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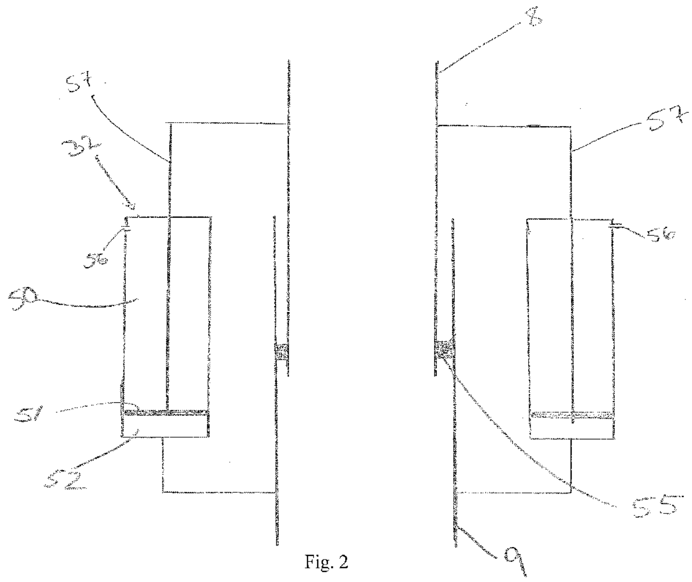

Fig. 2

(57) Abstract: The invention relates to a telescopic riser joint for connecting a first riser part and a second riser part, the riser joint comprising: a first pipe part and a second pipe part comprising means for connection to the first riser part and the second riser part respectively, which first and second pipe parts in use are arranged to form part of a riser with an internal flow passage, a cylinder arrangement comprising a first set of cylinders, each cylinder having a piston rod with a piston head and a cylinder housing, the piston rod and cylinder housing being respectively connectable to one of the first pipe part or second pipe part, wherein one side of the piston head in use is in communication with external pressure providing an axial force acting in the longitudinal direction of the riser, and the other side of the piston head is facing a sealed chamber, where the cylinder arrangement is configured such that a fluid in the sealed chamber and a fluid on the other side of the piston head give a resultant force tensioning the first riser part and the second riser part

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TELESCOPIC RISER JOINT

Field of the invention

The invention relates to a telescopic joint to be used as part of a riser configuration offshore. More particularly, the invention relates to a heave compensating telescopic riser joint.

Background of the invention

In offshore oil and gas exploration, well intervention and hydrocarbon production from subsurface formations, it is normal to equip floating surface equipment with a heave compensation system that compensates for the relative movements between a floating vessel and a riser. The riser is normally connected to the seabed through a subsea structure, e.g. a wellhead. The heave compensation system compensates for movements in the floating vessel caused by e.g. wind and waves. A drawback of such topside heave compensation systems is that they require large space on the vessel deck. Additionally, these known systems comprise large, heavy equipment that is difficult to move and/or maintain. It is also known prior art solutions which relate to drilling apparatuses where the tensioning equipment is arranged below the platform deck. Examples of such solutions are disclosed in US 3211224 and US 3643751.

Document US 3643751 relates to a hydrostatic riser pipe tensioner for use in underwater drilling operations, and discloses a drilling assembly comprising a wellhead-connector, ram-type blow-out preventers, sleeve-type blow out preventer, and a telescoping joint in a marine conductor pipe which extends upwardly to the vessel. The upper end of the conductor pipe is secured to the vessel against relative vertical motion therewith by means of tie rods or cables. The telescopic joint comprises an upper section which is connected to the lower end of a major portion of the conductor pipe and forms a continuation thereof, and a lower section which is fixedly secured to the top of the blow-out preventer, or the top of any other wellhead component arranged in a series-connected arrangement forming a drilling passage for a drill string.

It is an objective of the present invention to provide a heave compensation system that addresses at least one of the drawbacks of the prior art solutions.

Another objective of the invention is to provide a heave compensation system that heave-compensates the entire length of the riser, such as to minimize the loads exerted on the wellhead.

