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(54) **AN ELECTRO-MECHANICAL BLOCKING ACTUATOR AND AN ACCESS CONTROL DEVICE**

(57) An electro-mechanical blocking actuator (1) is provided comprising a housing (2), a spindle (3) and an electric driver (4) arranged to rotate the spindle and a helical spring (9) around a rotation axis(5). A substantially cylindrical sleeve (6) is arranged between the housing and the spindle. The sleeve comprises a slit (7). The sleeve is movable between a blocking position and a non-blocking position. If the electric driver rotates the spindle

and the helical spring in a certain rotational direction, the helical spring will act on the coupling means (10) so as to drive the sleeve in a certain co-axial direction from the blocking position to the non-blocking position and vice versa. The slit comprises a first and second slit portion (71', 71"), the second slit portion making an angle α relative to the first slit portion at the transition point, where $\alpha \leq 90$ degrees.

EP 2 963 212 A1

Description

FIELD OF THE INVENTION

[0001] The invention relates to an electro-mechanical blocking actuator and an access control device provided with such a blocking actuator.

BACKGROUND OF THE INVENTION

[0002] Publication US2013/0043751 (A1) describes an electrical liner actuator which consists of a motor, a slider, a rotating shaft, a substantially helical spring and a pin, wherein the motor is a common DC micro motor and directly connected with the rotating shaft. A hole for fixing the pin is formed on the rotating shaft. The spring is sleeved on the rotating shaft and an extended portion of the pin is disposed between two adjacent winding coils of the spring. The motor is fixed inside a lock's housing the slider is arranged inside a sliding chute which is arranged inside the lock's housing and the sliding chute has the function of limiting and guiding the slider. For the slider to move to a retracted position, the motor and the rotating shaft rotate clockwise. The pin enters into a first winding of the spring from a transition portion and continues to rotate along the spiral of the spring, so that coils of the first winding on the left of the pin are driven to move to the right of the pin in turn; meanwhile, the spring is compressed and drives the slider to move to the right until the pin is disposed at a transition portion between the left of the first winding and a second winding. In this way a buffer system is created in which energy can be stored within the spring. This energy could be used to move the slider to a blocking position or non-blocking position without a re-activation of the motor.

[0003] When using a blocking actuator as described above, there is a risk of manipulation. For example, if a sudden external force is applied in a direction along the rotating shaft, part of the spiral may be compressed resulting in an unwanted displacement of the slider relative to the sliding chute, which could lead to an unlocking of an access control device.

SUMMARY OF THE INVENTION

[0004] It is an object of the invention to provide a more reliable electro-mechanical blocking actuator.

[0005] This object is achieved by the electro-mechanical blocking actuator as claimed in claim 1. More particularly, the electro-mechanical blocking actuator according to the invention comprises a housing, a spindle and an electric driver arranged to rotate the spindle around a rotation axis. A substantially cylindrical sleeve is movably arranged between the housing and the spindle, the sleeve comprising a slit. A pin is inserted through the slit of the sleeve and fixed to the housing. A helical spring is arranged which comprises a plurality of windings arranged around the spindle and having at least one of its

outer ends fixed to the spindle. Coupling means are provided for movably coupling one of the windings of the helical spring to the sleeve. The sleeve is movable between a blocking position and a non-blocking position.

[0006] If the electric driver rotates the spindle and the helical spring in a first rotational direction, the helical spring will act on the coupling means so as to drive the sleeve in a first co-axial direction from the blocking position to the non-blocking position.

[0007] If the electric driver rotates the spindle and the helical spring in a second rotational direction, opposite to the first rotational direction, the helical spring will act on the coupling means so as to drive the sleeve in a second co-axial direction from the non-blocking position to the blocking position, the second direction being opposite to the first direction.

[0008] The slit comprises at least a first and second slit portion, the second slit portion directly following the first slit portion at a transition point on the sleeve, and making an angle α relative to the first slit portion at the transition point, where $\alpha \leq 90$ degrees. During movement of the sleeve in the first or second co-axial direction, the sleeve will also turn to some degree around the rotation axis in rotational directions determined by the orientation of the slit portions relative to the housing.

[0009] The provided blocking actuator is more robust to forceful manipulation as compared to known blocking actuators. An example of such a manipulation is knocking with a hammer on an access control device which comprises the blocking actuator, in a direction parallel to the rotation axis, which is the movement direction of the sleeve. Due to the presence of the angle α between the first and second slit portions, the pin will stop the sleeve. Since the force applied is only a temporary impulse, the helical spring will move the sleeve back to its blocked position, without the blocking actuator ever being in a non-blocking position.

[0010] In an embodiment, the slit in the sleeve has a substantially V-shaped form. In this embodiment, the slit only has two slit portions, but the slit may have more than two slit portions.

[0011] In an embodiment, the angle α lies in a range of 80-90 degrees. More preferably the angle α is in a range of 85-87 degrees.

[0012] In an embodiment the helical spring comprises two co-axial parts dividing the helical spring into a first helical part, a second helical part, and an intermediate helical part lying between the two co-axial parts.

[0013] In a further embodiment the sleeve comprises a further slit arranged on the opposite side of the slit, the further slit being line symmetrical relative to the slit with respect to the rotation axis. In this way, the pin can be inserted through both slits and be fixed at the housing on both sides of the sleeve which will result in a more stable pin construction.

[0014] In an embodiment the electro-mechanical blocking actuator further comprises a movable blocking element coupled to the sleeve for blocking a locking

means of an access control device. The blocking element may be rotatably coupled to the sleeve. In this way, forces on the blocking element created by the locking means, will cause the blocking element to rotate relative to the sleeve, thereby avoiding stress on and/or possible damage to the sleeve.

[0015] The invention also relates to an access control device including a first part and a second part, wherein at least one of the parts is movably arranged with respect to the other part, the device comprising an electro-mechanical blocking actuator as described above, wherein the first part and the second part are connectable, particularly securable, to each other and/or disconnectable, particularly releasable, from each other by means of the blocking actuator.

[0016] More particularly, the invention also relates to an access control device including a stationary part and a movable part, and provided with the electro-mechanical blocking actuator according to the invention. More particularly, the device according to the invention is characterized in that the movable part and the stationary part are securable to each other and/or releasable from each by means of the blocking actuator. Examples of an access control device are e.g. an electronically controlled key safe, a security escutcheon, a door lock, an industrial locking unit, a door handle and a cylinder lock. Such devices often have limited power sources. The blocking actuator has an indirect functionality within a mechanical construction of the access control device in order to save energy.

[0017] Generally, such devices are manually operated by an authorized person who wishes access. The manual action may include e.g. rotating a handle, turning a knob or moving a sliding cover. The access control device according to the invention has advantages similar to the advantages of the blocking actuator according to the invention.

