidanschluss (7) mit einem ersten Fluid (8) verbunden sind, wobei sich das Ventil in einer offenen Stellung mit einem geringen Druckunterschied zwischen dem ersten und zweiten Fluid und in einer geschlossenen Stellung mit einem großen Druckunterschied zwischen dem ersten und zweiten Fluid befindet.

13. Ventilvorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** die hydraulische Verbindung zwischen der ersten und zweiten Balgvorrichtung (6, 16) einen Hydraulikfluidanschluss (15) mit einer Verzögerungsvorrichtung umfasst.

14. Ventilvorrichtung nach Anspruch 13, **dadurch gekennzeichnet, dass** die Verzögerungsvorrichtung in dem Hydraulikfluidanschluss (15) mindestens eine Platte (40) umfasst, in der eine oder mehrere Durchgangsöffnungen (41) vorgesehen sind.

15. Verfahren zum Betrieb eines Ventils in einem Bohrloch, eine Außenstruktur (1) mit einer Längsachse und einem Ventilsitz (2) und einem Ventilkörper (3) umfassend, **dadurch gekennzeichnet, dass** ein erstes externes Fluid (8) eine erste Balgvorrichtung (6) beeinflusst, die bei einer Bewegung in der radialen Richtung ein Hydraulikfluid in Bezug auf eine zweite Balgvorrichtung (16) verdrängt, die **dadurch** in der axialen Richtung bewegt wird, wobei die zweite Balgvorrichtung (16) von einem zweiten Fluid (41) beeinflusst wird, wobei die zweite Balgvorrichtung (16) einen ersten Teilkolben (26) beeinflusst, sich in eine Richtung zu bewegen, welcher Teilkolben (26) mit einem zweiten Teilkolben (34) zusammenwirkt, wodurch dem zweiten Teilkolben (34) eine Bewegung in der entgegengesetzten Richtung verliehen wird, um **dadurch** den Ventilkörper (3) in Bezug auf den Ventilsitz (2) zu betätigen.

16. Verfahren nach Anspruch 15, zum Verdrängen eines Fluids in einem Ringraum in einem Bohrloch, **dadurch gekennzeichnet, dass**, wenn Fluid sowohl in der Produktionsrohrleitung als auch im Ringraum vorhanden ist, sich die Ventilvorrichtung in einer offenen Stellung befindet und der Einlass und die zweite Balgvorrichtung (16) der Ventilvorrichtung mit dem Ringraum in Kontakt sind, und der Auslass und die erste Balgvorrichtung (6) mit der Rohrleitung in Kontakt sind, woraufhin Gas in den Ringraum eingeleitet wird, wodurch der Druck im Ringraum erhöht und bewirkt wird, dass Fluid und Gas durch das Ventil verdrängt werden, bis der Druck des Fluids am Einlass in Bezug auf den Fluideinlassdruck an der ersten Balgvorrichtung (6) und der Vorspannungsvorrichtung (19) am Ventil gesenkt ist, wodurch bewirkt wird, dass das Ventil schließt.

17. Verwendung einer Ventilvorrichtung nach Anspruch 1 in Verbindung mit einer Steuerung einer Gaseinleitung in einem Bohrloch.

18. Verwendung einer Ventilvorrichtung nach Anspruch 1 in Verbindung mit einer Fluidverdrängung während des Anfahrens.

Revendications

1. Dispositif de soupape destiné à être utilisé dans un puits, comprenant une structure externe (1) avec un axe longitudinal (1b) et un siège de soupape (2), et un corps de soupape (3) monté de façon mobile à l'intérieur de la structure externe (1), et un premier dispositif de soufflet (6) pouvant être déplacé dans une direction sensiblement radiale, en raccord fluidique avec un premier fluide, **caractérisé en ce que** le premier dispositif de soufflet (6) est raccordé hydrauliquement à un second dispositif de soufflet (16) pouvant être déplacé dans une direction sensiblement axiale, lequel second dispositif de soufflet (16) est raccordé à un premier piston partiel (26) coopérant avec un second piston partiel (34), fournissant ainsi au second piston partiel (34) un mouvement dirigé de façon opposée par rapport au premier piston partiel (26), qui ainsi déplace le corps de soupape (3) par rapport au siège de soupape (2).