Summary of the invention

The invention is defined in the main claim, while the dependent claims describe other characteristics of the invention.

The invention relates to a telescopic riser joint for connecting a first riser part and a second riser part giving the possibility of telescopic movement between the riser parts while at the same time forming a continuous riser.

The telescopic riser joint according to the invention comprises a first pipe part and a second pipe part with means for connection to, and forming part of, a riser with an internal flow passage. The telescopic joint will connect a first riser part and a second riser part to form a riser.

The telescopic joint comprises a cylinder arrangement comprising a first set of cylinders, each cylinder having a piston rod with a piston head and a cylinder housing and the piston rod and cylinder housing being respectively connectable to one of the first pipe part or second pipe part. One side of the piston head in the first set of cylinders is, during use, in communication with external pressure providing an axial force acting in the longitudinal direction of the riser and the other side of the piston head is facing a sealed chamber. The first set of cylinders is configured such that a fluid in the sealed chamber and a fluid on the other side of the piston head give a resultant force tensioning the first riser part and the second riser part. The sealed chamber will have a fluid with a relatively low pressure compared with the pressure on the other side of the piston head, creating a “vacuum effect” of the sealed chamber.

In the system according to the invention the riser is typically connected to a subsea structure in its lower end and to a floating vessel or platform in its upper end. Due to the configuration of the arrangement, problems may occur when the floating vessel heaves due to wind, waves and currents. To address this problem it is provided a telescopic riser joint in the riser as defined above.

The cylinder arrangement may be arranged on the radial outside of the pipe parts, the cylinder arrangement may be arranged at least partly outside the pipe parts. Parts of the cylinder arrangement may be provided in between the pipe parts. It is also possible to envisage parts of the cylinder arrangement provided inside the pipe parts.

The telescopic joint according to the invention may be provided in different kinds of risers. The riser may stand in seawater or within another riser, and it may or may not be configured to tolerate higher internal pressures. It may be provided in different riser, such as a marine riser, a workover riser or possibly a drill string riser, an open sea workover riser or in a production riser.

By having a telescopic joint according to the invention which provide heave compensation of the riser, will give a possibility to clear space on the vessel deck. The telescopic joint according to the invention may on the piston side be exposed to external pressure. The external pressure may be the ambient seawater, or another external pressure source such as a column with a heavy fluid inside a marine riser, or possibly also a separate pipe or hose with a fluid arranged inside or outside the riser and/ or marine riser. It would be the static height of the fluid that provides the external pressure in the telescopic joint. It would also be possible to provide the connection to the external fluid pressure with a pressure intensifier, e.g a pump. This could be interesting when applying the invention in situations with less water depths. Another possibility is to provide the telescopic joint with means providing additional external forces assisting the pressure from the external fluid, normally seawater. This additional means may be accumulators, springs, booster pump, weights etc. The alternative pressure sources for the external pressure may be used alone or in combinations. The external pressure, independent on which source, must always give a pressure on the system larger than the pressure from the sealed chamber.

The force acting on the telescopic joint is dependent on the working area of the cylinder piston heads and the sea depth, i.e. the weight of the column working on the cylinder piston heads. At larger depths the hydrostatic pressure exerted from the fluid above the cylinder pistons increases, resulting in a greater withstanding force preventing separation of the first riser part and the second riser part. Similarly, at shallower depths the hydrostatic pressure exerted from the fluid above the cylinder pistons decreases, resulting in a smaller withstanding force preventing separation of the first riser part and the second riser part.

