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(54) Title: DIAPHRAGM PUMP FOR A SEAT ADJUSTING DEVICE AND SEAT ADJUSTING DEVICE

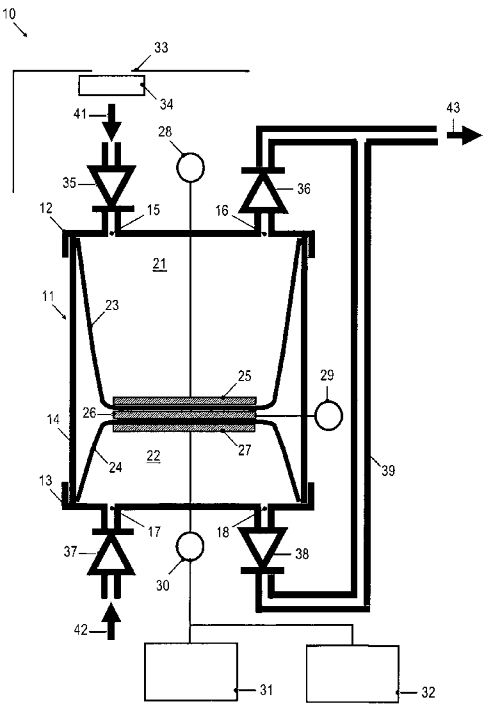

Fig. 2

(57) Abstract: A diaphragm pump for a seat adjusting device comprises an enclosure (11) and at least one diaphragm (23, 24) disposed within the enclosure (11) to delimit a first pump chamber (21) and a second pump chamber (22). Each one of the first and second pump chambers (21, 22) respectively has a gas inlet (15, 17) and a gas outlet (16, 18). The at least one diaphragm (23, 24) includes at least one dielectric elastomer film (23, 24). At least a portion of the dielectric elastomer film (23, 24) is sandwiched between electrodes (25-27) to form a dielectric elastomer actuator. The at least one diaphragm (23, 24) is attached to the enclosure (11) such that the at least one diaphragm (23, 24) is displaced relative to the enclosure (11) when a voltage applied to the electrodes (25-27) is altered, such that a volume of one of the first and second pump chambers (21, 22) is increased and a volume of the other one of the first and second pump chambers (21, 22) is decreased by the displacement of the at least one diaphragm (23, 24).

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Diaphragm pump for a seat adjusting device and seat adjusting device

FIELD OF THE INVENTION

The invention relates to a diaphragm pump for a seat adjusting device and to a seat adjusting device. The invention relates in particular to a diaphragm pump operative to supply gas to an inflatable chamber of a seat adjusting device.

BACKGROUND

Lumbar supports or other adjustable supports are frequently provided in seats to enhance, for example, a driver's or passenger's comfort. Lumbar support devices are provided in backrests in order to provide adequate support in the lumbar vertebral or lordosis region of a person sitting on the seat by forming a suitable support surface. Some implementations of seat adjusting devices utilize one or plural inflatable chambers. The inflatable chambers may be configured as inflatable cushions or bladders which change their shape and/or size in response to an amount of gas contained therein. Examples for such lumbar support devices are described, for example, in EP 1 072 465 A1 or in DE 100 63 478 A1. An adjustment of the adjustable support may be effected by means of a pressure source and a suitably configured pneumatic circuit comprising valves and connecting members.

In conventional seat adjusting devices, an electric motor is used to drive a pump. Conventionally, the pump includes mechanical componentry, such as a gearing or other transmission members, which converts the rotational movement of the electric motor into a volume flow supplied by the pump. If the pump is configured as a diaphragm pump, a transmission may be provided which causes the diaphragm to be displaced under the action of the electric motor.

The mechanical componentry used in a conventional pump for a seat adjusting device may include a significant number of parts. Design requirements for each one of the parts may be high. This may add to the costs of the seat adjusting device. This mechanical componentry may also add to the weight and complexity. In use of the pump, the moving parts of the mechanical transmission may give rise to vibration and/or noise. If damping materials are used to reduce the transmission of vibration and/or noise, this may further add to weight, costs and installation space requirements.

There is a continued need in the art for an improved pump for a seat adjusting device. In particular, there is a continued need in the art for a pump which reduces the number of mechanical parts required to drive a pump cycle in the pump. There is also a need in the art for a pump which is less susceptible to generating vibrations and/or noise

SUMMARY

There is a continued need in the art for a pump for a seat adjusting device and for a seat adjusting device which address some of the above needs.

According to embodiments, diaphragm pumps and a seat adjusting device as defined in the independent claims are provided. The dependent claims define embodiments.

According to an embodiment, a dual chamber diaphragm pump for a seat adjusting device is provided. The dual chamber diaphragm pump comprises an enclosure and at least one diaphragm disposed within the enclosure to delimit a first pump chamber and a second pump chamber within the enclosure. Each one of the first and second pump chambers respectively has a gas inlet and a gas outlet. The at least one diaphragm includes at least one dielectric elastomer film. At least a portion of the at least one dielectric elastomer film is sandwiched between electrodes to form a dielectric elastomer actuator. The at least one diaphragm is attached to the enclosure such that the at least one diaphragm is displaced relative to the enclosure when a voltage applied to the electrodes is altered, such that a volume of one of the first and second pump chambers is increased and a volume of the other one of the first and second pump chambers is decreased by the displacement of the at least one diaphragm.

According to another embodiment, a diaphragm pump for a seat adjusting device is provided. The diaphragm pump comprises an enclosure, at least one diaphragm and a resiliently deformable bias member. The at least one diaphragm is disposed within the enclosure to delimit a pump chamber within the enclosure, the pump chamber having a gas inlet and a gas outlet. The resiliently deformable bias member is arranged in the pump chamber. The bias member is coupled to the at least one diaphragm. The at least one diaphragm includes at least one dielectric elastomer film. At least a portion of the at least one dielectric elastomer film is sandwiched between electrodes to form a dielectric elastomer actuator.

According to another embodiment, a seat adjusting device is provided. The seat adjusting device comprises at least one inflatable gas cushion, a supply channel to supply gas to the at least one inflatable gas cushion, and a dual chamber diaphragm pump. The dual chamber diaphragm pump comprises an enclosure and at least one diaphragm disposed within the enclosure to delimit a first pump chamber and a second pump chamber within the enclosure. Each one of the first and second pump chambers respectively has a gas inlet and a gas outlet. The gas outlet of the first pump chamber and the gas outlet of the second pump chamber are in communication with the supply channel. The at least one diaphragm includes at least one dielectric elastomer film. At least a portion of the at least one dielectric elastomer film is sandwiched between electrodes to form a dielectric elastomer actuator. The at least one diaphragm is attached to the enclosure such that the at least one diaphragm is displaced relative to the enclosure when a voltage applied to the electrodes is altered, such that a volume of one of the first and second pump chambers is increased and a volume of the other one of the first and second pump chambers is decreased by the displacement of the at least one diaphragm.

According to another embodiment, a seat is provided which includes a seat adjusting device of an aspect or embodiment.

According to embodiments, a diaphragm of a diaphragm pump is configured as a dielectric elastomer actuator. The diaphragm pump may be operated by applying a voltage to the electrodes of the dielectric elastomer actuator. It is no longer required to provide an electric motor and a transmission to displace the diaphragm. This may lead to a reduction in complexity, weight, noise and vibrations.

Embodiments of the invention will be described with reference to the accompanying drawings.

Fig. 1 is a schematic view of a seat having a seat adjusting device according to an embodiment.

Fig. 2 is a schematic sectional view of a diaphragm pump according to an embodiment.

Fig. 3 shows an exploded view of a diaphragm used in the diaphragm pump of an embodiment.

Fig. 4 shows an exploded view of another diaphragm used in the diaphragm pump of an embodiment.

Fig. 5 shows a sectional view of the diaphragm of Fig. 4 in the installed state.

Fig. 6 shows an exploded view of another diaphragm used in the diaphragm pump of an embodiment.

Fig. 7 is a schematic sectional view of a diaphragm pump according to another embodiment.

Fig. 8 is a schematic sectional view of a diaphragm pump according to another embodiment.

Fig. 9 is a diagram illustrating the volume flow of the diaphragm pump of an embodiment.

Fig. 10 is a schematic sectional view of a diaphragm pump according to another embodiment.

Fig. 11 is a schematic sectional view of a diaphragm pump according to another embodiment.

Exemplary embodiments of the invention will be described with reference to the drawings. While some embodiments will be described in the context of specific fields of application, such as in the context of lumbar supports for vehicle seats, the embodiments are not limited to this field of application. The features of the various embodiments may be combined with each other unless specifically stated otherwise. Throughout the following description, same or like reference numerals refer to same or like components or mechanisms.