[0018] With reference to the attached claims it is noted that all possible combinations of features mentioned in the claims are part of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] A detailed description of the invention is provided below. The description is provided by way of non-limiting examples to be read with reference to the drawings in which:

Figure 1 is an exploded view of an electro-mechanical blocking actuator according to an embodiment of the invention;

Figure 2 shows a perspective view of an embodiment of the helical spring;

Figure 3 shows a perspective view of the blocking actuator in cooperation with a locking mechanism with the housing removed;

Figure 4 is a cross section of the blocking actuator in cooperation with a locking mechanism according

to the embodiment of Figure 1 and 3;

Figure 5 shows a perspective view of the blocking actuator in cooperation with the locking mechanism in a situation wherein the blocking actuator is driven to unlock;

Figure 6 shows a cross section of the blocking actuator wherein the helical spring is partly pushed in;

Figure 7 shows a perspective view of the blocking actuator in cooperation with the locking mechanism in a situation wherein the blocking actuator is in an unlocked state;

Figure 8 shows a cross section of the blocking actuator of the situation of Figure 7, wherein the helical spring is not pushed in;

Figure 9 shows a perspective view of the blocking actuator in cooperation with the locking mechanism in a situation wherein the sleeve of the blocking actuator is driven to its locked position;

Figure 10 shows a cross section of the blocking actuator of the situation of Figure 9;

Figure 11 shows a perspective view of a sleeve according to an embodiment;

Figure 12 shows a projection of the slit onto the plane;

Figure 13A, 13B and 13C show examples of slits which comprise two or more slit portions;

Figure 14 shows the embodiment of Figure 1-10, wherein the T-shaped pin is blocked by the blocking pin;

Figure 15 shows a part of a cross section of a key safe according to an embodiment, provided with the electro-mechanical blocking actuator in a blocking position, and

Figure 16 shows a part of a cross section of a key safe according to an embodiment, provided with the electro-mechanical blocking actuator in a non-blocking position.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0020] It is expressly noted that the disclosed embodiments are schematically depicted. The embodiments only represent examples. The same reference numerals have been used in the several embodiments for the same or corresponding elements and parts, however not all the elements and parts have been indicated in the several embodiments.

[0021] Figure 1 is an exploded view of an electro-mechanical blocking actuator 1 according to an embodiment of the invention. The blocking actuator 1 comprises a housing 2, a spindle 3 and an electric driver 4 arranged to rotate the spindle 3 around a rotation axis 5. The blocking actuator 1 further comprises a substantially cylindrical sleeve 6 movably arranged between the housing 2 and the spindle 3. The sleeve 6 comprises a slit 7. A pin 8 is inserted through the slit 7 of the sleeve 6 and fixed to the housing 2. A helical spring 9 comprising a plurality of windings is arranged around the spindle 3 and has its

outer ends, or at least one of the outer ends, fixed to the spindle 3. The blocking actuator 1 comprises coupling means 10 for movably coupling one of the windings of the helical spring 9 to the sleeve 6. In this embodiment, the coupling means comprise a helical spring 101 and a hook 102. The helical spring 101 of the coupling means 10 can be arranged around the sleeve 6 at a collar 61. Figure 1 also shows a blocking pin 11 which can be coupled to the sleeve 6 in a preferably rotatable manner.

[0022] Figure 2 shows a perspective view of an embodiment of the helical spring 9. The helical spring 9 comprises two co-axial parts 91, 92 dividing the helical spring 9 into a first helical part 93, a second helical part 94, and an intermediate helical part 95 lying between the two co-axial parts 91, 92.

[0023] During assembling the helical spring 101 of the coupling means 10 is arranged around the sleeve 6 at the collar 61. Next, the sleeve 6 is placed around the spindle 3 and the helical spring 9. The hook 102 of the coupling means 10 is hooked onto one of the windings of the intermediate helical part 95.

[0024] When the spindle 3 and thus the helical spring 9 are rotated by the electric driver 4, the hook will slide along the windings of the intermediate helical part 95. Once the hook 102 reaches one of the two co-axial parts 91, 92 the movement of the helical spring 9 and thus the spindle 3 is stopped.

[0025] Due to the two co-axial parts 91, 92 the hook is limited in its movement, and will not drift after some time as would be the case in the absence of the co-axial parts 91, 92.

[0026] For a proper operation of the blocking actuator no (electronic) start and end position detection is required. The electric driver 4 is controlled by a fixed time period (e.g. 50ms). This time period may be chosen in a way that the sleeve 6 can make the stroke from the blocked to the unblocked position and vice versa. The end positions of the sleeve 6 will be determined by the slit 7 and the pin 8. Provided of course, that the electric driver 4 is activated sufficiently long. When the electric driver 4 is activated for an insufficient period of time, e.g. 10ms, the sleeve 6 is not yet moved sufficiently. The time required to move the sleeve 6 is not always exactly the same. For example, a buffered stroke may take more time than a non-buffered stroke. Because prior to driving it is not known to the electric driver 4 whether there is a buffered or non-buffered movement to be made, a spacious activation period will be chosen. As a consequence, the motor 4 is almost always activated for a longer period than required to make a full stroke.

[0027] It is noted that an additional start and end position detection may be present, which would result a further reduction in energy consumption. For this purpose a small magnet may be placed in the sleeve 6 in conjunction with sensors in the housing.

[0028] The sleeve 6 is movable between a blocking position and a non-blocking position. Figure 3 shows a perspective view of the blocking actuator 1 in cooperation

with a locking mechanism 30 with the housing 2 removed. The locking mechanism 30 may be part of an access control device as will be explained below in more detail. The locking mechanism 30 comprises a T-shaped pin 31, a spring 32 and a blocking ball 33. Figure 3 shows the sleeve 6 of the blocking actuator 1 in the blocking position in which the blocking pin 11 prevents movement of the T-shaped pin 31 caused by an external force on the locking mechanism.

[0029] Figure 4 is a cross section of the blocking actuator 1 in cooperation with a locking mechanism 30 according to the embodiment of Figure 1 and 3. As can be seen in Figure 4, the hook 102 of the coupling means 10 is hooking into one of the windings of the helical spring 9, more particularly of one of the windings of the intermediate helical part 95.

[0030] If the electric driver 4 rotates the spindle 3 and the helical spring 9 in a first rotational direction, the helical spring 9 will act on the coupling means 10 so as to drive the sleeve 6 in a first co-axial direction from the blocking position to the non-blocking position. If the electric driver rotates the spindle and the helical spring in a second rotational direction, opposite to the first rotational direction, the helical spring will act on the coupling means so as to drive the sleeve in a second co-axial direction from the non-blocking position to the blocking position, the second direction being opposite to the first direction. The helical spring 9 thus acts as a flexible thread between the spindle 9 and the sleeve 6.

[0031] Figure 5 shows a perspective view of the blocking actuator 1 in cooperation with the locking mechanism 30 in a situation wherein the blocking actuator 1 is driven to unlock, but the blocking pin 11 is held by the blocking mechanism 30. Due to the rotation of the spindle 3 and thus the helical spring 9, a part of the helical spring will be pushed in.

[0032] Figure 6 shows a cross section of the blocking actuator 1 wherein the helical spring 9 is partly pushed in. In this case the second helical part 94 and the intermediate helical part 95 are pressed in. The locking mechanism 30 that is holding the blocking pin 11 results in a fixed position of the hook 102. Driving the spindle 3 with the helical spring 9 towards the non-blocking position than causes the first helical part 93 to be stretched out and the other helical parts to be compressed. The result is a buffered situation, in which the blocking actuator 1 will automatically switch to its non-blocking state, as soon as the force on the blocking pin 11 is released.

[0033] Figure 7 shows a perspective view of the blocking actuator 1 in cooperation with the locking mechanism 30 in a situation wherein the blocking actuator 1 is in an unlocked state with the helical spring 9 in its released (i.e. not buffered) state. The blocking pin 11 is not blocking the locking mechanism 30.