The telescopic riser joint is typically constructed in a collapsed state while, in use, it is set in "an operational position", i.e. a position pre-tensioning both the first and second riser parts (both above and below the telescopic riser joint) while at the same time allowing the riser to move both upwards and downwards, extending and collapsing the riser joint. The telescopic joint will, in use, provide tension in both the first and second riser parts due to that the cylinder arrangement is connectable to the first or second pipe parts and the forces will try to collapse the telescopic joint and therefore make a pull or tension in both of the riser parts. The hydrostatic column works on one side of the piston head, while the sealed chamber provides a "vacuum effect" on the other side of the piston head, resulting in that the fluid in the sealed chamber and the fluid on the other side of the piston head give a resultant force tensioning the first and second riser parts. The "vacuum effect" in the sealed chamber increases as the first and second pipe parts move relatively away from each other, and decreases a bit as the first and second pipe parts are moved towards each other again. However the change in tension may be quite limited.

In an aspect of the invention it is possible to provide a pressure compensated telescopic joint for risers wherein there is a fluid under pressure. According to the invention the telescopic joint may then be provided with a second set of cylinders in the cylinder arrangement. The second set of cylinders is arranged for pressure compensating the riser for the end cap effect of the internal pressure in the riser. The second set of cylinders are configured such that the pressure within the riser act on a piston head in the cylinders and counteract the end cap effect of the pressure within the riser. The second set of cylinders have a piston rod with a piston head and a cylinder housing respectively connectable to the first pipe part and the second pipe part, where one side of the piston head is in fluid communication with the internal fluid in the riser and compensates the riser joint for the internal pressures inside the riser.

The first set of cylinders and the second set of cylinders may in one embodiment have similar length.

The first set of cylinders and the second set of cylinders may be arranged next to each other, around the periphery of the riser. They may also be arranged with several cylinders in each set, alternating around or alternating in groups around the circumference of the pipe parts. In one embodiment at least one of the sets of cylinders may also be an annular cylinder. The first and second set of cylinders may be arranged such that they are positioned with the first set radially within the second set of cylinders. This giving the possibility of removing the second set of cylinders in cases where the riser is not experiencing internal pressure and adding them in case there are going to be internal pressure.

According to an aspect of the invention the cylinder arrangement may be configured such that some of the cylinders in one set of cylinders, or the whole set of cylinders, may be removed or added to the telescopic joint. This will give flexibility in adapting the system to different water depths or with or without internal pressure within the telescopic joint.

The telescopic joint may also be provided with an override system to be used in situations where it is expected large external forces on the system, i.e. to provide a system that increases the connection force between the first and second riser parts, i.e. the first pipe part and the second pipe part. One such situation is for instance when the riser joint is lifted through the splash zone. The telescopic joint may be configured such that it can be extended or collapsed to an end position. The telescopic joint may be configured to be mechanically or hydraulically be locked in such a position. This may be unlocked remotely or by for instance an ROV, when in position or wen there is no longer a need for locking the joint. This override system might be done with separate cylinders or with the cylinders used for reading the external pressure or cylinders pressure compensating the telescopic joint. These cylinders may also be provided with a remotely operated valve in the connection, giving the possibility of locking the telescopic joint in a position by locking a fluid, preferably liquid, within the cylinders.

Another alternative is to provide a separate cylinder/ piston arrangement connected between the first and the second pipe parts, or alternatively by using all or some of the second set of cylinders for this function, or position these specific cylinders in between the cylinders in the first set of cylinders. The cylinder arrangement providing the override system is then fluid filled and locked in a set position. The fluid may be locked in the cylinders by means of a valve which may be remotely operated. The fluid locked inside the cylinders may be released to an active receiver with for instance 1 bar pressure, or to the sea. Alternatively, one may add an additional pressure to the fluid in the cylinder by a connection to a pressure cylinder with for instance ~700 bar pressure. This override system may comprise a set of cylinders, including one cylinder, but preferably two or more separate cylinders such as to provide redundancy in the system.

In an aspect the riser joint may comprise a manifold adapted for distributing a fluid in order to compensate for the internal pressure within the riser to the different cylinders in the second set of cylinders. Further, the manifold may comprise at least one flow regulating means, which flow regulating means may be adapted for regulating to which of the cylinders the fluid is distributed. The flow regulating means may then also be used when removing or adding cylinders from the telescopic joint.

