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(54) **DEVICE AND METHOD FOR
TRANSFERRING LINEAR MOVEMENTS**

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(57) **ABSTRACT**

The invention relates to a device, a method and the use of the device, for transferring linear movements. The device consists of a hollow cylinder, in which a pressurized space is found, wherein the pressurized space is bounded by a connection flange, which is attached to a terminal opening of the hollow cylinder, and a movable piston flange, which is applied in a pressure-tight manner to the inside of the cylinder wall of the hollow cylinder, and wherein the connection flange and the piston flange are joined together by means of a reversibly deformable component.

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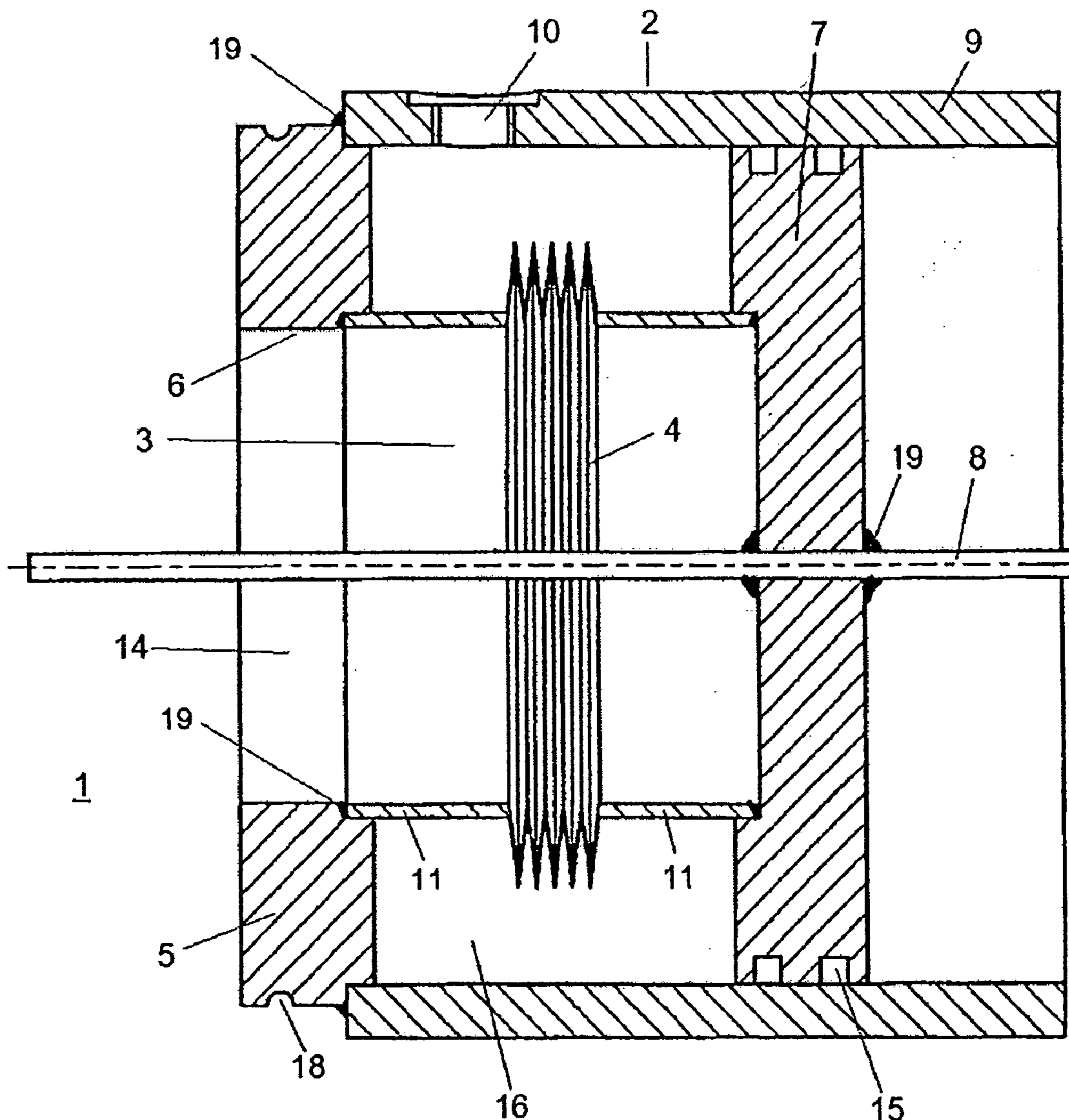


