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(72) Inventors:  
• **Tew, You Wei Derek**  
**ANG MO KIO Avenue 1 (SG)**  
• **Ho, Weiming Derek**  
**Redhill Lane (SG)**  
• **Bienek, Volker**  
**Ennepetal (DE)**

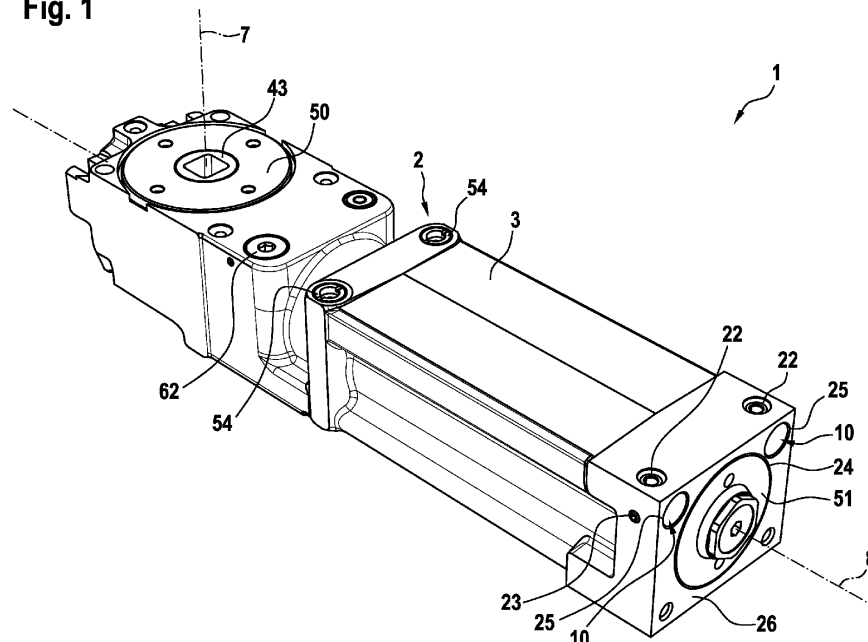
(71) Applicant: **dormakaba Deutschland GmbH**  
**58256 Ennepetal (DE)**

(74) Representative: **Balder IP Law, S.L.**  
**Paseo de la Castellana 93**  
**5ª planta**  
**28046 Madrid (ES)**

**(54) DOOR ACTUATOR**

(57) The present invention concerns a door actuator (1) for opening and/or closing a door, comprising a housing (2) with a housing wall (3), the housing wall (3) enclosing a central inner space (4), the central inner space (4) accommodates hydraulic fluid and an actuating mechanism (5) for actuating the door, and at least one volume compensator (6), wherein each volume compensator (6) comprising a separate chamber (10) formed in the hous-

ing wall (3), a fluid compartment (11) within the chamber (10), the fluid compartment (11) being fluidly connected to the central inner space (4), an enclosed gas compartment (12) within the chamber (10), and a separator (14) separating the fluid compartment (11) from the gas compartment (12), the separator (14) being displaceable to vary the volume of the gas compartment (12) in dependence on the pressure in the fluid compartment (11).

**Fig. 1****EP 4 269 736 A1**

## Description

**[0001]** The present invention concerns a door actuator for opening and/or closing a door.

**[0002]** Door closers and door operators, which are generally referred as door actuators, are known from the prior art. Door closers normally have a main spring as an energy storage device. When a person opens the door manually, this spring is loaded. When the door is closed, the energy of the spring is discharged. Door operators on the other hand have an electrical or hydraulic drive that provides the complete force to open and/or close a door. In addition to the drive, a spring can be used also in the door operator.

**[0003]** Most of the door actuators use hydraulic fluid within a housing. The hydraulic fluid is for example used for damping the movement of the mechanism. However, for example a change in temperature changes the volume of the hydraulic fluid. This volume change would cause extreme pressure increases in a closed housing, which can destroy the housing. It would not be enough to simply keep compressible air or gas as compensation in the housing, as this gas would be uncontrollable. To avoid pressure increases as well as uncontrolled gas, volume compensators are required.

**[0004]** It is an object of the present invention to provide a door actuator for opening and/or closing a door, which works reliably and is designed for low maintenance.

**[0005]** This object is solved by the features of the independent claim. The dependent claims contain advantageous embodiments of the present invention.

**[0006]** The invention discloses a door actuator for opening and/or closing a door. The door actuator can be a door closer, preferably floor door closer, or a door operator. If the door actuator is designed as a door closer, it is preferably without any drive, i.e. it does not comprise any electric motor or hydraulic pump for moving the door. Preferably, the door actuator is designed to be mounted on or at a door of a building, especially on the door leaf, on the door frame, or in the floor under the door leaf (floor door closer, also called floor spring).

**[0007]** The door actuator has a housing with a housing wall. Preferably, the housing is cast from metal. The housing wall is enclosing a central inner space of the door actuator. Further, the door actuator comprises an actuating mechanism, which is positioned in the central inner space. The actuating mechanism is adapted for actuating the door. Moreover, the door actuator comprises hydraulic fluid in the central inner space. The hydraulic fluid is for example used for damping the movement of the actuating mechanism and thereby damping for example the closing movement of the door.

**[0008]** Preferably, the housing is completely filled with the hydraulic fluid, which means that there are no air bubbles within the housing. Contrary to this preferred design, most of the known door-closers have air bubbles (also called rest-air) inside the housing. Only the versions with a very sensitive hydraulic-system or a hydraulic hold-

open function can not work with such uncontrolled rest-air.

**[0009]** For the description of the invention, a longitudinal axis and an output axis of the door actuator are defined. The output axis is the rotation axis of an output shaft of the actuating mechanism. The longitudinal axis is perpendicular to the output axis. A preferably used piston of the actuating mechanism moves along this longitudinal axis. Further, a preferably used piston rod of the actuating mechanism extends along the longitudinal axis.

**[0010]** The door actuator comprises at least one volume compensator. Preferably, more than one volume compensator is used within the door actuator. Even if not explicitly mentioned, every following description of the volume compensator or parts of the volume compensator applies to each volume compensator, if more than one volume compensator is used.

**[0011]** The volume compensator comprises a separate chamber formed in the housing wall. This chamber preferably extends parallel to the longitudinal axis. The chamber is preferably radially outside the central inner space. The chamber and therefore the volume compensator is not inside the central inner space and preferably not inside any other part of the door actuator, but is positioned inside the housing wall.

**[0012]** Further, the volume compensator comprises a fluid compartment within the chamber. The fluid compartment is fluidly connected to the central inner space, especially a tank room of the central inner space. Preferably, the fluid compartment is fully filled with the hydraulic fluid.

**[0013]** Further, the volume compensator comprises an enclosed gas compartment within the chamber. The gas compartment is "enclosed", which means that the gas, preferably air or nitrogen, in the gas compartment can be compressed for volume compensation.

**[0014]** The volume compensator further comprises a separator, which is also called compensator piston. The separator separates the fluid compartment from the gas compartment. So, the separator is preferably between the two compartment and contacts the fluid in the fluid compartment on one side and the gas in the gas compartment on the other side.

**[0015]** The separator is displaceable, preferably slidable, to vary the volume of the gas compartment in dependence on the pressure in the fluid compartment. For example a relatively high pressure in the fluid compartment moves the separator in a direction to decrease the volume of the gas compartment, thereby compressing the gas.

**[0016]** Preferably, the separator of at least one volume compensator, preferably of each volume compensator, is slidable back and forth, so that in one movement direction of the separator, the volume of the fluid compartment is increased and the volume of the gas compartment is decreased at the same time. Further, in the other movement direction of the separator, the volume of the

fluid compartment is decreased and the volume of the gas compartment is increased at the same time.

**[0017]** Preferably, the door actuator comprises at least two of the volume compensators. Preferably, the door actuator comprises exactly two, three or four of the volume compensators. Preferably, all volume compensators comprise identical spatial dimensions. Preferably, all volume compensators are identically constructed.

**[0018]** Further preferably, the gas compartment of at least one volume compensator, preferably of each volume compensator, has a length and an inner diameter. The length is preferably defined parallel to the longitudinal axis. The maximum length of the gas compartment - i.e. with the shortest fluid compartment - is relevant. The ratio of the length to the inner diameter is preferably at least 4, more preferably at least 6, further preferably at least 8. According to this ratio, the volume compensator is slim and fits very well in the housing wall.

**[0019]** As explained, the fluid compartment is connected to the central inner space. Preferably, the fluid compartment is only connected to the central inner space. In particular, the fluid compartment has preferably no connection to any other space of the door actuator, especially not to the gas compartment. "No connection" means preferably that there is also no temporarily closed connection, which may be opened while the door actuator is mounted at the door.