Additionally or alternatively the manifold may be adapted for distributing the internal pressure within the riser to the different cylinders in the cylinder arrangement, having at least one bore in the manifold, leading to one cylinder comprising a floating piston and a stop surface for the floating piston.

In an aspect the telescopic riser joint may be arranged in the lower half of the riser. According to one embodiment it may be arranged in close proximity of the wellhead, possibly as a joint above the wellhead. It may be positioned as a joint close to the wellhead.

The number of cylinders in the first set of cylinders and in the second set of cylinders may be adjustable. The number of cylinders in a set may be one, two, three, four, five or another number higher than this. There may be different numbers in the different sets. The number of cylinders in the first set of cylinders and in the second set of cylinders may be adjustable. The riser joint may for this be equipped with means for connecting and disconnecting cylinders in both the first set and second set of cylinders. The connection means for the second set of cylinders comprises quick couplings, which when connected also opens a fluid connection between the cylinder and the fluid within the riser joint. The quick coupling closes the fluid connection automatically when a cylinder is removed from the riser joint. There may be different connection means for the cylinders of the first set of cylinders and the second set of cylinders.

Brief description of the drawings

Fig. 1 shows an overview of a riser system configuration.
Fig. 2 shows a simplified perspective view of a first set of cylinders according to the invention.
Fig. 3 shows a perspective view of an override system according to the invention.
Fig. 4 shows an alternative embodiment of the invention.

Fig. 1 shows an overview of a riser system configuration including subsea equipment connected to a riser, which riser extends through a body of water up to a floating vessel, where the riser is tensioned by a tensioning system connected to the platform in one end and to the riser in the other end. The maximum operational trim condition for the riser is disclosed in the Figure.

Fig. 2 shows a simplified perspective view of a first set of cylinders according to the invention. The first set of cylinders 32 may comprise one, two or several cylinders. In the disclosed embodiment, the cylinders of the first set of cylinders 32 are provided with at least one opening 56 to the sea in the volume 50 on the upper side of the cylinder piston 51, and has a fluid on the lower side 52 of the piston 51, i.e. in the sealed chamber. Alternatively, the cylinder piston 51 and cylinder may be rotated 180 degrees such that the opening 56 is arranged on the lower side of the piston 51 (as disclosed in Fig. 4). The figure shows that the piston rod 57 is mechanically linked to the first pipe part 8 and the cylinder is mechanically linked to the second pipe part 9. The first and second pipe parts 8 are connectable to first and second riser parts (not shown). When the telescopic riser joint 4 is extending, the external pressure, e.g. from the seawater, acting on the upper side of the cylinder piston 51 and the "vacuum effect" (~low pressure) from the sealed chamber 52 on the lower side of the piston 51 both assist in forcing the two pipe parts 8, 9 to a collapsed state, i.e. they provide a force that acts against the separation forces in the telescopic riser joint 4 heave compensating the riser.

Fig. 3 shows a perspective view of an override system according to the invention. The override system may be used in situations where it is expected large external forces on the system, i.e. to provide a system that increases the connection force between the first and second pipe parts 8, 9. This might be done by providing a separate cylinder/ piston arrangement 40 between the first and the second pipe parts 8, 9, or alternatively by using the second set of cylinders, or a combination of the second set of cylinders and the separate cylinder/ piston arrangement 40 for this function. The volume 41 above the pistons 42 in the override cylinders 47 constituting the separate cylinder/ piston arrangement 40 is then fluid filled and locked in a set position. The fluid may be locked in the override cylinders 47 by means of a valve (not shown) which may be remotely operated. The locked fluid within the override cylinders 47 may be released to an active receiver 43 with for instance 1 bar pressure or to the sea 44. Valves 45, 46 may be provided between the sea 44 and the override cylinders 47 and between the active receiver 43 and the override cylinders 47. Alternatively, one may add an additional pressure to the fluid in the override cylinders 47 by a connection to a pressure cylinder 48 with for instance ~700 bar pressure. This override system may comprise a set of cylinders 47, including one cylinder, but preferably two or more separate cylinders such as to provide redundancy in the system.