Fig. 1

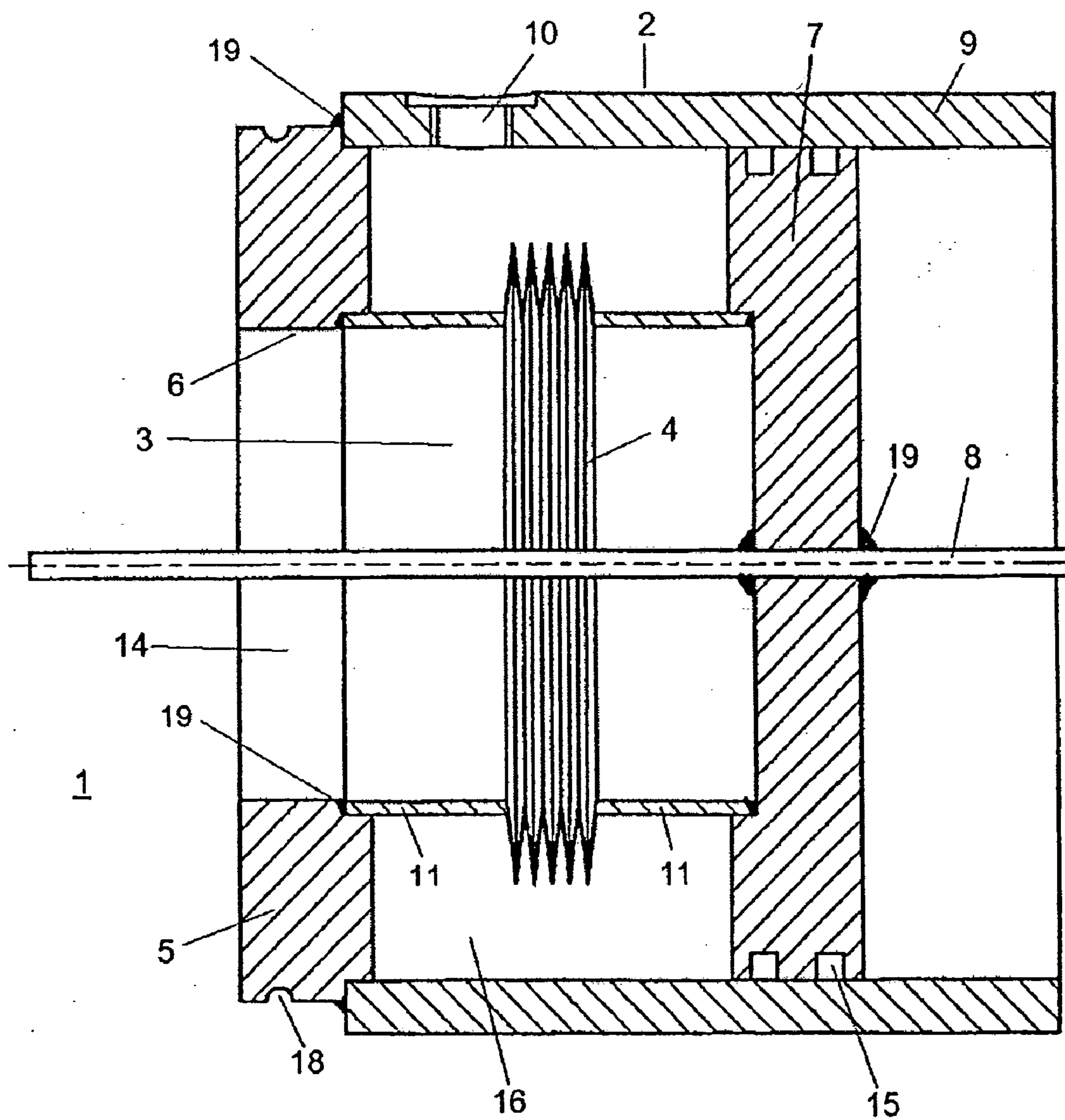


Fig. 2

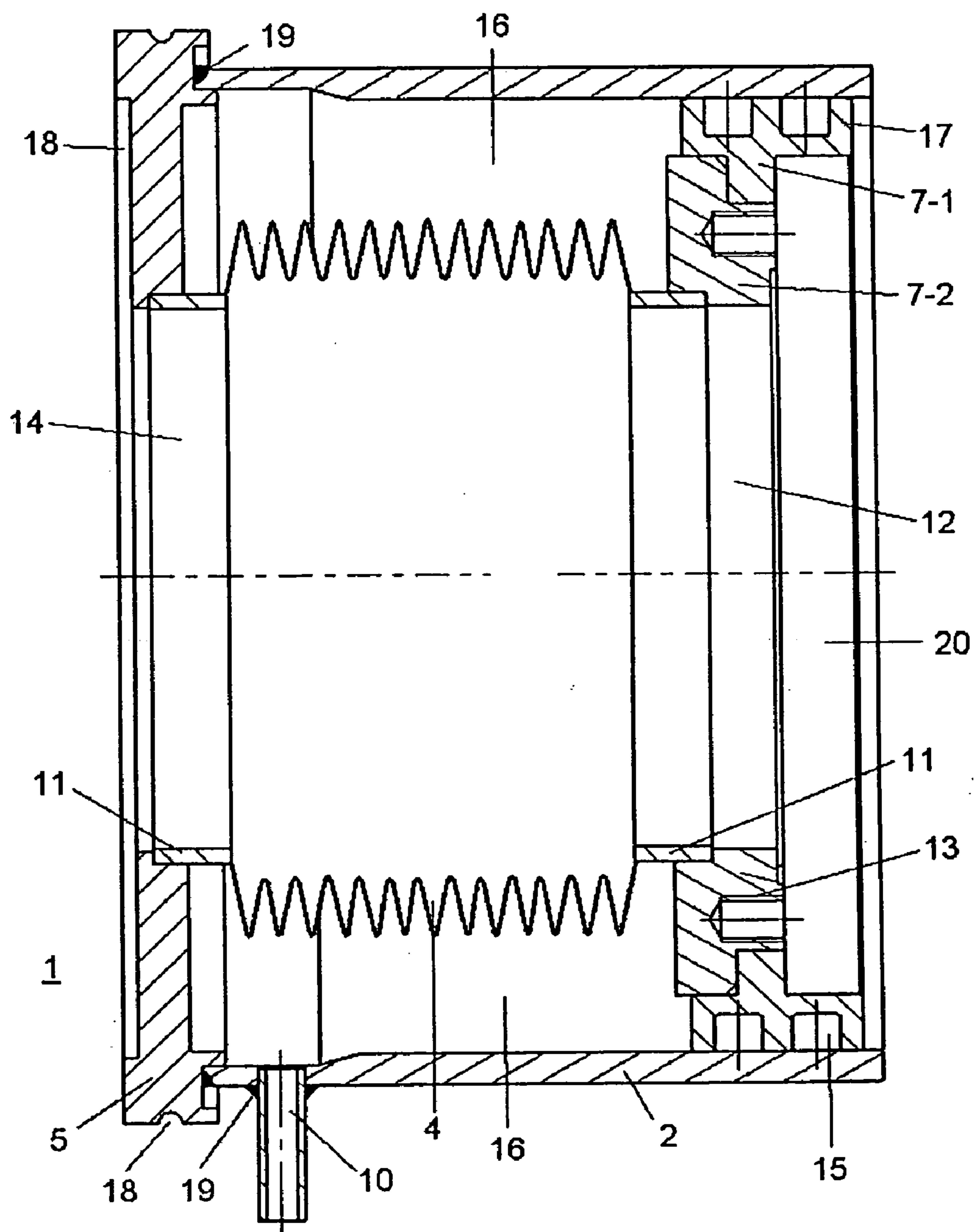


Fig. 3

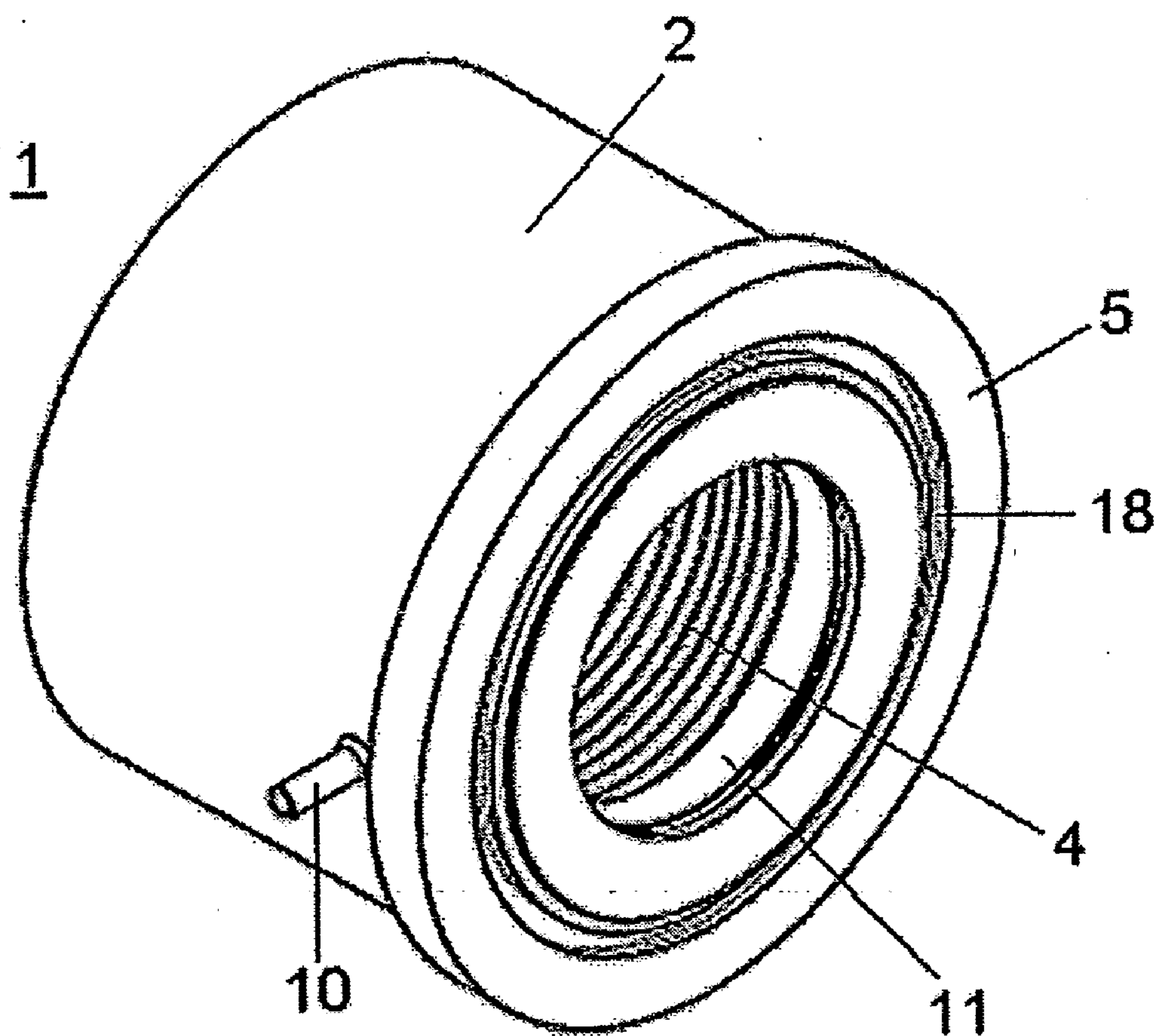
