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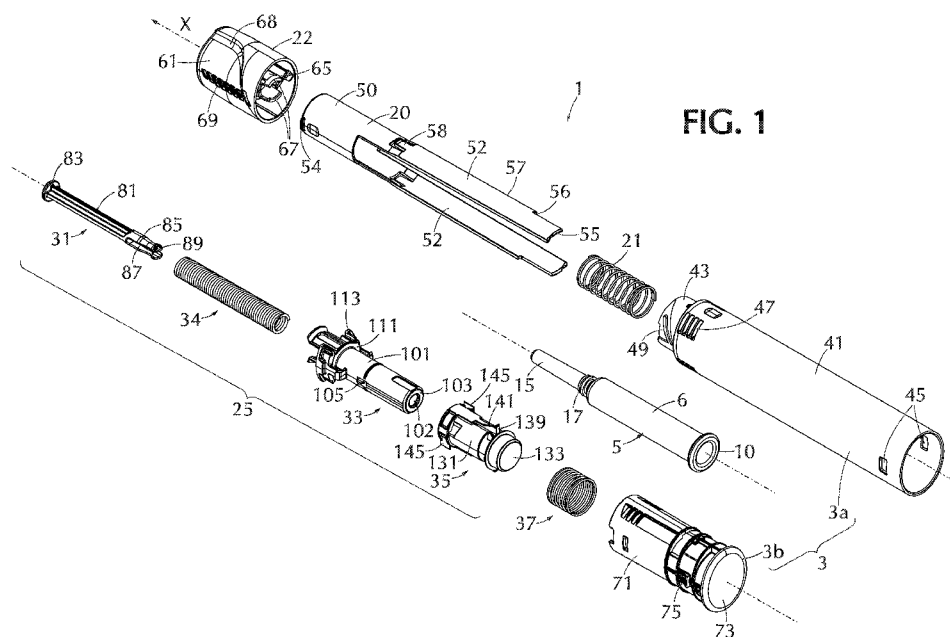
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(54) Title: INJECTION DEVICE WITH AN IMPROVED TRIGGERING MECHANISM



(57) Abstract: The invention relates to an injection device comprising a housing (3), a needle guard (20), an injection drive mechanism for driving a plunger within the container (5) and including o a plunger rod (31); o an injection spring (34) for biasing the plunger rod; o a retaining member (33), the retaining member and the plunger rod having corresponding latching features for retaining the plunger rod in its proximal position against the action of the injection spring, in an initial state of the injection device; and o a trigger member (35) for preventing the release of the latching features in the initial state of the device, the trigger member being axially displaceable by the needle guard (20) for releasing the latching features. The trigger member (35) and the housing (3) comprise corresponding locking features (79, 139) in mutual releasable engagement for maintaining the trigger member (35) in its blocking position, and wherein said locking features are designed to be released by the needle guard (20) when moving to its retracted position.

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INJECTION DEVICE WITH AN IMPROVED TRIGGERING MECHANISM

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Technical field

The present invention relates to injection devices, in particular to so-called “needle guard-activated” auto-injectors that can be fired by the user by pressing the device on the injection site.

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This type of devices is often preferred for injecting drugs to be administered in emergency conditions. In particular, emergency devices are required to be not only robust and reliable, but also easy to use with a minimal number of steps.

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Background of the invention

In some devices known from the prior art, e.g. WO 2009/114542, a detachable safety member is provided that prevents accidental firing of the device during the manipulation of the device. For this purpose, the safety member blocks a trigger member that is actuatable upon retraction of the needle guard, when the device is pressed against the injection site. The safety member needs to be removed by the user before actuating the device for performing the injection. A device of this type also includes a cap detachably arranged at the distal end of the device housing for covering the needle guard and maintain it in an extended position, thus preventing accidental firing during shipping for example due to a shock. The cap is also provided with features that grip the sheath typically protecting the needle of the drug container, whereby the sheath is removed at the same time as the cap.

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Such devices require three steps to be performed by the user for firing the device and injecting the medicament: 1) removing the cap; 2) removing the safety member; and 3) pressing the device against the injection site to trigger the device and perform the injection.