Fig. 4 shows an alternative embodiment of the invention, where the cylinder arrangement in the telescopic riser joint has been turned 180 degrees. The piston rod 57 is in this embodiment mechanically linked to the second pipe part 9 and the cylinder is mechanically linked to the first pipe part 8. As the telescopic riser joint 4 is extending, the pressure from the seawater acting on the lower side of the cylinder piston 51 and the "vacuum effect" from the sealed chamber 52 on the upper side of the piston 51 both assist in forcing the two pipe parts 8, 9 to a collapsed state.

The invention is herein explained with reference to the accompanied drawings. A person skilled in the art will understand that there may be made alterations and modifications to this embodiment that are within the scope of the invention as defined in the attached claims.

CLAIMS

1. Telescopic riser joint comprising:

a first pipe part and a second pipe part, comprising means for connection to respectively a first riser part and a second riser part, which first and second pipe parts are overlapping and in use are arranged to form part of a riser with an internal flow passage,

a cylinder arrangement comprising a first set of cylinders, each cylinder having a piston rod with a piston head and a cylinder housing, the piston rod and cylinder housing being respectively connected to one of the first pipe part or second pipe part,

where one side of the piston head in use is in communication with external pressure providing an axial force acting in the longitudinal direction of the riser,

and the other side of the piston head is facing a sealed chamber,

where the first set of cylinders is configured such that a fluid in the sealed chamber and a fluid on the other side of the piston head give a resultant force tensioning the first riser part and the second riser part.

2. Telescopic riser joint according to claim 1, wherein the riser joint further comprises a second set of cylinders, each cylinder has a piston rod with a piston head and a cylinder housing respectively connected to the first pipe part and the second pipe part, and wherein one side of the piston head is in fluid communication with the internal fluid in the riser and compensates the telescopic riser joint for the internal pressures in the riser.

3. Telescopic riser joint according to claims 1 - 2, wherein the riser joint comprises an override system adapted for increasing the connection force between the first riser part and the second riser part.

4. Telescopic riser joint according to claim 2, wherein the first set of cylinders and the second set of cylinders are arranged next to each other, around the periphery of the riser.

5. Telescopic riser joint according to claims 1-4, wherein the riser joint comprises a manifold adapted for distributing the internal pressure within the riser to the different cylinders in the cylinder arrangement, having at least one bore in the manifold leading to one cylinder, comprising a floating piston and a stop surface for the floating piston.

6. Telescopic riser joint according to any of the preceding claims, wherein the riser joint is arranged in the lower half of the riser.

7. Telescopic riser joint according to any of the preceding claims 2-6, wherein the number of cylinders in the first set of cylinders and in the second set of cylinders are adjustable.