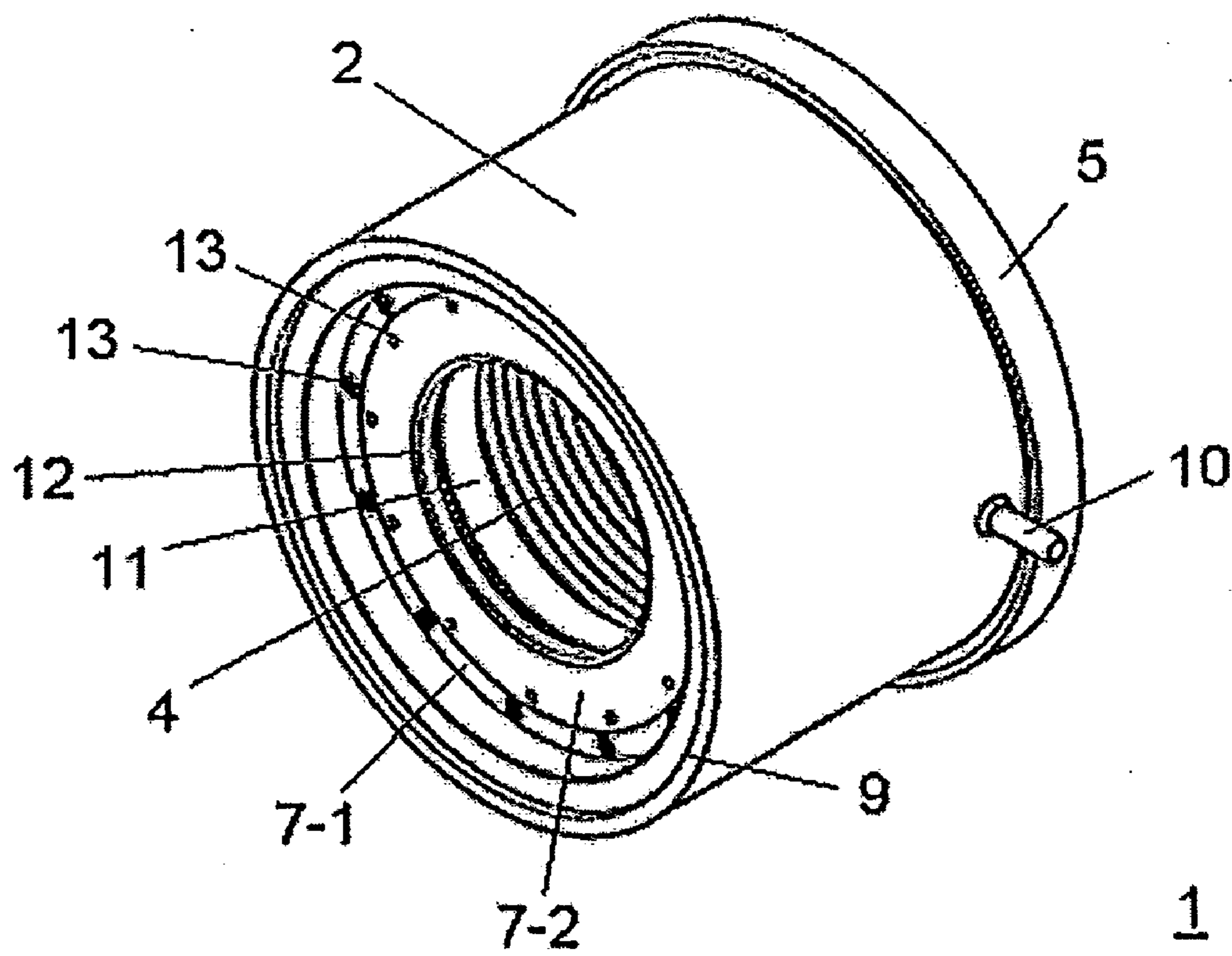


Fig. 4



DEVICE AND METHOD FOR TRANSFERRING LINEAR MOVEMENTS

[0001] The invention relates to a device and a method for transferring linear movements. In addition, the invention relates to a use of the device.