Fig. 1 is a schematic view of a vehicle seat 1 having an adjusting device which utilizes a diaphragm pump. The diaphragm of the pump includes a dielectric elastomer film sandwiched between electrodes to form a dielectric elastomer actuator. The adjusting device is illustrated to be a four-way lumbar support device. The lumbar support device includes inflatable pump chambers, which are configured as a first inflatable bladder 2, a second inflatable bladder 3, and a third inflatable bladder 4. The bladders 2-4 are configured to change their exterior dimensions when a gas pressure in the respective bladder is adjusted. The bladders 2-4 are provided at a lower portion of the backrest of the vehicle seat 1 and are offset relative to each other in a longitudinal direction of the backrest. By inflating or deflating the bladders 2-4, the amount of curvature in the lower backrest portion may be adjusted. By inflating one of the bladders while deflating another one, the apex position may be shifted. Thereby, a four-way lumbar support device may be implemented. While a lumbar support device is illustrated in Fig. 1, bladders may also be provided at other positions of the seat. For illustration, inflatable bladders may be provided in side bolster portions of the seat to implement a side bolster support device. Inflatable bladders may be provided in a seat portion to adjust a seat contour to a user's thighs.

The adjusting device includes a diaphragm pump 6, a controllable valve assembly 7 and a control device 5. The valve assembly 7 is configured to receive gas provided by the diaphragm pump 6 and to supply the gas to the bladders via gas lines 8, 9. The control device 5 is configured to control the diaphragm pump 6 and the valve assembly 7. The control device 5 may be configured to control the diaphragm pump 6 and/or the valve assembly 7 automatically, for example in order to implement a massage-type movement. The control device 5 may be configured to control the diaphragm pump 6 and/or the valve assembly 7 in response to control commands input by a user. The control device 5 may be configured to allow a user to control operation of the diaphragm pump 5 to thereby control inflation of the bladders 2-4. The control device 5 may be configured to control the valve assembly 7, for example by allowing a user to select to which one of the bladders 2-4 pressure air is supplied.

Embodiments of the diaphragm pump will be described in more detail with reference to Figs. 2-11 below. Generally, the diaphragm pump includes a dielectric elastomer actuator. At least a portion of the diaphragm of the pump is a dielectric elastomer film sandwiched between electrodes. The electrodes may be formed from a resilient material which is conductive. The electrodes and the dielectric elastomer film may be laminated to form a layered structure. By applying a voltage to the electrodes, the thickness of the dielectric elastomer film sandwiched therebetween is varied. This causes the dielectric elastomer film to extend or contract in a lateral direction, i.e.

within the plane of the film. With ends of the diaphragm being attached to a pump enclosure in an air-tight manner, the diaphragm is displayed when the voltage between the electrodes is altered, owing to the changing lateral dimensions.

A suitable bias mechanism may be used to mechanically bias the diaphragm. In some implementations, a second diaphragm may be used to bias the diaphragm. Thereby, a dual-chamber pump may be formed. In other implementations, a resiliently deformable element may be arranged in a pump chamber.

The diaphragm pump of the various embodiments described herein is configured to operate with gas, in particular with air, as a working medium. Correspondingly, the diaphragm may be sealed to an enclosure of the pump in an air-tight manner to delimit a pump chamber.

In an embodiment, the diaphragm pump 6 of Fig. 1 is a dual chamber diaphragm pump for a seat adjusting device. The dual chamber diaphragm pump comprises an enclosure and at least one diaphragm disposed within the enclosure to delimit a first pump chamber and a second pump chamber within the enclosure. Each one of the first and second pump chambers respectively has a gas inlet and a gas outlet. The at least one diaphragm includes at least one dielectric elastomer film, at least a portion of the at least one dielectric elastomer film being sandwiched between electrodes to form a dielectric elastomer actuator. The at least one diaphragm is attached to the enclosure such that the at least one diaphragm is displaced relative to the enclosure when a voltage applied to the electrodes is altered, such that a volume of one of the first and second pump chambers is increased and a volume of the other one of the first and second pump chambers is decreased by the displacement of the at least one diaphragm.

By using a dielectric elastomer actuator, shortcomings of conventional mechanical transmissions interconnected between a motor and a diaphragm, which add to weight and noise of conventional pump, may be mitigated. Further, by configuring the pump as a dual-chamber pump, when a finite voltage is applied to the electrodes, one of the pump chambers decreases in volume, thereby delivering gas. When the voltage applied to the electrodes is set back to zero, the other one of the pump chambers decreases in volume, thereby delivering gas. A high volume flow may thus be attained.

The diaphragm may be sealed to the enclosure in an air-tight manner at an outer periphery thereof.

The at least one diaphragm may include a first diaphragm delimiting the first pump chamber and a second diaphragm delimiting the second pump chamber. The first diaphragm and the second diaphragm may be attached to each other, the second diaphragm being arranged to bias the first diaphragm. The first diaphragm and the second diaphragm may be attached to each other at only a center portion thereof. This allows the second diaphragm to act as a bias member for the first diaphragm and vice versa.

The first diaphragm may include a first dielectric elastomer film to form the dielectric elastomer actuator, and the second diaphragm may be arranged to displace the dielectric elastomer actuator when a voltage is applied to the electrodes. Thereby, a change in volume of both the first pump chamber and the second pump chamber is attained in response to a voltage applied to the electrodes.

The first diaphragm may include a first dielectric elastomer film, and the second diaphragm may include a second dielectric elastomer film. The dual chamber diaphragm pump may include at least three electrodes, at least a portion of the first dielectric elastomer film being sandwiched between a first pair of electrodes of the at least three electrodes, and at least a portion of the second dielectric elastomer film being sandwiched between a second pair of electrodes of the at least three electrodes. Thereby, two dielectric elastomer actuators may be provided. The flow rates which can be attained may be increased.

The dual chamber diaphragm pump may comprise an electronic control circuit configured to selectively apply the voltage to one of the first pair of electrodes or the second pair of electrodes. The electronic control circuit may be configured to apply the voltage in an alternating fashion to the first pair of electrodes and the second pair of electrodes. Thereby, efficient cycling between the different states of the pump may be realized. The dual chamber diaphragm pump may include three electrodes, one of the electrodes being sandwiched between the first dielectric elastomer film and the second dielectric elastomer film. This allows two dielectric elastomer actuators to be operated using three electrodes.

A resiliently deformable bias member may be coupled to the at least one diaphragm and the enclosure, the resiliently deformable bias member being arranged in the first pump chamber or in the second pump chamber. The bias member may decrease the time required for the diaphragm to return to its position when a voltage applied to the electrodes is reset to zero.

The pump may comprise a sensor circuit electrically coupled to the electrodes and configured to derive a pressure from electrical characteristics of the electrodes. The sensor circuit may derive the pressure from a voltage at the electrodes or from a capacitance of the capacitor formed by the electrodes and the dielectric elastomer film interposed between the electrodes. Thereby, pressure sensing may be performed using the electrodes of the dielectric elastomer actuator.

The gas inlet and the gas outlet of the first pump chamber may be provided on a first face of the enclosure, and the gas inlet and the gas outlet of the second pump chamber may be provided on an opposing second face of the enclosure. The at least one diaphragm may be attached to the enclosure such that, when a voltage applied to the electrodes is altered, the at least one dielectric elastomer actuator is displaced towards one of the first and second faces and away from the other one of the first and second faces. The enclosure may extend cylindrically about an axis, and the first face and the second face may be spaced along the axis. Such a design allows the changes in the lateral dimensions of the dielectric elastomer film which are attainable in the dielectric elastomer actuator to be efficiently converted into a volume flow output by the diaphragm pump.

The dual chamber diaphragm pump may comprise a first check valve in communication with the gas outlet of the first pump chamber and a second check valve in communication with the gas outlet of the second pump chamber. The check valves may be integrated into a housing of the diaphragm pump.

A communication channel may be provided between an outlet port of the first check valve and an outlet port of the second check valve. Thereby, gas output from either one of the first and second pump chambers may be supplied to a common gas channel.

In another embodiment, the diaphragm pump 6 of Fig. 1 is a diaphragm pump for a seat adjusting device. The pump comprises an enclosure, at least one diaphragm, and a resiliently deformable bias member. The at least one diaphragm is disposed within the enclosure to delimit a pump chamber within the enclosure, the pump chamber having a gas inlet and a gas outlet. The resiliently deformable bias member is arranged in the pump chamber, the bias member being coupled to the at least one diaphragm. The at least one diaphragm includes at least one dielectric elastomer film, at least a portion of the at least one dielectric elastomer film being sandwiched between electrodes to form a dielectric elastomer actuator.

By using a dielectric elastomer actuator, shortcomings of conventional transmissions mechanisms which may add to the weight and noise of a conventional pump may be mitigated. Further, by using the bias member disposed within the pump chamber, pump cycles may be performed efficiently. By arranging the bias member in the pump chamber, a compact construction can be attained. The bias member displaces the diaphragm when a voltage is applied to the electrodes of the dielectric elastomer actuator.

The pump chamber may be barrel-shaped, the at least one dielectric elastomer film forming a side wall of the pump chamber. The electrodes may be arranged at axial ends of the barrel-shaped pump chamber.

Reference will now be made to Figs. 2-11.

Fig. 2 shows a cross-sectional view of a dual chamber diaphragm pump 10 according to an embodiment.