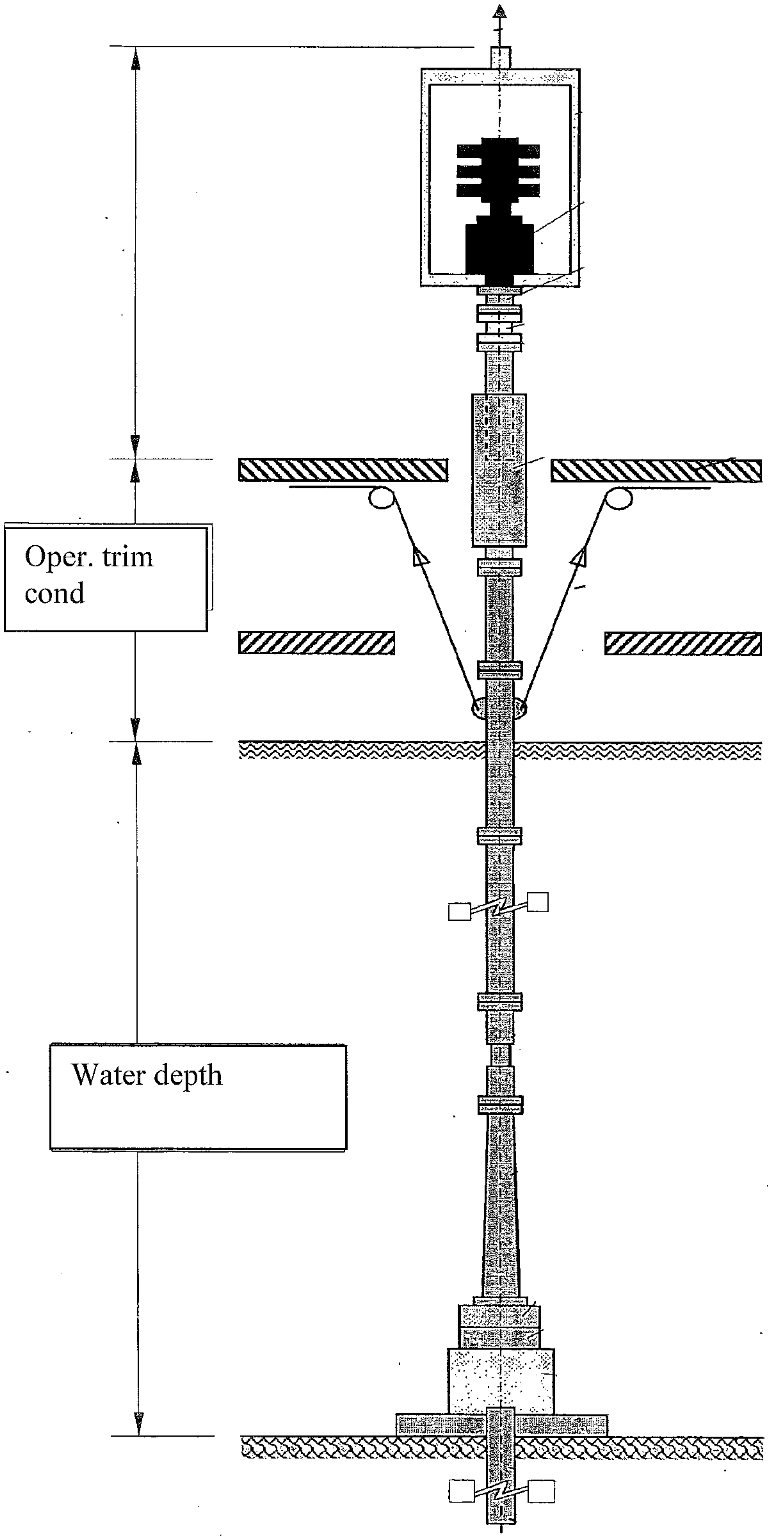

Fig. 1

