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(54) **DOOR ACTUATOR**

TÜRBETÄTIGER

ACTIONNEUR DE PORTE

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(73) Proprietor: **dormakaba Deutschland GmbH**  
**58256 Ennepetal (DE)**

(72) Inventors:  
• **LEONG, Jackson**  
**58256 Ennepetal (DE)**

• **THO, Say Kiong**  
**58256 Ennepetal (DE)**

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

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## Description

**[0001]** The invention relates to a door actuator for a door leaf.

**[0002]** Door actuators, for example door closers, are mountable to door leaves for supporting the same. Typically, a door actuator enables the door to be pivotally opened or closed.

**[0003]** For example, EP 2 617 925 A1 discloses a patch fitting for a glass door. The patch fitting includes a mount for being mounted on a floor, a shaft connected with the mount, a clamping seat pivotally connected with the shaft, and a piston unit installed inside the clamping seat. When the glass door is sweeping to open or close, the clamping seat will turn along with the sweeping movement of the glass door about the shaft and the piston unit will be pushed by an eccentric cam of the shaft to press the hydraulic oil contained in the clamping seat so as to provide a damping resistance in response to the sweeping movement of the glass door.

**[0004]** In a conventional door actuator such as disclosed by EP 2 617 925 A1, free-play or backlash between the eccentric cam and the movable piston unit may occur in certain situations. This may pose a safety issue, because the door could suddenly slam against an end user in case a strong external force, for example a gust of wind, acts on a (partly) opened door.

**[0005]** To avoid this, a door actuator, particularly a hydraulic door closer, for a door leaf, comprises a housing for mounting to the door leaf. The door actuator comprises a shaft rotatably supported in the housing for actuating the door leaf. The shaft includes an eccentric cam. The door actuator comprises a piston assembly, particularly a hybrid piston assembly. The piston assembly includes an outer piston unit reciprocally supported in the housing to follow the eccentric cam, and an inner piston unit reciprocally supported in the outer piston unit to follow the eccentric cam.

**[0006]** Thus, the door actuator includes two piston units following the eccentric cam. This may allow to more precisely follow the eccentric cam, and, based on an arrangement of the piston units, to reduce or prevent backlash or free-play of the eccentric cam with respect to the piston units.

**[0007]** EP 2 738 332 A1 and US 20140290144 A1 disclose such door actuators.

**[0008]** The problem to be solved by the present disclosure is to arrange the inner piston unit in a rotationally fixed manner in the outer piston unit so that a longitudinal axis of a contact member of the inner piston unit contacting the eccentric cam extends parallel to the shaft. This reduces wear of the piston assembly while maintaining user safety of the door actuator.

**[0009]** The problem is solved by a door actuator according to the independent claim. Preferable embodiments are given in the dependent claims and the description.

**[0010]** The inner piston of the inner piston unit includes

a first, particularly cylindrical, body section and a second, particularly cylindrical, body section. A central longitudinal axis of the first body section extends displaced from, particularly parallel to, a central longitudinal axis of the second body section. Additionally or alternatively, the second body section longitudinally extends eccentric with respect to the first body section. The eccentric arrangement provides a reliable solution for rotationally fixing the inner piston unit in the outer piston unit. Additionally, it may be easy to manufacture and, thus, cost efficient.

**[0011]** Preferably, the housing may be configured as a, particularly multi-piece, clamping seat for the door leaf.

**[0012]** Particularly, the inner piston unit and/or the outer piston unit may directly follow or contact the eccentric cam.

**[0013]** For example, the inner piston unit may include an inner piston and the outer piston unit may include an outer piston.

**[0014]** In particular, the inner piston unit may be movable in the outer piston unit along a longitudinal axis of the piston assembly, and/or the outer piston unit may be movable in the housing along the longitudinal axis of the piston assembly.

**[0015]** Additionally, the inner piston unit may be reciprocally arranged in a hole, preferably a throughhole of the outer piston unit. Particularly, the hole may be arranged in an end body section of an outer piston of the outer piston unit.

**[0016]** Further, the shaft may be configured for mounting to a door mount, for example a top door mount or a floor door mount.

**[0017]** In some embodiments, the inner piston unit is biased, particularly spring-loaded, to contact the eccentric cam. Additionally or alternatively, the outer piston unit is biased, particularly spring-loaded, to contact the eccentric cam. By biasing the piston units it can be ensured that the piston units maintain a contact with the eccentric cam.

**[0018]** In some embodiments, the inner piston unit is biased to contact the eccentric cam irrespective of a rotational position of the eccentric cam to prevent backlash or free-play of the eccentric cam with respect to the inner piston unit and/or the piston assembly. Additionally or alternatively, the outer piston is biased to contact the eccentric cam irrespective of a rotational position of the eccentric cam to prevent backlash or free-play of the eccentric cam with respect to the outer piston unit and/or the piston assembly.

**[0019]** In some embodiments, the inner piston unit includes a contact member for contacting the eccentric cam. Additionally or alternatively, the outer piston unit may include a contact member for contacting the eccentric cam. Preferably, the contact member of the outer piston unit contacts the eccentric cam separate from the contact member of the inner piston unit. By providing contact members, an improved contact between the piston units and the eccentric cam may be achieved.

**[0020]** Particularly, the contact member(s) may be configured as cam follower(s).

**[0021]** In some embodiments, the contact member of the inner piston unit and/or the outer piston unit is a bolt or a roller. Additionally or alternatively, the contact member of the inner piston unit and the contact member of the outer piston unit are arranged on opposite sides of the eccentric cam.

**[0022]** In some embodiments, the outer piston unit and the inner piston unit contact or follow the eccentric cam on opposite sides of the eccentric cam. Additionally or alternatively, the outer piston unit and the inner piston unit contact or follow the eccentric cam at different sections of the eccentric cam. This may further help to reduce free-play or backlash between the piston assembly and the eccentric cam.

**[0023]** In some embodiments, an outer piston of the outer piston unit includes a hole for supporting the inner piston unit. The hole has a first hole section and a second hole section. A central longitudinal axis of the first hole section extends displaced from, particularly parallel to, a central longitudinal axis of the second hole section. Additionally or alternatively, the second hole section longitudinally extends eccentric with respect to the first hole section.

**[0024]** In some embodiments, the first hole section matches with the first body section, and/or the second hole section matches with the second body section.

**[0025]** In some embodiments, an inner piston of the inner piston unit includes an outer circumferential face contacting an outer piston of the outer piston unit. The outer circumferential face includes at least one flat or planar section, and/or has a shape different from a solid of revolution. Additionally or alternatively, an outer piston of the outer piston unit includes an inner circumferential face contacting an inner piston of the inner piston unit. The inner circumferential face includes at least one flat or planar section, and/or has a shape different from a solid of revolution. The inner circumferential face may be defined by a hole of the outer piston. This may also provide a reliable solution for further rotationally fixing the inner piston unit in the outer piston unit.

**[0026]** As another example, an inner piston of the inner piston unit and a hole of an outer piston of the outer piston unit may be engaged with each other, for example, by a spline or a key connection.

**[0027]** In some embodiments, an outer piston of the outer piston unit includes a first, particularly cylindrical, end body section reciprocatingly supporting the inner piston unit, and a second, particularly cylindrical, end body section opposite of the first end body section with respect to the eccentric cam. For example, the second end body section may hold a contact member for contacting the eccentric cam and/or abuts against a biasing member, for instance a spring member, for biasing the outer piston unit to contact the eccentric cam.