[0002] Intervening in a process that takes place in a vacuum chamber is frequently associated with an adverse effect on the vacuum in the vacuum chamber.

[0003] A linear movement into a vacuum or out from a vacuum is possible with a linear motion leadthrough, an expansion bellows, a pneumatic cylinder, a linear motor and axial guides. Often the known devices lay claim to a relatively large footprint. Also, the movement stroke, which is required for a linear motion leadthrough, an expansion bellows or a cylinder, as well as the structural length of the individual components are taken into consideration in the space requirement.

[0004] Another disadvantage of the use of linear motion leadthroughs is that leakage losses occur with these.

[0005] Linear motors or pneumatic/hydraulic cylinders are suitable for movements, but not for a relatively long, constant introduction of forces.

[0006] Also, an additional guide is necessary in order to transfer forces free of lateral or crosswise forces to an expansion bellows.

[0007] For the generation of the necessary forces, including forces that counter air pressure, among others, there are relatively large pneumatic/hydraulic cylinders or electrical motors, which must be joined in a structurally complex manner with the expansion bellows and the vacuum housing.

[0008] The object of the invention is thus to find a simple, space-saving solution, by means of which linear movements are transferred to regions of high vacuum with good axial guide precision and without leakage losses, and a defined holding force can be introduced over a relatively long time frame.

[0009] The object of the present invention is accomplished by a device comprising a hollow cylinder, in which a pressurized space is found, wherein the pressurized space is bounded by a connection flange, which is attached to a terminal opening of the hollow cylinder, and a movable piston flange, which is applied in a pressure-tight manner to the inside of the cylinder wall (inner lateral surface) of the hollow cylinder, and wherein the connection flange and the piston flange are joined by means of a reversibly deformable component in the axial direction.

[0010] An axial guidance is assured by the device according to the invention.

[0011] The device according to the invention operates in a leak-free manner. The integrated method of construction has the advantage that the device possesses a small footprint and is also easy to construct.

[0012] The reversibly deformable component in the axial direction is preferably completely comprised or partially comprised of a good reversibly deformable material. This material makes it possible to bring about an axial movement of the piston flange in the hollow cylinder by a longitudinal extension or contraction. The material must be selected such that it does not cave in on itself due to the difference in pressure between the pressurized space and the inside space of the deformable component.

[0013] The inside space, which is formed by the hollow space of the reversibly deformable component, essentially has the shape of a cylinder, hexahedron, parallelepiped or prism.

[0014] In a particularly preferred embodiment of the invention, the reversibly deformable component is an expansion bellows. Expansion bellows are particularly well suitable for operating in vacuum, since they barely deform at all except in the desired longitudinal direction, and well withstand a drop in pressure.

[0015] The reversibly deformable component, however, may also be constructed of several parts.

[0016] In a preferred embodiment, the reversibly deformable component is comprised of at least three parts, wherein two non-deformable parts are each joined with one end of a deformable part and one non-deformable part is joined to the connection flange and the second non-deformable part is joined to the movable piston flange.

[0017] The reversibly deformable component can be extended in the longitudinal direction and again contracted by means of the deformable part. The non-deformable, rigid parts serve for fastening the deformable part of the component to the connection flange and the piston flange.

[0018] The linear movement is produced by a change in pressure in the pressurized space. Due to a higher pressure in the pressurized space, the component or the reversibly deformable part of the component (for example, an expansion bellows) is extended longitudinally. If the pressure is reduced, then the component again contracts.

[0019] An axial movement of the piston flange in the hollow cylinder, however, may also be invoked by a pressure change in the inside space of the reversibly deformable component.

[0020] The force for tightening and holding any component in vacuum can be built up by the atmospheric pressure. The loosening force necessary for a short time is already produced by a slight overpressure in the pressurized chamber. The reversibly deformable component (for example, an expansion bellows) can withstand this overpressure.

[0021] The device preferably can be fastened to a container by means of the connection flange or a terminal end of the hollow cylinder. To do so, the connection flange is attached to the container by means of welding, bonding, screwing, clamping, crimping or other suitable fastening possibilities.

[0022] Normally, the connection flange serves for joining the device to a container. It is also possible, however, that the device enters into a pressure-tight connection with a container by one terminal end of the hollow cylinder. Such a connection can join the container and device by another flange, or can be created by a rigid installation of the device in or on a container.

[0023] The container is preferably a vacuum chamber.

[0024] The device according to the invention can be easily fastened to a container by the connection flange, for example, by a screw connection or a bayonet joint or quarter-turn fastener.