[0034] Figure 8 shows a cross section of the blocking actuator 1 of the situation of Figure 7, wherein the helical spring 9 is not pushed in.

[0035] Figure 9 shows a perspective view of the block-

ing actuator 1 in cooperation with the locking mechanism 30 in a situation wherein the sleeve 6 of the blocking actuator 1 is driven to its blocking position but it is blocked by the locking mechanism 30. Due to activation of electric driver 4 spindle 3 and thus the helical spring 9 are rotated until helical spring 9 is pressed in as shown in Figure 10, which shows a cross section of the blocking actuator 1 in the situation of Figure 9. As can be seen from Figure 10, both the first helical part 93 and the intermediate helical part 95 are pressed in. The result is a buffered situation, in which the blocking actuator will automatically switch to its blocking position as soon as the blocking pin 11 is no longer obstructed by the locking mechanism 30.

[0036] Figure 11 shows a perspective view of a sleeve 70 according to an embodiment. The sleeve 70 comprises two V-shaped slits 71, 72 which are symmetrical around the rotation axis 5. In Figure 11 a tangent plane 80 is shown which is a flat plane touching the sleeve 70 at a point where the slit 71 changes direction.

[0037] Figure 12 shows a projection 81 of the slit 71 onto the tangent plane 80. As can be derived from the projection 81, the slit 71 comprises two slit portions 71' and 71". These two slit portions 71' and 71" make an angle α which is smaller than or equal to 90 degrees. In a specific embodiment, the angle α is in the range of 80-90 degrees and is preferably between 85-87 degrees, such as 85 degrees.

[0038] The first and second slit portions 71', 71" do not necessarily have to be straight lines, they may be curved. Figure 13A shows such an example. Furthermore, the slits 71, 72 may comprise more than two slit portions, wherein a third slit portion makes a further angle β relative to the second slit portion. Figure 13B and 13C show examples of such embodiments. The angle β may be smaller than or equal to 90 degrees. Adding more slit portions can reduce the free travel of the sleeve when an impulse force is applied to the access control device.

[0039] It is noted that the sleeve may comprise only one slit 71, wherein the pin 8 will only extend from the housing through the slit 71, but will not extend through the sleeve 6.

[0040] Due to the specific form of the slit 7, the pin 8 will force the sleeve 6 to turn when it is moved in the first or second co-axial direction by the helical spring 9. The sleeve 6 will turn around the rotation axis in rotational directions determined by the orientation of the slit portions 71', 71" relative to the housing 2.

[0041] In the following the embodiment with the V-shaped slit 7 is used to describe how the embodiments described provide an actuator that is less vulnerable for manipulation. Figure 14 shows the embodiment of Figure 1-10, wherein the T-shaped pin 31 is blocked by the blocking pin 11. So, in Figure 14, a blocking position of the sleeve 6 (and thus of the blocking actuator) is shown. Figure 14 shows an arrow which indicates an impulse which may be created by a forceful attempt to manipulate the blocking actuator 1. An example of such a manipulation attempt is knocking with a hammer on an access

control device which comprises the blocking actuator 1 in a direction parallel to the rotation axis, which is the movement direction of the sleeve 6; see the arrow F in Figure 14. In the event that an impulse is applied to the blocking actuator 1 to move the sleeve 6 to a non-blocking position, the sleeve 6 will at most move to a position shown in Figure 14. The impulse will be transferred to the movable sleeve 6, which will move in the direction towards the electric driver 4. Due to the presence of the angle α the sleeve 7 will be stopped by the pin at a transition point between the two slit portions 71' and 71" where the slit 7 makes an angle α which is less or equal than 90 degrees. Since the force applied is only a temporary impulse, the helical spring 9 will move the sleeve 6 back to its blocked position, without the blocking actuator 1 ever being in a non-blocking position.

[0042] According to an embodiment, an access control device is provided comprising a first part and a second part, wherein at least one of the parts is movably arranged with respect to the other part. The access control device may be e.g. a key safe or a security escutcheon. Figure 15 shows part of a cross section of a key safe having a first part 201, being a slidable movable cover, and a second part, being an inner frame 202 of the key safe. So the cover 201 and the inner frame 202 are movably arranged with respect to each other. The device is provided with the electro-mechanical blocking actuator as described above. The first part and the second part are securable to each other and/or releasable from each other by means of the blocking actuator 1. As can be seen from Figure 15, the blocking actuator 1 is driven so that the blocking pin 11 is blocking the T-shaped pin 31. The T-shaped pin 31, due to the forces of the spring 32, pushes the blocking ball 33 into a cavity 203 of the cover 201. If someone tries to open the cover 201, the cover 201 will be forced into the direction indicated by an arrow 205. But due to the blocking ball 33, the cover cannot be slid, so the key safe stays closed. Once the blocking actuator 1 is in the non-blocking position, see Figure 16, the cover 201 can be slid and will then force the blocking ball 33 to move, which is possible in the situation of Figure 16.

[0043] So in summary, Figure 15 and 16 show a device wherein the first part is a stationary part and the second part is a movable part, and wherein the movable part and the stationary part are securable to each other and/or releasable from each other by means of the blocking actuator.

[0044] The electro-mechanical blocking actuator according to the invention may also be called the mechatronic blocking actuator or blocking actuator according to the invention. The blocking actuator and parts thereof can be made of any suitable material, such as metals, like stainless steel, aluminium alloys, copper alloys, or plastics, or composites of plastics.

[0045] It will be clear to a person skilled in the art that the scope of the present invention is not limited to the examples discussed in the foregoing. Several amendments and modifications of the discussed examples are

possible without deviating from the scope of the present invention as defined in the claims. While the present invention has been illustrated and described in detail in the figures and the description, such illustrations and descriptions are to be considered illustrative or exemplary only, and not restrictive. The present invention is not limited to the disclosed embodiments. Any variation to and combination of the described and/or depicted embodiments which can be understood and effected by a person skilled in the art of practicing the claimed invention, from a study of the figures, the description and the attached claims, is part of the invention. In the claims, the word "comprise" and conjugations thereof do not exclude other steps or elements, and the indefinite article "a" or "an" does not exclude a plurality. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage. Any reference signs in the claims should not be construed as limiting the scope of the present invention.

Claims

1. An electro-mechanical blocking actuator (1) comprising:

- a housing (2);
- a spindle (3);
- an electric driver (4) arranged to rotate the spindle around a rotation axis (5),
- a substantially cylindrical sleeve (6) movably arranged between the housing and the spindle, the sleeve comprising a slit (7);
- a pin (8) inserted through the slit of the sleeve and fixed to the housing;
- a helical spring (9) comprising a plurality of windings arranged around the spindle and having at least one of its outer ends fixed to the spindle;
- coupling means (10) for movably coupling one of the windings of the helical spring to the sleeve,

wherein the sleeve is movable between a blocking position and a non-blocking position, and wherein, if the electric driver rotates the spindle and the helical spring in a first rotational direction, the helical spring will act on the coupling means so as to drive the sleeve in a first co-axial direction from the blocking position to the non-blocking position and if the electric driver rotates the spindle and the helical spring in a second rotational direction, opposite the first rotational direction, the helical spring will act on the coupling means so as to drive the sleeve in a second co-axial direction from the non-blocking position to the blocking position, the second direction being opposite to the first direction, wherein the slit (7) comprises at least a first and sec-

ond slit portion (71', 71''), the second slit portion directly following the first slit portion at a transition point on the sleeve, and making an angle α relative to the first slit portion at the transition point, where $\alpha \leq 90$ degrees, wherein during movement of the sleeve in the first or second co-axial direction, the sleeve will also turn around the rotation axis in rotational directions determined by the orientation of the slit portions relative to the housing.