**[0028]** Additionally, the outer piston unit may include an intermediate body section interconnecting the first end

body section and the second end body section. Preferably, the intermediate body section may have a plate shape and/or may include a throughhole for the shaft.

**[0029]** In some embodiments, the door actuator further comprises a biasing member, for example a spring member, supported at an end cap of the housing and biasing the inner piston unit. In particular, the biasing member may bias the inner piston unit to contact or follow the eccentric cam.

**[0030]** In some embodiments, the inner piston unit includes a pressure relief valve, a hydraulic oil passage extending through an inner piston of the inner piston unit and/or a seal, particularly a sealing ring. The seal seals against the outer piston unit and may be particularly arranged in an outer circumferential groove of an inner piston of the inner piston unit.

**[0031]** In some embodiments, the housing includes a hydraulic oil compartment formed as a blind hole sealed or closed by an end cap, and/or accommodating the piston assembly. The hydraulic oil compartment is separated into a first section and a second section by the piston assembly. The first section and the second section are fluidly connected to each other. The inner piston unit, the outer piston unit and/or the piston assembly includes a hydraulic oil passage. Additionally or alternatively, a first biasing member, for example a spring member, biasing the inner piston unit is disposed in the first section and/or a second biasing member, for example a spring member, biasing the outer piston unit is disposed in the second section.

**[0032]** The above described preferred embodiments and features of the invention can be combined as required. Further details and advantages of the invention are described in the following with reference to the attached drawings. In the drawings:

- Fig. 1 shows a cutaway drawing of an exemplary door actuator according to the present disclosure;
- Fig. 2 shows a perspective view of a hybrid piston assembly according to the present disclosure;
- Fig. 3 shows an exploded view of the hybrid piston assembly;
- Fig. 4 shows a perspective view of an outer piston of the hybrid piston assembly;
- Fig. 5 shows a schematic view of an inner piston unit and an end section of an outer piston unit;
- Fig. 6 shows a cut view of a conventional door actuator; and
- Fig. 7 shows a cut view of the door actuator according to the present disclosure.

**[0033]** The embodiments shown in the Figs. are at

least partially identical. Similar and identical parts are identified with the same reference sign, and for describing those parts it is referred to the description of the other embodiments and Figs., respectively, to avoid repetitions.

**[0034]** Fig. 1 shows an exemplary door actuator 10. The door actuator 10 is configured as a hydraulic door closer. The door actuator 10 includes a housing 12, a shaft or pinion 14, a piston assembly 16, at least one first biasing member 18, and at least one second biasing member 20.

**[0035]** The housing 12 accommodates the shaft 14, the piston assembly 16, the at least one first biasing member 18 and the at least one second biasing member 20. The housing 12 is connectable to a door leaf (not shown), particularly a glass door leaf. In particular, the housing 12 may be clamped to the door leaf. In other words, the housing 12 serves as a clamping seat for the door leaf. The shaft 14, particularly an outer end 26 of the shaft 14, is mountable to a door mount (not shown), for example a floor mount or a top mount. When the door leaf is sweeping to open or close, the housing 12 turns along with the sweeping movement of the door leaf about the shaft 14.

**[0036]** Specifically, the housing 12 includes a longitudinal blind hole forming a hydraulic oil compartment 22 filled with hydraulic oil. The hydraulic oil compartment 22 is divided into a first section 22A and a second section 22B by the piston assembly 16. In the shown configuration, the first section 22A serves as a dampening section for dampening a movement of the door leaf. The second section 22B serves as an opening section to allow opening the door leaf.

**[0037]** The hydraulic oil compartment 22 is closed and sealed by a replaceable end cap 24. The piston assembly 16 is positioned in the hydraulic oil compartment 22. The at least one first biasing member 18 is positioned in the first section 22A of the hydraulic oil compartment 22. The at least one second biasing member is positioned in the second section 22B of the hydraulic oil compartment 22.

**[0038]** In the depicted embodiment, the biasing members 18, 20 are configured as spring members, particularly coil springs.

**[0039]** The shaft 14 is rotatably supported in the housing 12. The outer end 26 of the shaft 14 extends outwards of the housing 12. The outer end 26 is configured for mounting to above described door mount.

**[0040]** The shaft 14 includes an eccentric cam 28 for actuating the piston assembly 16. For example, when the door leaf is sweeping to open, the eccentric cam 28 pushes the piston assembly 16 in a direction to the second section 22B of the hydraulic oil compartment 22. The opening motion of the door leaf is damped by hydraulic oil flowing from the second section 22B through hydraulic oil passages in the piston assembly 16 to the first section 22A of the hydraulic oil compartment 22. Additionally, the at least one second biasing member 22 functions to return the door leaf into a closed position.

**[0041]** The piston assembly 16 is configured as a hy-

brid piston assembly including an outer piston unit 30 and an inner piston unit 32. The outer piston unit 30 is reciprocally supported in the housing 12, particularly the hydraulic oil compartment 22. In other words, the outer piston unit 30 is movable with respect to the housing 12 in a longitudinal direction of the hydraulic oil compartment 22.

**[0042]** The piston assembly 16 is shown in more detail in Figs. 2 and 3.

**[0043]** The outer piston unit 30 includes an outer piston 34 and a contact member 36. The outer piston 34 includes a first end body section 38, an intermediate body section 40, and a second end body section 42.

**[0044]** The first end body section 38 includes a bore or hole (throughhole) 44 for reciprocally supporting the inner piston unit 32. In other words, the inner piston unit 32 is movable with respect to the outer piston unit 30 in a longitudinal direction of the piston assembly 16. For example, the first end body section 38 may have a cylindrical outer shape.

**[0045]** The intermediate body section 40 interconnects the first end body section 38 and the second end section 42. The intermediate body section 40 provides space for the shaft 14 and the eccentric cam 28 (see Fig. 1). The intermediate body section 40 includes an elongated throughhole 46. The throughhole 46 is elongated in a longitudinal direction of the outer piston unit 30. In a mounted state, the shaft 14 passes through the throughhole 46. For example, the intermediate body section 40 may have plate shape.

**[0046]** The second end body section 42 supports the contact member 36. The second end body section 40 includes an end face 48 and a hydraulic oil passage 49. In a mounted state, the at least one second biasing member 20 (see Fig. 1) contacts the end face 48. The hydraulic oil passage 49 extends through the second end body section 42. For example, the second end body section 42 may have a cylindrical outer shape.

**[0047]** In the shown embodiment, the contact member 36 is configured as a roller. The contact member 36 is rotatably supported by a bolt 50 secured to the second end body section 42. In the mounted state, the contact member 36 contacts the eccentric cam 28 (see Fig. 1) to follow a contour of the eccentric cam 28. In other embodiments, the contact member 36 may have another configuration. For example, the contact member 36 may be configured as a rotationally fixed bolt.

**[0048]** The inner piston unit 32 includes an inner piston 52 and a contact member 54. The inner piston unit 32 is movable along a longitudinal direction of the hole 44 of the outer piston 34. The inner piston unit 32 is biased by the at least one first biasing member 18 in a direction to the second end body section 42 of the outer piston 34. In the shown embodiment, the contact member 54 is configured as a bolt. In other embodiments, the contact member 54 may be a roller.

**[0049]** In the mounted state (see Fig. 1), the at least one first biasing member 18 biases the inner piston unit

32 so that the contact member 54 contacts the eccentric cam 28 irrespective of a rotational position of the eccentric cam 28 (and the shaft 14) about a longitudinal axis of the shaft 14.

**[0050]** Similarly, the at least one second biasing member 20 biases the outer piston unit 30 so that the contact member 36 contacts the eccentric cam 28 irrespective of a rotational position of the eccentric cam 28 (and the shaft 14) about a longitudinal axis of the shaft 14.