The pump 10 generally includes an enclosure 11, a first diaphragm 23 and a second diaphragm 24 disposed within the enclosure 11. The first diaphragm 23 is sealed to the enclosure 11 to delimit a first pump chamber 21. For illustration, a periphery of the first diaphragm 23 may be sealingly clamped between an end member 12 and a cylindrical shell 14 of the enclosure 11. The second diaphragm 24 is sealed to the enclosure 11 to delimit a second pump chamber 22. For illustration, a periphery of the second diaphragm 24 may be sealingly clamped between an opposite end member 13 and a cylindrical shell 14 of the enclosure 11. The first diaphragm 23 and the second diaphragm 24 are attached to each other at central portions thereof. The first diaphragm 23 and the second diaphragm 24 may be arranged such that the first diaphragm 23 exerts a force onto the second diaphragm 24, and that the second diaphragm 24 exerts a force onto the first diaphragm. This may be attained by prestretching the first diaphragm 23 and the second diaphragm 24, such that an elastic restoration force respectively exerts a force onto the other diaphragm.

The first pump chamber 21 has a gas inlet 15 and a gas outlet 16. An outlet port of a check valve 35 is in communication with the gas inlet 15. An inlet port of another check valve 36 is in communication with the gas outlet 16.

The second pump chamber 22 has a gas inlet 17 and a gas outlet 18. An outlet port of a check valve 37 is in communication with the gas inlet 17. An inlet port of another check valve 38 is in communication with the gas outlet 18.

The enclosure 11 may be formed from a plastic material. The enclosure 11 may have a generally cylindrical shape. The enclosure 11 includes a shell 14 which defines the side walls of the enclosure 11 and which may be cylindrical. The enclosure 11 includes an axial end member 12 and an opposing axial end member 13. The axial end members 12, 13 may be attached to the shell 14 in an air-tight manner. The gas inlet 15 and gas outlet 16 of the first pump chamber 21 are formed in the axial end member 12. The gas inlet 17 and gas outlet 18 of the second pump chamber 22 are formed in the axial end member 13. The dimensions of the enclosure 11 may be selected as appropriate.

Displacement of the first diaphragm 21 and of the second diaphragm 22 is effected using dielectric elastomer actuators. The first diaphragm 23 may be a dielectric elastomer film or may include such a dielectric elastomer film. Electrodes 25 and 26 sandwich a portion of the dielectric elastomer film. The electrodes 25 and 26 may be laminated to the dielectric elastomer film so as to cover the entire surface of the dielectric elastomer film, or may be applied to only cover a portion of the dielectric elastomer film. An insulating cover may be provided over the electrode 25 and over the electrode 26. With the diaphragm pump 10 using gas as a working medium, such an insulating cover does not need to be provided, i.e., the electrode 25 may be exposed to the first pump chamber 21. The sandwich structure of electrodes 25 and 26 and dielectric elastomer film interposed therebetween forms a dielectric elastomer actuator.

When a voltage is applied to the electrodes 25 and 26 by setting electrode 25 to a positive potential and electrode 26 to a negative potential or vice versa, the electrodes 25 and 26 are displaced towards each other due to electrostatic attraction.

Thereby, the dielectric elastomer film interposed therebetween is compressed along its thickness direction. This causes the lateral dimensions of the dielectric elastomer film of the first diaphragm 23 to increase. Under the action of the second diaphragm 24, the increased lateral dimensions of the dielectric elastomer film of the first diaphragm 23 cause the first diaphragm 23 to be displaced away from the axial end face 12. The volume of the first pump chamber 21 is increased.

When application of a voltage to the electrodes 25 and 26 is terminated, the electrodes 25 and 26 are pushed away from each other under the resilient restoration force of the dielectric elastomer film. The lateral dimensions of the dielectric elastomer film decrease, causing the first diaphragm 23 to be displaced towards the axial end face 12. The volume of the first pump chamber 21 is decreased.

Another dielectric elastomer actuator may be formed by the second diaphragm 24. The second diaphragm 24 may be a dielectric elastomer film or may include such a dielectric elastomer film. Electrodes 26 and 27 sandwich a portion of the dielectric elastomer film. The electrodes 26 and 27 may be laminated to the dielectric elastomer film so as to cover the entire surface of the dielectric elastomer film, or may be applied to only cover a portion of the dielectric elastomer film. An insulating cover may be provided over the electrode 27. With the pump 10 using gas as a working medium, the electrode 27 may be exposed to the second pump chamber 22. The sandwich structure of electrodes 26 and 27 and dielectric elastomer film interposed therebetween forms a second dielectric elastomer actuator.

The operation of the second dielectric elastomer actuator corresponds to the one of the first dielectric elastomer actuator formed on the first diaphragm 23.

In operation, the first dielectric elastomer actuator and the second dielectric elastomer actuator may be activated in an alternating manner. A voltage may be applied selectively to the pair of electrodes 25 and 26, to increase the volume of the first pump chamber 21 and decrease the volume of the second pump chamber 22, or to the pair of electrodes 26 and 27, to decrease the volume of the first pump chamber 21 and increase the volume of the second pump chamber 22. A control circuit 31 may be provided to control the timing at which a voltage is applied to the different pairs of electrodes. The control circuit 31 may be coupled to a terminal 28 which is electrically connected to the electrode 25, to a terminal 29 which is electrically connected to the electrode 26 and to a terminal 30 which is electrically connected to the electrode 27. The control circuit 27 may apply a negative potential to terminal 29 and may apply a positive potential to respectively one of terminals 28 and 30 in an alternating fashion.

When the voltage applied to the electrodes of the dielectric elastomer actuators is varied in an alternating manner, the central portion of the two diaphragms moves along the axial direction of the enclosure 11, i.e., up and down in Fig. 2.

In operation, when the volume of the first pump chamber 21 increases, gas is drawn into the first pump chamber 21 through valve 35 and gas inlet 15. This results in a gas inflow 41 into the first pump chamber 21. In parallel, the volume of the second pump chamber 22 decreases, which causes gas to be output via the gas outlet 18 and valve 38. An output port of the valve 38 may be in communication with a common channel 39 which communicates the output ports of the valves 36 and 38. The gas output from the second pump chamber 22 may be supplied as gas outflow 43 to the valve assembly 7 (shown in Fig. 1) and further on to the inflatable bladders of the seat adjusting device (shown in Fig. 1).

When the volume of the first pump chamber 21 decreases, gas is output via the gas outlet 16 and valve 36. An output port of the valve 36 may be in communication with the common channel 39 which communicates the output ports of the valves 36 and 38. The gas output from the first pump chamber 21 may be supplied as gas outflow 43 to the valve assembly 7 and further on to the inflatable bladders of the seat adjusting device. In parallel, gas is drawn into the second pump chamber 22 through valve 37 and gas inlet 17.

The dual chamber pump 10 provides a gas outflow 43 when the first dielectric elastomer actuator provided on the first diaphragm 23 is actuated, which causes the volume of the second pump chamber 22 to decrease, and when the second dielectric elastomer actuator provided on the second diaphragm 24 is actuated, which causes the volume of the first pump chamber 21 to decrease. Each diaphragm respectively acts as a bias member for the other diaphragm, thereby effecting a displacement when the lateral dimensions of a diaphragm change due to actuation of the dielectric elastomer actuator.

The dual chamber pump 10 may be used not only for pumping, but also for pressure sensing. A sensor circuit 32 may be connected to at least two of the terminals 28-30.

The sensor circuit 32 may, for example, be connected to terminals 28 and 29. The sensor circuit 32 may sense a capacitance of the capacitor formed by electrodes 25 and 26 to determine the pressure in the first pump chamber 21. A controllable by-pass valve may be interconnected between the communication channel 39 and the first pump chamber 21. The by-pass valve may be opened when pressure sensing is to be performed, thereby allowing the pressure in the first pump chamber 21 to become equal to the pressure of the bladder 4-6 for which pressure sensing is to be performed. The sensor circuit 32 may use a look-up table or other processing to convert a measured electronic characteristic, such as a capacitance, into a corresponding pressure value.

The control circuit 31 and the sensor circuit 32 may be integrated into a pump housing or may be provided separately.

All or some of the valves 35-38 may be integrated into a pump housing. The inlet port of the check valve 35 may be arranged to draw in ambient air. In order to reduce noise, the inlet port of the check valve 35 may be arranged in an interior of a housing 33 of the pump 10. The housing 33 may have a suction opening through which ambient air can flow to the inlet port of the check valve 35. A noise damping material 34 may be provided in an interior of the housing 33, such that air drawn in through the opening in the housing 33 passes the noise damping material 34 on its way to the inlet port of the check valve 35. Similarly, the inlet port of the check valve 37 may be arranged in an interior of the housing 33, and air may pass the noise damping material 34 as it passes from the suction opening in the housing 33 to the inlet port of the check valve 37.

The diaphragm(s) and dielectric elastomer actuator of the pump explained with reference to Fig. 2 or of the pump of any other embodiment described herein may have any one of a variety of configurations, as will be explained with reference to Figs. 3-6. While various configurations for the diaphragm and dielectric elastomer actuator will be explained in the context of the first diaphragm 23, any one of these configurations may also be used for the second diaphragm.

Fig. 3 illustrates an exploded view of a diaphragm 23 of a diaphragm pump which consists of a dielectric elastomer film. A central portion 44 of the dielectric elastomer film is sandwiched between electrodes 25 and 26 to form a dielectric elastomer actuator. No electrodes are applied to the dielectric elastomer film at a peripheral area surrounding the central portion 44.

