

(19)



(11)

EP 2 543 807 B2

(12)

NEW EUROPEAN PATENT SPECIFICATION

After opposition procedure

(45) Date of publication and mention
of the opposition decision:
18.03.2020 Bulletin 2020/12

(51) Int Cl.:
E05F 15/54 ^(2015.01)

(45) Mention of the grant of the patent:
26.07.2017 Bulletin 2017/30

(21) Application number: **11425180.4**

(22) Date of filing: **06.07.2011**

(54) **Rotary actuator for moving a swivel swing door, particularly in vehicles**

Drehantrieb zum Bewegen einer Drehschwingtür, insbesondere in Fahrzeugen

Actionneur rotatif pour déplacer une porte battante pivotante, en particulier dans des véhicules

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**
Designated Extension States:
BA ME

(43) Date of publication of application:
09.01.2013 Bulletin 2013/02

(73) Proprietor: **Isaf Bus Components S.r.l.**
21020 Mornago (VA) (IT)

(72) Inventors:
• **Sessa, Massimo**
21014 Laveno Mombello, VA (IT)

• **Turcatti, Gianni**
21020 Casale Litta, VA (IT)

(74) Representative: **Leihkauf, Steffen Falk et al**
Jacobacci & Partners S.p.A.
Via Senato 8
20121 Milano (IT)

(56) References cited:
EP-A1- 0 058 323 EP-A1- 0 365 377
EP-A1- 0 578 995 DE-A1- 2 062 135
DE-A1- 3 705 369 DE-A1-102007 025 375
DE-B3-102008 034 994 DE-B3-102009 027 794
DE-B4-102006 031 477 FR-A1- 2 528 128
US-A- 3 255 806

EP 2 543 807 B2

Description

[0001] The present invention relates to a rotary actuator for moving a swivel swing door, particularly for vehicles, such as buses and trains.

[0002] The swivel swing door for a vehicle, such as a bus, is connected by means of swivel arms to a rotary column and can be displaced, by a rotational and lifting movement of the rotary column, to a closing and locking position in which locking means of the door and swing frame are engaged. The movement of the rotary column is carried out by means of a rotary actuator which comprises a linear actuator and a screw drive which turns the actuator linear movement into a rotary movement.

[0003] DE3705369 describes a known example of a rotary actuator for moving a swivel swing door in a vehicle, wherein the linear actuator comprises a fluid dynamic piston-cylinder unit and the screw drive is formed externally of the linear actuator and comprises a female screw member which accommodates a cam shaft by the interposition of a set of spheres. The connection of the piston to the female screw member is carried out by means of a stem extending from the piston within the cylinder to the female screw member outside of the cylinder.

[0004] In this known solution, the stroke of the piston, and accordingly the shortest length of the hydrodynamic cylinder-piston unit adds to the length and diameter of the screw drive which are necessary to achieve the rotation angle and torsional moment as required by the particular application. This makes the actuator axially and radially bulky and often incompatible with the narrow spaces provided in the areas of the transport means doors. US3255806A describes an actuator in accordance with the preamble of claim 1.

[0005] Furthermore, the spheres interposed between the female screw member and the cam shaft only partially work under rolling friction and cause a considerable amount of sliding friction which results in energy dissipation and wear phenomena, which, in turn, make it necessary to further increase both the drive stroke (due to a reduction in the thread pitch) and the cam shaft diameter.

[0006] The object of the present invention is thus to provide a rotary actuator for moving a swivel swing door, particularly for vehicles, such as buses, having such characteristics as to overcome the drawbacks mentioned with reference to the prior art.

[0007] Within the primary object, a particular object of the invention is to provide a rotary actuator which is more compact in terms of length and/or width.

[0008] A still further object of the invention is to provide a rotary actuator having a simplified and sturdy structure which is efficient in terms of power consumption.

[0009] This and other objects are achieved by means of a rotary actuator for moving a swivel swing door, particularly for vehicles, said rotary actuator having the features of claim 1 and defining a rotation axis and comprising:

- a fluid dynamic linear actuator with a cylinder defining an annular pressure chamber therein and an annular piston accommodated within the pressure chamber in a sliding manner parallel to the rotation axis,
- a screw drive with a stator which is fastened such as not to rotate about the rotation axis and connected to the piston such as to translate together with the piston in a parallel direction to the rotation axis, as well as a rotor shaft engaged by the stator by means of one or more revolving members and configured such as to rotate about the rotation axis in response to the translation of the stator,

wherein the rotor shaft forms an inner surface of the cylinder and directly defines the pressure chamber and the piston is in a sealing sliding contact with this inner surface.

[0010] Due to the integration of the rotor shaft in the structure of the fluid dynamic cylinder a reduction is obtained both in the axial and radial dimensions of the actuator as compared with the rotary actuators of the prior art, as well as the total elimination of at least one wall of the fluid dynamic cylinder. This results in considerable structural simplification of the actuator as well as saving of material and working time required for assembling the same.

[0011] In order to better understand the invention and appreciate the advantages thereof, several exemplary and non-limiting embodiments thereof will be described below with reference to the drawings, in which:

Fig. 1 is a perspective view of a rotary actuator mounted to the door of a transport means;

Fig. 2 is a view of a rotary actuator wherein an outer wall has been removed;

Fig. 3 is a view of a rotary actuator wherein an outer wall and a stator have been removed;

Fig. 4 shows an enlarged detail of the actuator in Fig. 3;

Fig. 5 is a cross-sectional view of a revolving body of the rotary actuator;

Fig. 6 is a cross-sectional view of a screw drive of the rotary actuator;

Fig. 7 is a longitudinal sectional view of a rotary actuator in a first operating configuration (retracted piston);

Fig. 8 is a longitudinal sectional view of the rotary actuator of Fig. 7 in a second operating configuration (forward piston);

Fig. 9 is a longitudinal sectional view of a rotary actuator according to a preferred embodiment of the invention.

[0012] With reference to the figures, a rotary actuator 1 for moving a swivel swing door 2, particularly for vehicles, is generally referenced 1.

[0013] The rotary actuator 1 defines a rotation axis 3

and comprises a fluid dynamic linear actuator 4 with a cylinder 5 defining an annular pressure chamber 6 therein and an annular piston 7 accommodated within the pressure chamber 6 in a sliding manner parallel to the rotation axis 3. The rotary actuator 1 further comprises a screw drive 8 with a stator 9 being fastened such as not to rotate about the rotation axis 3 and connected to the piston 7 such as to translate together with the piston 7 in a direction parallel to the rotation axis 3, as well as a rotor shaft 10 engaged with the stator 9 by means of one or more revolving members 11 and configured such as to rotate about the rotation axis 3 in response to the translation of the stator 9. The rotor shaft 10 provides an inner surface 12 of the cylinder 5 and directly defines the pressure chamber 6, the piston 7 being in sealing sliding contact to the inner surface 12.

[0014] As the rotor shaft 10 is incorporated within the structure of cylinder 5 a reduction in the axial and radial dimensions, as well as the complete elimination of at least one cylinder fluid dynamic wall are obtained for the actuator 1 as compared with prior art rotary actuators. This results in a considerable structural simplification and in a saving of both material and processing and assembling times.

[0015] In accordance with an embodiment, the rotor shaft 10 is co-axially integrated in the fluid dynamic actuator 4 and the inner surface 12 provides an inner circumferential surface of the annular pressure space 6.