2. The electro-mechanical blocking actuator according to claim 1, wherein the slit in the sleeve has a substantially V-shaped form.
3. The electro-mechanical blocking actuator according to any of claims 1 or 2, wherein the angle α lies in a range of 80- 90 degrees.
4. The electro-mechanical blocking actuator according to claim 3, wherein the angle α lies in a range of 85-87 degrees.
5. The electro-mechanical blocking actuator according to any of the preceding claims, wherein the helical spring comprises two co-axial parts dividing the helical spring into a first helical part, a second helical part, and an intermediate helical part lying between the two co-axial parts.
6. The electro-mechanical blocking actuator according to any of the preceding claims, wherein the sleeve comprises a further slit arranged at an opposite side of the slit, the further slit being line symmetrical relative to the slit with respect to the rotation axis.
7. The electro-mechanical blocking actuator according to any of the preceding claims, further comprising a movable blocking element (11) coupled to the sleeve for blocking a locking means of an access control device.
8. The electro-mechanical blocking actuator according to claim 7, wherein the blocking element is rotatably coupled to the sleeve.
9. An access control device comprising a first part and a second part, wherein at least one of the parts is movably arranged with respect to the other part, the device comprising an electro-mechanical blocking actuator according to any one of the previous claims, wherein the first part and the second part are securable to each other and/or releasable from each by means of the electro-mechanical blocking actuator.
10. The device according to claim 9, wherein the first part is a stationary part and the second part is a movable part, wherein the movable part and the stationary part are securable to each other and/or releas-

able from each other by means of the electro-mechanical blocking actuator.

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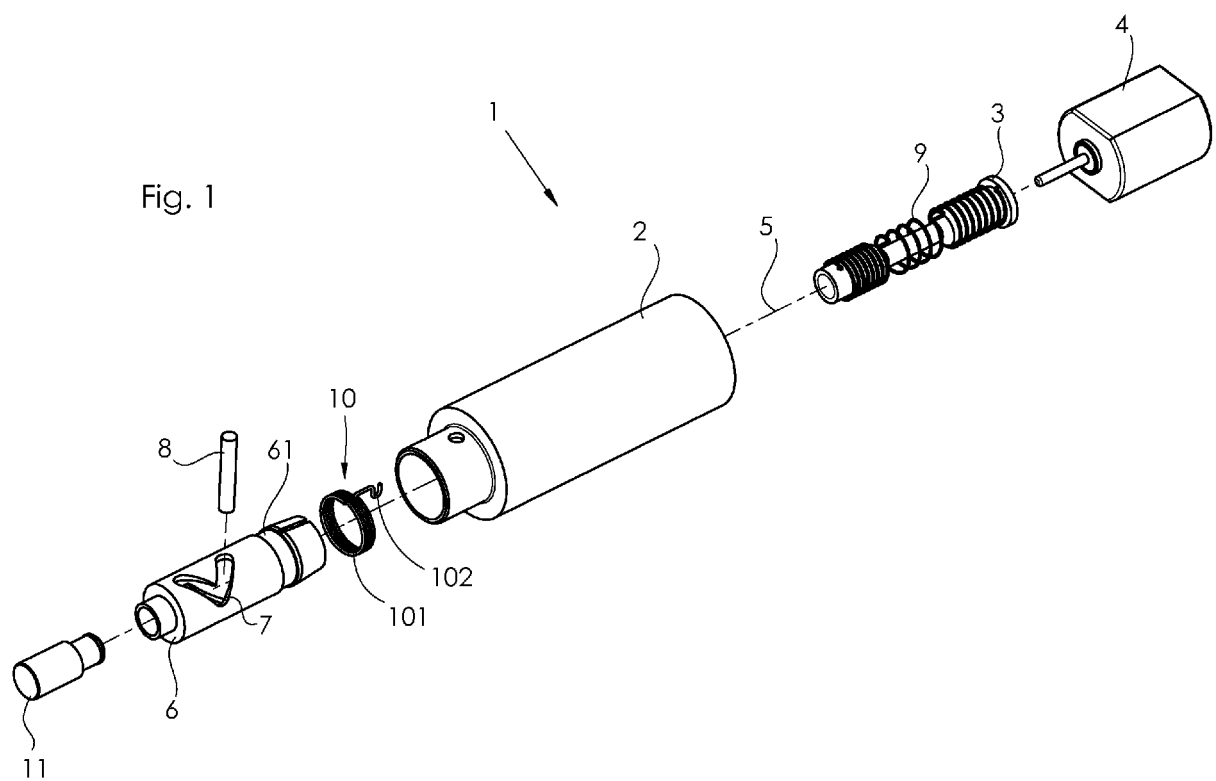
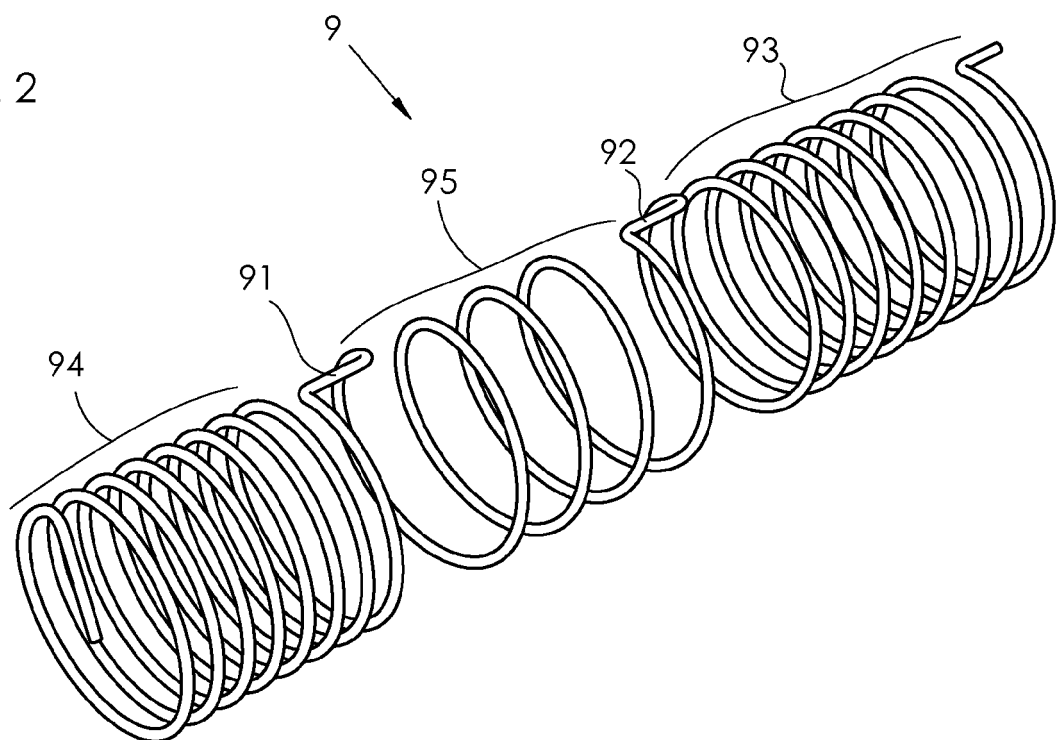