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It is desirable to reduce the number of steps to be performed by the user for injecting the pharmaceutical product contained in the device, while maintaining a high degree of safety by preventing accidental or unintended triggering of the device.

- 5 It is in particular an objective of the invention to eliminate the need for the user to manually remove a safety component in addition to removing the cap protecting the needle end, and therefore provide an auto-injector device that can be triggered in two steps.

Summary of the Invention

- 10 According to the present invention, it is provided an injection device comprising
- an elongated housing extending along a longitudinal axis (X) and configured to receive a medicament container provided with a barrel containing the medicament, a needle attached thereto and a plunger displaceable within the barrel to expel the medicament
 - 15 through the needle;
 - a needle guard telescopically mounted in the housing and axially movable between an extended position, wherein the needle guard distally protrudes from the housing and surrounds the needle, and a retracted position proximally spaced from the extended position corresponding to the condition of pressing the device against an injection site for
 - 20 firing the injection device;
 - an injection drive mechanism for driving the plunger within the barrel and thus expelling the medicament, the injection drive mechanism including
 - o a plunger rod axially movable within the housing, between a proximal position and a distal position, for driving the plunger within the barrel;
 - 25 o an injection spring arranged for biasing the plunger rod to its distal position;
 - o a retaining member fixed within the housing for, in an initial state of the injection device, retaining the plunger rod in its proximal position against the biasing action of the injection spring, the retaining member and the plunger rod having corresponding latching features including a stop surface and a corresponding
 - 30 radially deflectable resilient arm formed with a protrusion, whereby the plunger rod is retained in its proximal position by the engagement of the protrusion with the stop surface; and
 - o a trigger member comprising a blocking feature, and being axially displaceable by the needle guard when moving from its extended position to its retracted position,
 - 35 from a blocking position, wherein the blocking feature prevents the radial deflection

of the resilient arm thus preventing the disengagement of the protrusion from the corresponding stop surface, to a release position wherein the resilient arm is free to radially deflect whereby the protrusion is disengaged from the corresponding stop surface under the biasing action of the injection spring,

5 wherein the trigger member and the housing comprise corresponding locking features in mutual releasable engagement for maintaining the trigger member in its blocking position, and wherein said locking features are designed to be released by the needle guard when moving from its extended position to its retracted position, whereby the retraction of the needle guard causes the release of the locking features, the release of the latching
10 features and thus the firing of the injection device.

With this design, the trigger member being positively locked in its blocking position in an initial position, and then sequentially unlocked and moved out of engagement of the latching features by the needle guard retraction during the activation sequence. It
15 therefore achieves the function of a safety member and eliminates the need of an additional step of removing a separate component. This design thus makes it easier to use the device, is highly reliable from a safety perspective and reduces the required number of components, which is advantageous from a manufacturing and assembling perspective.

20 Preferred embodiments may include one or several of the following features:

- the needle guard has a sheath portion for surrounding the needle in the extended position, the sheath portion having a through hole at the distal end for the passage of the needle when the needle guard is retracted, and a leg axially and proximally projecting
25 from the sheath portion, said leg having a free end for engaging and displacing the trigger member when the needle guard is retracted;
- the leg has a notch distally spaced from the free end of the leg and forming a transverse edge that defines a stop surface for, in a final state of the injection device after the injection, preventing the needle guard from being proximally retracted;
- 30 - the leg has an axial edge with a section extending between the sheath portion and the notch, that defines a guiding element slidingly cooperating with a corresponding guiding element of the retaining member during axial displacement of the needle guard;
- the latching features include a pair of resilient arms formed on the plunger rod at the proximal end thereof and extending axially, respective protrusions being formed at the
35 free end of each resilient arm;