**[0051]** The inner piston unit 32 is arranged in a rotationally fixed manner in the hole 44 to maintain an orientational relationship between the contact member 54 and the eccentric cam 28 (the drive shaft 14). Particularly, an orientational relationship is maintained in which a longitudinal axis of the contact member 54 extends parallel to the drive shaft 14 (see Fig. 1). Additionally, this may reduce wear of the eccentric cam 28 and the inner piston unit 32.

**[0052]** The inner piston unit 32 is rotationally fixed in the hole 44 by an eccentric arrangement of sections of the piston 32 and the hole 44. The sections are shown in Figs. 3 and 4. Furthermore, to ease understanding, Fig. 5 schematically indicates the relevant sections of the inner piston 52 and the hole 44.

**[0053]** Specifically, the inner piston 52 includes a first body section 56 and a second body section 58. The first body section 56 and the second body section 58 have a cylindrical shape. A central longitudinal axis of the first body section 56 extends spaced apart and parallel to a central longitudinal axis of the second body section 58 (see Fig. 5). In other words, the second body section 58 extends eccentrically with respect to the first body section 56.

**[0054]** Similarly, the hole 44 includes a first hole section 60 and a second hole section 62, which extends eccentrically with respect to the first hole section 60. In a mounted state (see Fig. 2), the first body section 56 is positioned in the first hole section 60, and the second body section 58 is positioned in the second hole section 62. The eccentric arrangement of the sections 56-62 rotationally fixes the inner piston 52 in the hole 44 with respect to a longitudinal axis of the inner piston 52.

**[0055]** In other embodiments, a configuration of the inner piston and the hole may be adapted to further rotationally fix the inner piston unit in the hole. For example, outer circumferential faces of the inner piston and the hole may include flat or planar sections and/or the inner piston and the hole may have a shape different from a solid of revolution. As another example, the inner piston and the hole may be engaged with each other.

**[0056]** Turning to Figs. 6 and 7 for describing an effect of the configuration of the door actuator according to the present disclosure. Fig. 6 shows a conventional arrangement with a single piston, i.e. without a hybrid piston assembly as suggested herein. Fig. 7 shows a cut view of the door actuator including an inner piston unit and an outer piston unit according to the present disclosure.

**[0057]** Referring to Fig. 6, a conventional system may

include a piston 100 including a contact member 102. The piston 100 is biased to contact an eccentric cam 104 on one side of the eccentric cam 104 only. Further, the conventional system does not include a counter-roller mechanism which helps to reduce backlash or free-play during door opening or closing. Particularly, there is a gap  $d$  between the eccentric cam 104 and an inner face 106 of the piston 100. Due to the gap  $d$ , the eccentric cam 104 can rotate anticlockwise as indicated by arrow A until the eccentric cam 104 eventually contacts the inner face 106. This backlash or free play may impose a safety issue to an end user especially in the event of an external force acting on the door leaf. For example, the external force may be a gust of wind. Due to the gap  $d$ , the door could slam onto the end user during door opening or closing.

**[0058]** Referring to Fig. 7, the door actuator 10 according to the present disclosure solves above issue.

**[0059]** The piston assembly 16 of the door actuator 10 includes the inner piston unit 32 and the outer piston unit 30. Both the inner piston unit 32 and the outer piston unit 30 are biased, particularly spring-loaded, to contact the eccentric cam 28. Additionally, the inner piston unit 32 and the outer piston unit 30 contact the eccentric cam 28 on opposite sides of the eccentric cam 28. Therefore, there is no gap between the eccentric cam 28 and the piston assembly 16. Accordingly, backlash or free-play is efficiently reduced or prevented. For example, in the event of a gust of wind, the eccentric cam 28 directly contacts the inner piston 52, pressure builds up, and a resulting dampening force resists the external force exerted on the door leaf by the gust of wind.

**[0060]** Fig. 7 further shows an exemplary inner configuration of the inner piston unit 32. The piston unit 32 includes a hydraulic oil passage 64 for transferring hydraulic oil between the first section 22A and the second section 22B of the hydraulic oil compartment 22 (see Fig. 1) for dampening a movement of the door leaf. Furthermore, the inner piston unit 32 includes a pressure relief valve 66 arranged in the hydraulic oil passage 64. The purpose of the pressure relief valve 26 is to ensure that an additional oil leak path is generated when a sudden pressure surge builds-up in the door actuator 10. This may reduce the inner pressure in the door actuator 10 and may prevent or reduce deterioration of seals included in the door actuator 10. For example, the inner piston unit 32 may include a seal 68, particularly a sealing ring, disposed in an outer circumferential groove of the inner piston 52. The seal 68 seals against the outer piston unit 30.

**[0061]** The invention is not limited to the above described preferred embodiments. Instead, a plurality of variations and modifications using the inventive idea of the present application and, thus, falling under the scope of protection, as defined by the claims, are conceivable.

**List of reference signs****[0062]**

|     |                                |
|-----|--------------------------------|
| 10  | Door actuator                  |
| 12  | Housing (clamping seat)        |
| 14  | Drive shaft                    |
| 16  | Piston assembly                |
| 18  | First biasing member (spring)  |
| 20  | Second biasing member (spring) |
| 22  | Hydraulic oil compartment      |
| 22A | First section                  |
| 22B | Second section                 |
| 24  | End cap                        |
| 26  | Outer end of drive shaft       |
| 28  | Eccentric cam                  |
| 30  | Outer piston unit              |
| 32  | Inner piston unit              |
| 34  | Outer piston                   |
| 36  | Contact member                 |
| 38  | First end body section         |
| 40  | Intermediate body section      |
| 42  | Second end body section        |
| 44  | Hole                           |
| 46  | Throughhole                    |
| 48  | End face                       |
| 49  | Hydraulic oil passage          |
| 50  | Bolt                           |
| 52  | Inner piston                   |
| 54  | Contact member                 |
| 56  | First body section             |
| 58  | Second body section            |
| 60  | First hole section             |
| 62  | Second hole section            |
| 64  | Hydraulic oil passage          |
| 66  | Pressure relief valve          |
| 68  | Seal                           |

(58), characterised in that:

a central longitudinal axis of the first body section (56) extends displaced from, particularly parallel to, a central longitudinal axis of the second body section (58); and/or the second body section (58) longitudinally extends eccentric with respect to the first body section (56).

2. The door actuator (10) of claim 1, wherein the inner piston unit (32) is biased, particularly spring-loaded, to contact the eccentric cam (28), and, preferably, the outer piston unit (30) is biased, particularly spring-loaded, to contact the eccentric cam (28).

3. The door actuator (10) of claim 1 or claim 2, wherein the inner piston unit (32) is biased to contact the eccentric cam (28) irrespective of a rotational position of the eccentric cam (28) to prevent backlash or free-play of the eccentric cam (28) with respect to the inner piston unit (32) and/or the piston assembly (16), and, preferably, the outer piston unit (30) is biased to contact the eccentric cam (28) irrespective of a rotational position of the eccentric cam (28) to prevent backlash or free-play of the eccentric cam (28) with respect to the outer piston unit (30) and/or the piston assembly (16).

4. The door actuator (10) of any one of the preceding claims, wherein the inner piston unit (32) includes a contact member (54) for contacting the eccentric cam (28), and, preferably, the outer piston unit (30) includes a contact member (36) for contacting the eccentric cam (28) separate from the contact member (54) of the inner piston unit (32).