**[0020]** Further preferably, the gas compartment is tightly sealed. Preferably, the tightly sealed configuration of the gas compartment is defined in detail as follows: Additionally or alternatively preferred, the gas compartment of at least one volume compensator, preferably of each volume compensator, is tightly sealed against the fluid compartment.

**[0021]** Additionally or alternatively preferred, the gas compartment of at least one volume compensator, preferably of each volume compensator, is tightly sealed against the central inner space.

**[0022]** Additionally or alternatively preferred, the gas compartment of at least one volume compensator, preferably of each volume compensator, is tightly sealed against any space of the door actuator, which is filled with hydraulic fluid.

**[0023]** Additionally or alternatively preferred, the gas compartment of at least one volume compensator, preferably of each volume compensator, is tightly sealed against the atmosphere, or is connected to the atmosphere via a pressure relief valve. The pressure relief valve only opens under very special conditions, for example very high temperature.

**[0024]** Additionally or alternatively preferred, the gas compartment of at least one volume compensator, preferably of each volume compensator, has no connection to any other space of the door actuator. "No connection" means that there is preferably also no temporarily closed connection, which may be opened while the door actuator is mounted at the door.

**[0025]** Further preferably, at least one volume com-

pensator, preferably each volume compensator comprises a spring, which is arranged in the gas compartment. Preferably, the separator is displaceable against the force of the spring, so that the spring is loaded when the gas compartment decreases its volume.

**[0026]** Further preferably, at least one volume compensator, preferably each volume compensator comprises a tube. The tube is inserted into the chamber. Preferably, the separator is guided in the tube. Preferably, the complete gas compartment except of the separator is formed by the tube. Preferably the separator can slide within the tube, thereby tightly separating the gas compartment from the fluid compartment.

**[0027]** The advantage of the tube is, that the tube together with the spring and the separator can be easily mounted into the chamber. Further, when using the tube, the inner surface of the chamber must not be machined very exactly, because the separator preferably slides on the inner surface of the tube and not on the inner surface of the chamber.

**[0028]** Preferably, the inner surface of the tube has a lower roughness value than the inner surface of the chamber.

**[0029]** The tube is preferably made of a different material than the housing. Preferably the tube is made of stainless steel or aluminum or plastic.

**[0030]** Preferably, the tube is closed at one end by the separator and at the other end by a bottom. The bottom is preferably an integral part of the rest of the tube. "Integral" means that the bottom is preferably welded, soldered or glued to the shell surface of the tube or the tube (including the bottom) is manufactured in one piece, for example by forming a sheet metal or injection molding.

**[0031]** The housing of the door actuator has preferably a polygonal, preferably rectangular, cross section. The cross section is thereby preferably defined perpendicular to the longitudinal axis. Important for the shape of the cross section are the positions of the corners and not necessarily the sides that connect the corners.

**[0032]** The chamber of the volume compensator is preferably positioned in a corner of the cross section. When multiple volume compensators are used, preferably each chamber is positioned in its own corner of the cross section.

**[0033]** The central inner space has, at least at some parts of the housing, a circular cross section, because the piston of the actuating mechanism is guided in the central inner space. Therefore, radially outside the central inner space, the volume compensators can be positioned in the corners of the rectangular cross section.

**[0034]** Preferably, the chamber of at least one volume compensator, preferably of each volume compensator, is formed by a hole, preferably a dead hole, in the housing wall. The opening of the hole is preferably located at an end side of the housing. This end side of the housing is preferably perpendicular to the longitudinal axis. If more than one volume compensators are used, preferably the openings of all holes forming the chambers are located

at the same end side of the housing.

**[0035]** Further, the opening of the hole is preferably closed by a compensator lock. The compensator lock is preferably a sealed cover screw.

**[0036]** Preferably, the central inner space has also an opening, which is located at the same end side of the housing. Insofar, the opening of the central inner space and the opening of the chambers are at the same end side and can be drilled from the same side of the housing.

**[0037]** As mentioned above, the tube of the volume compensator can have a bottom to close the tube. Alternatively, also the compensator lock can be used to close the tube.

**[0038]** Further preferably, a connection, in particular a channel (also called pot hole), in the housing wall leads from the fluid compartment of the volume compensator to the tank room. Preferably, a separate connection, particularly channel, is provided for each volume compensator.

**[0039]** Preferably, the fluid compartment is positioned at the inner end of the above-mentioned dead hole, which forms the chamber of the volume compensator. Preferably, the connection leads from this dead end, which is part of the fluid compartment, to the tank room.

**[0040]** The above-mentioned actuating mechanism preferably comprises the mentioned piston, which is linearly moveable in the central inner space along the longitudinal axis. Further preferably, the actuating mechanism comprises the mentioned output shaft, which is rotatable supported in the housing. The output axis is the axis of rotation of the output shaft..

**[0041]** When using the door actuator, the drive shaft is connected to a lever or directly to the rotary axis of the door leaf. The linkage is connected to the door leaf if the door actuator is mounted on the frame; or the linkage is connected to the frame if the door actuator is mounted on the door leaf. Especially, a door actuator built as floor door closer (floor spring) comprises a shaft which is designed to be on the same axis as the axis of the door leaf when mounted.

**[0042]** Further, the actuating mechanism comprises a transmission device for converting between the linear movement of the piston and the rotary movement of the output shaft. The transmission device is for example a cam follower, which has a cam disk on the output shaft and a role which contacts the cam disk and follows the cam. The role is preferably direct or indirect connected to the piston via a piston rod.

**[0043]** Alternatively, the transmission device can comprise a toothed rack and a toothed wheel for converting between linear and rotary movement.

**[0044]** Further preferably, the door actuator comprises a main spring for energy storage, which is compressed by movement of the piston in one direction and which can move the piston in the other direction.

**[0045]** The central inner space comprises preferably the already mentioned tank room on one side of the piston and a damping room on the other side of the piston. When

the piston moves in the direction of the damping room, hydraulic fluid is flowable from the damping room into the tank room, preferably controlled by adjustable valves, to dampen the movement. In the other direction, for example when the door is opened, the piston moves to compress the spring and thereby the damping room increases and is filled with the hydraulic fluid from the tank room.

**[0046]** As mentioned, preferably a piston rod connects the piston with the transmission device. Thereby, the main spring is preferably positioned on the piston rod.

**[0047]** Further preferably, the door actuator comprises a force adjusting device for adjusting the force of the main spring. This force adjusting device has a pressure disc which is displaceable arranged on the piston rod. The main spring is positioned between the pressure disk and the piston, so that the main spring abuts at the pressure disk and at the piston. Further preferably, the force adjusting device is positioned between the transmission device and the piston.

**[0048]** The force adjusting device preferably comprises an adjusting shaft with a worm of a worm gear. The adjusting shaft can be turned with a tool. The worm of the adjusting shaft engages with a worm wheel of the force adjusting device. This worm wheel is rotatable arranged on the piston rod and has a threaded connection to the pressure disk. So, when the adjusting shaft is turned, the worm wheel turns and thereby moves the pressure disk forth or back.

**[0049]** Further, the pressure disk has preferably an extension which is guided in a linear track of the inside of the housing, so that the pressure disk is not rotatable, but only linearly moveable on the piston rod along the longitudinal axis.

**[0050]** Preferably, the at least one volume compensator is at least partially arranged at a same longitudinal segment as the main spring. Preferably, the at least one volume compensator is at least partially arranged at a same longitudinal segment as the tank room and/or the damping room. Preferably the at least two volume compensators are at least partially arranged at the same longitudinal segment as the main spring, the tank room and/or the damping room.

**[0051]** Preferably, the piston can move at the longitudinal segment of the housing where the at least one volume compensator, preferably the at least two volume compensators, are arranged.

**[0052]** Preferably, the at least one volume compensator has a shorter length than the whole door actuator. In other words, the volume compensator extends from the end side less far than the whole housing. The transmission device and/or an adjusting valve can be arranged in a longitudinal segment where the volume compensator is absent. The transmission device and/or an adjusting valve can be arranged behind the volume compensator in the longitudinal direction from the end side. The transmission device and/or the adjusting valve can intersect with an imaginary extension of the volume compensator in the longitudinal direction. In case of at least two volume

compensators, this can apply to each of the volume compensators.

**[0053]** Preferably, the cross section of the longitudinal segment comprising the at least one volume compensator is smaller or equal than the cross section of the longitudinal segment comprising the transmission device.

**[0054]** Further details, advantages and features of a preferred embodiment of the present invention are described in detail with reference to the figures. Therein

Fig. 1 shows a perspective view of a door actuator according to an embodiment of present invention;

Fig. 2 shows a schematic cross section of the housing of the door actuator according to the embodiment of present invention;

Fig. 3 shows the inner parts of the door actuator according to the embodiment of present invention in a perspective view;

Fig. 4 shows the inner parts of the door actuator according to the embodiment of present invention in a side view;

Fig. 5 shows a schematic cross section of one of the volume compensators of the door actuator according to the embodiment of present invention;

Fig. 6 shows a first detail of Fig. 5;

Fig. 7 shows a second detail of Fig. 5;

Fig. 8 shows a schematic cross section perpendicular to a longitudinal axis of the door actuator of the embodiment of present invention;

Fig. 9 shows details of a transmission device and a force adjusting device of the door actuator according to the embodiment of present invention; and

Fig. 10 shows a further detail of the transmission device of the door actuator according the embodiment of the present invention.