A diameter of the central portion 44 varies as the electrodes 25 and 26 are attracted when a voltage is applied to the electrodes, so that the thickness of the central portion 44 is decreased, increasing the diameter of the central portion 44. The diameter of the central portion 44 varies when an applied voltage is reduced, allowing the dielectric elastomer film to push the electrodes 25 and 26 further apart, so that the thickness of the central portion 44 is increased, decreasing the diameter of the central portion 44. The change in size results in a displacement of the central portion 44 relative to the axial end faces of the enclosure.

Alternative structures may be used. For illustration, a multi-layer configuration having plural layers of dielectric elastomer film, each of which is sandwiched between a pair of electrodes, may be used.

Fig. 4 illustrates an exploded view of a diaphragm 50 which includes a dielectric elastomer film 51. The dielectric elastomer actuator is formed using a multi-layer structure of electrodes and plural layers of dielectric elastomer film. Patches 52a and 52b of dielectric elastomer film are provided. The patches 52a and 52b have a diameter corresponding to that of a central portion 52 of the dielectric elastomer film 51 which is sandwiched between electrodes 25 and 26. Each one of the patches 52a and 52b is sandwiched between a pair of electrodes 25 and 26. Electrode patches 25 are respectively connected to a terminal for applying an electric potential. Electrode patches 26 are respectively connected to another terminal for applying an electric potential. The electrode patches 25 and 26 are provided in an alternating fashion.

Fig. 5 illustrates a cross-sectional view through the diaphragm 50 when used in the diaphragm pump of an embodiment. In a central portion, the diaphragm 50 has a multi-layer structure of plural layers of dielectric elastomer film (indicated as solid areas), each of which is sandwiched between electrode patches (indicated as hatched areas). The various layers may be laminated onto each other.

While the electrodes may cover only a central portion of the dielectric elastomer film in some implementations, the electrodes may have a diameter corresponding to that of the dielectric elastomer film in other implementations.

Fig. 6 illustrates an exploded view of a diaphragm 23 of a diaphragm pump which is a dielectric elastomer film. The dielectric elastomer film is sandwiched between electrodes 25 and 26 to form a dielectric elastomer actuator. The electrodes 25 and 26 have a diameter which corresponds to that of the dielectric elastomer film.

In each one of the implementations for forming the dielectric elastomer actuator, the dielectric elastomer film may be made from any one of a variety of materials. For illustration, the dielectric elastomer film may be made from a silicone or an acrylic elastomer. The dielectric elastomer film may be made from a material selected from a group comprising: acrylic rubber, silicone rubber, fluoro-rubber, urethane rubber, nitrile rubber, ethylene propylene rubber, styrene butadiene rubber, and natural rubber.

The electrodes 25 and 26 may respectively also be formed of a resilient material. The electrodes 25 and 26 may respectively be formed from a material which allows the electrodes 25 and 26 to expand jointly with the dielectric elastomer film to which they are attached. The electrodes 25 and 26 may be made from a material produced from carbon nanotubes, carbon black, or other carbon materials, respectively mixed with silicone oil or another suitable material. A variety of materials may be used as binder for forming the electrodes, such as silicone rubber or acrylic rubber.

Diaphragm pumps according to other embodiments will be explained with reference to Figs. 7-11. The diaphragm(s) may respectively have any one of the various configurations explained above. Components which correspond, with respect to their configuration and operation, to components explained in the context of another embodiment are designated with the same reference numerals.

Fig. 7 shows a cross-sectional view of dual chamber diaphragm pump 60 according to an embodiment.

The pump 60 generally includes an enclosure 11, a first diaphragm 23 and a second diaphragm 24 disposed within the enclosure 11.

The first diaphragm 23 may be, or may include, a dielectric elastomer film. A central portion of the dielectric elastomer film is sandwiched between electrodes 25 and 26 to form a dielectric elastomer actuator.

The second diaphragm 24 is also formed from a resilient material. The second diaphragm 24 does not need to be formed from a dielectric material. The second diaphragm 24 is attached to the first diaphragm via an electrode 26, which is sandwiched between the first diaphragm 23 and the second diaphragm 24. The second diaphragm 24 is not provided with a pair of electrodes and does not form a dielectric elastomer actuator in this embodiment.

The mechanical coupling between the first diaphragm 23 and the second diaphragm 24 causes the second diaphragm 24 to be displaced when the voltage applied to the electrodes 25, 26 of the dielectric elastomer actuator is altered. When the voltage applied to the electrodes 25, 26 is varied in a cyclic manner, the central portion of the two diaphragms 23 and 24 moves along the axial direction of the enclosure 11 in a reciprocating manner, i.e., up and down in Fig. 7. Thereby, the volume of one of the pump chambers 21 and 22 is increased while the volume of the other pump chamber is simultaneously decreased as the voltage is varied.

One or several weight members 61 may be attached to the first diaphragm 23 to bias the first diaphragm 23 into a desired position in the rest state where no voltage is applied to the electrodes 25, 26.

In the pump 60, one dielectric elastomer actuator is used to displace two diaphragms which are mechanically coupled to each other, such that the volume of one pump chamber increases while the volume of the other pump chamber decreases when a voltage applied to the electrodes of the dielectric elastomer actuator is altered.

Fig. 8 shows a cross-sectional view of dual chamber diaphragm pump 80 according to an embodiment.

The pump 80 generally includes an enclosure 11 and a diaphragm 23 disposed within the enclosure 11.

The diaphragm 23 may be, or may include, a dielectric elastomer film. A central portion of the dielectric elastomer film is sandwiched between electrodes 25 and 26 to form a dielectric elastomer actuator.

The axial end members 12 and 13 of the enclosure 11 are attached to the shell 14 in an air-tight manner. The diaphragm 23 partitions the interior of the enclosure 11 into a first pump chamber 21 and a second pump chamber 22. There is no separate diaphragm to delimit the second pump chamber 22. The second pump chamber 22 is the portion of the interior of the enclosure 11 which is complementary to the first pump chamber 21.

A mechanical bias member 81 is arranged in the interior of the first pump chamber 21. The mechanical bias member 81 may include a spring. Other resiliently deformable members may be used. The mechanical bias member 81 biases the diaphragm 23.

When a voltage is applied to the electrodes 25 and 26, the lateral size of the dielectric elastomer actuator increases. The dielectric elastomer actuator is displaced towards the axial end face 13 under the action of the mechanical bias member 81.

When no voltage is applied to the electrodes 25 and 26, the restoration force of the dielectric elastomer film causes the lateral dimensions of the diaphragm 23 to be reduced. The dielectric elastomer actuator is displaced back to its initial position against the force of the mechanical bias member 81.

By alternatingly applying a finite voltage and no voltage to the electrodes 25 and 26, the volume of the first pump chamber is made to increase and decrease in a cyclic manner. The volume of the complementary second pump chamber 22 decreases and increases correspondingly, by respectively the same volume amount as the first pump chamber 21.

The diaphragm pump of the various embodiments described herein may be configured such that flow rates of 7 liters/minute may be attained. The enclosure and diaphragm(s) may be dimensioned such that, when the interior of the bladder to be supplied with pressure air is at ambient pressure, the diaphragm pump produces a flow rate of at least 7 liters/minute.

The volume flow produced by the diaphragm pump may decrease with increasing pressure difference between inlet ports and outlet ports. The diaphragm pump of the various embodiments described herein may be configured such that pressure air can be supplied at least until the interior of the bladder to be supplied with pressure air is at a pressure which is 0.7 bar higher than ambient pressure.

Fig. 9 illustrates the characteristics of the diaphragm pump of an embodiment. The flow rate is illustrated as a function of pressure at the connection channel 39 relative to the pressure at the inlet ports of the valves 35 and 37. If the communication channel 39, i.e. the outlet port of the pump, is at ambient pressure, a flow rate of at least 7 liters/minute is attained. The volume flow decreases with increasing pressure difference. A finite volume flow may be generated at least until the pressure difference is 0.7 bar.

According to further embodiments, a diaphragm pump for a seat adjusting device is a one-sided pump having only one pump chamber. Pumps for seat adjusting devices operative using a dielectric elastomer actuator will be explained with reference to Figs. 10 and 11. The pumps may be used in the seat adjusting device of Fig. 1.

Fig. 10 shows a cross-sectional view of dual chamber diaphragm pump 90 according to an embodiment.

The pump 90 generally includes an enclosure 11 and a diaphragm 23. The diaphragm 23 is sealed to the enclosure 11 to delimit a pump chamber 21. The enclosure 11 includes an axial end face 12 in which an air inlet 15 and an air outlet 16 are formed. The axial end face 12 is attached to a shell 14 of the enclosure 11. On the opposing axial end, an axial end face 93 is provided. The axial end face 93 may be configured such that it allows air to flow into the portion of the interior of the enclosure 11 which is complementary to the pump chamber 21. The axial end face does not have to include plural openings, but may have one opening for allowing air to flow into and out of the interior of the enclosure 11.

The diaphragm 23 may be, or may include, a dielectric elastomer film. A central portion of the dielectric elastomer film is sandwiched between electrodes 25 and 26 to form a dielectric elastomer actuator.