5. The door actuator (10) of claim 4, wherein:

the contact member (54, 36) of the inner piston unit (32) and/or the outer piston unit (30) is a bolt or a roller; and/or the contact member (54) of the inner piston unit (32) and the contact member (36) of the outer piston unit (30) are arranged on opposite sides of the eccentric cam (28).

6. The door actuator (10) of any one of the preceding claims, wherein:

the outer piston unit (30) and the inner piston unit (32) contact or follow the eccentric cam (28) on opposite sides of the eccentric cam (28); and/or the outer piston unit (30) and the inner piston unit (32) contact or follow the eccentric cam (28) at different sections of the eccentric cam (28).

**Claims**

1. A door actuator (10), particularly a hydraulic door closer, for a door leaf, comprising:

a housing (12) for mounting to the door leaf;  
a shaft (14) rotatably supported in the housing (12) for actuating the door leaf, the shaft (14) including an eccentric cam (28);  
a piston assembly (16), particularly a hybrid piston assembly, including:  
an outer piston unit (30) reciprocatingly supported in the housing (12) to follow the eccentric cam (28); and an inner piston unit (32) reciprocatingly supported in the outer piston unit (30) to follow the eccentric cam (28), wherein an inner piston (52) of the inner piston unit (32) includes a first, particularly cylindrical, body section (56) and a second, particularly cylindrical, body section

7. The door actuator (10) of any one of the preceding claims, wherein the inner piston unit (32) is arranged in a rotationally fixed manner in the outer piston unit (30) so that, preferably, a longitudinal axis of a contact member (54) of the inner piston unit (32) contacting the eccentric cam (28) extends parallel to the shaft (14).

8. The door actuator (10) of any one of the preceding claims, wherein an outer piston (34) of the outer piston unit (30) includes a hole (44) for supporting the inner piston unit (32), the hole (44) having a first hole section (60) and a second hole section (62), and wherein:

a central longitudinal axis of the first hole section (60) extends displaced from, particularly parallel to, a central longitudinal axis of the second hole section (62); and/or  
the second hole section (62) longitudinally extends eccentric with respect to the first hole section (60).

9. The door actuator (10) of claim 9, wherein the first hole section (60) matches with the first body section (56), and/or the second hole section (62) matches with the second body section (58).

10. The door actuator (10) of any one of the preceding claims, wherein:

an inner piston (52) of the inner piston unit (32) includes an outer circumferential face contacting an outer piston (34) of the outer piston unit (30), the outer circumferential face including at least one flat or planar section, and/or having a shape different from a solid of revolution; and/or  
an outer piston (34) of the outer piston unit (30) includes an inner circumferential face contacting an inner piston (54) of the inner piston unit (32), the inner circumferential face including at least one flat or planar section, and/or having a shape different from a solid of revolution.

11. The door actuator (10) of any one of the preceding claims, wherein an outer piston (34) of the outer piston unit (30) includes:

a first, particularly cylindrical, end body section (38) reciprocally supporting the inner piston unit (32); and  
a second, particularly cylindrical, end body section (42) opposite of the first end body section (38) with respect to the eccentric cam (28), the second end body section (42) holding a contact member (36) for contacting the eccentric cam (28) and/or abutting against a biasing member (20), for example a spring member, for biasing

the outer piston unit (30) to contact the eccentric cam (28).

12. The door actuator (10) of any one of the preceding claims, further comprising:  
a biasing member (18), for example a spring member, supported at an end cap (24) of the housing (12) and biasing the inner piston unit (32).

13. The door actuator (10) of any one of the preceding claims, wherein the inner piston unit (32) includes:

a pressure relief valve (66); and/or  
a hydraulic oil passage (64) extending through an inner piston (52) of the inner piston unit (32); and/or  
a seal (68), particularly a sealing ring, sealing against the outer piston unit (30), the seal (68) being particularly arranged in an outer circumferential groove of an inner piston (52) of the inner piston unit (32).

14. The door actuator (10) of any one of the preceding claims, wherein:

the housing (12) includes a hydraulic oil compartment (22) formed as a blind hole sealed or closed by an end cap (24), and/or accommodating the piston assembly (16), wherein the hydraulic oil compartment (22) is separated into a first section (22A) and a second section (22B) by the piston assembly (16), the first section (22A) and the second section (22B) being fluidly connected to each other;  
the inner piston unit (32), the outer piston unit (30) and/or the piston assembly (16) includes a hydraulic oil passage (49, 64); and/or  
a first biasing member (18), for example a spring member, biasing the inner piston unit (32) is disposed in the first section (22A) and/or a second biasing member (20), for example a spring member, biasing the outer piston unit (30) is disposed in the second section (22B).

## Patentansprüche

1. Türbetätiger (10), insbesondere ein hydraulischer Türschließer, für ein Türblatt, umfassend:

ein Gehäuse (12) zur Montage an das Türblatt; eine Welle (14), die drehbar in dem Gehäuse (12) zum Betätigen des Türblatts gelagert ist, wobei die Welle (14) eine exzentrische Nockenscheibe (28) umfasst;  
eine Kolbenanordnung (16), insbesondere eine hybride Kolbenanordnung, aufweisend:

eine Außenkolbeneinheit (30), die hin- und her bewegbar in dem Gehäuse (12) gelagert ist, um der exzentrischen Nockenscheibe (28) zu folgen; und  
eine Innenkolbeneinheit (32), die hin- und her bewegbar in der Außenkolbeneinheit (30) gelagert ist, um der exzentrischen Nockenscheibe (28) zu folgen, wobei ein Innenkolben (52) der Innenkolbeneinheit (32) einen ersten insbesondere zylindrischen Körperabschnitt (56) und einen zweiten insbesondere zylindrischen Körperabschnitt (58) aufweist,

**dadurch gekennzeichnet, dass:**

sich eine Mittellängsachse des ersten Körperabschnitts (56) beabstandet von, insbesondere parallel zu einer Mittellängsachse des zweiten Körperabschnitts (58) erstreckt; und/oder sich der zweite Körperabschnitt (58) längs exzentrisch zu dem ersten Körperabschnitt (56) erstreckt.

2. Türbetätiger (10) nach Anspruch 1, wobei die Innenkolbeneinheit (32) vorgespannt, insbesondere federbelastet ist, um mit der exzentrischen Nockenscheibe (28) in Kontakt zu sein, und vorzugsweise die Außenkolbeneinheit (30) vorgespannt, insbesondere federbelastet ist, um mit der exzentrischen Nockenscheibe (28) in Kontakt zu sein.
3. Türbetätiger (10) nach Anspruch 1 oder Anspruch 2, wobei die Innenkolbeneinheit (32) vorgespannt ist, um mit der exzentrischen Nockenscheibe (28) unabhängig von einer Drehposition der exzentrischen Nockenscheibe (28) in Kontakt zu sein, um Rückschlag oder um Spiel der exzentrischen Nockenscheibe (28) im Verhältnis zu der Innenkolbeneinheit (32) und/oder der Kolbenanordnung (16) zu verhindern, und vorzugsweise die Außenkolbeneinheit (30) vorgespannt ist, um mit der exzentrischen Nockenscheibe (28) unabhängig von einer Drehposition der exzentrischen Nockenscheibe (28) in Kontakt zu sein, um Rückschlag oder Spiel der exzentrischen Nockenscheibe (28) im Verhältnis zu der Außenkolbeneinheit (30) und/oder der Kolbenanordnung (16) zu verhindern.
4. Türbetätiger (10) nach irgendeinem der vorhergehenden Ansprüche, wobei die Innenkolbeneinheit (32) ein Kontaktglied (54) zum Kontaktieren der exzentrischen Nockenscheibe (28) aufweist, und vorzugsweise die Außenkolbeneinheit (30) ein Kontaktglied (36) zum Kontaktieren der exzentrischen Nockenscheibe (28) aufweist, das von dem Kontaktglied (54) der Innenkolbeneinheit (32) separat ist.