**[0055]** In the following, a door actuator 1 is explained with reference to the figures 1 to 10. Unless otherwise mentioned, reference is made to all figures.

**[0056]** The door actuator 1 of the embodiment is a floor door closer (also called floor spring) which is positioned under the door in the floor.

**[0057]** The door actuator 1 comprises a housing 2. The housing 2 is formed by a housing wall 3. The housing wall 3 enclosed a central inner space 4.

**[0058]** An actuating mechanism 5, which will be de-

scribed in more detail, is positioned in the central inner space 4 inside the housing.

**[0059]** As for example shown in Fig. 1, an output axis 7 and a longitudinal axis 8 are defined, to explain positions within the door actuator 1. The output axis 7 is the rotation axis of an output shaft 43. The longitudinal axis 8 is perpendicular to the output axis 7.

**[0060]** The door actuator 1 comprises, according to present embodiment, two volume compensators 6 with identical design.

**[0061]** Figs. 3 and 4 show the door actuator 1, wherein the housing 2 is faded out. Especially Figs. 1 to 4 show that the two volume compensators 6 are positioned within the housing wall 3 radially outside the central inner space 4.

**[0062]** Each volume compensator 6 comprises a chamber 10, which is formed by a dead hole in the housing wall 3. Especially Figs. 5, 6 and 7 disclose that a tube 13 is inserted in the chamber 10. Within the tube 13, a separator 14 is slideably guided. The separator 14 can also be referred to as compensator piston.

**[0063]** The separator 14 separates a fluid compartment 11 from a gas compartment 12 of the volume compensator 6. The gas compartment 12 is completely positioned in the tube 13 and thus also in the chamber 10. The fluid compartment 11 is formed by chamber 10 and can extend, depending on the position of separator 14, into tube 13.

**[0064]** In one movement direction of the separator 14 (in Figure 5 from left to right), the volume of the fluid compartment 11 is increased and the volume of the gas compartment 12 is decreased at the same time. In the other movement direction of the separator 14 (in Figure 5 from right to left), the volume of the fluid compartment 11 is decreased and the volume of the gas compartment 12 is increased at the same time.

**[0065]** The construction of the volume compensator 6 is the same for both volume compensators 6.

**[0066]** The fluid compartment 11 is connected to the central inner space 4, especially a tank room 52. As can be seen in the detail of Fig. 6 as well as in the schematic cross section of Fig. 8, a connection 15, preferably oil channel, connects the chamber 10 and insofar the fluid compartment 11 with the tank room 52.

**[0067]** For example Fig. 6 shows, that the separator 14 is sealed on its radially outside by a separator sealing ring 16. This separator sealing ring 16 slides on the inner surface of the tube 13. Further, a locking ring 17 within the tube 13 limits the movement of the separator 14 thereby limiting the volume of the gas compartment 12. Thereby, the gas compartment is tightly sealed against the fluid compartment 11 and the central inner space 4.

**[0068]** As shown in the detail of Fig. 7, the tube 13 is closed by a bottom 19. So, the gas compartment 12 is formed between the separator 14 and a bottom 19. The bottom is formed in one piece with the rest of the tube 13.

**[0069]** The lateral surface of the tube 13 as well as the bottom 19 are built free of through-holes. Thereby, the

gas compartment 12 is tightly sealed against the atmosphere. Alternatively, as purely schematically shown in Figure 7, a pressure relief valve 68 can connect the gas compartment 12 to the atmosphere.

**[0070]** A compensator spring 18 is positioned within the gas compartment 12. The separator 14 of each volume compensator 6 can be displaced against the force of the compensator spring to decrease the volume of the gas compartment if the hydraulic fluid heats up.

**[0071]** Further, as also can be seen in Fig. 7, the chamber 10 is closed by a compensator lock 20, especially a sealed cover screw. This compensator lock 20 has a lock sealing ring 21 to seal the compensator lock 20 relatively to the housing 2.

**[0072]** Figure show a thread-insert 22 for a cover-plate (not shown) and a fixing 23 for the thread-insert 22, which however have no influence on the compensator lock 20.

**[0073]** Figures show an end side 26 of the housing 2, which is perpendicular to the longitudinal axis 8. Compensator openings 25 of the dead holes, which form the chambers 10, are positioned at this end side 26. Further, also a central opening 24 of the central inner space 4 is also positioned at this end side 26.

**[0074]** Further, the housing 2 has a rectangular cross section, at least at this end side 26. Both compensator openings 25 are positioned in the corners of this rectangular cross section.

**[0075]** Fig. 5 shows a length 27 of the gas compartment 12. This length 27 defines the maximum length of the gas compartment 12. Further, Fig. 5 shows an inner diameter 28 of the gas compartment 12. The ratio of the maximal length 27 to the inner diameter 28 for each volume compensators 6 is at least 4, preferably at least 6, further preferably at least 8, further preferably at least 15. The inner diameter 28 of the gas compartment 12 is preferably consistent along the entire length 27.

**[0076]** The actuating mechanism 5 of the door actuator comprises a piston 40, which is linearly moveable within the central inner space 4. The piston 40 is connected to a transmission device 42 by a piston rod 41. Further, the actuating mechanism 5 comprises a main spring 44, which is positioned on the piston rod 41.

**[0077]** The output shaft 43 is rotatably arranged within the housing 2 and fixed by a shaft cover screw 50.

**[0078]** The central opening 24 at the end side 26 is enclosed by a central lock 51. The "central lock 51" is a cover-screw with additional internal hydraulic functions and can also be called "control-head". Between the central lock 51 and the piston 40, the central inner space 41 comprises a damping room 53 filled with hydraulic fluid. The tank room 52, also filled with hydraulic fluid, is positioned on the other side of the piston 40.

**[0079]** At least one adjusting valve 54 is used within the door actuator 1 to adjust the flow of the hydraulic fluid between the damping room 53 and the tank room 52, in order to adjust the damping and/or the speed of the movement of the piston 40.

**[0080]** Figs. 9 and 10 disclose details of the transmis-

sion device 42. The transmission device 42 includes a cam disc 45 and the cam follower 46. The cam disc 45 is positioned on the output shaft 43. This cam disc 45 is an excentric element, which rotates together with the output shaft 43.

**[0081]** The cam follower 46 includes two parallel plates 47. Both plates 47 have oblong holes 49 through which the output shaft 43 protrudes, so that the two plates 47 can move relatively to the output shaft 43 along the longitudinal axis 8. Further, the cam follower 46 includes a roll 48, which is arranged between the two plates 47. The roll 48 contacts the cam disc 45.

**[0082]** The piston rod 41 connects the transmission device 42 with the piston 40. So it is possible that the transmission device 42 transfers between the rotation of the output shaft 43 and the linear movement of the piston 40.

**[0083]** In Fig. 10, the shaft cover screw 50 and the upper plate 47 are faded off, in order to show the details of the transmission device 42.

**[0084]** Figs. 3, 4 and 9 show a force adjusting device 60 of the door actuator 1. The force adjusting device 60 is positioned between the transmission device 42 and the piston 40.

**[0085]** The force adjusting device 60 comprises a pressure disc 61, an adjusting shaft 62 and a worm wheel 63.

**[0086]** The pressure disc 61 is positioned on the piston rod 41 and is not rotatable but linearly moveable along the longitudinal axis 8. Therefore, the pressure disc 61 has an extension 64, which is linearly moveable guided in a linear track 65 of the housing 2 (see Fig. 2).

**[0087]** The adjusting shaft 62 includes a worm of a worm gear. This worm engages with the worm wheel 63. The worm wheel 63 is rotatable positioned coaxial to the longitudinal axis 8. By a threaded connection 66 between the worm wheel 63 and the pressure disc 61, it is possible to move the pressure disc 61 by rotation of the worm wheel 63. For that reason, the worm wheel comprises a threaded portion 67.