[0016] The concentric arrangement of the rotor shaft 10 within the linear actuator 4 relative to the annular pressure chamber 6 minimizes the outer diameter of the pressure chamber, with the axial pressure surface and diameter of the rotor shaft 10 being equal, and allows defining the annular pressure chamber 6 by means of a simple outer tubular wall 13 which is radially positioned outside the rotor shaft 10.

[0017] In accordance with a further aspect of the invention, the fluid dynamic actuator 4 can be configured as a double-effect actuator wherein the pressure chamber 6 is divided by the piston 7 into a first pressure chamber 6A and a second pressure chamber 6B which are arranged on opposite sides of the piston 7. In this case, the rotor shaft 10 can directly define a part of both first 6A and second 6B pressure chambers. Advantageously, also the translatable stator 9, the revolving members 11 and a cam surface 14 (or race) engaged by them are accommodated within the annular pressure chamber 6.

[0018] Thereby, the area in which the translational motion is turned into a rotary motion is completely enclosed within the pressure chamber 6 of the fluid dynamic linear actuator 4, thereby allowing to provide one outer housing 15 only for the entire rotary actuator 1, the side and end walls thereof being capable of directly defining also the pressure chamber.

[0019] This further reduces the overall axial dimensions of the rotary actuator, simplifies and makes the structure thereof lighter and facilitates processing and assembly thereof.

[0020] In accordance with a further embodiment, the revolving members 11 comprise a pin 16 being provided at the translating stator 9 and a bush 17 pivotally supported on the pin by means of the interposition of a set of (cylindrical) rolls and having a cam-follower surface 18 which engages by rolling contact the cam surface 14 provided in the rotor shaft 10.

[0021] The arrangements of the pin 16 and cam-surface 14 on the rotor shaft 10 and on the translating stator 9 can be inverted according to the particular design requirements and design choices.

[0022] The revolving members 11 are thus formed by (cylindrical) rolling bearings, the inner support thereof (pin 16) being connected to the stator 9 and the outer ring (bush 17) thereof forming the cam-follower surface 18 in contact to the cam surface 14 of the rotor shaft 10 or vice versa.

[0023] Advantageously, the orientation of the pin 16 or, in other words, the local rolling axis of the bush 17 is substantially radial relative to the rotation axis 3 which, in turn, corresponds to the longitudinal axis of the rotor shaft 10.

[0024] Two revolving members 11 may be provided in diametrically opposite positions relative to the rotation axis 3 or three revolving members with 120° angular pitch.

[0025] The cam-follower surface 18 is advantageously convex or rounded in the direction of the rolling axis to eliminate the sliding friction due to the rolling differential between the radially outer area of the bush and the radially inner area thereof.

[0026] In accordance with one exemplary embodiment, the actuator 1 comprises an outer housing 15 formed by a tubular wall 13 and two opposite head walls 19 connected to each other and to the tubular wall 13 by means of a plurality of preferably three tie rods 20. The head walls 19 radially support the rotor shaft 10, by means of roller bearings 21, and axially, by means of one or two axial roller bearings 22 enclosed within fifth wheels against which a shoulder 23 of the rotor shaft 10 is abutted. The tie rods 20 axially extend at an angular pitch (either constant, e.g. of 120° or irregular depending on the inner space conditions of the device) through the annular pressure chamber 6 provided between the outer tubular wall 13 and the rotor shaft 10 and provide translation and anti-rotation guides for the piston 7. At least one, preferably both head walls 19 have a central hole through which at least one end 24 is extended, preferably both opposite ends 24 of the rotor shaft 10 outside the housing 15. The ends 24 of the rotor shaft 10 can be either grooved or profiled such as to allow an integral connection with a swivel arm 25 of a door 2.

[0027] At the head walls 19 or at the outer wall 13 brackets 26 can be provided for securing the rotary actuator 1 to a utility, particularly a vehicle, for example a bus or railway wagon.

[0028] The piston 7 can comprise an annular body that can be either single-piece or made of several pieces joined to each other, which forms:

- an outer circumferential surface 27, preferably with one or more seats accommodating outer annular gaskets 28, for sliding and sealing engagement with an outer surface of the cylinder formed by the tubular wall 13,
- an inner circumferential surface 29, preferably with one or more seats accommodating inner annular gaskets 30, for sliding and sealing engagement with the inner surface 12 of the cylinder formed by the rotor shaft 10,
- as well as a plurality of preferably three axial holes 31, which are possibly provided with annular gaskets 32, which accommodate the axial tie rods 20 to fasten the piston 7 such as not to be capable of rotating about the rotation axis 3.

[0029] The translatable stator 9 can comprise a tubular portion that forms the stator and can be formed either as one piece with the piston 7 or connected thereto integrally in rotation (for example by means of a key 33).

[0030] At an end region of the pressure chamber 6 being defined by the cam surface 14 of the screw drive (and, accordingly, not affected by the movement of the piston) an (annular) filling body 34 can be advantageously provided which is suitable to reduce, in this region, the volume that can be filled with pressure fluid, with the axial length of the end region (Fig. 7,8) being equal. This allows a fast emptying and a fast pressurization of the fluid volume, e.g. compressed air in that region (for example, during the return-stroke of the piston), without any requirement of sealingly isolating the region from the remaining part of the pressure chamber.

[0031] Thereby, a further structural simplification is obtained as compared with prior art solutions.

[0032] The return stroke of the piston 7 can be obtained by means of pneumatic or hydrodynamic control (pressurization of the second pressure chamber 6B in the case of a double-effect actuator (shown in the drawings) or, alternatively, by means of a return spring acting on the piston (not illustrated).

[0033] In accordance with a further aspect of the invention, the linear actuator 4 comprises a pneumatic dampening system that slows down the movement of the piston 7 when it enters an end-of-stroke region.

[0034] In an embodiment, the cylinder 5 forms a first duct 35 for feeding and draining the pressure fluid, which communicates with a first opening in the pressure chamber 6 and a second feed and drain duct 36 communicating with a second opening in the pressure chamber, wherein the second duct 36 has a throttled section (by means of an adjustment screw 37) relative to the section of the first duct 35. Furthermore, the piston 7 forms an isolating annular wall 38 which is adapted to sealingly engage an isolating annular seat 39 (which is possibly provided with a gasket) when the piston 7 enters the end-of-stroke region. The isolation annular seat 39 extends between the first opening and the second opening such that, when the piston 7 enters within the end-of-stroke region, the

engagement of the isolating wall 38 with the isolating seat 39 separates an air volume within the pressure chamber 6 from the first opening and forces it to pass only through the second opening and the second duct 36 with the throttling. Thereby, the speed of the piston 7 is damped when approaching the end-of-stroke thereof.

[0035] In accordance with an embodiment, the second duct 36 is connected to the first duct 35 at a downstream location (drain direction) of the throttling, such as to allow a feeding and a pressurization of the pressure fluid (compressed air) through the first duct 35 and first opening, thereby avoiding any undesired slowing down during the initial phases of the movement of piston 7, and accordingly of the door being operated.

[0036] As shown in Fig. 7 and 8, this concept and the structure of the pneumatic damper described herein can be similarly implemented in both pressure chambers 6A, 6B of a double-effect actuator.