5. Türbetätiger (10) nach Anspruch 4, wobei:  
das Kontaktglied (54, 36) der Innenkolbeneinheit (32) und/oder der Außenkolbeneinheit (30) ein Bolzen oder eine Rolle ist; und/oder das Kontaktglied (54) der Innenkolbeneinheit (32) und das Kontaktglied (36) der Außenkolbeneinheit (30) auf gegenüberliegenden Seiten der exzentrischen Nockenscheibe (28) angeordnet sind.

6. Türbetätiger (10) nach irgendeinem der vorhergehenden Ansprüche, wobei:  
die Außenkolbeneinheit (30) und die Innenkolbeneinheit (32) mit der exzentrischen Nockenscheibe (28) auf gegenüberliegenden Seiten der exzentrischen Nockenscheibe (28) in Kontakt sind oder ihr folgen; und/oder die Außenkolbeneinheit (30) und die Innenkolbeneinheit (32) mit der exzentrischen Nockenscheibe (28) an unterschiedlichen Abschnitten der exzentrischen Nockenscheibe (28) in Kontakt sind oder ihr folgen.

7. Türbetätiger (10) nach irgendeinem der vorhergehenden Ansprüche, wobei die Innenkolbeneinheit (32) rotationsfest in der Außenkolbeneinheit (30) dergestalt angeordnet ist, dass vorzugsweise eine Längsachse eines Kontaktglieds (54) der Innenkolbeneinheit (32) die exzentrische Nockenscheibe (28) kontaktierend sich parallel zu der Welle (14) erstreckt.

8. Türbetätiger (10) nach irgendeinem der vorhergehenden Ansprüche, wobei ein Außenkolben (34) der Außenkolbeneinheit (30) eine Öffnung (44) zur Lagerung der Innenkolbeneinheit (32) aufweist, wobei die Öffnung (44) einen ersten Öffnungsabschnitt (60) und einen zweiten Öffnungsabschnitt (62) aufweist, und wobei:

sich eine Mittellängsachse des ersten Öffnungsabschnitts (60) beabstandet von, insbesondere parallel zu einer Mittellängsachse des zweiten Öffnungsabschnitts (62) erstreckt; und/oder sich der zweite Öffnungsabschnitt (62) längs exzentrisch zu dem ersten Öffnungsabschnitt (60) erstreckt.

9. Türbetätiger (10) nach Anspruch 9, wobei der erste Öffnungsabschnitt (60) zu dem ersten Körperabschnitt (56) passt, und/oder der zweite Öffnungsabschnitt (62) zu dem zweiten Körperabschnitt (58) passt.

10. Türbetätiger (10) nach irgendeinem der vorhergehenden Ansprüche, wobei:

ein Innenkolben (52) der Innenkolbeneinheit (32) eine Außenumfangsfläche einen Außenkolben (34) der Außenkolbeneinheit (30) kon-

- taktierend aufweist, wobei die Außenumfangsfläche mindestens einen flachen oder planen Abschnitt aufweist, und/oder eine Form aufweist, die sich von einem Drehkörper unterscheidet; und/oder der
- 5 ein Außenkolben (34) der Außenkolbeneinheit (30) eine Innenumfangsfläche einen Innenkolben (54) der Innenkolbeneinheit (32) kontaktierend aufweist, wobei die Innenumfangsfläche mindestens einen flachen oder planen Abschnitt
- 10 aufweist, und/oder eine Form aufweist, die sich von einem Drehkörper unterscheidet.
11. Türbetätiger (10) nach irgendeinem der vorhergehenden Ansprüche, wobei ein Außenkolben (34) der Außenkolbeneinheit (30) aufweist:
- 15 einen ersten, insbesondere zylindrischen Endkörperabschnitt (38) hin- und her bewegbar die Innenkolbeneinheit (32) lagernd; und
- 20 einen zweiten, insbesondere zylindrischen Endkörperabschnitt (42) gegenüberliegend dem ersten Endkörperabschnitt (38) im Verhältnis zu der exzentrischen Nockenscheibe (28), wobei der zweite Endkörperabschnitt (42) ein Kontaktglied (36) zum Kontaktieren der exzentrischen Nockenscheibe (28) hält und/oder gegen ein Vorspannungsglied (20) anschlägt, zum Beispiel ein Federelement, zum Vorspannen der Außenkolbeneinheit (30), um mit der exzentrischen Nockenscheibe (28) in Kontakt zu sein.
- 30
12. Türbetätiger (10) nach irgendeinem der vorhergehenden Ansprüche, des Weiteren umfassend: ein Vorspannungsglied (18), zum Beispiel ein Federelement, das an einem Endstopfen (24) des Gehäuses (12) gelagert ist und die Innenkolbeneinheit (32) vorspannt.
- 35
13. Türbetätiger (10) nach irgendeinem der vorhergehenden Ansprüche, wobei die Innenkolbeneinheit (32) aufweist:
- 40 ein Druckentlastungsventil (66); und/oder einen Hydrauliköldurchgang (64), der sich durch den Innenkolben (52) der Innenkolbeneinheit (32) erstreckt; und/oder
- 45 eine Dichtung (68), insbesondere einen Dichtungsring, der gegen die Außenkolbeneinheit (30) abdichtet, wobei die Dichtung (68) insbesondere in einer Außenumfangsnut des Innenkolbens (52) der Innenkolbeneinheit (32) angeordnet ist.
- 50
14. Türbetätiger (10) nach irgendeinem der vorhergehenden Ansprüche, wobei:
- 55 das Gehäuse (12) einen Hydraulikölraum (22)

aufweist, der als Sackloch ausgebildet ist, das durch einen Endstopfen (24) abgedichtet oder verschlossen ist, und/oder die Kolbenanordnung (16) aufnimmt, wobei der Hydraulikölraum (22) in einen ersten Abschnitt (22A) und einen zweiten Abschnitt (22B) durch die Kolbenanordnung (16) unterteilt ist, wobei der erste Abschnitt (22A) und der zweite Abschnitt (22B) miteinander fluidisch verbunden sind;

die Innenkolbeneinheit (32), die Außenkolbeneinheit (30) und/oder die Kolbenanordnung (16) einen Hydrauliköldurchgang (49, 64) aufweisen/aufweist; und/oder

ein erstes Vorspannungsglied (18), zum Beispiel ein Federglied, die Innenkolbeneinheit (32) vorspannend in dem ersten Abschnitt (22A) angeordnet ist, und/oder ein zweites Vorspannungsglied (20), zum Beispiel ein Federglied, die Außenkolbeneinheit (30) vorspannend in dem zweiten Abschnitt (22B) angeordnet ist.