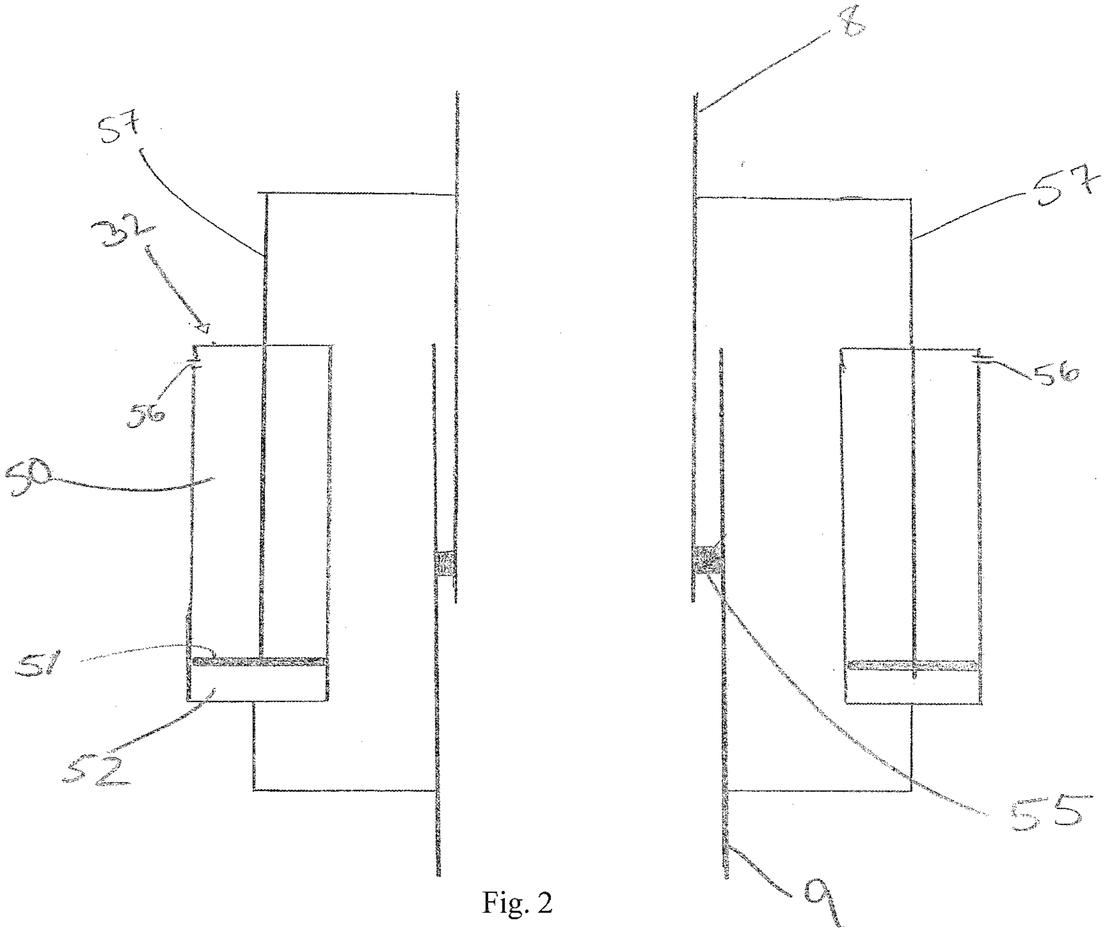

Fig. 2

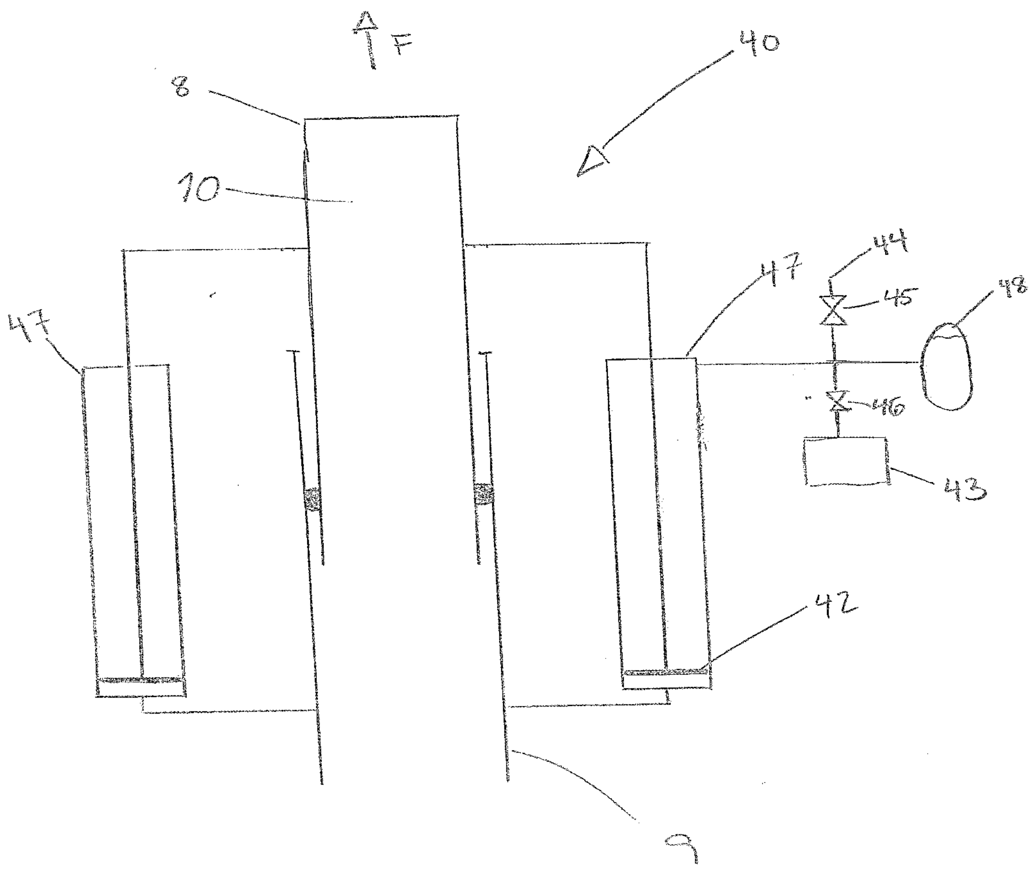