[0025] The connection flange preferably has an (inner) opening, whereby it is possible to transfer a movement into the container (or the vacuum chamber).

[0026] A standard flange, for example an ISO K or an ISO CF flange can be used as the connection flange.

[0027] Linear movements into a vacuum are made possible by the device according to the invention. It is thus possible to conduct movements, such as, for example, the actuating of a

switch or the adjusting of a mirror or the tightening of a part, by means of the device, inside a vacuum chamber. For this, a pin which is attached to the piston flange and which projects into the container can serve as the actuator. The pin is guided linearly by the device, by the movement of the piston flange, and, by changing pressure in the pressurized space or in the inside space of the deformable component, can execute movements in the container such as, for example, actuating a switch or moving samples in the container.

[0028] The piston flange preferably also has an (outer) opening. In this way, special flanges can be introduced or electrical or other leadthrough components can be attached.

[0029] At least one connection is preferably provided on the piston flange, such as, for example, an ISO K or an ISO CF connection. Flanges suitable for the specific action can be attached to the piston flange at this connection.

[0030] In addition, the connection makes it possible for additional equipment to be flange-mounted to the device.

[0031] The flange designations ISO K and ISO CF stand for standardized connections in specific nominal widths, but individual flange shapes and flange dimensions may also be used.

[0032] The connection is preferably a screw thread, a plug connection, a bayonet joint, a screw connection, or another detachable connection with a vacuum seal.

[0033] The piston flange forms a pressure-tight connection with the inside of the hollow cylinder. In order to seal the sliding piston flange, for example, the piston flange is provided with peripheral grooves, in which O-rings are inserted as gaskets. Other seals with surfaces that slide over one another may also be used.

[0034] The piston ring of the piston flange can be provided with a material with good sliding properties for this purpose. The sliding properties of the piston flange can be positively influenced by the use of different materials for the piston gaskets. The piston ring can also be provided with a lubricant.

[0035] The piston flange may also be produced in one piece. The piston flange, however, preferably consists of a piston and at least one flange. This two-part or multi-part embodiment of the piston flange has the advantage that it facilitates maintenance. In addition, the functionality is thereby increased.

[0036] Piston sealing rings serve for the seal between the piston of the piston flange and the inside of the hollow cylinder.

[0037] The cylinder wall of the hollow cylinder preferably has an opening in the region of the pressurized space. A gas or a liquid can be guided into or out from the pressurized space through this opening.

[0038] The device according to the invention consists of materials that are able to withstand the pressure fluctuations occurring in the device. Steel, particularly stainless steel, is a suitable material for the hollow cylinder and the flange of the device according to the invention. Other materials known to the person skilled in the art, which are suitable for the applications described herein, for example, plastics such as polytetrafluorethylene (Teflon®), metal alloys such as aluminum or magnesium alloys, and metals such as aluminum can be used for the production.

[0039] The reversibly deformable component is produced, for example, from metals such as steel, metal alloys, plastics such as silicone, rubber and/or other materials suitable for the respective application.

[0040] The gaskets are produced from metals such as non-ferrous metals, plastics such as silicone, rubber and/or other materials suitable for the respective application.

[0041] The workpieces of the device according to the invention can be milled, turned, stamped, extruded, cast or shaped in another way or can be produced by means of other methods known to the person skilled in the art.

[0042] In addition, the object of the present invention is accomplished by a method for transferring a linear movement, wherein a movement of the piston flange in the hollow cylinder is produced by a change in the pressure ratios in the pressurized space and/or in the inside space of the reversibly deformable component and/or in the inside space of a container connected to the device.

[0043] The change in the pressure ratios in the pressurized space is preferably produced by introducing or removing a gas or a liquid via the opening in the cylinder wall.

[0044] The change in pressure can be conducted by means of a pump. A gas (for example, air), a gel or a liquid (for example, a hydraulic oil) can be pumped by means of a pump through the opening in the cylinder wall of the hollow cylinder into the pressurized space of the device, whereby the piston flange is moved away from the container and the reversibly deformable component is extended. An actuator (e.g., a pin), which is attached directly to the piston flange or is attached via another flange, or any other flange is moved with the piston flange and in this way, the desired linear movement is carried out.

[0045] The speed and direction of the linear movement are preferably controlled by adjusting the pressure in the pressurized space. By blowing or pumping the gas or liquid out of the pressurized space, the pressure in the pressurized space is reduced and the piston flange moves in the direction of the connection flange. If the pressure in the pressurized space is increased, the piston flange moves in the opposite direction (away from the connection flange). The speed with which the gas or liquid is pumped into the pressurized space has an influence on the speed at which the piston flange moves and thus also how rapidly a linear movement is conducted in the device.