A mechanical bias member 91 is arranged in the interior of the pump chamber 21. The mechanical bias member 91 may include a spring. Other resiliently deformable members may be used. The mechanical bias member 91 biases the diaphragm 23.

When a voltage is applied to the electrodes 25 and 26, the lateral size of the dielectric elastomer actuator increases. The diaphragm 23 with the dielectric elastomer actuator is displaced towards the axial end face 93 under the action of the mechanical bias member 91.

When a voltage is no longer applied to the electrodes 25 and 26, the restoration force of the dielectric elastomer film causes the lateral dimensions of the diaphragm 23 to be reduced. The diaphragm 23 with dielectric elastomer actuator is displaced back to its initial position against the force of the mechanical bias member 91.

By alternatingly applying a finite voltage and no voltage to the electrodes 25 and 26, the volume of the pump chamber is made to increase and decrease in a cyclic manner. There is a corresponding inflow 41 and outflow 43 of air.

Fig. 11 shows a cross-sectional view of dual chamber diaphragm pump 100 according to an embodiment.

The pump 100 generally includes an enclosure 101 and a diaphragm 105. The diaphragm 105 defines a side face of a cylindrical or barrel-shaped pump chamber 21.

The enclosure 101 includes a shell 104 defining a side face of the enclosure 101. The shell 104 may extend cylindrically about an axis of the enclosure 101. An axial end member 102 is slideably supported on the shell 104. An opposing axial end face 103 is provided, in which an air inlet 15 and air outlet 16 are formed.

The diaphragm 105 is interposed between a first electrode 25 and a second electrode 26. The first electrode 25 is attached to the axial end member 102, so as to be moveable relative to the shell 104 together with the axial end member 102. The diaphragm is attached to the first and second electrodes 25 and 26 in an air-tight manner.

A mechanical bias member 111 is arranged in the interior of the pump chamber 21. The mechanical bias member 111 may include a spring. Other resiliently deformable members may be used. The mechanical bias member 111 acts upon the electrodes 25 and 26 and thereby biases the diaphragm 105. The mechanical bias member 111 may stretch the diaphragm 105.

When a voltage is applied to the electrodes 25 and 26, such that electrode 25 is at a positive potential and electrode 26 is at a negative potential or vice versa, the electrode 25 is displaced towards electrode 26. The mechanical bias member 111 is compressed correspondingly. The volume of the pump chamber 21 decreases.

When no voltage is applied to the electrodes 25 and 26, the restoration force of the mechanical bias member 111 causes the axial end member 102 and the electrode 25 attached thereto to move in a direction away from the electrode 26. Displacement of the electrode 25 terminates when the force applied to the electrode 25 by the mechanical bias member 111 and the force applied to the electrode 25 by the diaphragm 25 cancel.

By alternatingly applying a finite voltage and no voltage to the electrodes 25 and 26, the volume of the pump chamber 21 is made to increase and decrease in a cyclic manner. There is a corresponding inflow 41 and outflow 43 of air.

Diaphragm pumps using one or several dielectric elastomer actuators have been described in detail. Other configurations may be implemented in other embodiments. For illustration, each one of the pumps may be provided with a control circuit and a sensor circuit as explained with reference to Fig. 2.

While exemplary embodiments have been described in the context of lumbar support adjustment in the backrest of a vehicle seat, the pumps according to various embodiments of the invention are not limited to this particular field of application. Rather, embodiments of the invention may be advantageously employed to adjust various types of supports in a wide variety of seats. The seat adjusting device having a pump of an embodiment may be a lumbar support device. The seat adjusting device having a pump of an embodiment may be a side bolster support device.

Diaphragm pumps and seat adjusting devices of embodiments may be used in vehicle seats, without being limited thereto.

CLAIMS

1. A dual chamber diaphragm pump for a seat adjusting device (2-9), said dual chamber diaphragm pump comprising:

an enclosure (11);

at least one diaphragm (23, 24; 50) disposed within said enclosure (11) to delimit a first pump chamber (21) and a second pump chamber (22) within said enclosure (11), each one of said first and second pump chambers (21, 22) respectively having a gas inlet (15, 17) and a gas outlet (16, 18);

wherein said at least one diaphragm (23, 24; 50) includes at least one dielectric elastomer film (23, 24; 51, 52a, 52b), at least a portion (44; 52, 52a, 52b) of said at least one dielectric elastomer film (23, 24; 51, 52a, 52b) being sandwiched between electrodes (25-27) to form a dielectric elastomer actuator, and

wherein said at least one diaphragm (23, 24; 50) is attached to said enclosure (11) such that said at least one diaphragm (23, 24; 50) is displaced relative to said enclosure (11) when a voltage applied to said electrodes (25-27) is altered, such that a volume of one of said first and second pump chambers (21, 22) is increased and a volume of the other one of said first and second pump chambers (21, 22) is decreased by said displacement of said at least one diaphragm (23, 24; 50).

2. The dual chamber diaphragm pump of claim 1,

wherein said at least one diaphragm (23, 24; 50) includes a first diaphragm (23) delimiting said first pump chamber (21) and a second diaphragm (24) delimiting said second pump chamber (22).

3. The dual chamber diaphragm pump of claim 2,

wherein said first diaphragm (23) and said second diaphragm (24) are coupled to each other, said second diaphragm (24) being arranged to bias said first diaphragm (23).

4. The dual chamber diaphragm pump of claim 3,

wherein said first diaphragm (23) includes a first dielectric elastomer film (23, 24; 51, 52a, 52b) to form said dielectric elastomer actuator, and said second diaphragm (24) is arranged to displace said dielectric elastomer actuator when a voltage is applied to said electrodes (25, 26).

5. The dual chamber diaphragm pump of any one of claims 2-4,

wherein said first diaphragm (23) includes a first dielectric elastomer film (23, 24; 51, 52a, 52b), and said second diaphragm (24) includes a second dielectric elastomer film (51, 52a, 52b),

wherein said dual chamber diaphragm pump (10) includes at least three electrodes (25-27), at least a portion (44; 52, 52a, 52b) of said first dielectric elastomer film (23; 51, 52a, 52b) being sandwiched between a first pair of electrodes (25, 26) of said at least three electrodes (25-27), and at least a portion (52, 52a, 52b) of said second dielectric elastomer film (24; 51, 52a, 52b) being sandwiched between a second pair of electrodes (26, 27) of said at least three electrodes (25-27).

6. The dual chamber diaphragm pump of claim 5,

comprising an electronic control circuit (31) configured to selectively apply said voltage to one of said first pair of electrodes (25, 26) or said second pair of electrodes (26, 27).

7. The dual chamber diaphragm pump of claim 6,

wherein said electronic control circuit (31) is configured to apply said voltage in an alternating fashion to said first pair of electrodes (25, 26) and said second pair of electrodes (26, 27).

8. The dual chamber diaphragm pump of any one of claims 5-7,

wherein said dual chamber diaphragm pump (10) includes three electrodes (25-27), one of said electrodes (26) being sandwiched between said first dielectric elastomer film (23) and said second dielectric elastomer film (24).

9. The dual chamber diaphragm pump of any one of the preceding claims,

wherein a resiliently deformable bias member (81) is coupled to said at least one diaphragm (23, 24) and to said enclosure (11), said resiliently deformable bias member (81) being arranged in said first pump chamber (21) or in said second pump chamber (22).

10. The dual chamber diaphragm pump of any one of the preceding claims,

wherein said gas inlet (15) and said gas outlet (16) of said first pump chamber (21) are provided on a first face (12) of said enclosure (11), and said gas inlet (17) and said gas outlet (18) of said second pump chamber (22) are provided on an opposing second face (13) of said enclosure (11),

wherein said at least one diaphragm (23, 24; 50) is attached to said enclosure (11) such that, when a voltage applied to said electrodes (25-27) is altered, said at least one dielectric elastomer actuator is displaced towards one of said first and second faces (12, 13) and away from the other one of said first and second faces (12, 13).

11. The dual chamber diaphragm pump of claim 10,

wherein said enclosure (11) extends cylindrically about an axis, and said first face (12) and said second face (13) are spaced along said axis.

12. The dual chamber diaphragm pump of any one of the preceding claims,

comprising a first check valve (36) in communication with said gas outlet (16) of said first pump chamber (21) and a second check valve (38) in communication with said gas outlet (18) of said second pump chamber (22).

13. The dual chamber diaphragm pump of claim 12,

comprising a communication channel (39) between an outlet port of said first check valve (36) and an outlet port of said second check valve (38).

14. A seat adjusting device, comprising:

at least one inflatable gas cushion (2-4);

a supply channel (8, 9) to supply gas to said at least one inflatable gas cushion (2-4); and

the dual chamber diaphragm pump (10; 60; 80) of any one of the preceding claims, said gas outlet (16) of said first pump chamber (21) and said gas outlet (18) of said second pump chamber (22) being in communication with said supply channel (8, 9).

15. The seat adjusting device of claim 14,

wherein the dual chamber diaphragm pump is the dual chamber diaphragm pump (10; 60; 80) of claim 12 or claim 13, wherein an outlet port of said first check valve (36) and an outlet port of said second check valve (38) are in communication with said supply channel (8, 9).