## Reference signs

### [0088]

- |    |                     |
|----|---------------------|
| 1  | door actuator       |
| 2  | housing             |
| 3  | housing wall        |
| 4  | central inner space |
| 5  | actuating mechanism |
| 6  | volume compensator  |
| 7  | output axis         |
| 8  | longitudinal axis   |
| 10 | chamber             |
| 11 | fluid compartment   |
| 12 | gas compartment     |
| 13 | tube                |
| 14 | separator           |
| 15 | connection          |

16	separator sealing ring		(4),
17	locking ring		• an enclosed gas compartment (12) within the chamber (10),
18	compensator spring		• a separator (14) separating the fluid compartment (11) from the gas compartment (12), the separator (14) being displaceable to vary the volume of the gas compartment (12) in dependence on the pressure in the fluid compartment (11).
19	bottom		
20	compensator lock	5	
21	lock sealing ring		
22	thread-insert		
23	fixing		
24	central opening		
25	compensator opening	10	
26	end side		2. Door actuator according to claim 1, wherein the separator (14) of at least one volume compensator (6), preferably of each volume compensator (6), is slidable back and forth, so that
27	length		
28	inner diameter		
40	piston		
41	piston rod	15	
42	transmission device		• in one movement direction of the separator (14), the volume of the fluid compartment (11) is increased and the volume of the gas compartment (12) is decreased at the same time, and
43	output shaft		• in the other movement direction of the separator (14), the volume of the fluid compartment (11) is decreased and the volume of the gas compartment (12) is increased at the same time.
44	main spring		
45	cam disc		
46	cam follower	20	
47	plates		
48	roll		
49	oblong hole		
50	shaft cover screw		
51	central lock	25	3. Door actuator according to any forgoing claim,
52	tank room		
53	damping room		• comprising at least two of the volume compensators (6), preferably exactly two, three or four of the volume compensators (6),
54	adjusting valve		• and/or wherein the gas compartment (12) of at least one volume compensator (6), preferably of each volume compensator (6), has a length (27) and an inner diameter (28), the ratio of the length (27) to the inner diameter (28) is at least 4, preferably at least 6, further preferably at least 8, preferably at least 15.
60	force adjusting device	30	
61	pressure disc		
62	adjusting shaft		
63	worm wheel		
64	extension		
65	linear track		
66	threaded connection	35	
67	threaded part		
68	pressure relief valve		

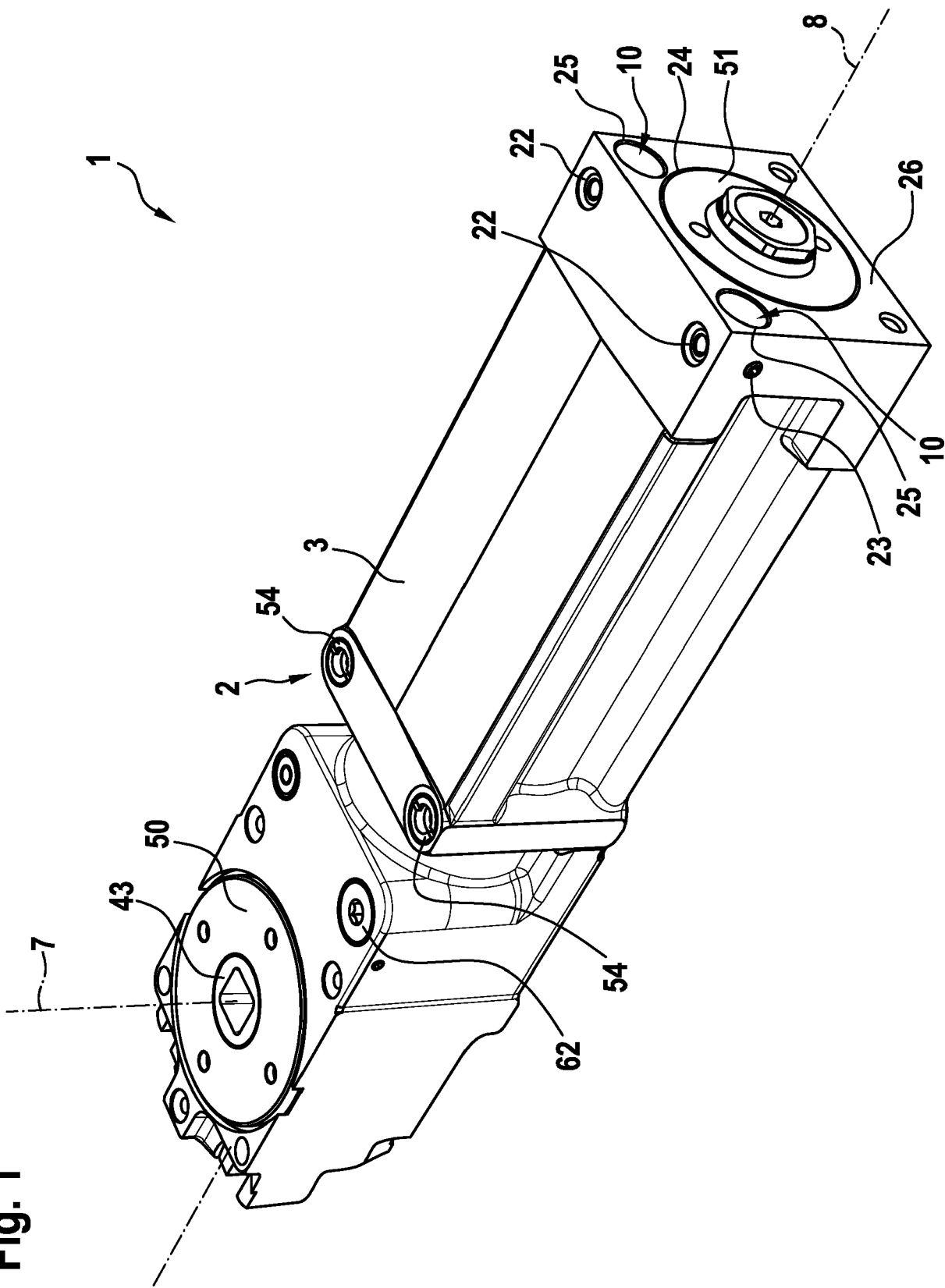
## Claims

1. A door actuator (1) for opening and/or closing a door, comprising:
- a housing (2) with a housing wall (3), the housing wall (3) enclosing a central inner space (4), the central inner space (4) accommodates hydraulic fluid and an actuating mechanism (5) for actuating the door,
  - and at least one volume compensator (6) wherein each volume compensator (6) comprising:
    - a separate chamber (10) formed in the housing wall (3),
    - a fluid compartment (11) within the chamber (10), the fluid compartment (11) being fluidly connected to the central inner space
2. Door actuator according to claim 1, wherein the separator (14) of at least one volume compensator (6), preferably of each volume compensator (6), is slidable back and forth, so that
- in one movement direction of the separator (14), the volume of the fluid compartment (11) is increased and the volume of the gas compartment (12) is decreased at the same time, and
  - in the other movement direction of the separator (14), the volume of the fluid compartment (11) is decreased and the volume of the gas compartment (12) is increased at the same time.
3. Door actuator according to any forgoing claim,
- comprising at least two of the volume compensators (6), preferably exactly two, three or four of the volume compensators (6),
  - and/or wherein the gas compartment (12) of at least one volume compensator (6), preferably of each volume compensator (6), has a length (27) and an inner diameter (28), the ratio of the length (27) to the inner diameter (28) is at least 4, preferably at least 6, further preferably at least 8, preferably at least 15.
4. Door actuator according to any forgoing claim, wherein
- the gas compartment (12) of at least one volume compensator (6), preferably of each volume compensator (6), is tightly sealed against the fluid compartment (11),
  - and/or the gas compartment (12) of at least one volume compensator (6), preferably of each volume compensator (6), is tightly sealed against the central inner space (4),
  - and/or the gas compartment (12) of at least one volume compensator (6), preferably of each volume compensator (6), is tightly sealed against any space of the door actuator (1) filled with hydraulic fluid,
  - and/or the gas compartment (12) of at least one volume compensator (6), preferably of each volume compensator (6), is tightly sealed against the atmosphere or is connected to the atmosphere via a pressure relief valve (68).