[0046] More preferably, the speed and the direction of linear movement are controlled by means of adjusting the pressure in the inside space of the reversibly deformable component and/or in the inside space of a container connected to the device. By blowing or pumping the gas or the liquid from the inside space of the reversibly deformable component and/or from the inside space of a container connected to the device, the pressure therein is reduced and the piston flange moves in the direction of the connected container. If the pressure is increased, the piston flange moves in the opposite direction (away from the connected container). The speed with which the gas or the liquid is pumped into the inside space of the reversibly deformable component and/or in the inside space of a container connected to the device, has an influence on the speed at which the piston flange moves and thus also how rapidly a linear movement is conducted in the device.

[0047] In addition, the object of the present invention is accomplished by a use of the device according to the invention for transferring linear movements into vacuum apparatuses, for example.

[0048] The device according to the invention can thus be used as a standard component for vacuum leadthroughs for conducting linear movements.

[0049] The invention will be described in more detail below on the basis of figures. Taken individually.

[0050] FIG. 1 shows a cross section through a first device according to the invention,

[0051] FIG. 2 shows a cross section through another embodiment of the device according to the invention,

[0052] FIG. 3 shows a three-dimensional representation of the device according to the invention shown in FIG. 2, and

[0053] FIG. 4 shows another three-dimensional representation of the device according to the invention shown in FIGS. 2 and 3.

[0054] FIG. 1 shows a cross section through a device 1 for transferring linear movements. Device 1 is comprised of a hollow cylinder 2 and a component 3 disposed between a connection flange 5 and a piston flange 7; component 3 consists of two non-deformable parts 11 that are joined together by an expansion bellows 4. In order to create a pressure-tight connection, the non-deformable parts 11 are welded to connection flange 5 and piston flange 7 (welds 19). Other connection possibilities, such as screws, bonding, soldering or crimping are also suitable.

[0055] Connection flange 5 serves for fastening device 1 to a container (for example, to a vacuum chamber). Connection flange 5 is shaped such that it makes possible a pressure-tight connection with the vacuum chamber by means of a screw connection, a bayonet joint or similar means. Further, connection flange 5 is welded to hollow cylinder 2 (weld 19). Other connection possibilities, such as bonding, soldering or crimping are also suitable. Embodiments are also conceivable, however, in which connection flange 5 and hollow cylinder 2 are joined together by other means, for example, by a pressure-tight screw connection or a bayonet joint.

[0056] On the inside, connection flange 5 has an opening 14 in the center. The reversibly deformable component 3 is attached to edge 6 of opening 14. The vacuum-side part 11 of component 3 is joined in a pressure-tight manner with connection flange 5, for example, by a welded joint (weld 19). Other connection possibilities, such as screws, bonding, soldering or crimping are also suitable. It is also possible, however, that the vacuum-side part 11 of the reversibly deformable component 3 is a part of connection flange 5.

[0057] The movable piston flange 7 corresponds in its diameter approximately to that of the inside diameter of hollow cylinder 2, so that piston flange 7 can be introduced with an accurate fit into hollow cylinder 2. A pin 8 runs through the center of piston flange 7 until it reaches into a container connected to device 1.

[0058] Piston flange 7 is joined in a pressure-tight manner with pin 8 and the inside of hollow cylinder 2. For this purpose, pin 8 is welded to piston flange 7 (weld 19). Other connection possibilities, such as screws, bonding, soldering or crimping are also suitable.

[0059] On the vacuum side, piston flange 7 is attached to reversibly deformable component 3. Component 3 can be a part of piston flange 7 or can be joined reversibly with this flange.

[0060] Expansion bellows 4 is compressed by an underpressure in pressurized space 16. If an overpressure prevails, then expansion bellows 4 extends longitudinally, so that the pin guided centrally through the entire device 1 (expansion bellows cylinder) executes a linear movement.

[0061] An overpressure or an underpressure can be built up in pressurized space 16 through opening 10 in cylinder wall 9. A pump (for example, a vacuum pump) can be connected to opening 10 for this purpose.

[0062] In addition, device 1 can be controlled by a change in pressure in the inside space of the deformable component 3. If device 1 is connected to a container, such as a vacuum chamber, for example, changes in pressure in the container also lead to a movement of piston flange 7.

[0063] Therefore, there are two pressurized spaces in which a movement of piston flange 7 can be executed by pressure differences.

[0064] The hollow space, which is formed between connection flange 5, piston flange 7, the inside of hollow cylinder 2 and the outside of the reversibly deformable component 3, forms an outer pressurized space 16.

[0065] In addition, another hollow space is created by the inside space of the deformable component 3 and a container connected to device 1. A movement of the piston flange 7 can also be brought about by a change in pressure in this hollow space.

[0066] The pressure (or the underpressure), which must be built up for control in pressurized space 16 and/or in the inside space of component 3, is dependent on the nature of the device, in particular the stability of component 3.

[0067] FIG. 2 shows a cross section through another embodiment of device 1 according to the invention with a connection flange 5 and a piston flange 7.