16. The seat adjusting device of claim 14 or claim 15,

comprising a sensor circuit (32) electrically coupled to said electrodes (25-27) and configured to derive a pressure from sensed electrical characteristics of said electrodes (25-27).

17. The seat adjusting device of claim 16,

wherein said sensor circuit (32) is configured to sense a capacitance of a capacitor formed by said electrodes (25-27).

18. The seat adjusting device of claims 16 or 17,

wherein said sensor circuit (32) is integrated into said dual chamber diaphragm pump (10; 60; 80).

19. A diaphragm pump for a seat adjusting device, said diaphragm pump comprising:

an enclosure (11; 101);

at least one diaphragm (23, 24; 23; 105) disposed within said enclosure (11; 101) to delimit a pump chamber (21) within said enclosure (11; 101), said pump chamber (21) having a gas inlet (15) and a gas outlet (16);

a resiliently deformable bias member (81; 91; 111) arranged in said pump chamber (21), said bias member (81; 91; 111) being coupled to said at least one diaphragm (23, 24; 23; 105);

wherein said at least one diaphragm (23, 24; 23; 105) includes at least one dielectric elastomer film (23; 105), at least a portion of said at least one dielectric elastomer film (23; 105) being interposed between electrodes (25, 26) to form a dielectric elastomer actuator.

20. The pump of claim 19,

wherein said pump chamber (21) is barrel-shaped, said at least one dielectric elastomer film (105) forming a side wall of said pump chamber (21).

21. The pump of claim 19 or claim 20,

wherein said enclosure (101) has a side wall (104) and an axial end member (102) which is slideable relative to said side wall (104) of said enclosure (101), wherein said at least one diaphragm (105) is coupled to said axial end member (102).

22. The pump of any one of claims 19-21,

wherein said resiliently deformable bias member (81; 91; 111) is a spring.

23. The pump of any one of claims 19-22,
wherein said pump is a one-sided pump (90; 100).

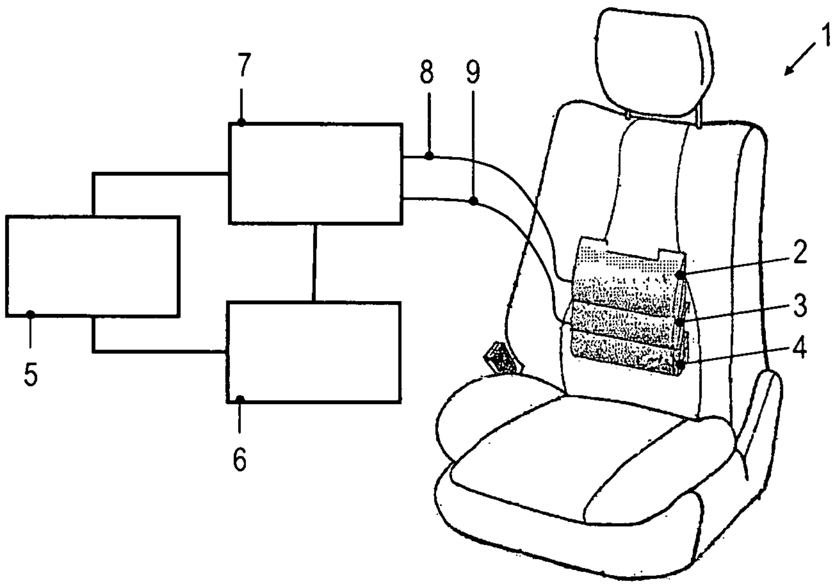

Fig. 1

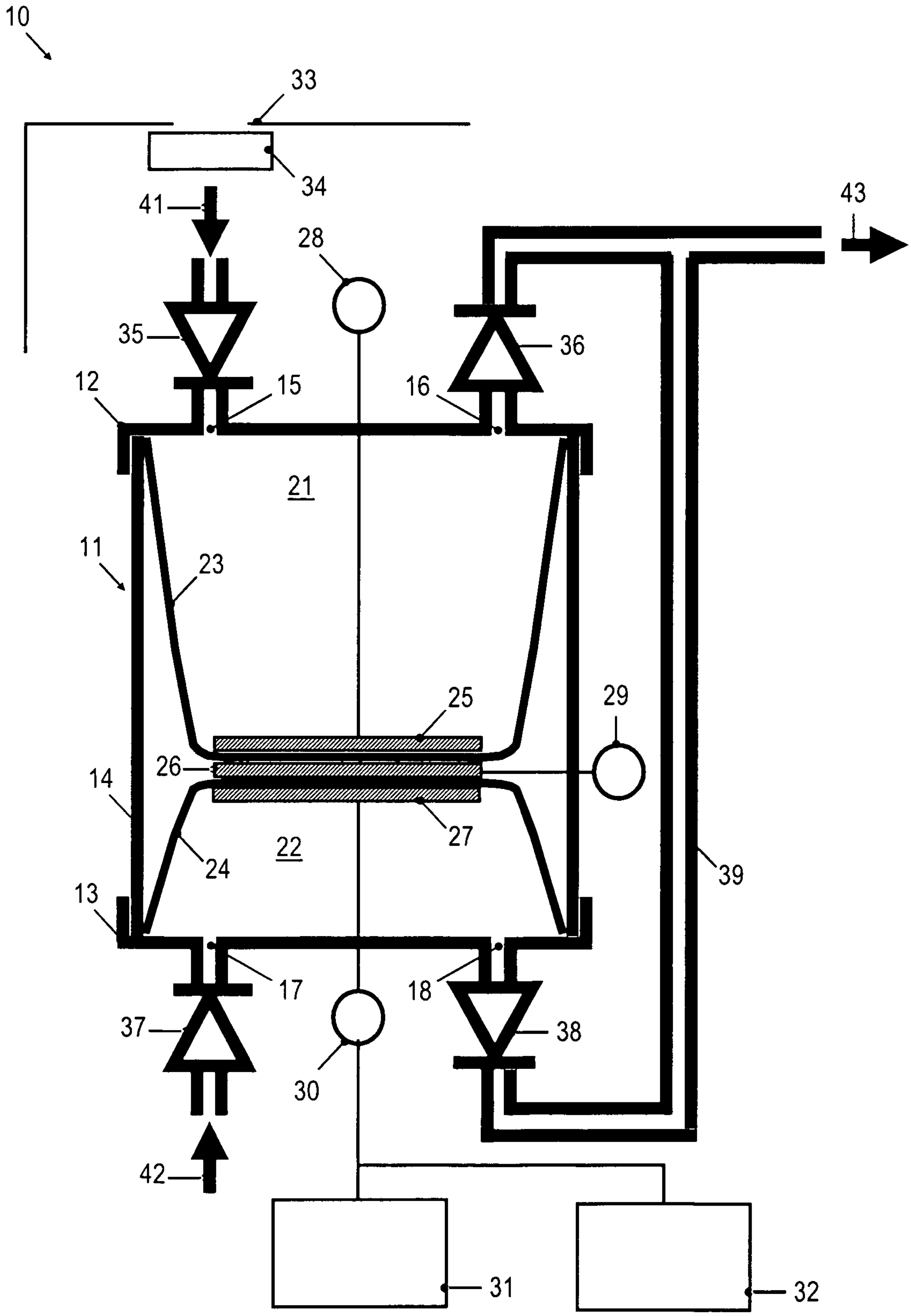
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Fig. 2