[0037] In accordance with the invention (Fig. 9), at one or preferably both axial ends of the cam surface 14 there is formed a stop surface 40 against which the revolving members 11 or the stator 9 are abutted when the end of a first length 41 of the stroke of the stator 9 (or the piston 7) dedicated to rotate the rotor shaft 10 is reached. When the stator 9 moves past the end of the first length and enters a second length 42 of stroke dedicated to translate or lift the rotor shaft 10, the axial engagement between the revolving members 11 or the stator 9 and the stop surface 40 causes the rotor shaft 10 to translate axially along with the stator 9 until the total end-of-stroke is reached (represented in Fig. 9 by the abutment surface 43 for example of an upper fifth wheel 22).

[0038] When the stator 9 is in the first length 41 of stroke (length dedicated to rotation) the axial translation of the rotor shaft 10 results to be prevented by the gravity force applied for example by the door connected to the rotor shaft, by a return spring (not illustrated) biasing the rotor shaft axially in a rest position or by a counter-surface being shaped such as to allow for the axial displacement of the rotor shaft 10 only in a predetermined angular position which corresponds to the completion of the rotational movement thereof.

[0039] Thereby, the rotary actuator 1 provides both for the rotation and translation of the rotor shaft 10 in two well-distinct steps, and hence to the orientation, locking lifting and release lowering of the door to which it is mounted.

[0040] Advantageously, sensors of axial and angular positions can be mounted to the housing 15 of the rotary actuator 1 and interact with the end/s 24 of the rotor shaft 10 which project outwards from the housing 15. These sensors can comprise e.g. potentiometric, mechanic, optical ad/or inductive sensors.

[0041] The rotary actuator of the present invention has a number of advantages, particularly it has reduced axial and radial dimensions, a sturdy, though simplified and lightened structure as well as a high energy efficacy in turning the translational movement produced by the lin-

ear actuator into a rotational movement of the rotor shaft.

[0042] Obviously, to the rotary actuator according to the present invention, those skilled in the art, aiming at meeting specific and contingent requirements, will be able to carry out further modifications and variations, all being encompassed within the scope of protection defined by the annexed claims.

Claims

1. A rotary actuator (1) for moving a door (2) particularly a swivel swing door, particularly for vehicles, said rotary actuator (1) defining a rotation axis (3) and comprising:

- a fluid dynamic linear actuator (4) with a cylinder (5) internally defining an annular pressure chamber (6), an annular piston (7) accommodated within the pressure chamber (6) in a sliding manner parallel to the rotation axis (3),
- a screw drive (8) having a stator (9) fastened such as not to rotate about the rotation axis (3) and connected to the piston (7) such as to translate along with the piston (7) in the direction parallel to the rotation axis (3), and a rotor shaft (10) being engaged with the stator (9) by means of one or more revolving members (11) which engage a cam surface (14) formed in said rotor shaft (10), and the rotor shaft (10) being configured such as to rotate about the rotation axis (3) in response to the translation of the stator (9),

wherein the rotor shaft (10) forms an inner surface (12) of the cylinder (5) and directly defines the pressure chamber (6) and in that the piston (7) is in sealing sliding contact with said inner surface (12), wherein the translatable stator (9), the revolving members (11) and the cam surface (14) engaged by the revolving members (11) are arranged within the annular pressure chamber (6), wherein the linear actuator (4) is configured as a double-effect actuator and the pressure chamber (6) is divided by the piston (7) in a first pressure chamber (6A) and a second pressure chamber (6B) which are arranged on opposite sides of the piston (7),

characterized in that at both axial ends of the cam surface (14) the rotor shaft (10) forms a stop surface (40) against which the revolving members (11) are abutted when the end of a first length (41) of the stroke of the stator (9) is reached and wherein, when the stator (9) moves past the end of the first length and enters a second length (42) of the stroke thereof, an axial engagement between the revolving members (11) and the stop surface (40) causes the rotor shaft (10) to translate axially along with the stator (9) until reaching a total end-of-stroke, wherein said first length (41) of the stroke is dedicat-

ed to the rotation of the rotor shaft (10) and said second length (42) of the stroke is dedicated to the translation or lifting of the rotor shaft (10), wherein the rotary actuator (1) comprises means that prevent an axial translation of the rotor shaft (10) when the stator (9) is within the first length (41) of stroke, wherein the rotary actuator (1) comprises an outer housing (15) formed by a tubular wall (13) and two opposite head walls (19), wherein the head walls (19) support the rotor shaft (10) in a radial manner by means of roller bearings (21) and in an axial manner by means of one or two axial roller bearings (22) enclosed within fifth wheels against which a shoulder (23) of the rotor shaft (10) is abutted and wherein an abutment surface 43 of an upper fifth wheel (22) forms said total end - of - stroke, wherein each of the head walls (19) has a central hole through which the two opposite ends (24) of the rotor shaft (10) extend outwards of the housing (15).

2. The rotary actuator (1) according to claim 1, wherein the rotor shaft (10) is co-axially connected in the fluid dynamic actuator (4) and the inner surface (12) forms an inner circumferential surface of the annular pressure space (6).
3. The rotary actuator (1) according to any preceding claims, wherein the revolving members (11) comprise roller bearings with an inner support (16) connected to the stator (9) and an outer ring (17) forming a cam-follower surface (18) in contact with a cam surface (14) of the rotor shaft (10) or vice versa.
4. The rotary actuator (1) according to claim 3, wherein the cam-follower surface (18) is rounded in the direction of a rolling axis thereof.
5. The rotary actuator (1) according to any one of the preceding claims, wherein the head walls (19) are connected to each other by means of a plurality of tie rods (20) axially extending through the annular pressure chamber (6) formed between the outer tubular wall (13) and the rotor shaft (10) and forming translational and anti-rotation guides for the piston (7).
6. The rotary actuator (1) according to claim 5, wherein the piston (7) comprises an annular body forming:
 - an outer circumferential surface (27) in sliding and sealing contact with the tubular wall (13),
 - an inner circumferential surface (29) in sliding and sealing contact to the inner surface (12) of the cylinder being formed by the rotor shaft (10),
 - a plurality of axial holes (31) accommodating the axial tie rods (20),
 - a tubular portion forming the translatable stator (9).

7. The rotary actuator (1) according to any preceding claim, wherein in an end area of the pressure chamber (6) being defined by a cam surface (14) of the screw drive there is arranged a filling body (34) which reduces the volume that can be filled with the pressure fluid, with the axial length of the end area being equal. 5
8. The rotary actuator (1) according to any preceding claim, wherein the linear actuator (4) comprises a pneumatic dampening system which slows down the movement of the piston (7) when it enters an end-of-stroke area. 10
9. The rotary actuator (1) according to claim 8, wherein the cylinder (5) forms: 15
- a first duct (35) for feeding and draining the pressure fluid in communication with a first opening in the pressure chamber (6), and
 - a second feeding and drain duct (36) in communication with a second opening within the pressure chamber (6), wherein the second duct (36) has a throttled section relative to the section of the first duct (35), 20 25
- and wherein the piston (7) forms an isolation wall (38) such that, when the piston (7) enters the end-of-stroke area, it sealingly engages an isolation seat (39) extending between the first opening and the second opening such as to separate an air volume within the pressure chamber (6) from the first opening and forcing the latter to be vented only through the second opening and second duct (36). 30
10. The rotary actuator (1) according to claim 9, wherein the second duct (36) is connected to the first duct (35) at a point downstream the throttling as viewed in the draining direction. 35 40