2. Dispositif de soupape selon la revendication 1, **caractérisé en ce que** le premier dispositif de soufflet (6) est monté entre deux dispositifs de butée (12, 13) qui limitent le mouvement radial.

3. Dispositif de soupape selon la revendication 2, **caractérisé en ce que** le premier dispositif de soufflet (6) enferme au moins partiellement un dispositif de butée interne (13).

4. Dispositif de soupape selon la revendication 3, **caractérisé en ce qu'**un élément de soufflet (9) dans le premier dispositif de soufflet (6) est supporté à ses extrémités axiales de manière telle qu'une première cavité (14) soit formée entre l'élément de soufflet et l'élément de butée interne (13) séparé d'un premier fluide (8) sur l'autre côté de l'élément de soufflet.

5. Dispositif de soupape selon la revendication 4, **caractérisé en ce que** la première cavité (14) est en raccord fluidique avec le second dispositif de soufflet (16).

6. Dispositif de soupape selon la revendication 1, **caractérisé en ce que** le premier piston partiel (26) est monté en association avec un dispositif de précontrainte (19).

7. Dispositif de soupape selon la revendication 6, **caractérisé en ce que** le dispositif de précontrainte (19) comprend des dispositifs (21, 22, 23, 24) pour régler la précontrainte contre le premier piston partiel (26).

8. Dispositif de soupape selon la revendication 7, **caractérisé en ce qu'**il comprend un accès aux dispositifs (24) pour régler la précontrainte à partir de l'extérieur de la structure externe (1).

9. Dispositif de soupape selon la revendication 1, **caractérisé en ce que** le premier piston partiel (26) est raccordé au second piston partiel (34) par un dispositif d'articulation (30).

10. Dispositif de soupape selon la revendication 1, **caractérisé en ce qu'**une entrée (4) du siège de soupape (2) est agencée sur un côté d'au moins une zone (39) de la structure externe (1) adaptée pour

réaliser une étanchéité contre un second élément encerclant (52) et une sortie (5) est agencée sur le côté opposé de la même zone (39).

11. Dispositif de soupape selon la revendication 1, **caractérisé en ce que** la structure externe (1) comprend en outre au moins une seconde zone (40) adaptée pour réaliser une étanchéité contre un second élément encerclant (52) monté entre l'entrée (4) et le raccord fluidique (7) pour le premier fluide (8).

12. Dispositif de soupape selon la revendication 11, **caractérisé en ce que** l'entrée (4) du dispositif de soupape est raccordée à un second fluide (41), et la sortie (5) du dispositif de soupape et l'entrée de fluide (7) sont raccordées à un premier fluide (8), où la soupape est dans une position ouverte avec une faible différence de pression entre les premier et second fluides et est dans une position fermée avec une différence de pression importante entre les premier et second fluides.

13. Dispositif de soupape selon la revendication 1, **caractérisé en ce que** le raccord hydraulique entre les premier et second dispositifs de soufflet (6, 16) comprend un raccord fluidique hydraulique (15) comprenant un dispositif de retard.

14. Dispositif de soupape selon la revendication 13, **caractérisé en ce que** le dispositif de retard dans le raccord fluidique hydraulique (15) comprend au moins une plaque (40), dans laquelle plaque (40) un ou plusieurs orifices débouchants (41) sont prévus.

15. Méthode pour faire fonctionner une soupape dans un puits, comprenant une structure externe (1) avec un axe longitudinal et un siège de soupape (2) et un corps de soupape (3), **caractérisée en ce qu'**un premier fluide externe (8) influence un premier dispositif de soufflet (6), qui, lors d'un mouvement dans la direction radiale, déplace un fluide hydraulique par rapport à un second dispositif de soufflet (16) qui est ainsi déplacé dans la direction axiale, où le second dispositif de soufflet (16) est influencé par un second fluide (41), où le second dispositif de soufflet (16) influence un premier piston partiel (26) pour se déplacer dans une direction, lequel piston partiel (26) coopère avec un second piston partiel (34), fournissant au second piston partiel (34) un mouvement dans la direction opposée afin ainsi d'actionner le corps de soupape (3) par rapport au siège de soupape (2).