Fig. 2



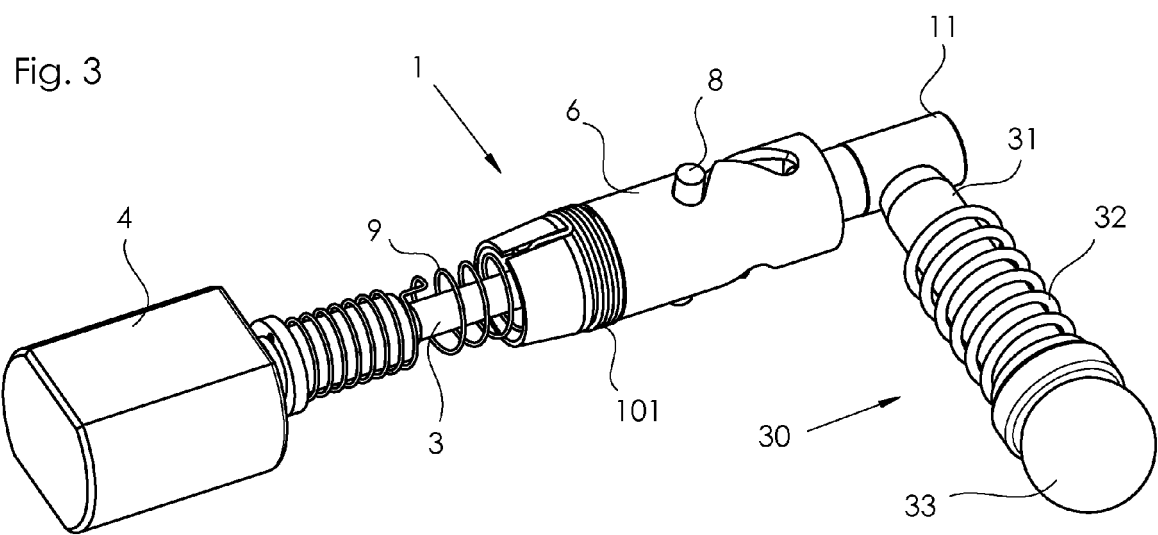
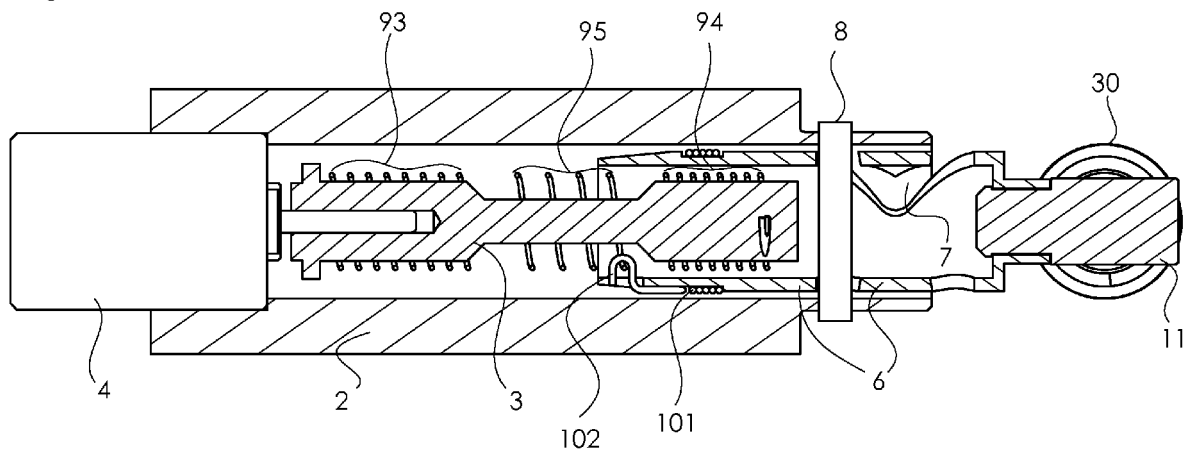


Fig. 4



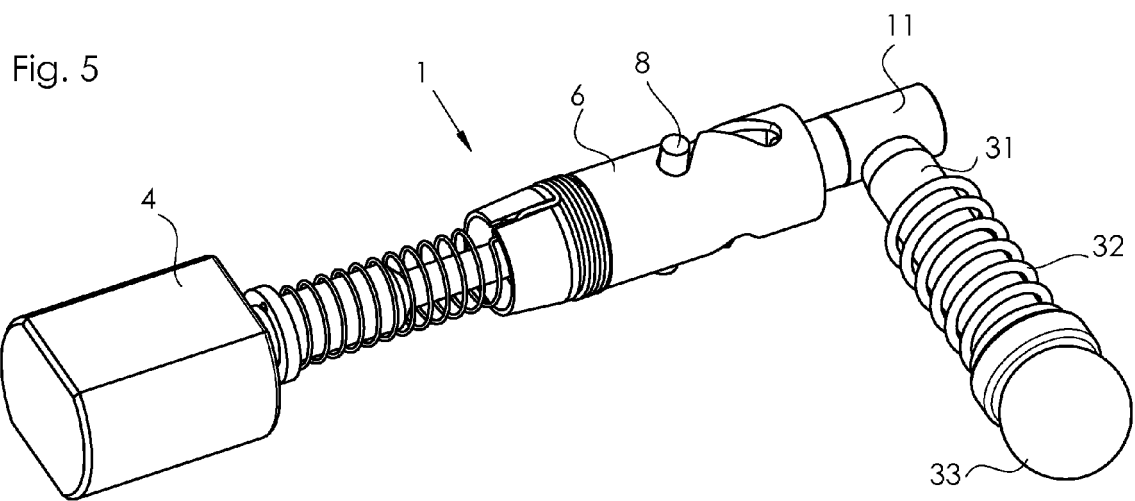
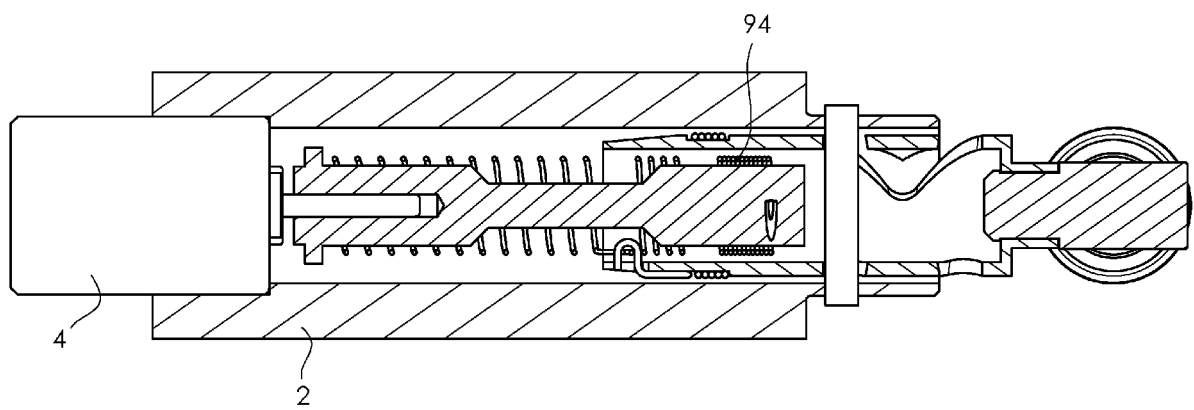