Patentansprüche

1. Drehaktuator (1) zum Bewegen einer Tür (2), insbesondere einer schwenkbaren Schwingtür, insbesondere für Fahrzeuge, wobei der Drehaktuator (1) eine Drehachse (3) definiert und umfasst: 45
- einen fluiddynamischen Linearaktuator (4) mit einem Zylinder (5), welcher innerhalb eine ringförmige Druckkammer (6) definiert, einen ringförmigen Kolben (7), welcher innerhalb der Druckkammer (6) in einer gleitenden Weise parallel zu der Drehachse (3) aufgenommen ist,
 - einen Gewindetrieb (8), welcher einen Stator (9) aufweist, welcher derart befestigt ist, dass er sich nicht um die Drehachse (3) dreht, und derart mit dem Kolben (7) verbunden ist, dass er sich 50 55

zusammen mit dem Kolben (7) in der Richtung parallel zu der Drehachse (3) verschiebt, und eine Rotorwelle (10), welche mit dem Stator (9) mittels eines oder mehrerer sich drehender Elemente (11) in Eingriff steht, welche mit einer in der Rotorwelle (10) gebildeten Nockenfläche (14) in Eingriff treten, und wobei die Rotorwelle (10) derart dafür eingerichtet ist, dass sie sich als Reaktion auf die Verschiebung des Stators (9) um die Drehachse (3) dreht,

wobei die Rotorwelle (10) eine innere Fläche (12) des Zylinders (5) bildet und direkt die Druckkammer (6) definiert und wobei der Kolben (7) in einem dichtenden Gleitkontakt mit der inneren Fläche (12) steht,

wobei der verschiebbare Stator (9), die sich drehenden Elemente (11) und die mit den sich drehenden Elementen (11) in Eingriff stehende Nockenfläche (14) innerhalb der ringförmigen Druckkammer (6) angeordnet sind,

wobei der Linearaktuator (4) als ein Doppelwirkungsaktuator eingerichtet ist und die Druckkammer (6) von dem Kolben (7) in eine erste Druckkammer (6A) und eine zweite Druckkammer (6B) unterteilt ist, welche an entgegengesetzten Seiten des Kolbens (7) angeordnet sind,

dadurch gekennzeichnet, dass an beiden axialen Enden der Nockenfläche (14) die Rotorwelle (10) eine Anschlagfläche (40) bildet, gegen welche die sich drehenden Elemente (11) anliegen, wenn das Ende einer ersten Länge (41) des Hubs des Stators (9) erreicht ist, und wobei, wenn sich der Stator (9) über das Ende der ersten Länge hinaus bewegt und in eine zweite Länge (42) des Hubs davon gelangt, ein axialer Eingriff zwischen den sich drehenden Elementen (11) und der Anschlagfläche (40) bewirkt, dass sich die Rotorwelle (10) zusammen mit dem Stator (9) verschiebt, bis sie ein totales Hubende erreichen, 40

wobei die erste Länge (41) des Hubs der Drehung der Rotorwelle (10) gewidmet ist und die zweite Länge (42) des Hubs der Verschiebung oder dem Heben der Rotorwelle (10) gewidmet ist,

wobei der Drehaktuator (1) Mittel umfasst, welche eine axiale Verschiebung der Rotorwelle (10) verhindern, wenn sich der Stator (9) innerhalb der ersten Hublänge (41) befindet,

wobei der Drehaktuator (1) ein äußeres Gehäuse (15) umfasst, welches von einer rohrförmigen Wand (13) und zwei gegenüberliegenden Kopfwänden (19) gebildet ist, wobei die Kopfwände (19) die Rotorwelle (10) mittels Rollenlagern (21) in einer radialen Weise und mittels eines oder zweier axialer Rollenlager (22) in einer axialen Weise halten, welche innerhalb fünfter Räder eingeschlossen sind, gegen welche eine Schulter (23) der Rotorwelle (10) anliegt, und wobei eine Anlagefläche (43) eines oberen

- fünftens Rads (22) das totale Hubende bildet, wobei jede der Kopfwände (19) ein zentrales Loch aufweist, durch welches sich die zwei entgegengesetzten Enden (24) der Rotorwelle (10) aus dem Gehäuse (15) nach außen erstrecken. 5
2. Drehaktuator (1) nach Anspruch 1, wobei die Rotorwelle (10) koaxial in dem fluiddynamischen Aktuator (4) verbunden ist und die innere Fläche (12) eine innere Umfangsfläche des ringförmigen Druckraums (6) bildet. 10
3. Drehaktuator (1) nach einem der vorhergehenden Ansprüche, wobei die sich drehenden Elemente (11) Rollenlager mit einer inneren Halterung (16), welche mit dem Stator (9) verbunden ist, und einem äußeren Ring (17) umfassen, welcher eine Nockenstoßfläche (18) in Kontakt mit einer Nockenfläche (14) der Rotorwelle (10) oder vice versa bildet. 15
4. Drehaktuator (1) nach Anspruch 3, wobei die Nockenstoßfläche (18) in der Richtung einer Rollachse davon abgerundet ist. 20
5. Drehaktuator (1) nach einem der vorhergehenden Ansprüche, wobei die Kopfwände (19) mittels einer Mehrzahl von Zugstangen (20) miteinander verbunden sind, welche sich axial durch die ringförmige Druckkammer (6) erstrecken, welche zwischen der äußeren rohrförmigen Wand (13) und der Rotorwelle (10) gebildet ist, und Translations- sowie Drehsicherungen für den Kolben (7) bilden. 25
6. Drehaktuator (1) nach Anspruch 5, wobei der Kolben (7) einen ringförmigen Körper umfasst, welcher bildet: 30
- eine äußere Umfangsfläche (27) in gleitendem und dichtendem Kontakt mit der rohrförmigen Wand (13),
 - eine innere Umfangsfläche (29) in gleitendem und dichtendem Kontakt zu der inneren Fläche (12) des Zylinders, welche von der Rotorwelle (10) gebildet ist,
 - eine Mehrzahl von axialen Löchern (31), welche die axialen Zugstangen (20) aufnehmen,
 - einen rohrförmigen Abschnitt, welcher den verschiebbaren Stator (9) bildet. 35
7. Drehaktuator (1) nach einem der vorhergehenden Ansprüche, wobei in einem Endbereich der Druckkammer (6), welcher durch eine Nockenfläche (14) des Gewindetriebs definiert ist, ein Füllkörper (34) angeordnet ist, welcher das Volumen reduziert, welches mit dem Druckfluid befüllt werden kann, wobei die axiale Länge des Endbereichs gleich ist. 40
8. Drehaktuator (1) nach einem der vorhergehenden 45

Ansprüche, wobei der Linearaktuator (4) ein pneumatisches Dämpfungssystem umfasst, welches die Bewegung des Kolbens (7) verlangsamt, wenn er in einen Hubende-Bereich gelangt.

9. Drehaktuator (1) nach Anspruch 8, wobei der Zylinder (5) bildet:

- einen ersten Kanal (35) zum Zuführen und Abführen des Druckfluids in Verbindung mit einer ersten Öffnung in der Druckkammer (6), und
- einen zweiten Zufuhr- und Abfuhrkanal (36) in Verbindung mit einer zweiten Öffnung innerhalb der Druckkammer (6),

wobei der zweite Kanal (36) einen in Bezug auf den Querschnitt des ersten Kanals (35) gedrosselten Querschnitt aufweist und wobei der Kolben (7) derart eine Isolationswand (38) bildet, dass, wenn der Kolben (7) in den Hubende-Bereich gelangt, er dichtend mit einer Isolationsaufnahme (39) in Eingriff tritt, welche sich derart zwischen der ersten Öffnung und der zweiten Öffnung erstreckt, dass sie ein Luftvolumen innerhalb der Druckkammer (6) von der ersten Öffnung separiert und die Letztere zwingt, nur durch die zweite Öffnung und den zweiten Kanal (36) entlüftet zu werden.