Fig. 3

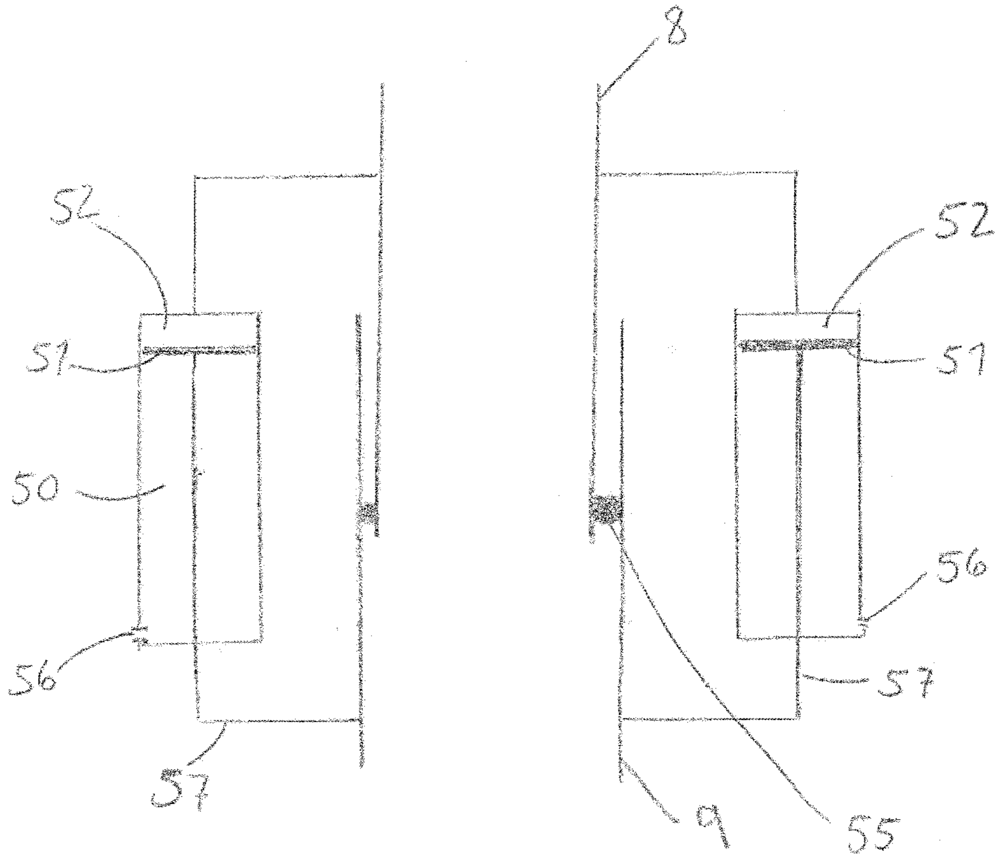

Fig. 4