Fig. 6



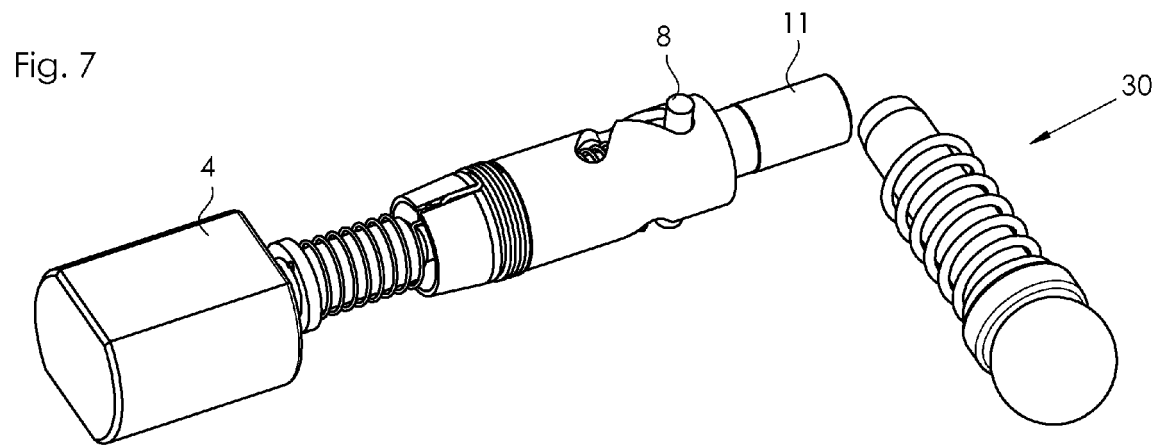


Fig. 8

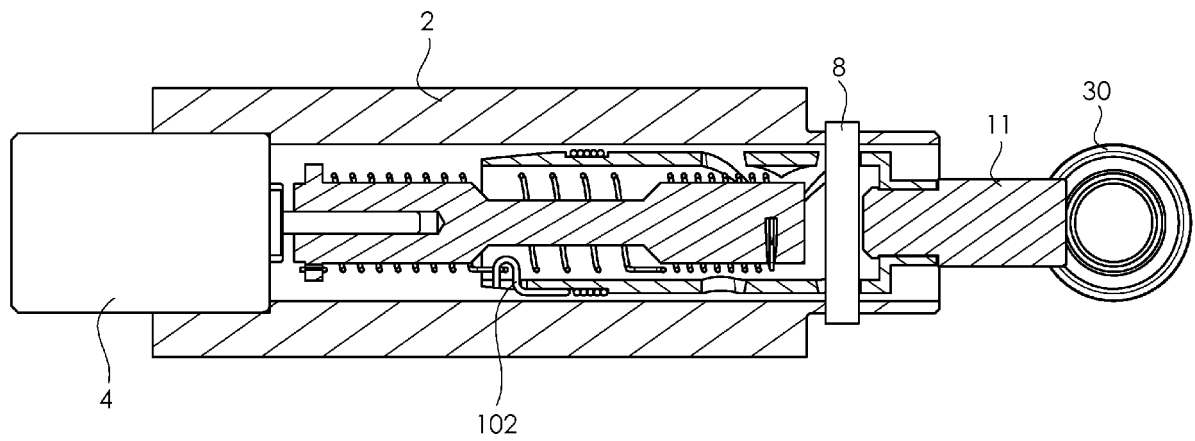


Fig. 9

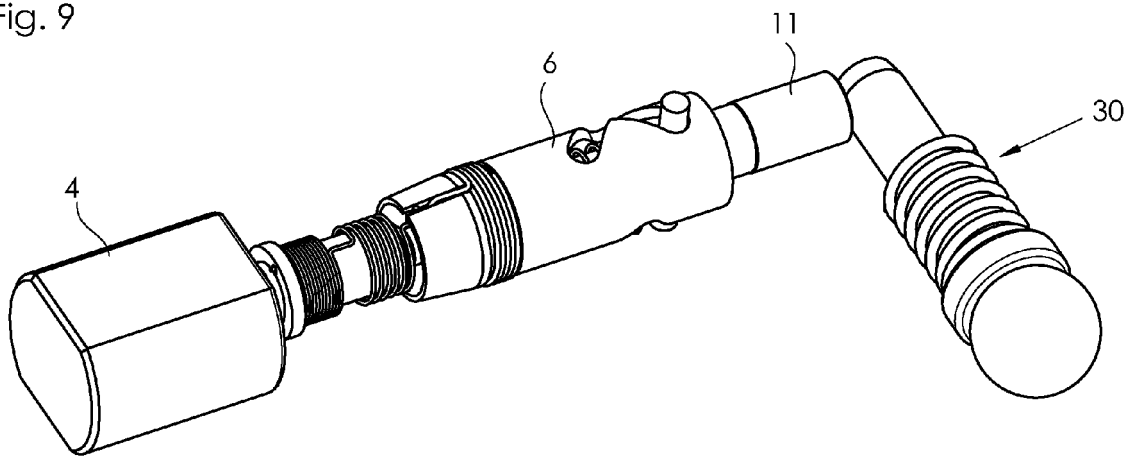


Fig. 10

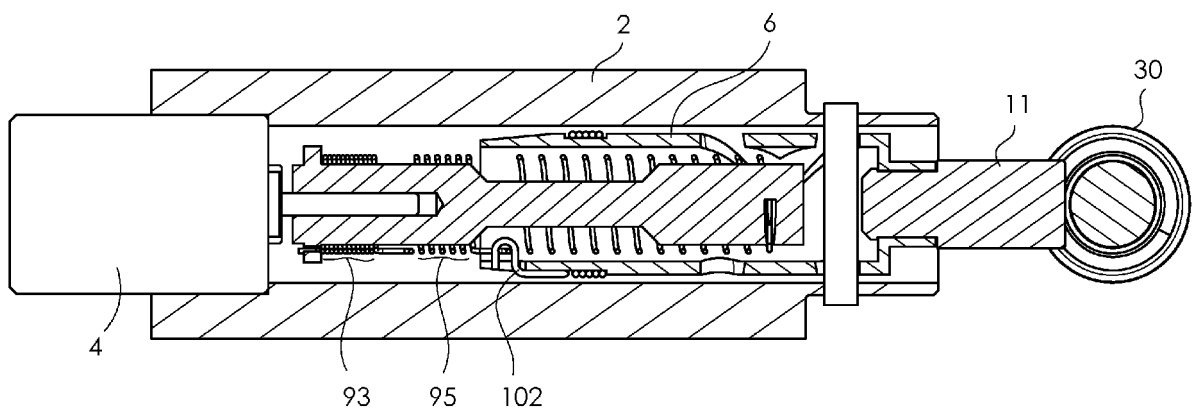


Fig. 11

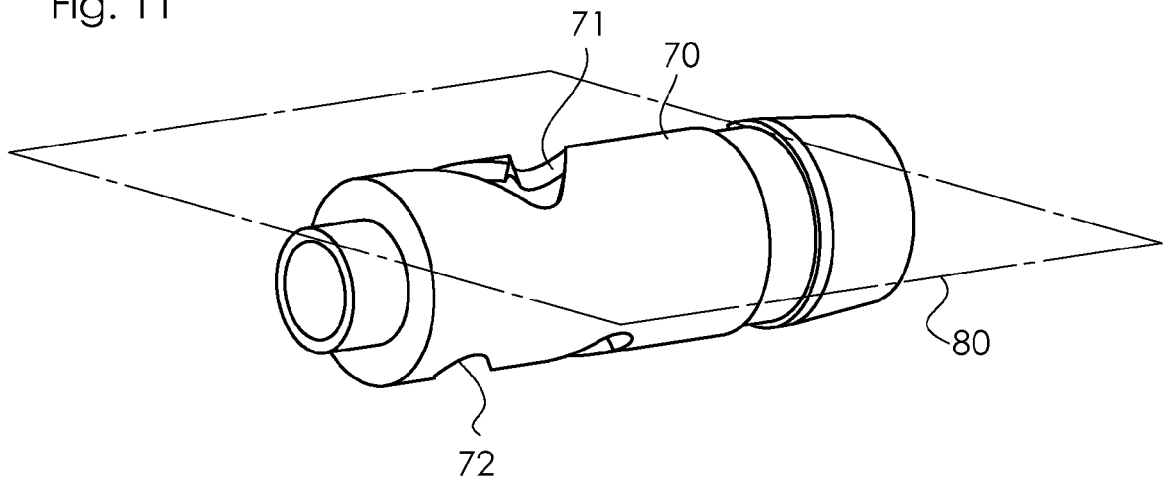


Fig. 12

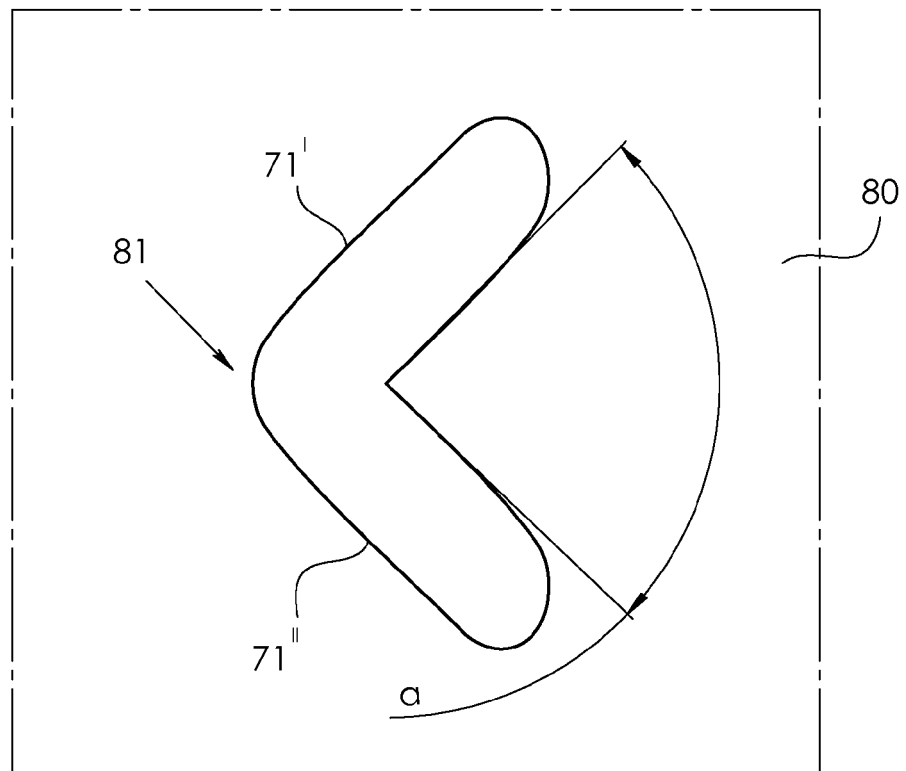