10. Drehaktuator (1) nach Anspruch 9, wobei der zweite Kanal (36), in der Abfuhrrichtung betrachtet, an einer stromabwärts der Drosselung gelegenen Stelle mit dem ersten Kanal (35) verbunden ist. 30

Revendications 35

1. Actionneur rotatif (1) pour déplacer une porte (2), particulièrement une porte battante pivotante, particulièrement pour des véhicules, ledit actionneur rotatif (1) définissant un axe de rotation (3) et comprenant : 40

- un actionneur linéaire (4) à dynamique des fluides avec un cylindre (5) définissant de façon interne une chambre de pression annulaire (6), un piston annulaire (7) logé à l'intérieur de la chambre de pression (6) de manière coulissante parallèle à l'axe de rotation (3),
- un entraînement à vis (8) possédant un stator (9) fixé de manière à ne pas entrer en rotation autour de l'axe de rotation (3) et raccordé au piston (7) de manière à se déplacer en translation conjointement avec le piston (7) dans la direction parallèle à l'axe de rotation (3), et un arbre rotor (10) étant en prise avec le stator (9) au moyen d'un ou de plusieurs organes tournants (11) qui entrent en prise avec une surface de came (14) formée dans ledit arbre rotor (10), et 45

l'arbre rotor (10) étant configuré de manière à entrer en rotation autour de l'axe de rotation (3) en réponse à la translation du stator (9),

l'arbre rotor (10) formant une surface intérieure (12) du cylindre (5) et définissant directement la chambre de pression (6) et le piston (7) étant en contact coulissant étanche avec ladite surface intérieure (12), le stator (9) adapté pour pouvoir être déplacé en translation, les organes tournants (11) et la surface de came (14) en prise avec les organes tournants (11) étant agencés à l'intérieur de la chambre de pression annulaire (6),
l'actionneur linéaire (4) étant configuré comme actionneur à double effet et la chambre de pression (6) étant divisée par le piston (7) en une première chambre de pression (6A) et une seconde chambre de pression (6B) qui sont agencées sur des côtés opposés du piston (7), **caractérisé en ce qu'**aux deux extrémités axiales de la surface de came (14), l'arbre rotor (10) forme une surface d'arrêt (40) contre laquelle les organes tournants (11) sont en appui lorsque la fin d'une première longueur (41) de la course du stator (9) est atteinte et, lorsque le stator (9) se déplace au-delà de la fin de la première longueur et entre dans une seconde longueur (42) de la course de celui-ci, une entrée en prise axiale entre les organes tournants (11) et la surface d'arrêt (40) fait en sorte que l'arbre rotor (10) se déplace en translation axialement conjointement avec le stator (9) jusqu'à atteindre une fin de course totale, la première longueur (41) de la course étant dédiée à la rotation de l'arbre rotor (10) et la seconde longueur (42) de la course étant dédiée à la translation ou le levage de l'arbre rotor (10),
l'actionneur rotatif (1) comprenant des moyens qui empêchent une translation axiale de l'arbre rotor (10) lorsque le stator (9) est à l'intérieur de la première longueur (41) de course, l'actionneur rotatif (1) comprenant un boîtier extérieur (15) formé par une paroi tubulaire (13) et deux parois de tête (19) opposées, les parois de tête (19) supportant l'arbre rotor (10) de manière radiale à l'aide de roulements à rouleaux (21) et de manière axiale à l'aide d'un ou de deux roulements à rouleaux axiaux (22) enfermés à l'intérieur de cinq roues contre lesquelles un épaulement (23) de l'arbre rotor (10) est en appui et une surface d'appui (43) d'une cinquième roue supérieure (22) formant la fin totale de course, chacune des parois de tête (19) ayant un trou central à travers lequel les deux extrémités opposées (24) de l'arbre rotor (10) s'étendent à l'extérieur du boîtier (15).

2. Actionneur rotatif (1) selon la revendication 1, dans lequel l'arbre rotor (10) est raccordé de façon coaxiale dans l'actionneur (4) à dynamique des fluides et la surface intérieure (12) forme une surface intérieure

re circonférentielle de l'espace de pression annulaire (6).

3. Actionneur rotatif (1) selon l'une quelconque des revendications précédentes, dans lequel les organes tournants (11) comprennent des roulements à rouleaux avec un support intérieur (16) raccordé au stator (9) et une bague extérieure (17) formant une surface suiveuse de came (18) en contact avec une surface de came (14) de l'arbre rotor (10) ou vice versa.
4. Actionneur rotatif (1) selon la revendication 3, dans lequel la surface suiveuse de came (18) est arrondie dans la direction d'un axe de roulement de celle-ci.
5. Actionneur rotatif (1) selon l'une quelconque des revendications précédentes, dans lequel les parois de tête (19) sont raccordées l'une à l'autre à l'aide d'une pluralité de tirants (20) s'étendant axialement à travers la chambre de pression annulaire (6) formée entre la paroi tubulaire extérieure (13) et l'arbre rotor (10) et formant des guidages de translation et d'anti-rotation pour le piston (7).
6. Actionneur rotatif (1) selon la revendication 5, dans lequel le piston (7) comprend un corps annulaire formant
 - une surface circonférentielle extérieure (27) en contact coulissant et étanche avec la paroi tubulaire (13),
 - une surface circonférentielle intérieure (29) en contact coulissant et étanche avec la surface intérieure (12) du cylindre formée par l'arbre rotor (10),
 - une pluralité de trous axiaux (31) logeant les tirants axiaux (20),
 - une portion tubulaire formant le rotor (9) adapté pour pouvoir être déplacé en translation.
7. Actionneur rotatif (1) selon l'une quelconque des revendications précédentes, dans lequel dans une zone d'extrémité de la chambre de pression (6) définie par une surface de came (14) de l'entraînement à vis, est agencé un corps de remplissage (34) qui réduit le volume qui peut être rempli avec le fluide de pression, la longueur axiale de la zone d'extrémité étant égale.
8. Actionneur rotatif (1) selon l'une quelconque des revendications précédentes, dans lequel l'actionneur linéaire (4) comprend un système amortisseur pneumatique qui ralentit le mouvement du piston (7) lorsqu'il entre dans une zone de fin de course.
9. Actionneur rotatif (1) selon la revendication 8, dans lequel le cylindre (5) forme

- un premier conduit (35) pour distribuer et drainer le fluide de pression en communication avec une première ouverture dans la chambre de pression (6) et
- un second conduit (36) de distribution et de drainage en communication avec une seconde ouverture à l'intérieur de la chambre de pression (6), le second conduit (36) présentant une section étranglée par rapport à la section du premier conduit (35),

et dans lequel le piston (7) forme une paroi d'isolation (38) de telle sorte que, lorsque le piston (7) entre dans la zone de fin de course, il entre en prise étanche avec un siège d'isolation (39) s'étendant entre la première ouverture et la seconde ouverture de manière à séparer un volume d'air, à l'intérieur de la chambre de pression (6), de la première ouverture et forçant cette dernière à être évacuée seulement par l'intermédiaire de la seconde ouverture et du second conduit (36).