16. Méthode pour déplacer un fluide dans un espace annulaire dans un puits selon la revendication 15, **caractérisée en ce que**, lorsqu'il y a un fluide dans la colonne de production et l'espace annulaire, le dispositif de soupape est dans une position ouverte et l'entrée et le second dispositif de soufflet (16) du dispositif de soupape sont en contact avec l'espace annulaire et la sortie et le premier dispositif de soufflet (6) sont en contact avec la colonne, sur quoi un gaz est injecté dans l'espace annulaire, augmentant ainsi la pression dans l'espace annulaire et faisant en sorte que le fluide et le gaz soient déplacés à travers la soupape jusqu'à ce que la pression du fluide à l'entrée par rapport à la pression d'entrée de fluide sur le premier dispositif de soufflet (6) et le dispositif de précontrainte (19) à travers la soupape soit réduite, entraînant la fermeture de la soupape.

17. Utilisation d'un dispositif de soupape selon la revendication 1 en association avec la régulation d'injection de gaz dans un puits.

18. Utilisation d'un dispositif de soupape selon la revendication 1 en association avec le déplacement de fluide au cours du démarrage.

Fig.1.

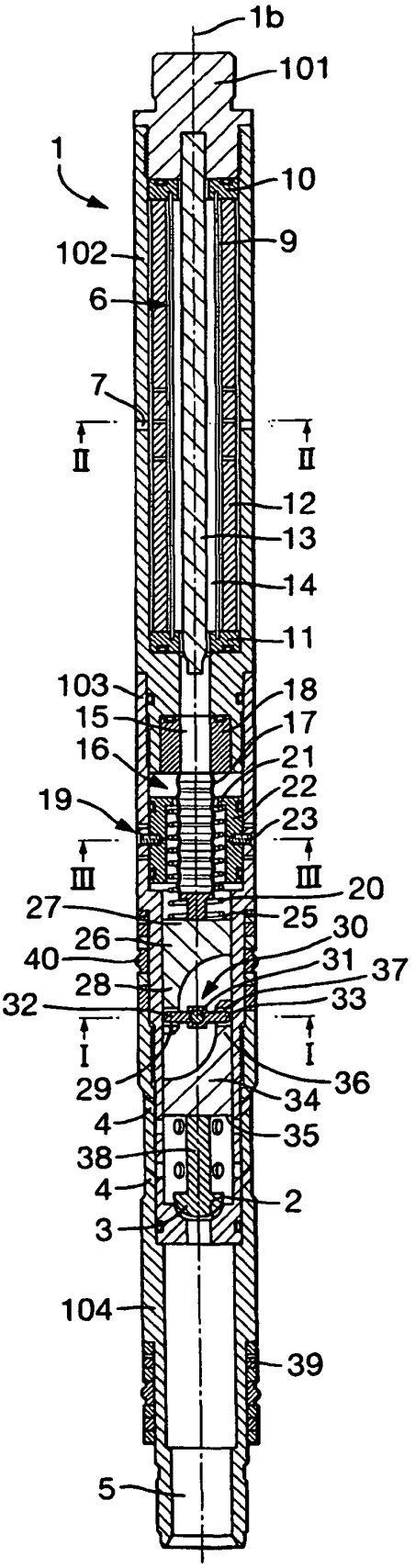
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Fig.2.