## Revendications

1. Actionneur de porte (10), tout particulièrement un ferme-porte hydraulique, pour un vantail de porte, comportant :

un boîtier (12) pour le montage au vantail de porte ;  
un arbre (14) supporté de façon rotative dans le boîtier (12) pour actionner le vantail de porte, l'arbre (14) comprenant une came excentrique (28) ;  
un agencement de pistons (16), tout particulièrement un agencement de pistons hybride, comprenant :

une unité de piston extérieur (30) supportée en mouvement va-et-vient dans le boîtier (12) pour suivre la came excentrique (28), et une unité de piston intérieur (31) supportée en mouvement va-et-vient dans l'unité de piston extérieur (30) pour suivre la came excentrique (28), dans lequel un piston intérieur (52) de l'unité de piston intérieur (32) comprend une première section de corps (56), tout particulièrement cylindrique, et une deuxième section de corps (58), tout particulièrement cylindrique,

### caractérisé en ce que

un axe longitudinal central de la première section de corps (56) s'étend de façon décalée, tout particulièrement parallèlement à un axe longitudinal central de la deuxième section de corps (58) ; et/ou  
la deuxième section de corps (58) s'étend de

façon longitudinale excentriquement par rapport à la première section de corps (56).

2. Actionneur de porte (10) selon la revendication 1, dans lequel l'unité de piston intérieur (32) est précontrainte, tout particulièrement chargée par ressort, pour contacter la came excentrique (28) et de façon préférée l'unité de piston extérieur (30) est précontrainte, tout particulièrement chargée par ressort, pour contacter la came excentrique (28). 5
3. Actionneur de porte (10) selon la revendication 1 ou la revendication 2, dans lequel l'unité de piston intérieur (32) est précontrainte pour contacter la came excentrique (28) indépendamment d'une position rotative de la came excentrique (28) pour éviter un contrecoup ou du jeu de la came excentrique (28) par rapport à l'unité de piston intérieur (32) et/ou de l'agencement de pistons (16), et, de préférence l'unité de piston extérieur (30) est précontrainte pour contacter la came excentrique (28) indépendamment de la position rotative de la came excentrique (28) pour éviter un contrecoup ou du jeu de la came excentrique (28) par rapport à l'unité de piston extérieur (30) et/ou de l'agencement de pistons (16). 10 15 20 25
4. Actionneur de porte (10) selon l'une quelconque des revendications précédentes, dans lequel l'unité de piston intérieur (32) comprend un membre de contact (54) pour contacter la came excentrique (28) et, de préférence, l'unité de piston extérieur (30) comprend un membre de contact (36) pour contacter la came excentrique (28) séparément du membre de contact (54) de l'unité de piston intérieur (32). 30 35
5. Actionneur de porte (10) selon la revendication 4, dans lequel :  
le membre de contact (54, 36) de l'unité de piston intérieur (32) et/ou de l'unité de piston extérieur (30) est un boulon ou un galet ; et/ou le membre de contact (54) de l'unité de piston intérieur (32) et le membre de contact (36) de l'unité de piston extérieur (30) sont agencés aux côtés opposés de la came excentrique (28). 40 45
6. Actionneur de porte (10) selon l'une quelconque des revendications précédentes, dans lequel :  
l'unité de piston extérieur (30) et l'unité de piston intérieur (32) contactent ou suivent la came excentrique (28) sur des côtés opposés de la came excentrique (28) ; et/ou  
l'unité de piston extérieur (30) et l'unité de piston intérieur (32) contactent ou suivent la came excentrique (28) à des sections différentes de la came excentrique (28). 50 55
7. Actionneur de porte (10) selon l'une quelconque des

revendications précédentes, dans lequel l'unité de piston intérieur (32) est agencée solidaire en rotation dans l'unité de piston extérieur (30) de sorte que de préférence un axe longitudinal d'un membre de contact (54) de l'unité de piston intérieur (32) touchant la came excentrique (28) s'étend parallèlement à l'arbre (14).

8. Actionneur de porte (10) selon l'une quelconque des revendications précédentes, dans lequel un piston extérieur (34) de l'unité de piston extérieur (30) comprend un trou (44) pour supporter l'unité de piston intérieur (32), le trou (44) ayant une première section de trou (60) et une deuxième section de trou (62), dans lequel :

un axe longitudinal central de la première section de trou (60) s'étend de façon décalée de, tout particulièrement parallèlement à un axe longitudinal central de la deuxième section de trou (62) ; et/ou

la deuxième section de trou (62) s'étend longitudinalement excentriquement par rapport à la première section de trou (60).

9. Actionneur de porte (10) selon la revendication 9, dans lequel la première section de trou (60) concorde avec la première section de corps (56), et/ou la deuxième section de trou (62) concorde avec la deuxième section de corps (58).

10. Actionneur de porte (10) selon l'une quelconque des revendications précédentes, dans lequel :

un piston intérieur (52) de l'unité de piston intérieur (32) comprend une face circonférentielle extérieure contactant le piston extérieur (34) de l'unité de piston extérieur (30), la face circonférentielle extérieure comprenant au moins une section plate ou plane, et/ou ayant une forme différente d'un solide de révolution ; et/ou  
un piston extérieur (34) de l'unité de piston extérieur (30) comprend une face circonférentielle intérieure contactant un piston intérieur (54) de l'unité de piston intérieur (32), la face circonférentielle intérieure comprenant au moins une section plate ou plane, et/ou ayant une forme différente d'un solide de révolution.

11. Actionneur de porte (10) selon l'une quelconque des revendications précédentes, dans lequel un piston extérieur (34) de l'unité de piston extérieur (30) comprend :

une première section de corps terminal (38), tout particulièrement cylindrique, supportant en mouvement va-et-vient l'unité de piston intérieur (32) ; et

une deuxième section de corps terminal (42), tout particulièrement cylindrique, à l'opposé de la première section de corps terminal (38) par rapport à la came excentrique (28), la deuxième section de corps terminal (42) maintenant un membre de contact (36) pour contacter la came excentrique (28) et/ou butant contre un membre de précontrainte (20), par exemple un membre de ressort, pour précontraindre l'unité de piston extérieur (30) pour contacter la came excentrique (28).

précontrainte l'unité de piston extérieur (30) est agencé dans la deuxième section (22B).

12. Actionneur de porte (10) selon l'une quelconque des revendications précédentes, comportant par ailleurs :
- un membre de précontrainte (18), par exemple un membre de ressort, supporté à un bouchon d'extrémité (24) du boîtier (12) et mettant l'unité de piston intérieur (32) sous précontrainte.
13. Actionneur de porte (10) selon l'une quelconque des revendications précédentes, dans lequel l'unité de piston intérieur (32) comprend :
- une soupape de réduction de pression (66) ; et/ou un passage à huile hydraulique (64) s'étendant à travers le piston intérieur (52) de l'unité de piston intérieur (32) ; et/ou un joint (68), tout particulièrement un anneau d'étanchéité, étanchéifiant contre l'unité de piston extérieur (30), le joint (68) étant tout particulièrement agencé dans une rainure circonferentielle extérieure d'un piston intérieur (52) de l'unité de piston intérieur (32).
14. Actionneur de porte (10) selon l'une quelconque des revendications précédentes, dans lequel :
- le boîtier (12) comprend un compartiment à huile hydraulique (22) aménagé comme un trou borgne étanchéifié ou fermé par un bouchon d'extrémité (24) et/ou recevant l'agencement de pistons (16), dans lequel le compartiment à huile hydraulique (22) est séparé en une première section (22A) et une deuxième section (22B) par l'agencement de pistons (16), la première section (22A) et la deuxième section (22B) étant en communication fluidique l'une avec l'autre ; l'unité de piston intérieur (32), l'unité de piston extérieur (30) et/ou l'agencement de pistons (16) comprennent/comprend un passage à huile hydraulique (49, 64) ; et/ou un premier membre de précontrainte (18), par exemple un membre de ressort, mettant sous précontrainte l'unité de piston intérieur (32) est agencé dans la première section (22A) et/ou un deuxième membre de précontrainte (20), par exemple un membre de ressort, mettant sous