10. Actionneur rotatif (1) selon la revendication 9, dans lequel le second conduit (36) est raccordé au premier conduit (35) à un point en aval de l'étranglement, vu dans la direction de drainage.

30

35

40

45

50

55

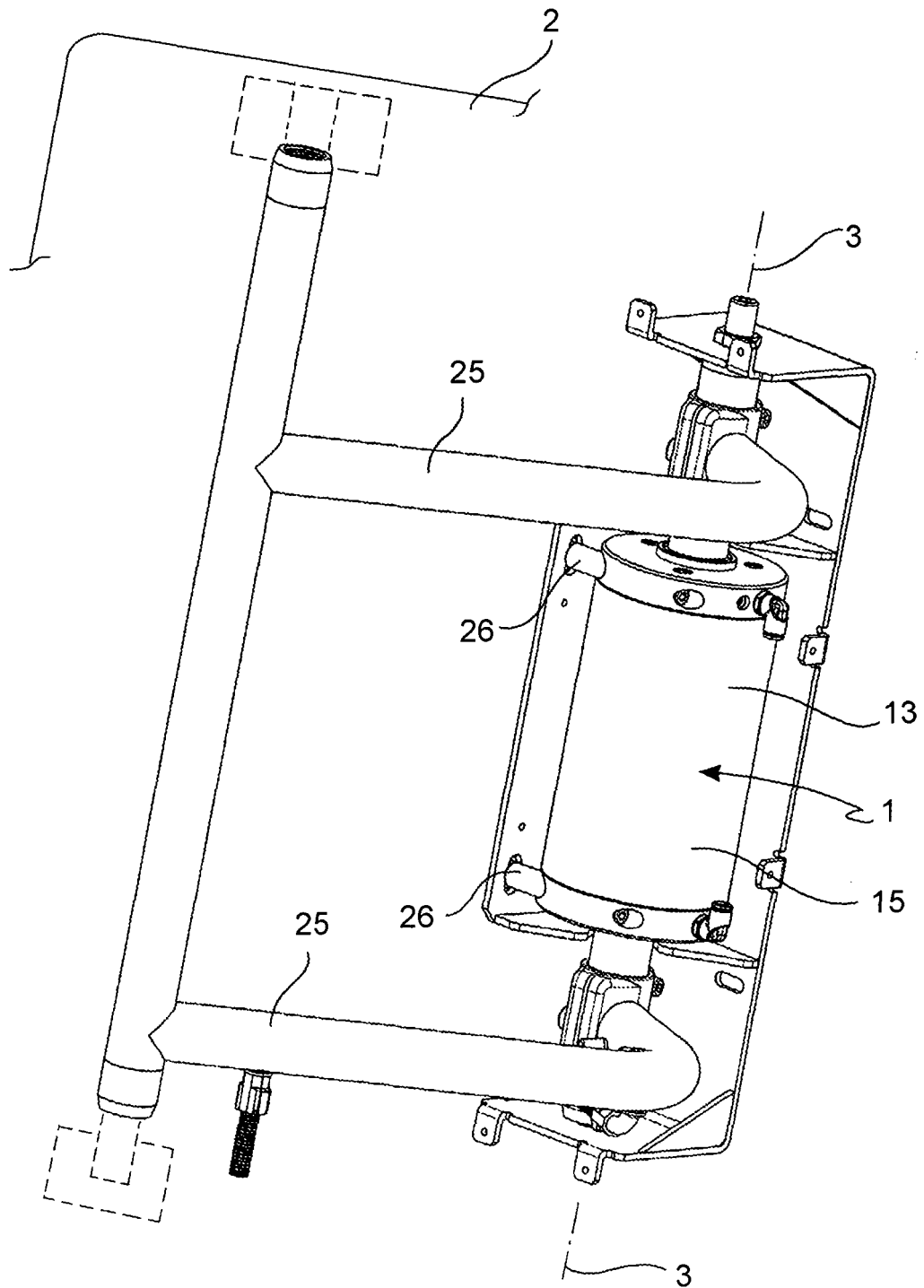