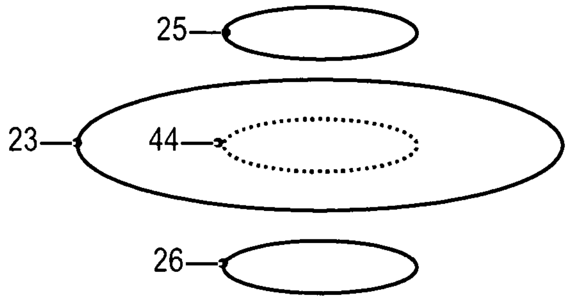

Fig. 3

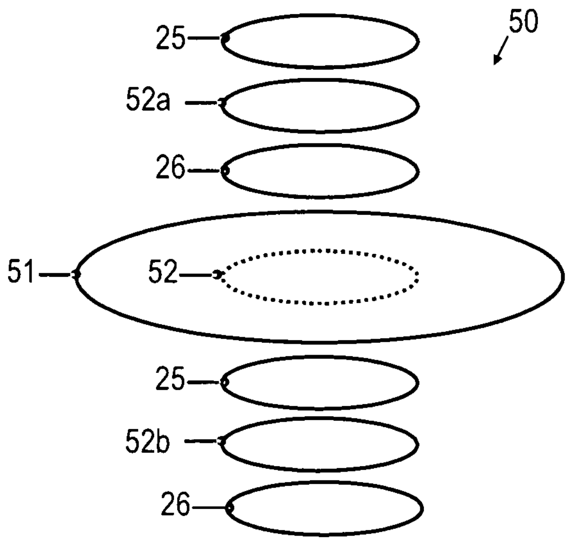

Fig. 4

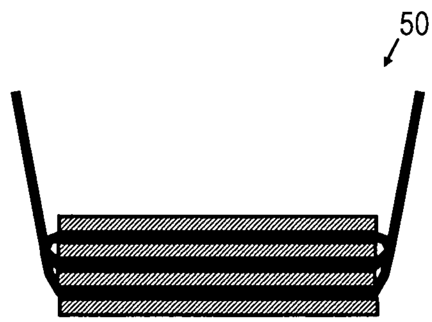

Fig. 5

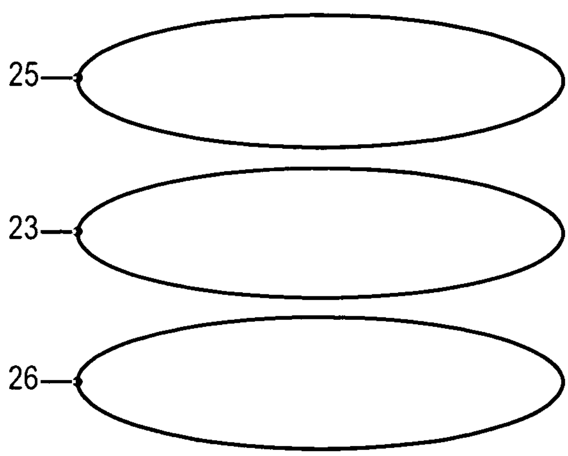

Fig. 6

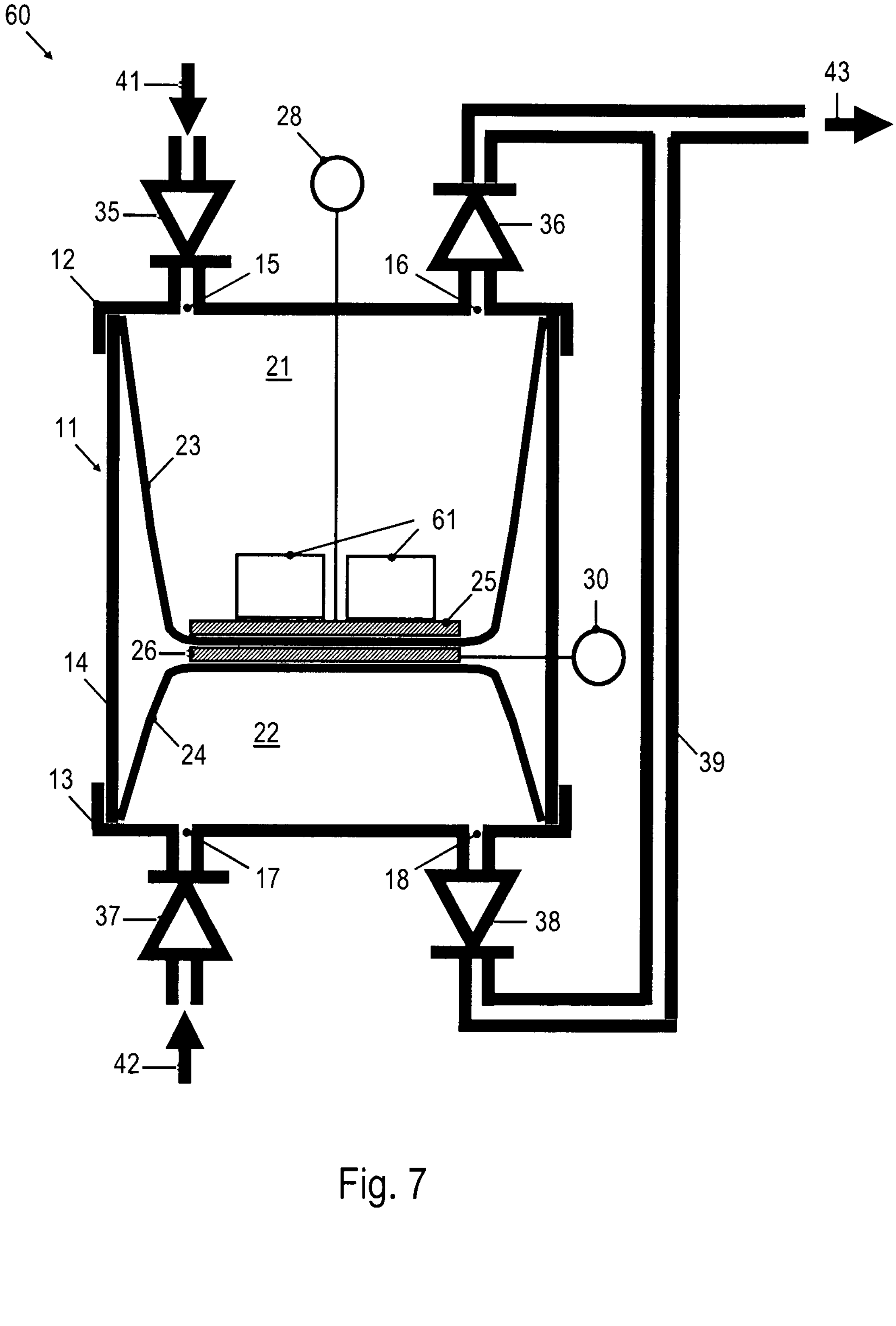
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Fig. 7

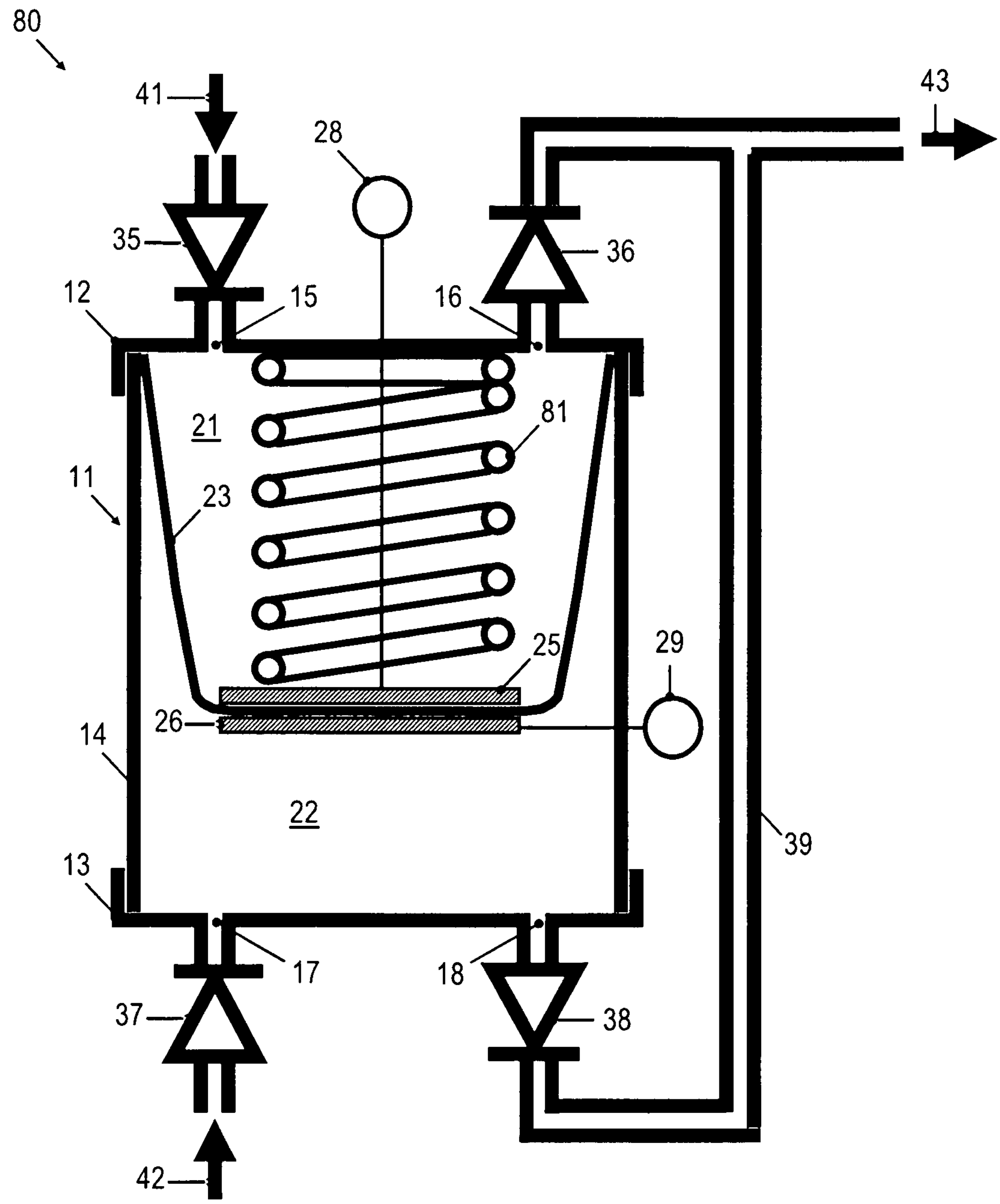
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Fig. 8