Fig. 1

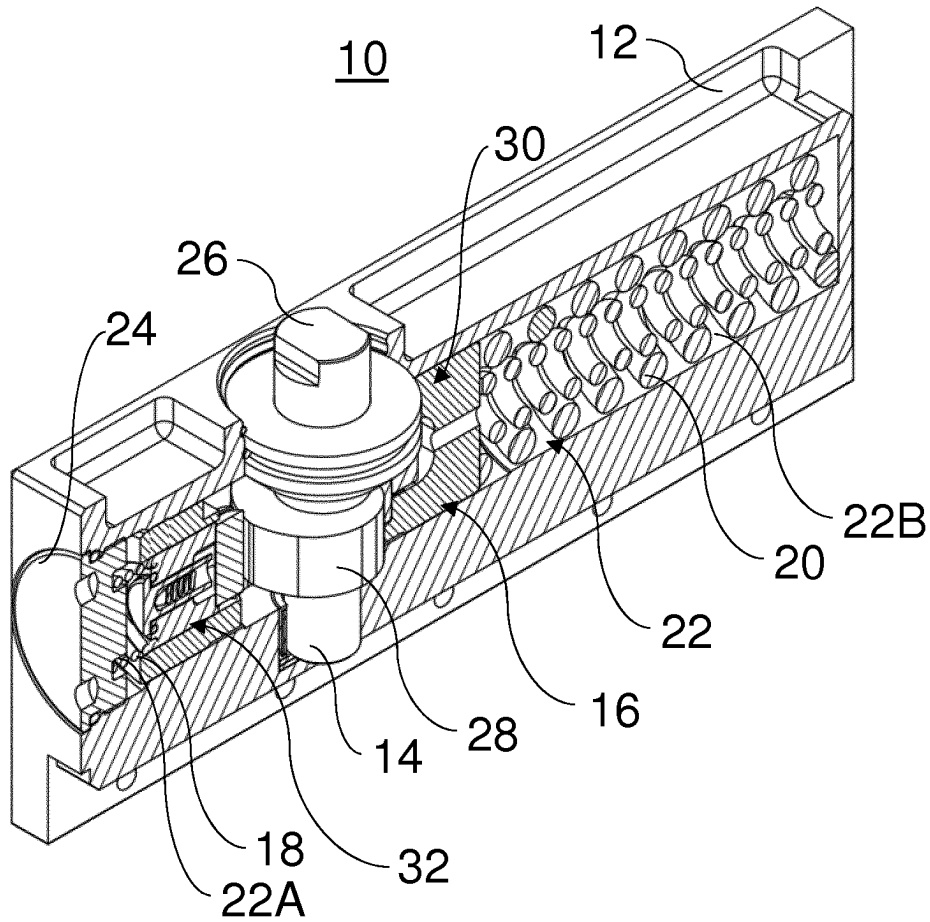


Fig. 2

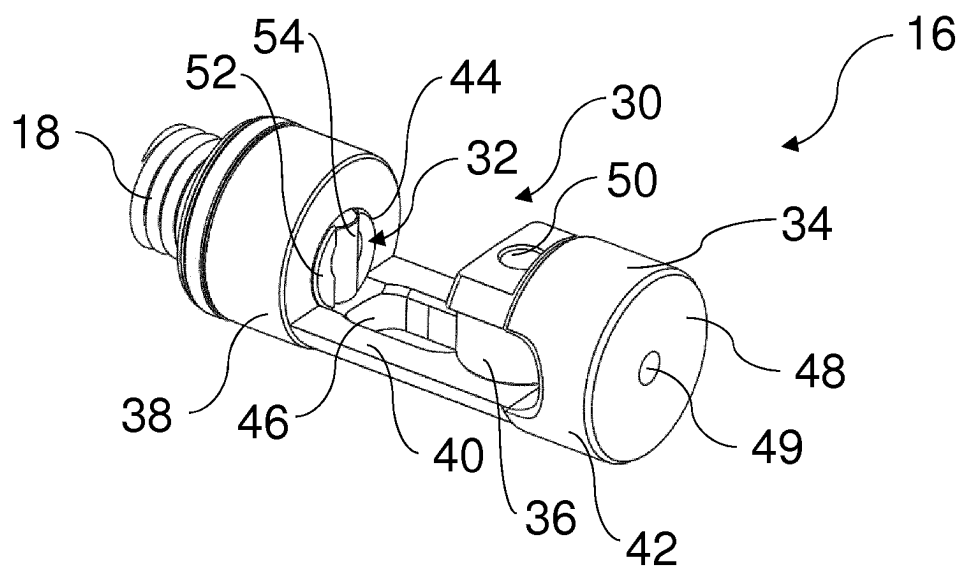


Fig. 3

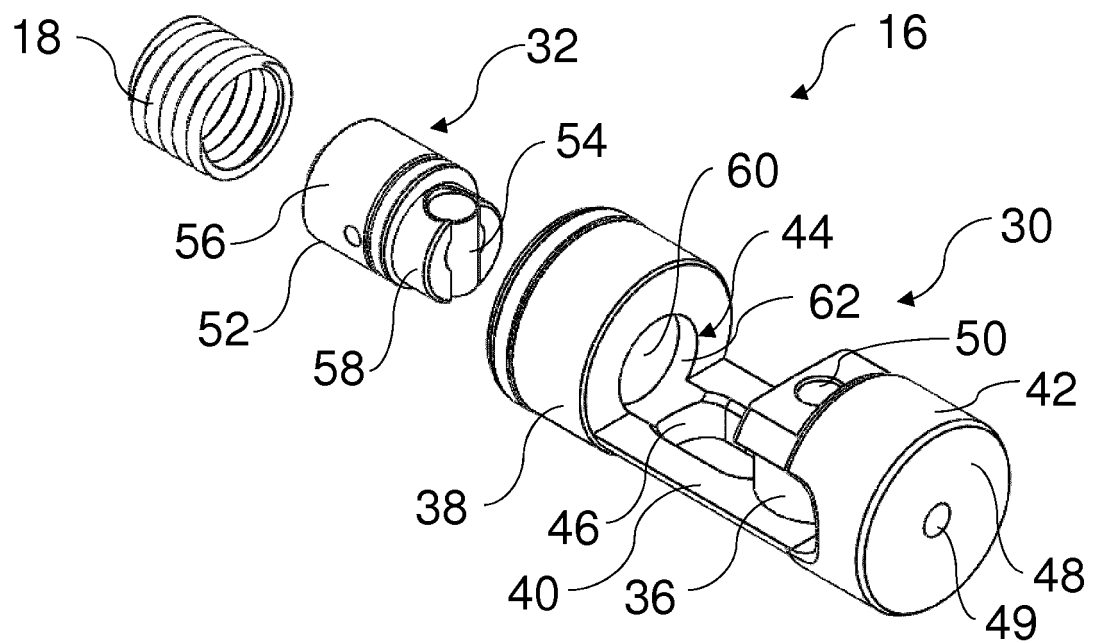


Fig. 4

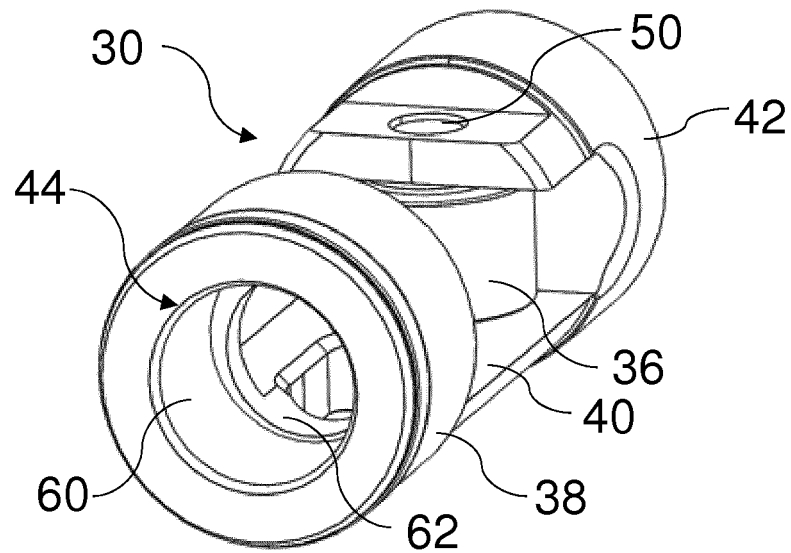


Fig. 5