[0068] The connection flange 5 shown in FIG. 2 has a recess 18 for a sealing ring. In this embodiment, the piston flange 7 consists of a piston 7-1 and a flange 7-2. In the region in which it is applied to the inside of hollow cylinder 2, piston 7-1 has a piston ring 17, in which O-rings are inserted as gaskets 15. The gaskets create a pressure-tight connection between piston ring 17 of piston 7-1 and the inside of hollow cylinder 2. Flange 7-2 has a connection 13 for the uptake of another flange 20. This additional flange 20 is guided coaxially through device 1 by the movement of piston flange 7 in hollow cylinder 2.

[0069] Opening 10 of the embodiment shown in FIG. 2 is extended by a tube. The tube facilitates the connection of lines, with which device 1 can be joined to a vacuum pump. For this purpose, the tube is joined in a pressure-tight manner with cylinder wall 9 of hollow cylinder 2 by a weld 19.

[0070] FIGS. 3 and 4 show three-dimensional views of device 1. An opening 10, through which gas or a liquid can be introduced into or removed from pressurized space 16 is found in the region between connection flange 5 and piston flange 7 in cylinder wall 9 of hollow cylinder 2.

[0071] Device 1 with connection flange 5 points toward the viewer in FIG. 3. In the embodiment shown in FIG. 3, connection flange 5 has a recess 18 for uptake of a sealing ring.

[0072] Device 1 with piston flange 7 points toward the viewer in FIG. 4. Piston flange 7 consists of a piston 7-1 and a flange 7-2.

[0073] Piston 7-1 forms a pressure-tight connection to the inside of hollow cylinder 2. On the outwardly directed surface of the piston, piston 7-1 has connections 13 for fastening another flange or other devices.

[0074] Flange 7-2 has an opening 12 in its center. The outer surface of flange 7-2 is provided with connections 13.

[0075] List of Reference Numbers:

[0076] 1 Device for transferring linear movements.

[0077] 2 Hollow cylinder

- [0078] 3 (Reversibly deformable) component
- [0079] 4 Expansion bellows
- [0080] 5 Connection flange
- [0081] 6 Edge (of the inner opening)
- [0082] 7 Piston flange
- [0083] 7-1 Piston
- [0084] 7-2 Flange
- [0085] 8 Pin
- [0086] 9 Cylinder wall
- [0087] 10 Opening
- [0088] 11 Non-deformable part of component 3
- [0089] 12 (Outer) opening
- [0090] 13 Connection
- [0091] 14 (Inner) opening
- [0092] 15 Gasket
- [0093] 16 (Outer) pressurized space
- [0094] 17 Piston ring
- [0095] 18 Recess
- [0096] 19 Weld
- [0097] 20 Flange

1. A device for transferring linear movements, consisting of a hollow cylinder, in which a pressurized space is found, wherein the pressurized space is bounded by a connection flange, which is fastened to a terminal opening of hollow cylinder, and a movable piston flange, which is applied in a pressure-tight manner to the inside of the cylinder wall of hollow cylinder, and

wherein the connection flange and the piston flange are joined together by means of a reversibly deformable component.

2. The device according to claim 1, further characterized in that the reversibly deformable component is completely or partially comprised of a reversibly deformable material.

3. The device according to claim 1, further characterized in that the reversibly deformable component is an expansion bellows.

4. The device according to claim 1, further characterized in that the reversibly deformable component is comprised of at least three parts, wherein two non-deformable parts are each joined with one end of a deformable part and one non-deformable part is joined to the connection flange and the second non-deformable part is joined to the movable piston flange.

5. The device according to claim 1, further characterized in that the device can be fastened to a container by means of connection flange or a terminal end of hollow cylinder.

6. The device according to claim 5, further characterized in that the container is a vacuum chamber.

7. The device according to claim 1, further characterized in that connection flange has an opening.

8. The device according to claim 1, further characterized in that connection flange has an opening.

9. The device according to claim 1, further characterized in that at least one connection is provided on piston flange.

10. The device according to claim 9, further characterized in that connection is a screw thread, a plug connection, a bayonet joint, a screw connection, or another detachable connection.

11. The device according to claim 1, further characterized in that the piston flange is comprised of a piston and at least one flange.

12. The device according to claim 1, further characterized in that cylinder wall of hollow cylinder has a opening in the region of pressurized space.

13. A method for transferring a linear movement by means of a device according to claim 1, wherein a movement of piston flange in hollow cylinder is produced by a change in the pressure ratios in pressurized space and/or in the inside space of the reversibly deformable component and/or in the inside space of a container connected to device.

14. The method according to claim 13, further characterized in that the changes of the pressure ratios in pressurized space are produced by introducing or removing a gas or a liquid through opening in cylinder wall.

15. The method according to claim 13, further characterized in that the speed and direction of the linear movement are controlled by adjusting the pressure in pressurized space.

16. The method according to claim 15, further characterized in that the speed and direction of the linear movement are controlled by adjusting the pressure in the inside space of the reversibly deformable component and/or in the inside space of a container connected to device.

17. A use of device according to claim 1 for transferring linear movements in vacuum apparatuses.

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