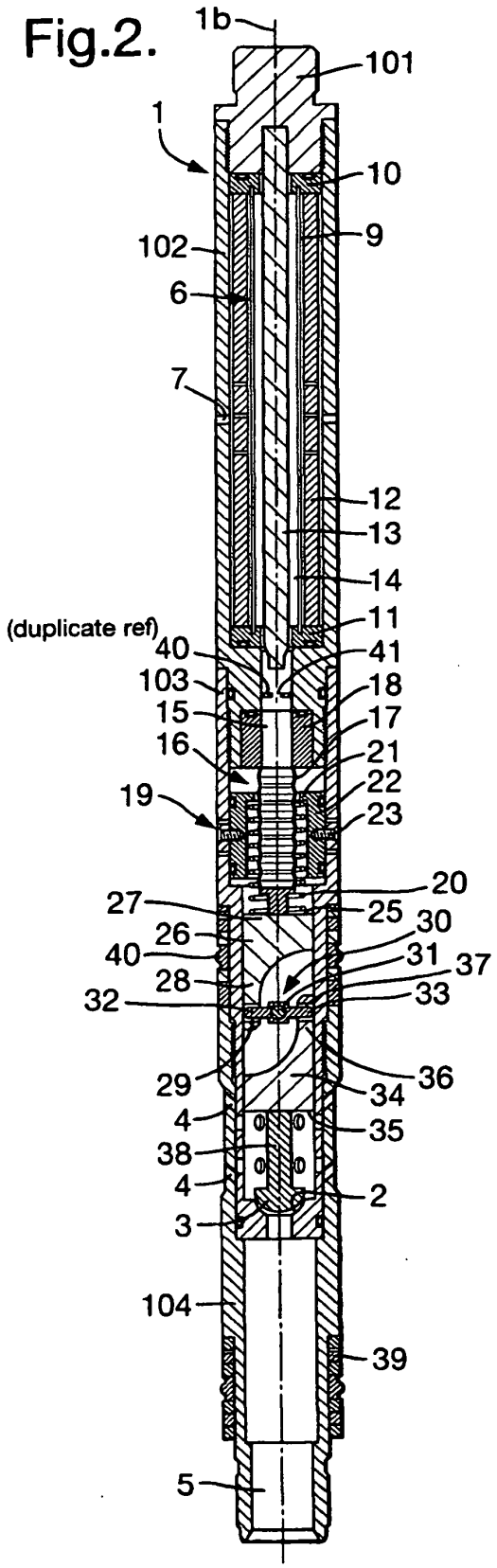


Fig.3.

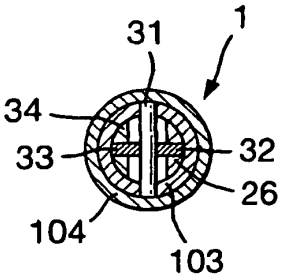


Fig.4.

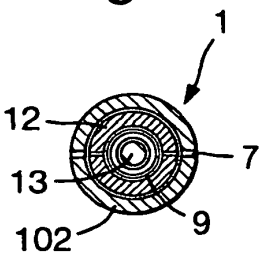


Fig.5.

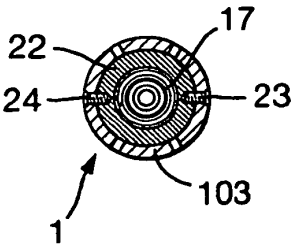
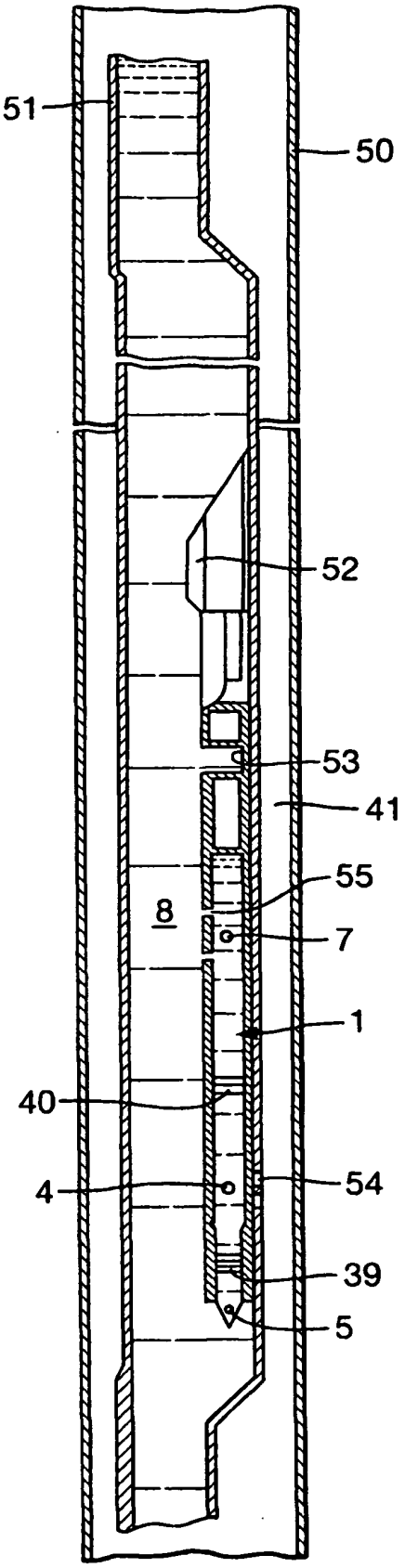


Fig.6.



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