FIG. 1

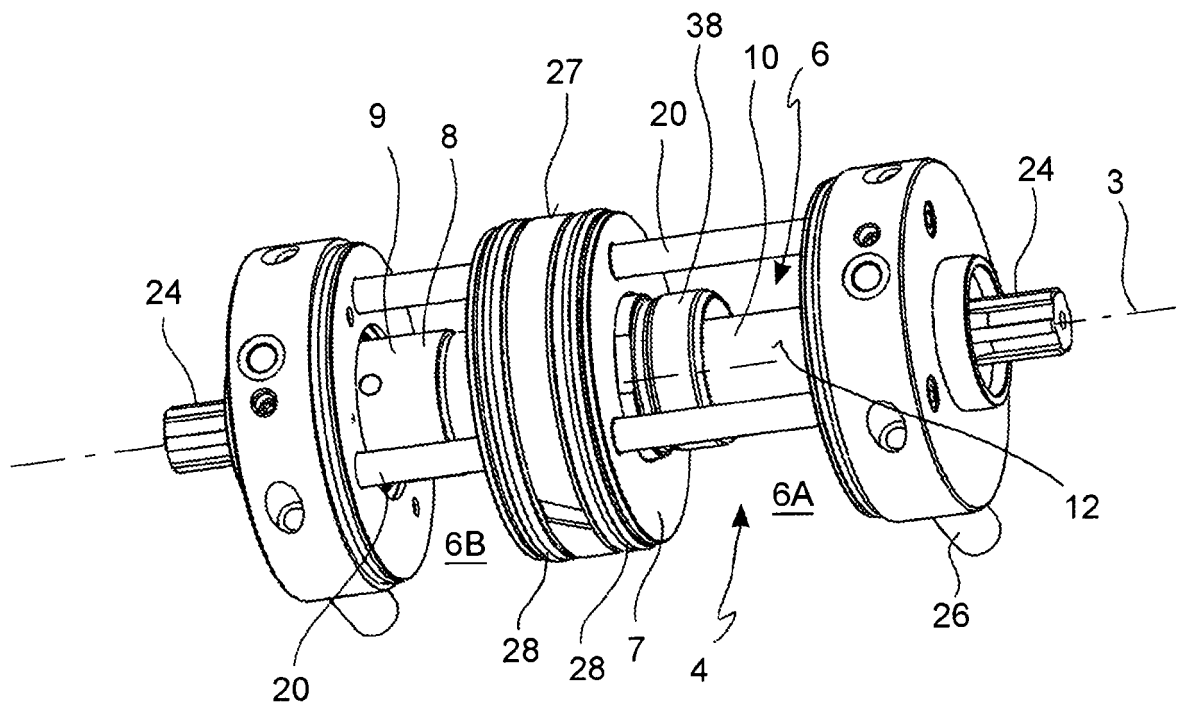


FIG. 2

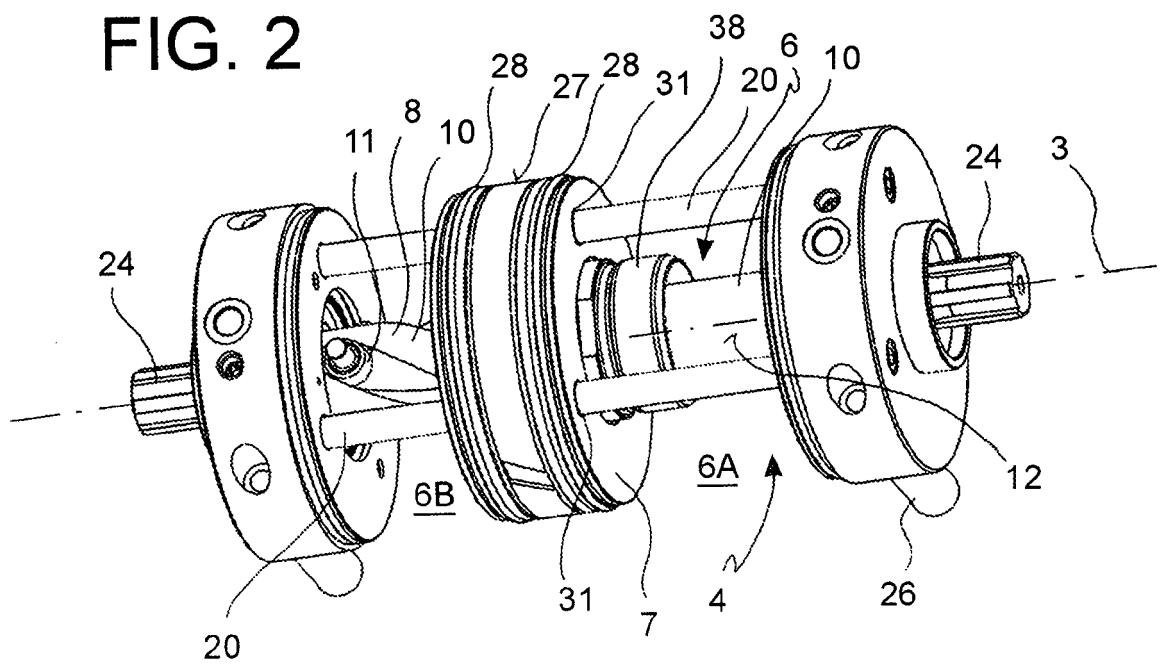


FIG. 3

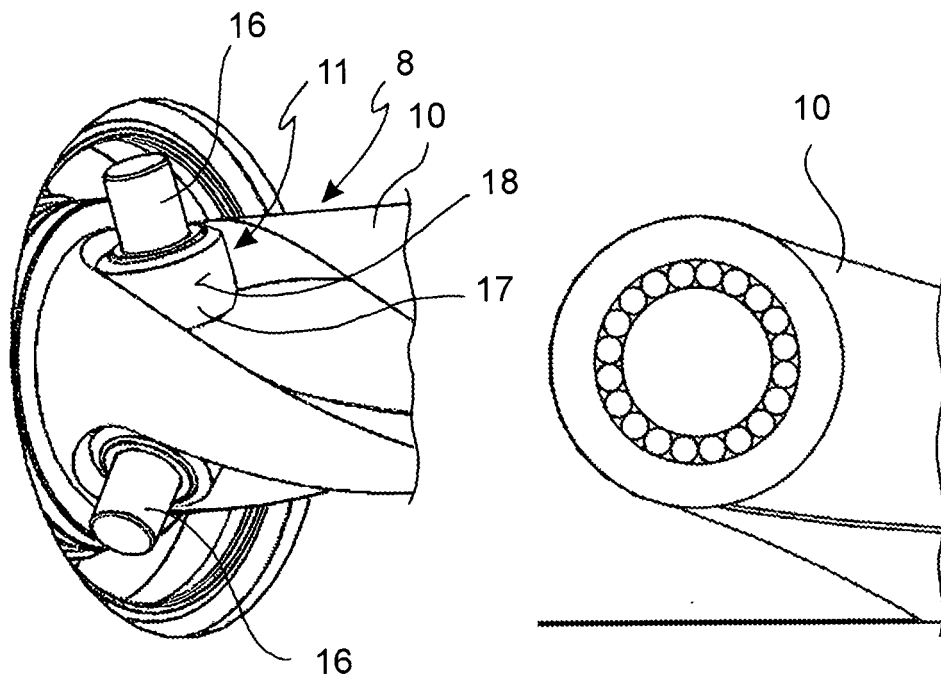


FIG. 4

FIG. 5

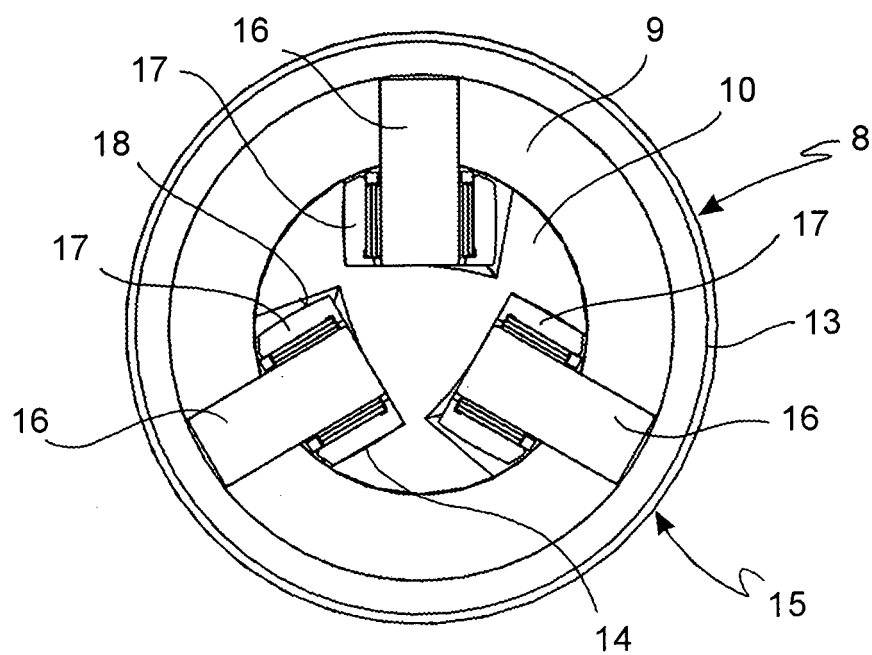


FIG. 6