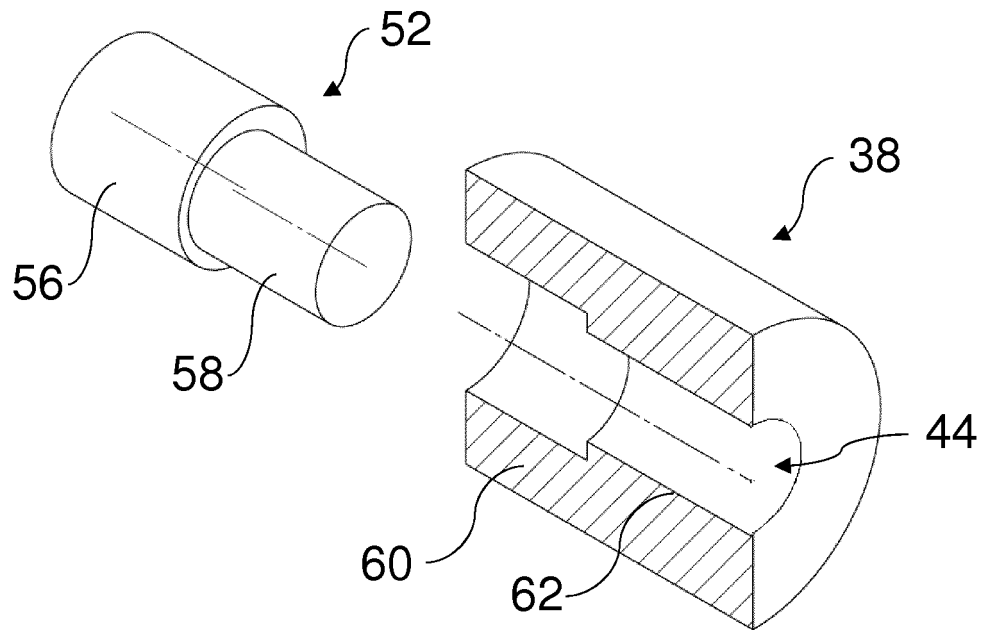


Fig. 6

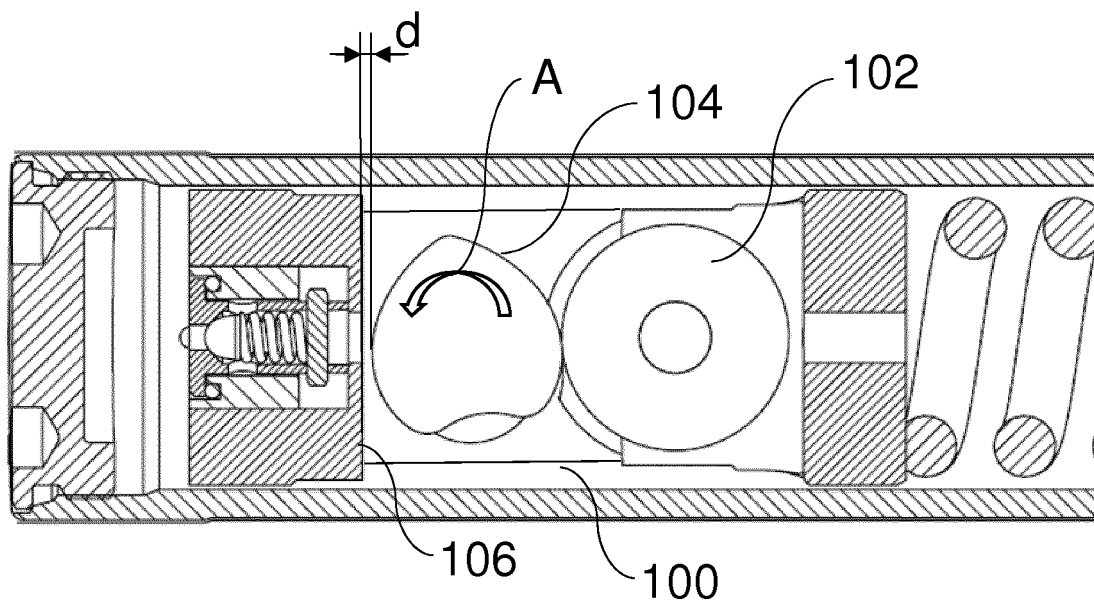
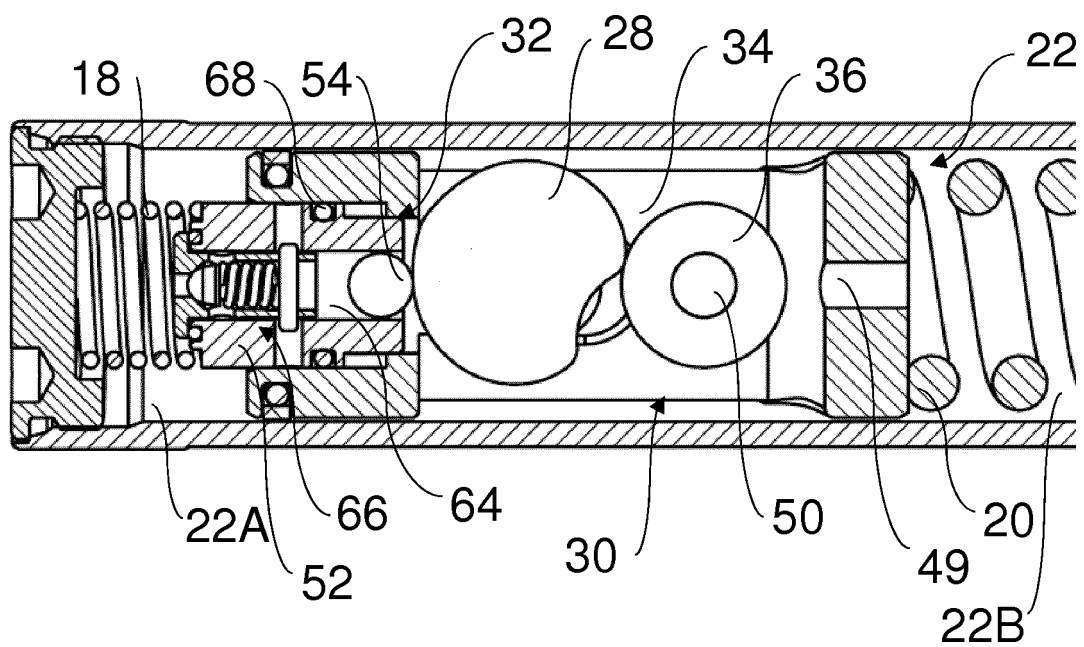


Fig. 7



**REFERENCES CITED IN THE DESCRIPTION**

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