5. Door actuator according to any forgoing claim, wherein,
- a compensator spring (18) is arranged in the gas compartment (12) of at least one volume compensator (6), preferably a compensator spring (18) is arranged in the gas compartment (12) of each volume compensator (6),
  - and the separator (14) of at least one volume compensator (6), preferably of each volume compensator (6), is preferably displaceable against the force of the compensator spring (18) to decrease the volume of the gas compartment (12).
6. Door actuator according to any forgoing claim, wherein at least one volume compensator (6), preferably each volume compensator (6), comprises a tube (13) which is inserted into the chamber (10), wherein the separator (14) is guided in the tube (13); preferably wherein the complete gas compartment (12) is formed by the tube (13).
7. Door actuator according to claim 6, wherein the tube (13) is closed at one end by the separator (14) and at the other end by a bottom (19), the bottom (19) is preferably an integral part of the rest of the tube (13).
8. Door actuator according to any forgoing claim,
- wherein the housing (2) has a polygonal, preferably rectangular, cross-section,
  - wherein the chamber (10) of the volume compensator (6) is positioned in a corner of the cross-section; wherein, in case of multiple volume compensators (6), each chamber (10) is preferably positioned in its own corner of the cross-section.
9. Door actuator according to any forgoing claim, wherein
- the chamber (10) of at least one volume compensator (6), preferably of each volume compensator (6), is formed by a hole, preferably a dead hole, in the housing wall (3),
  - the opening (25) of the hole is located at an end side (26) of the housing (2) and is closed by a compensator lock (20), preferably a sealed cover screw.
10. Door actuator according to any foregoing claim, wherein the actuating mechanism (5) comprises:
- a piston (40), which is linearly movable in the central inner space (4),
  - an output shaft (43) rotatable supported in the housing (2),
  - and a transmission device (42) for converting between the linear movement of the piston (40) and the rotary movement of the output shaft (43).
11. Door actuator according to claim 10, wherein the central inner space (4) comprises a tank room (52) on one side of the piston (40) and a damping room (53) on the other side of the piston (40).
12. Door actuator according to claim 11, wherein a connection (15), in particular a channel in the housing wall (3), leads from the fluid compartment (11) of the volume compensator (6) to the tank room (52); wherein, in case of multiple volume compensators (6), preferably a separate connection (15) is provided for each volume compensator (6).
13. Door actuator according to claim 11 or 12, wherein, when the piston (40) moves in the direction of the damping room (53), hydraulic fluid is flowable from the damping room (53) into the tank room (52) to dampen the movement.
14. Door actuator according to any one of claims 10 to 13, wherein the actuating mechanism (5) comprises: A main spring (44) and a piston rod (41) connecting the piston (40) with the transmission device (42), wherein the main spring (44) is positioned on the piston rod (41).
15. Door actuator according to claim 14, comprising a force adjusting device (60) with a pressure disc displaceable arranged on the piston rod (41), wherein the main spring (44) abuts at the pressure disc (61).