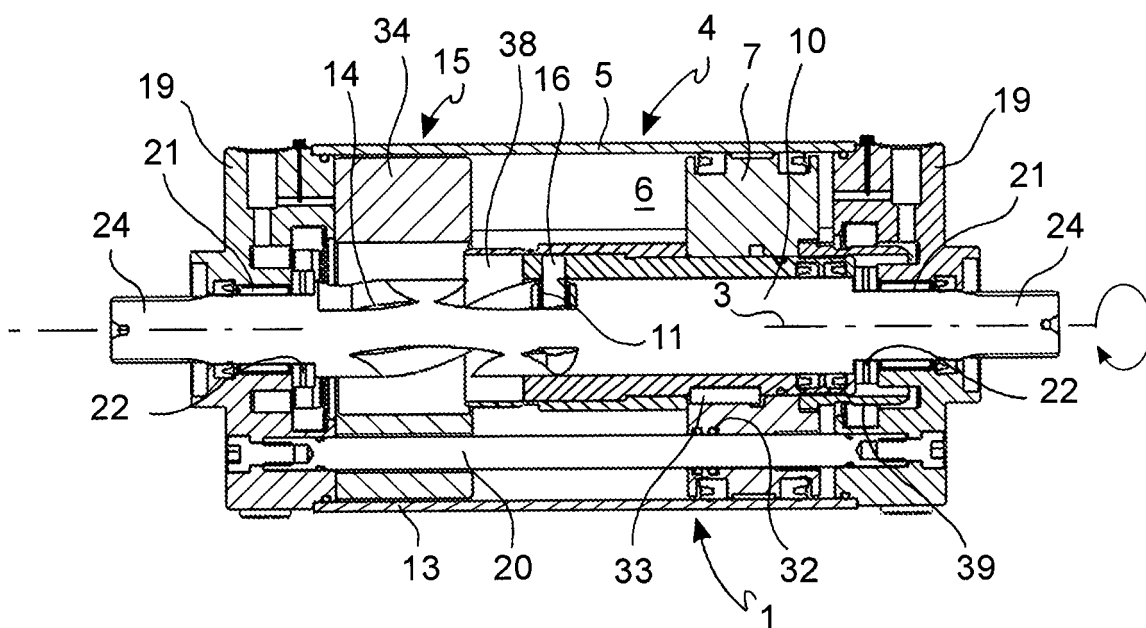


FIG. 7

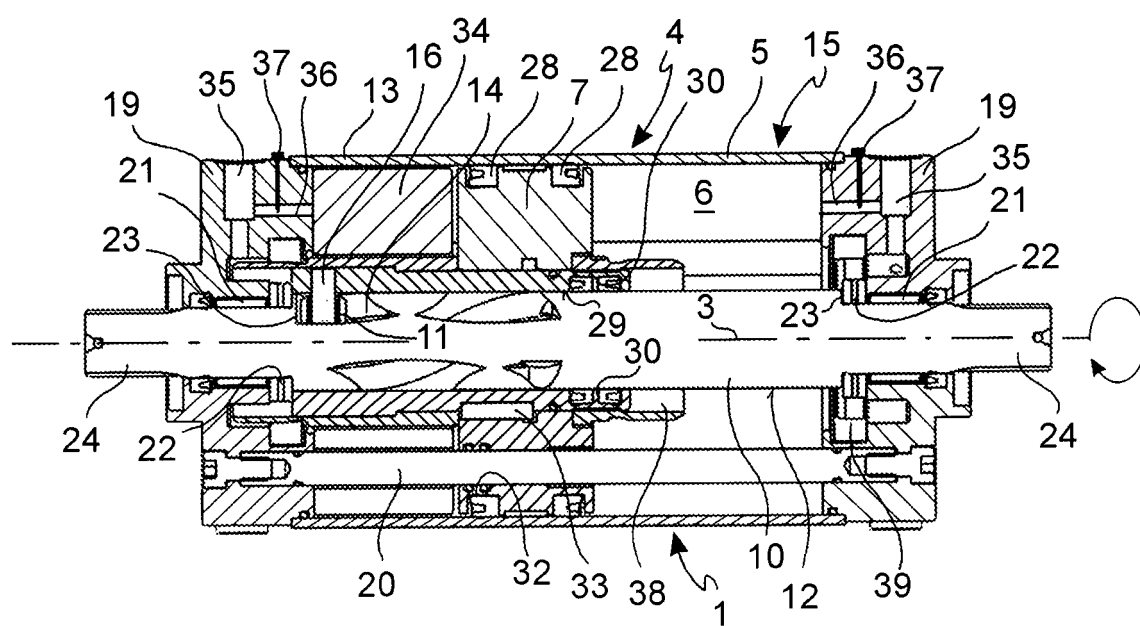


FIG. 8

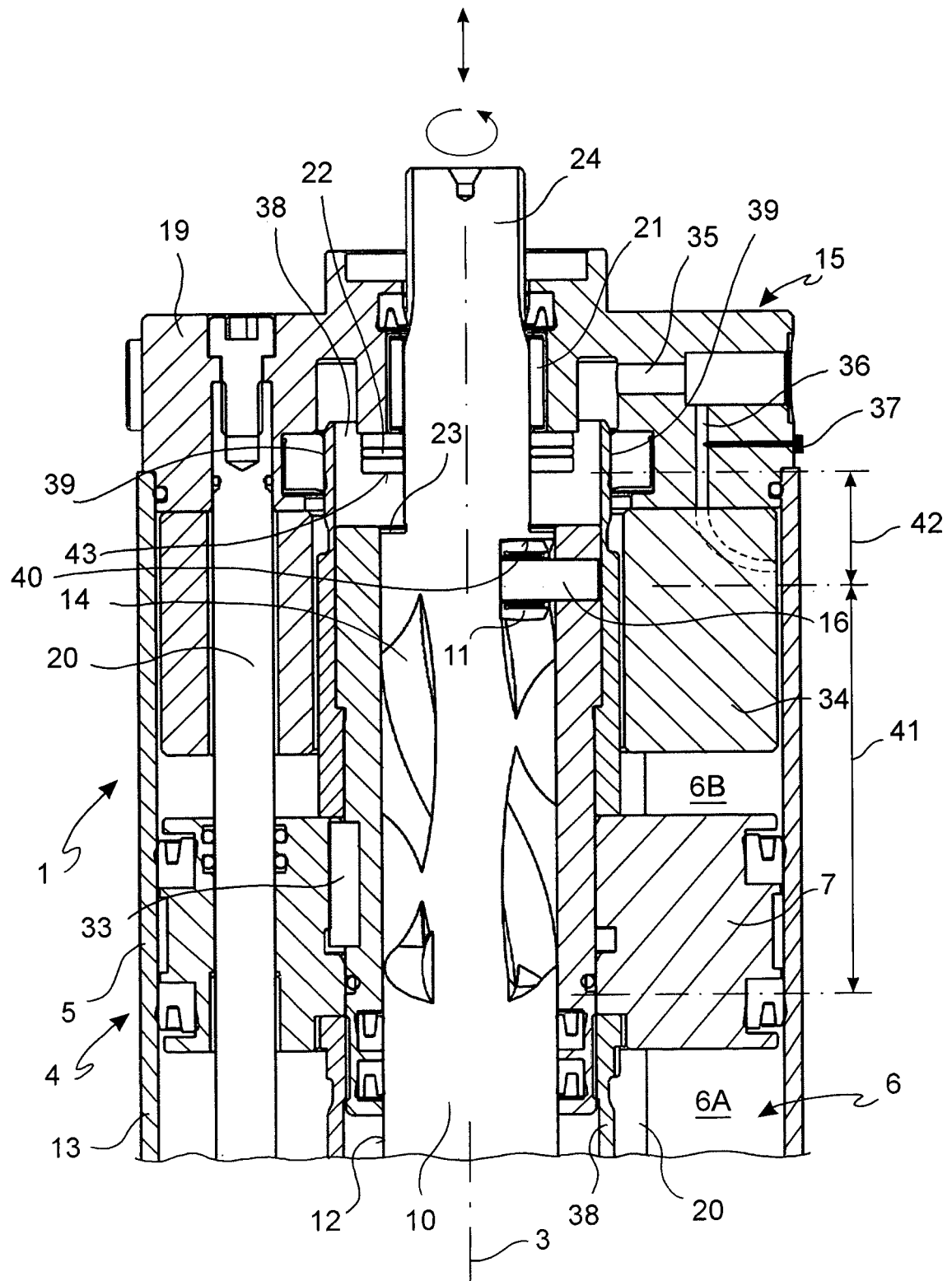


FIG. 9

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- DE 3705369 [0003]
- US 3255806 A [0004]