Fig. 13A

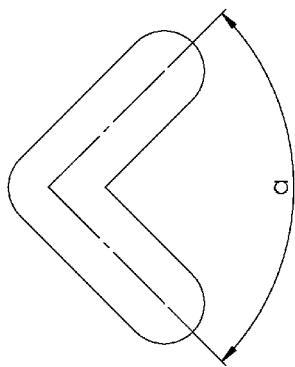


Fig. 13B

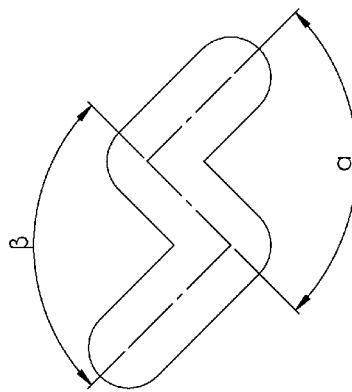


Fig. 13C

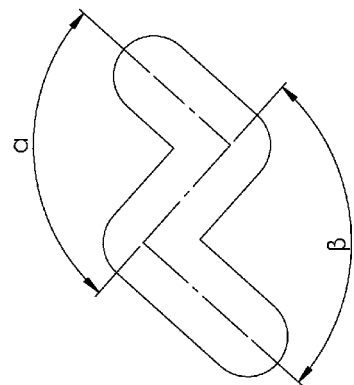


Fig. 14

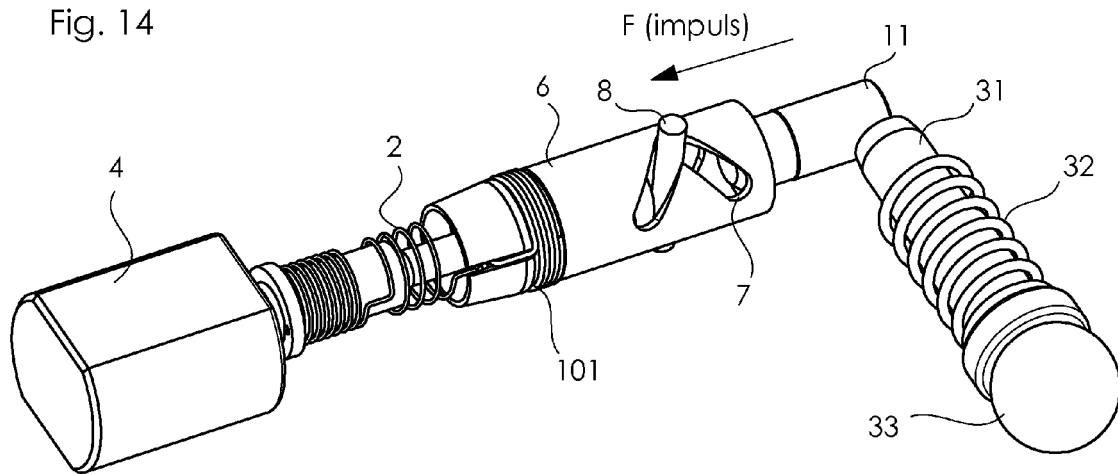


Fig. 15

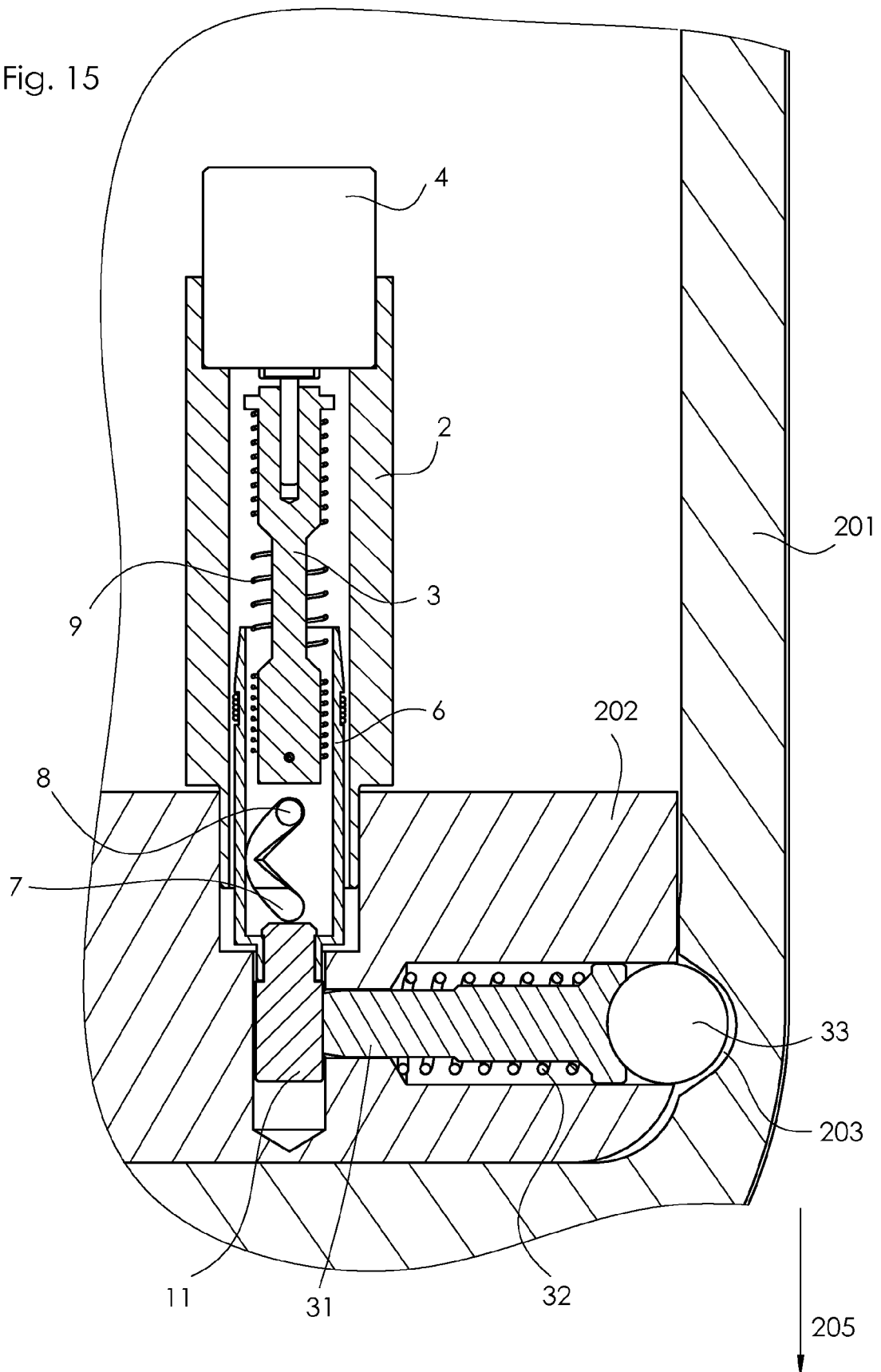