Fig. 1



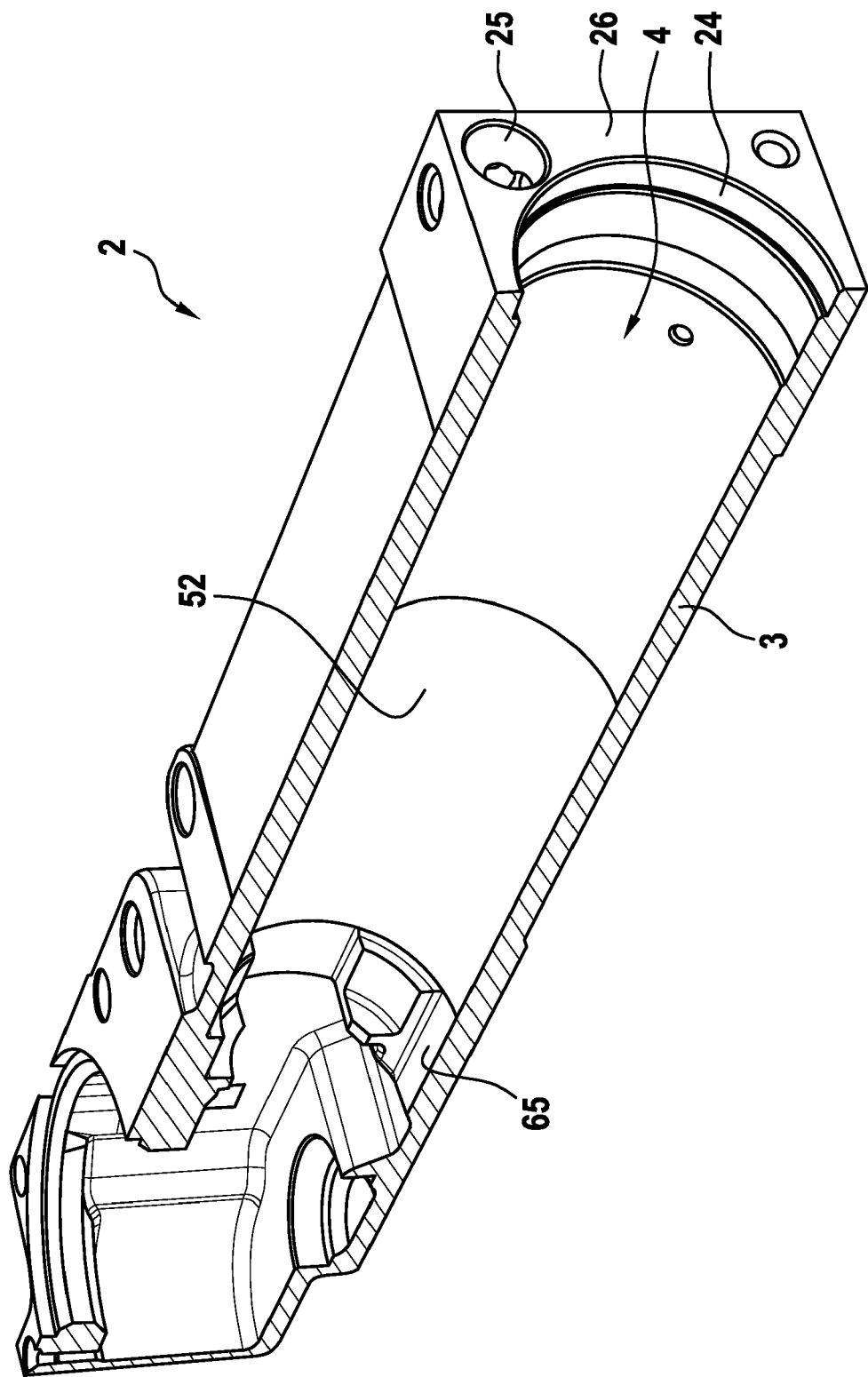


Fig. 2

Fig. 3

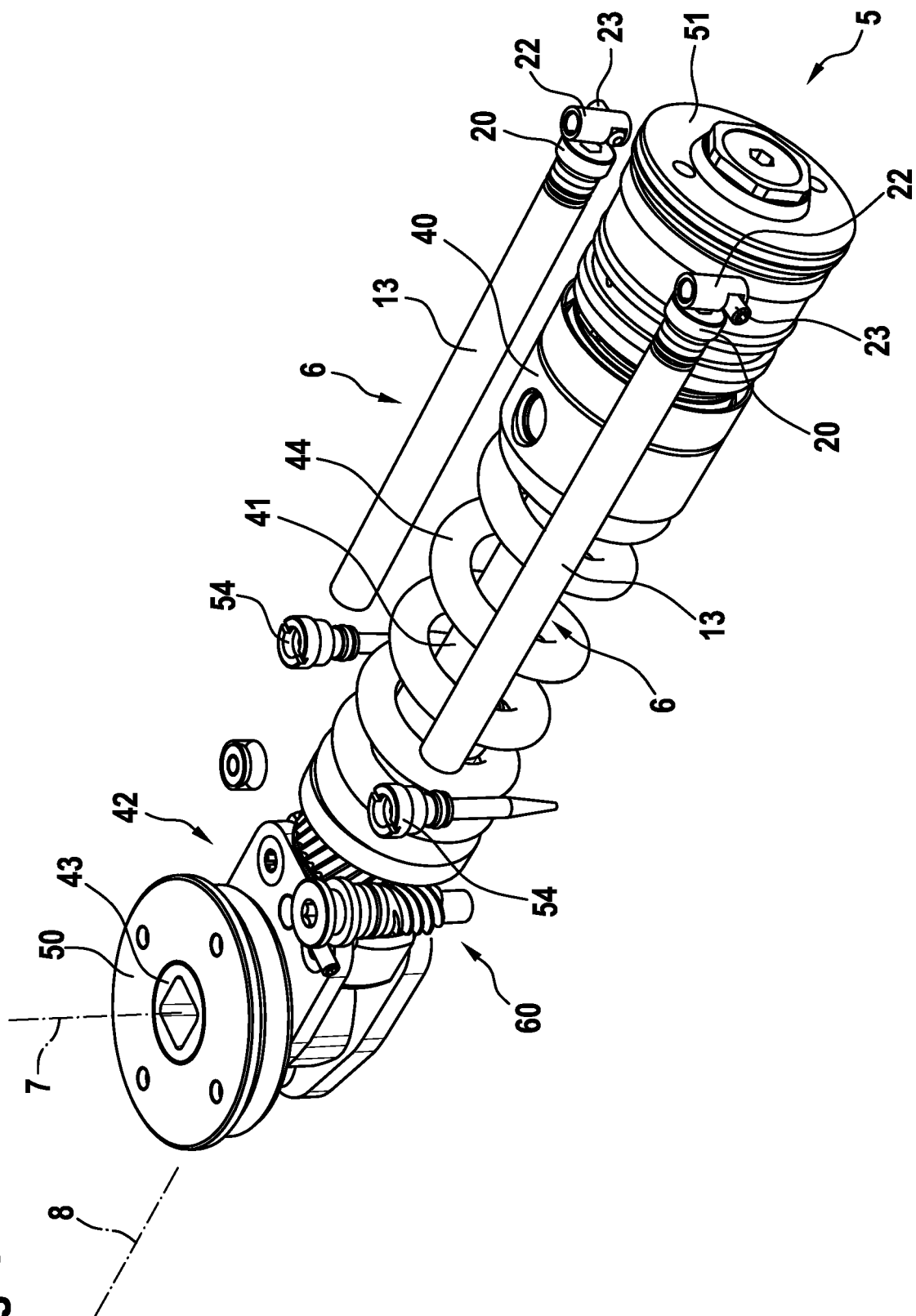


Fig. 4

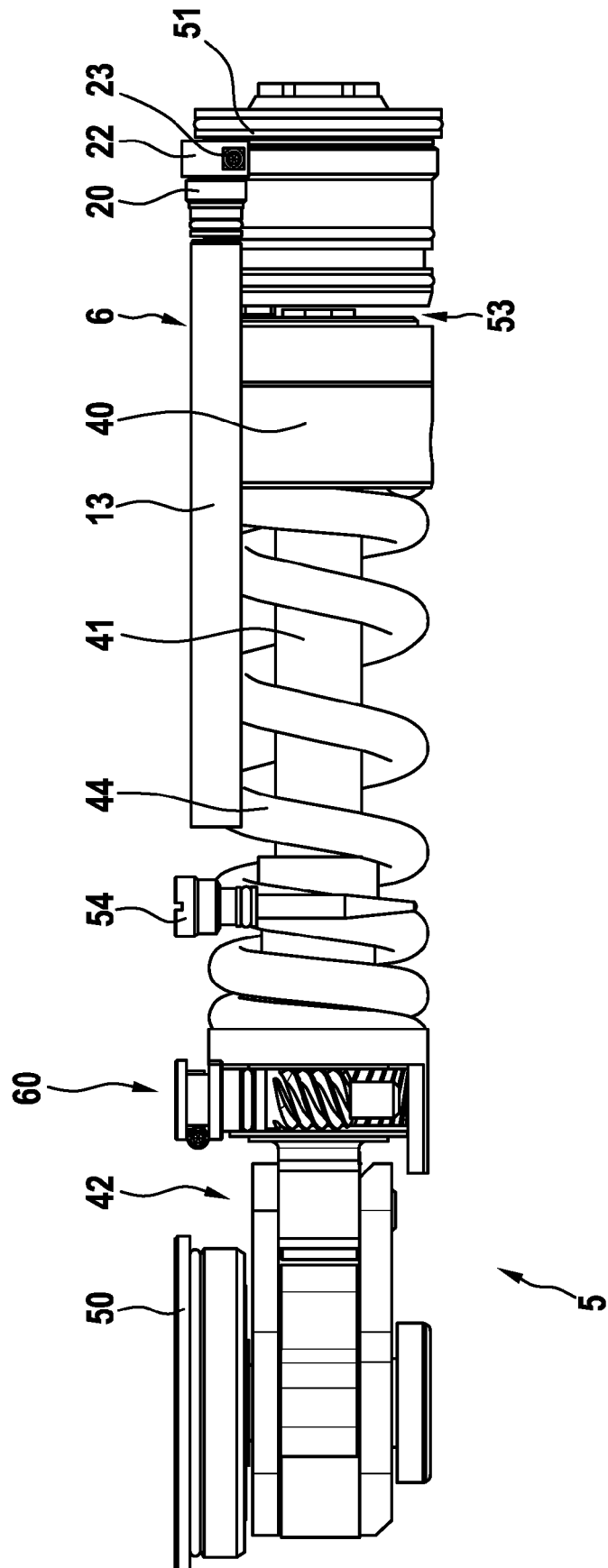


Fig. 5

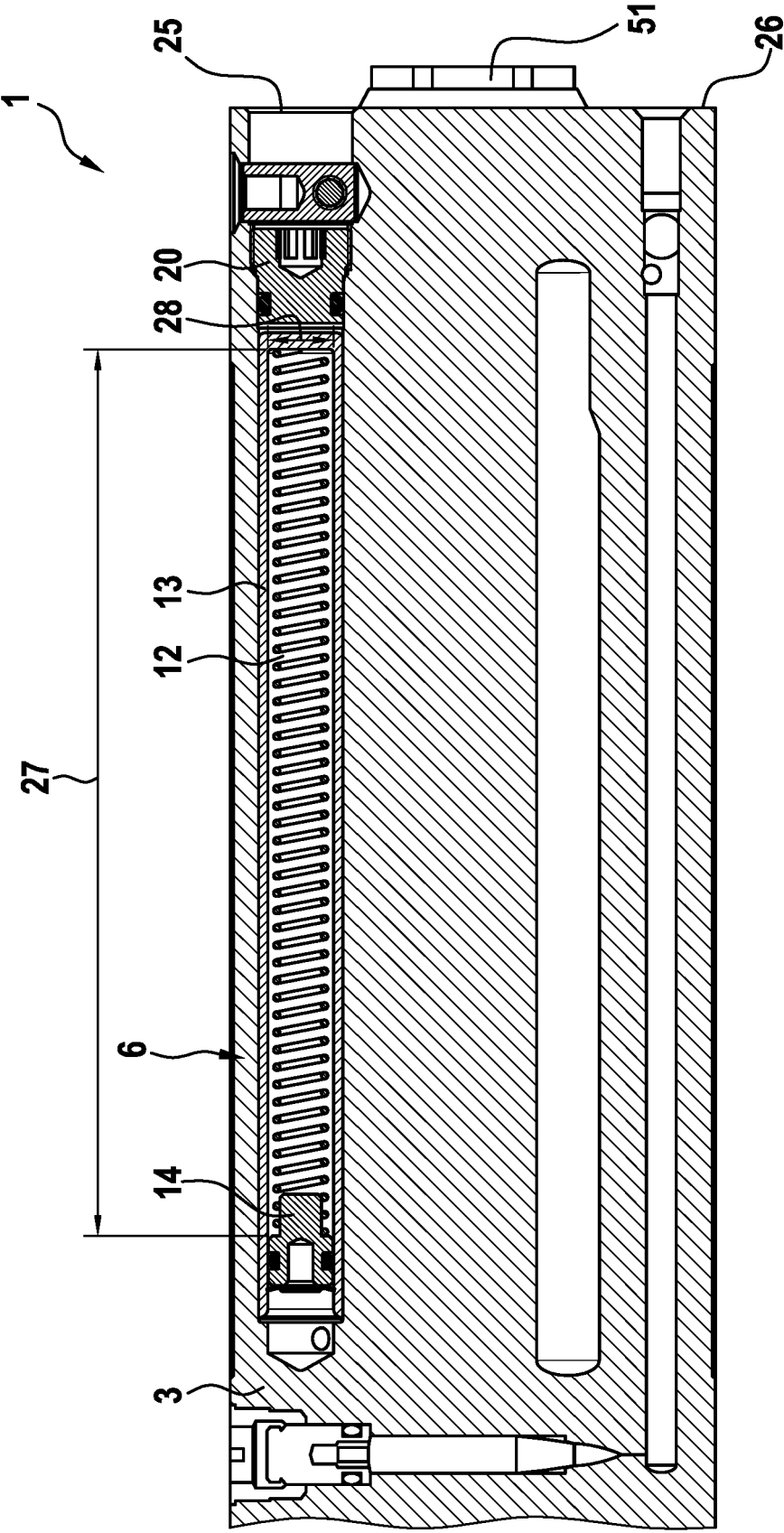


Fig. 6

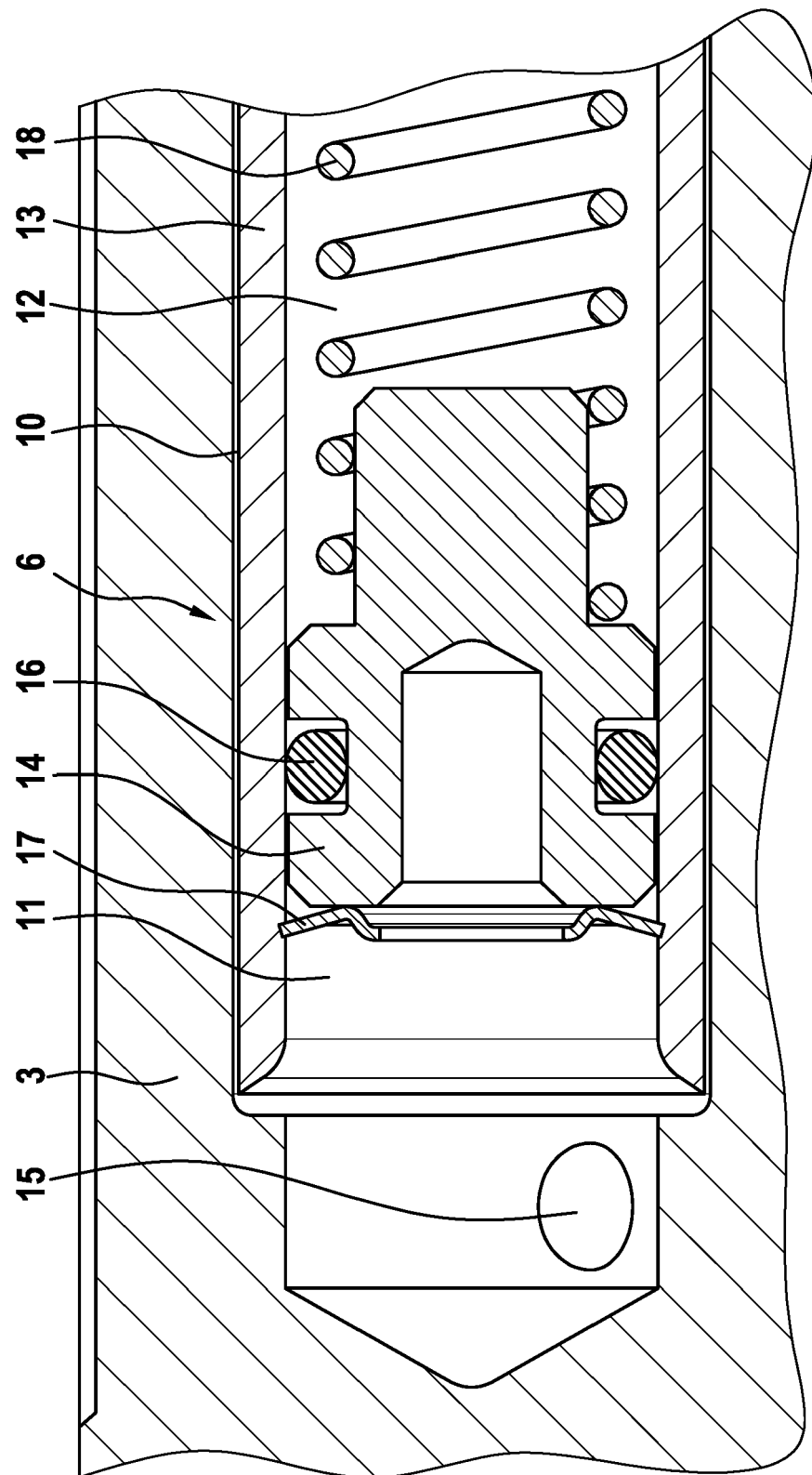


Fig. 7

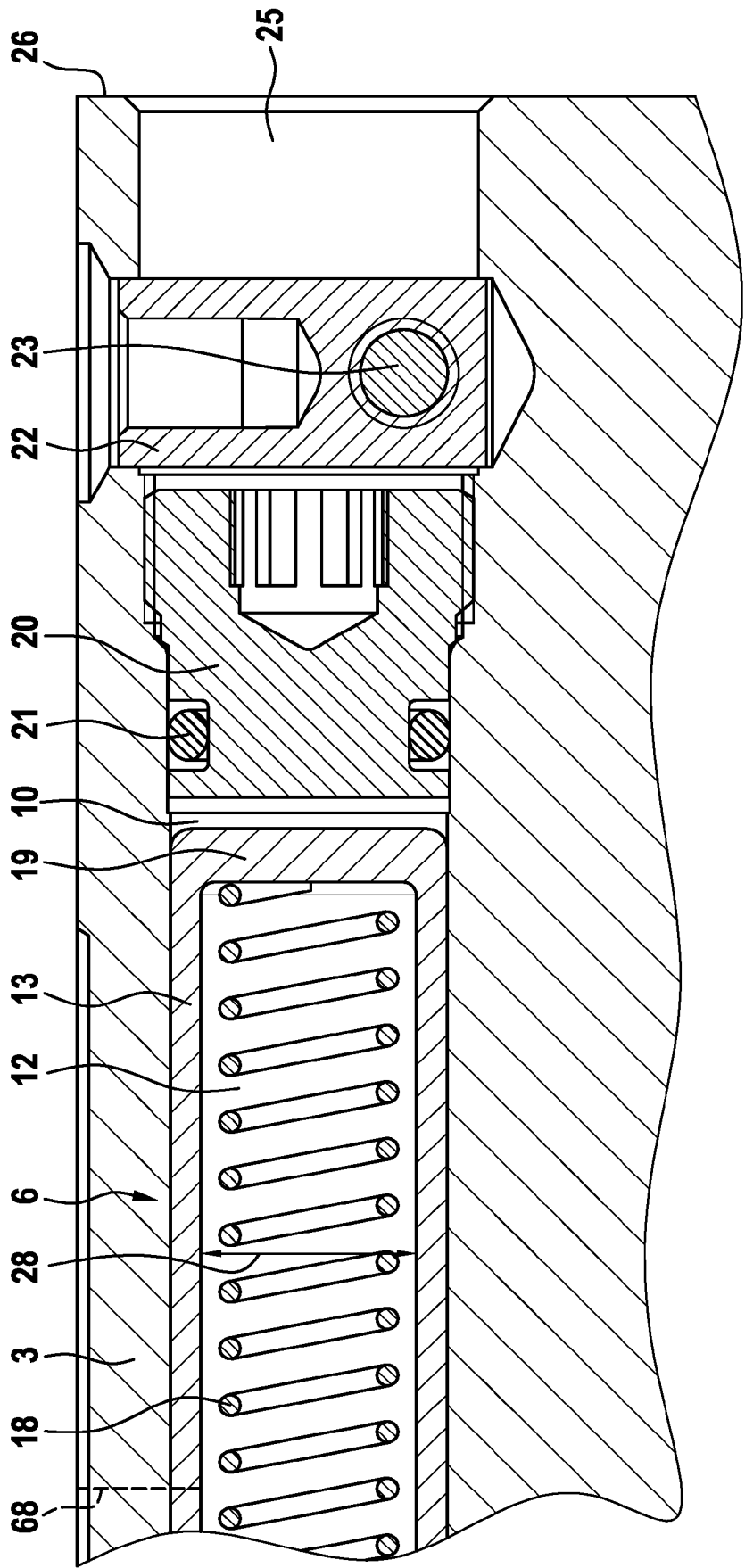


Fig. 8

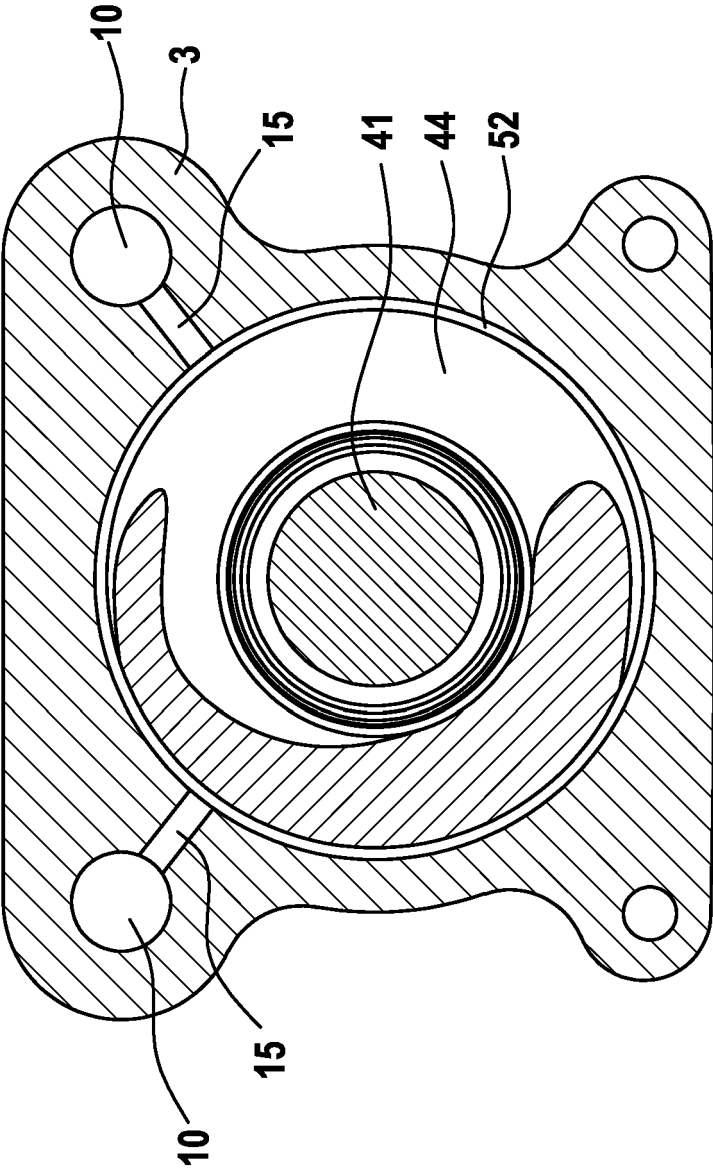
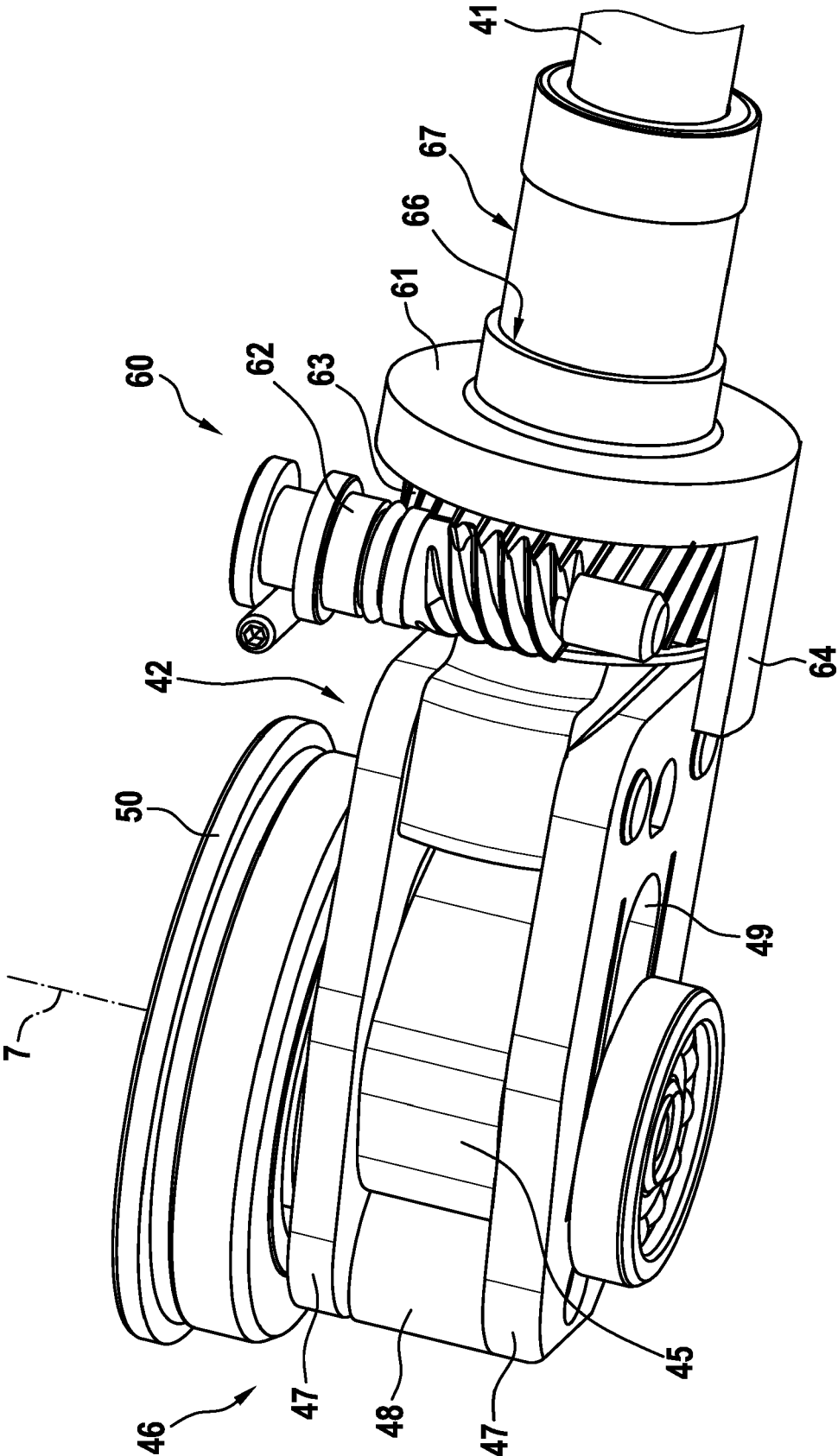




Fig. 9



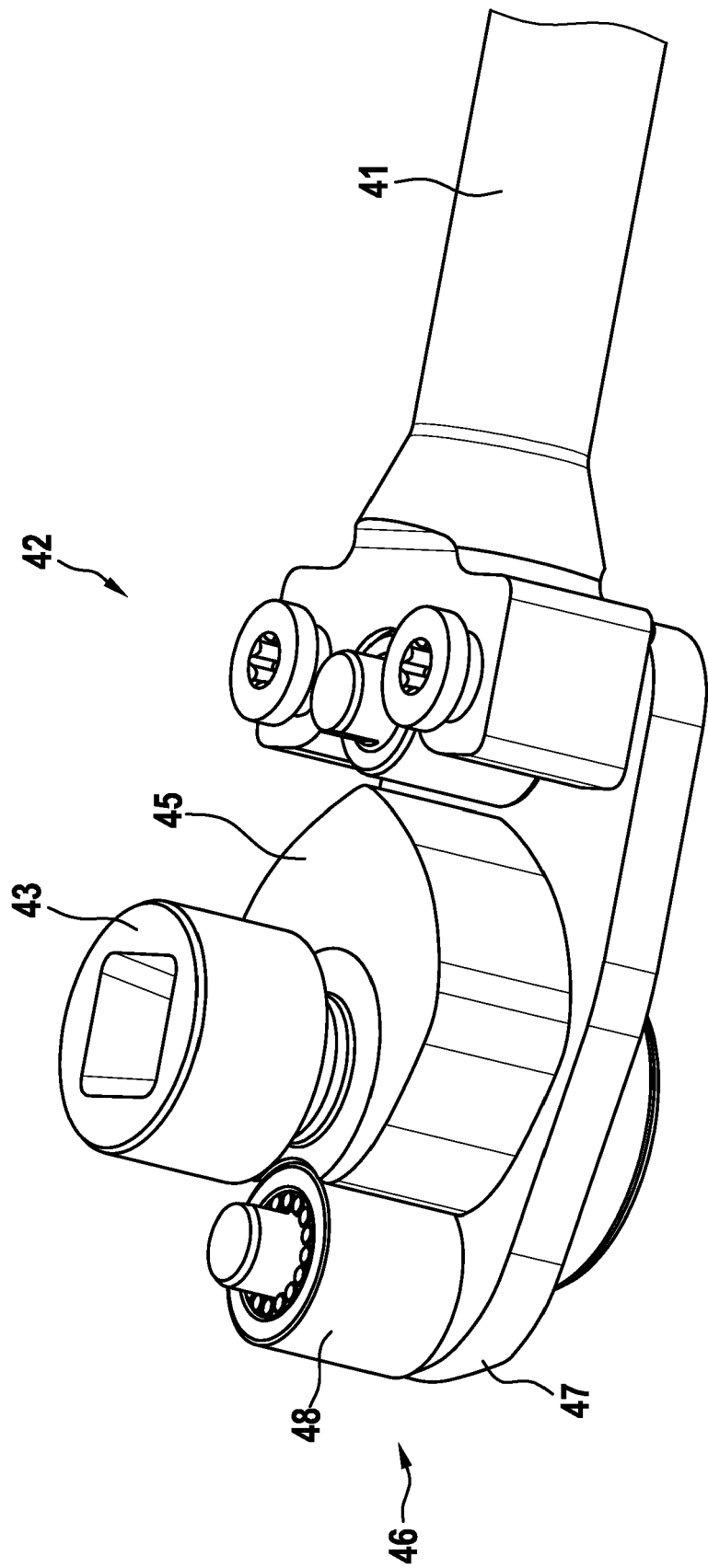


Fig. 10



## EUROPEAN SEARCH REPORT

Application Number

EP 22 17 0791

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	DE 10 2019 209264 A1 (GEZE GMBH [DE]) 31 December 2020 (2020-12-31)	1-8, 10-15	INV. E05F3/10
Y	* paragraphs [0007] - [0010], [0036] - [0038], [0041], [0052] - [0061]; figures 1-6, 12 *	9	
Y	DE 10 2015 223747 B3 (GEZE GMBH [DE]) 15 December 2016 (2016-12-15)	9	
A	* paragraphs [0038] - [0035]; figures 1-5 *	1-8, 10-15	
			TECHNICAL FIELDS SEARCHED (IPC)
			E05F
The present search report has been drawn up for all claims			
Place of search <b>The Hague</b>		Date of completion of the search <b>12 October 2022</b>	Examiner <b>Klemke, Beate</b>
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.  
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12-10-2022

10	Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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15	<b>DE 102015223747 B3</b>	<b>15-12-2016</b>	<b>NONE</b>	
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82