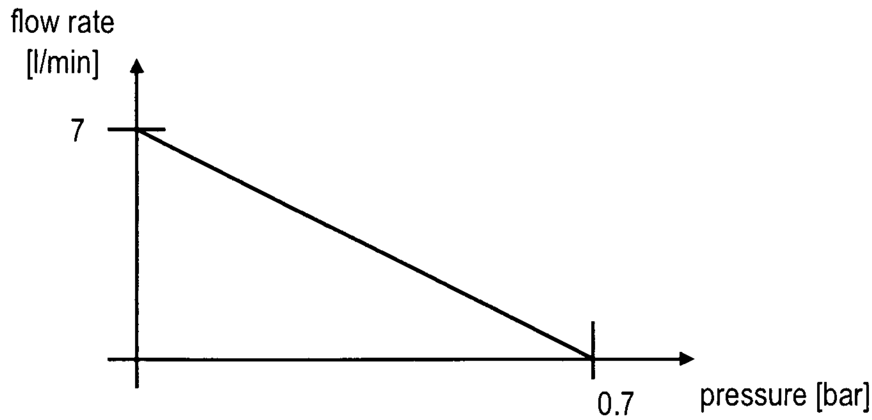
flow rate
[l/min]
7
0.7
pressure [bar]

Fig. 9

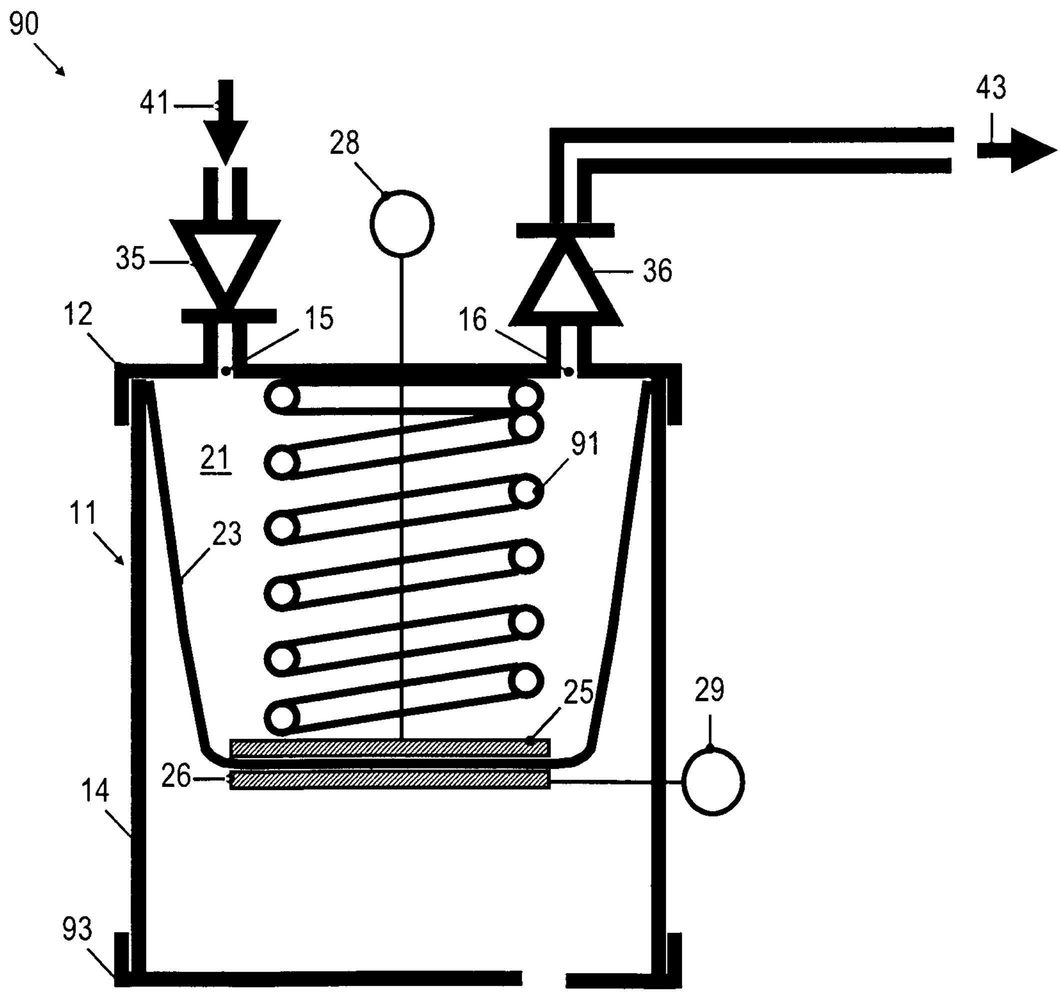
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Fig. 10

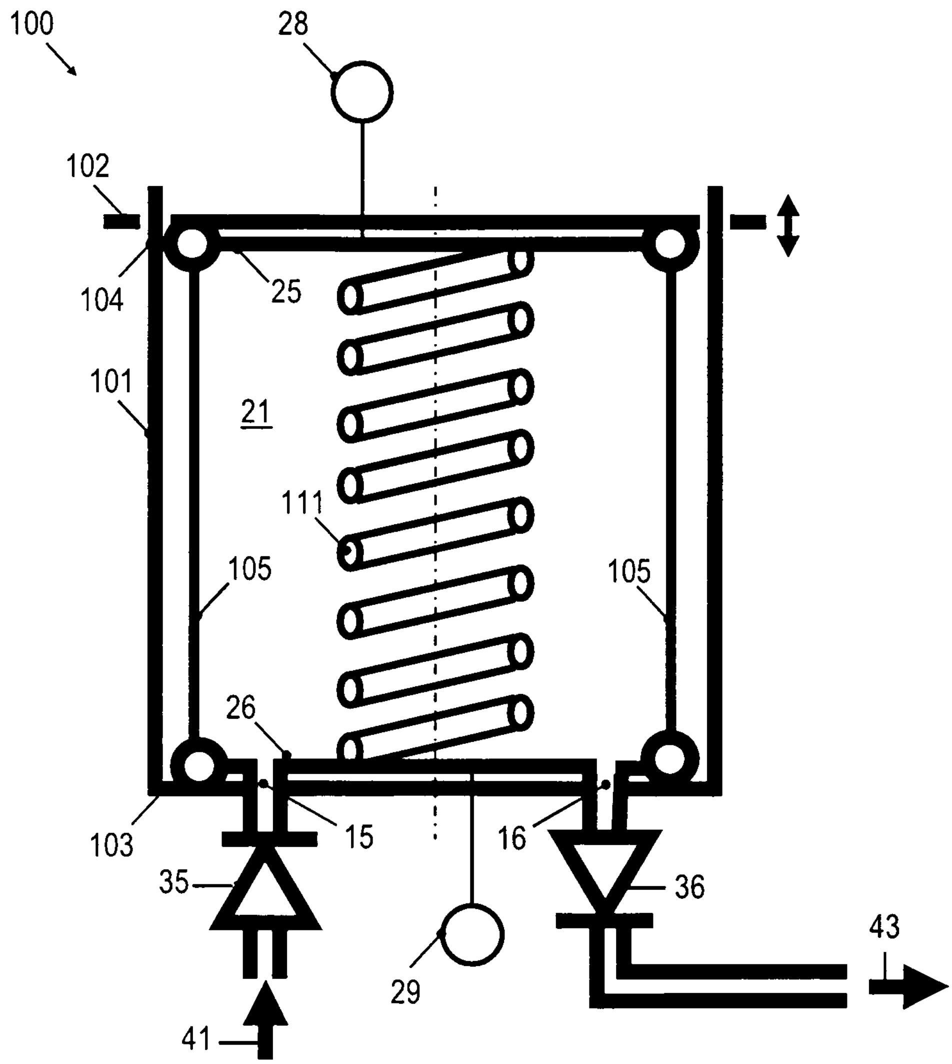

Fig. 11

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2011/003926

A. CLASSIFICATION OF SUBJECT MATTER
INV. F04B43/00 F04B43/02 F04B43/04 F04B45/04 F04B45/047
B60N2/44 B60N2/66 H02N1/00
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)
F04B B60N H02N

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.
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Y	figures 10,31A,31B,32A,32B	14,15
A	paragraph [0009] - paragraph [0011] paragraph [0142] - paragraph [0148]	5-8,16, 17,21

Y	WO 98/58567 A1 (MCCORD WINN TEXTRON INC. [US]) 30 December 1998 (1998-12-30) figures 1-3 page 3, line 14 - page 8, line 8	14,15

X	US 2009/060760 A1 (TOKAI RUBBER IND., LTD.; HONDA MOTOR CO., LTD. [JP]) 5 March 2009 (2009-03-05)	1-4, 9-13,19, 20,22,23
Y	figures 17-20	14
A	paragraph [0157] - paragraph [0169] claim 1	5-8, 15-17,21

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"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

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"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	Date of mailing of the international search report
25 May 2012	06/06/2012

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Gnüchtel, Frank

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Form PCT/ISA/210 (second sheet) (April 2005)

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	US 2010/109486 A1 (ARTIFICIAL MUSCLE, INC. [US]) 6 May 2010 (2010-05-06) figures 13A-15B claim 1 paragraph [0064] - paragraph [0067] -----	1-23
A	FR 2 841 943 A1 (ROBERT BOSCH GMBH [DE]) 9 January 2004 (2004-01-09) page 3, line 20 - page 6, line 8 figure 1 -----	1-23

2

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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