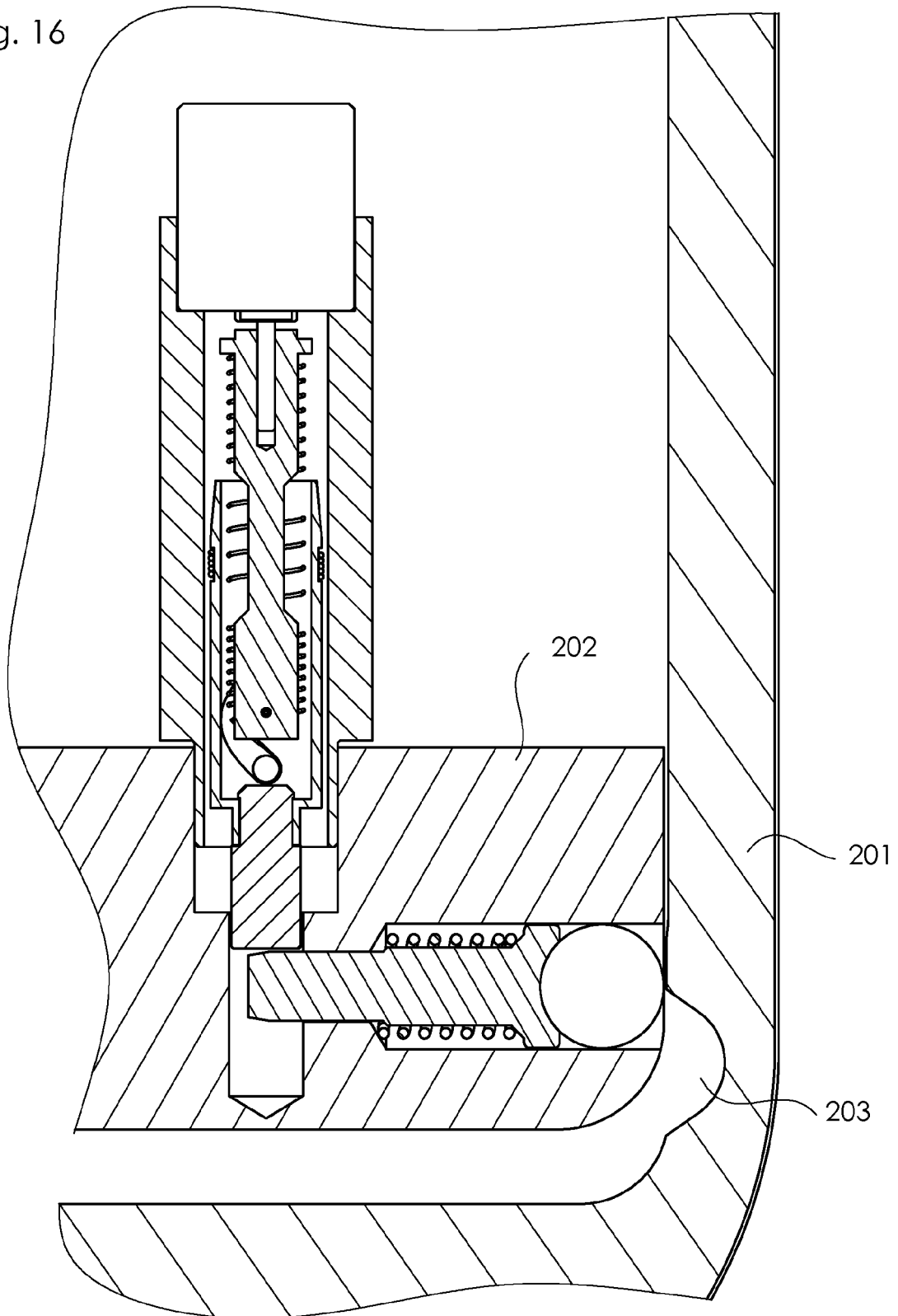


Fig. 16





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Application Number
EP 15 17 1202

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CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	
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