- the retaining member comprises a radial wall having an axial bore with a circumferential rim defining the stop surface of the latching features;
- the protrusions are radially and outwardly protruding from the respective resilient arms, the resilient arms axially projecting from the radial wall through the bore, with the protrusions and the stop surface mutually engaged, when the plunger rod is in its proximal position;
- the blocking feature includes an axial pin that, in the blocking position of the trigger member, prevents the inward deflection of the resilient arms and hence disengagement of the protrusions from the stop surface;
- the housing comprises at least a recess and the trigger member comprises a sleeve body and, outwardly projecting from the sleeve body, at least a cantilever flexible arm provided with a radial tab at the free end thereof for releasable engagement with the recess of the housing, the locking features including said tab and corresponding recess;
- the sleeve body is provided with a first rib for engagement with the free end of the leg when the needle guard is retracted, whereby the trigger member is caused to be proximally displaced;
- the tab is biased into engagement within the recess by the cantilever flexible arm and the cantilever flexible arm is inwardly deflectable by the needle guard for the release of the tab from the recess;
- the cantilever flexible arm comprises a ramp for engagement with the needle guard, the profile of the ramp determining an inward deflection of the cantilever flexible arm caused by an axial displacement of the needle guard, when the needle guard is moved in the proximal direction;
- the housing and the trigger member respectively have a pair of diametrically opposed recesses and corresponding cantilever flexible arms;
- the trigger member includes, radially projecting from the sleeve body, a second rib for selective engagement with the needle guard for preventing the needle guard from being proximally retracted;
- the second rib is arranged on the sleeve body for, in the final state of the injection device after the injection, engaging the transverse edge of the leg and thus preventing the needle guard from being proximally retracted;
- the second rib is distally spaced from the first rib;
- the device further comprises a trigger spring arranged between the housing and the trigger member for distally biasing the trigger member, whereby the trigger member, in the initial state of the injection device, is biased to its blocking position;

- the trigger member includes, radially projecting from the sleeve body, a stop member defining a seat for the trigger spring;
- the trigger member and the retaining member comprise lockout features in mutual engagement for locking the needle guard in an extended position corresponding to the final state of the device after the injection, wherein the lockout features include a cam follower provided on one and a cam track provided on the other of the trigger member and retaining member;
- the retaining member has a substantially cylindrical hollow body and the sleeve body of the trigger member fits over said cylindrical hollow body, with the sleeve body being able, depending on the axial displacement and position of the needle guard, to slide or rotate with respect to the cylindrical hollow body;
- the cam follower is provided on the retaining member and includes a prong radially and outwardly projecting from the cylindrical hollow body, and the cam track is provided on the sleeve body of the trigger member;
- the cylindrical hollow body is provided for housing the injection spring and the radial wall, arranged at the proximal end of the cylindrical hollow body, defines a seat for the injection spring;
- the cam track has a transversally oriented dead-end channel connected with an axial channel extending in the proximal direction, the axial channel having an open proximal end;
- the device further includes a needle guard spring biasing the needle guard in the distal direction, wherein the prong is forced toward the dead-end channel under the action of the trigger member, whereby the trigger member is caused to rotate and the second rib to engage the transverse edge of the leg, when the needle guard, under the action of the needle guard spring, moves back to an extended position corresponding to the final state of the device after the injection;
- the injection spring is designed to impart to the plunger rod, in its proximal position, a force overcoming the retention force of the latching features in mutual engagement, whereby the release of the blocking feature causes the latching features to disengage and the injection spring to drive the plunger rod to its distal position.

Brief Description of the Drawings

A preferred embodiment of the invention will now be described in more details, with reference to the following drawings wherein:

- FIG.1 is an exploded perspective view of an injection device according to a preferred embodiment of the invention;
- FIG.2 is a cross-sectional view, in a first axial plane, of the device of FIG.1 as assembled in a storage configuration, before use;
- 5 - FIG.2A is a cross-sectional view of the device in the configuration of FIG.2, in a perpendicular axial plane;
- FIG.3 is an elevation view of the front housing alone of the device of FIG.1;
- FIG.3A and 3B are, respectively, a side view in direction 3A and a cross section view in the axial plane 3B-3B from FIG.3;
- 10 - FIG.4 is a perspective view of the needle guard alone of the device of FIG.1;
- FIG.5 is a top view of the retaining member alone of the device of FIG.1;
- FIG.6 is a top view of the trigger member alone of the device of FIG.1;
- FIG.6A is a cross section view in the axial plane 6A-6A from FIG.6;
- FIG.7 is a cross-sectional view, in the plane of FIG.2, of the device of FIG.1 in a first step of triggering the device, wherein the needle guard is partially retracted, corresponding to the user starting to press the device against the injection site;
- 15 - FIG.7A and 7B are partially broken away views without the housing, respectively elevation and top views, of the device in the configuration of FIG.7;
- FIG.8 is a cross-sectional view, in the plane of FIG.2, of the device of FIG.1 in a second step of triggering the device, wherein the needle guard is fully retracted, corresponding to the full insertion of the needle in the injection site;
- 20 - FIG.8A and 8B are partially broken away views without the housing, respectively elevation and top views, of the device in the configuration of FIG.8;
- FIG.9 is a cross-sectional view, in the plane of FIG.2, of the device of FIG.1 in a first lock out step of the device, wherein the needle guard is returned to a partially extended position, corresponding to the user starting to withdraw the device from the injection site;
- 25 - FIG.9A and 9B are partially broken away views without the housing, respectively elevation and top views, of the device in the configuration of FIG.9;
- 30 - FIG.10 is a cross-sectional view, in the plane of FIG.2, of the device of FIG.1 in a final lock out configuration of the device, wherein the needle guard is returned to its fully extended position, corresponding to the final after-use configuration of the device;
- FIG.10A and 10B are partially broken away views without the housing, respectively elevation and top views, of the device in the configuration of FIG.10.

Detailed Description of a Preferred Embodiment

Definitions

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The following definitions will be used in the present description and claims:

- the term auto-injector designates an injection device, wherein the force for expelling the medicament from the medicament container is provided by an energy source of the device that is triggered by the user, as opposed to a device using manual force from the user to expel the medicament. In the present description, the term auto-injector encompasses the injectors having a stationary needle as well as those having an auto-penetration feature, wherein the needle is moved and inserted into the injection site by an energy source of the device before the medicament is expelled;
- 10 - the term “distal” refers to a location or direction that is close to, or oriented toward, the outlet port for the content of the medicament cartridge when received in the injection device. The “distal” location and direction may also be referred to as, respectively, the “front” location and the “forward” direction; and
- 15 - the term “proximal” refers to a location or direction opposing to the distal location or direction, and/or that is close to, or oriented toward, the prehension part of the injection device. The “proximal” location and direction may also be referred to as, respectively, the “rear” location and the “rearward” direction.

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The invention will now be further illustrated by the following preferred embodiment shown on the figures (FIG.1-10).

The injection device depicted on the figures is a single use auto-injector.

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With reference to FIG.1, 2 and 2A, the injection device 1 comprises an elongated housing 3 extending along a longitudinal axis X and configured to receive a medicament container 5. In the illustrated embodiment, the housing 3 is made in two parts including a front housing 3a and a rear housing 3b, which are coaxially and fixedly attached. However, in other embodiments, the housing 3 may be integrally made as a one-piece component.

In the illustrated embodiment, the medicament container 5 is a pre-filled syringe provided with a barrel 6 containing the medicament 7, a needle 8 attached thereto and a plunger 9 displaceable within the barrel 6 to expel the medicament through the needle. The barrel 6 is formed with a flange 10 at its proximal end, a tip at its distal end connected to the needle 8 presenting a reduced diameter and thereby forming a front shoulder 11. The barrel 6 is made from glass but, in other embodiments, could be made from plastic material. The syringe 5 is further provided with a removable protecting sheath 15 surrounding the needle 8 and comprising an enlarged base portion 17 at its proximal end. The sheath 15 is typically made, at least partially, from an elastomeric material such as rubber. As will be detailed in the following, the syringe 5 is fixedly mounted within the front housing 3a.

The device 1 further comprises a needle guard 20 telescopically mounted in the housing 3 and axially movable between an extended position and a retracted position. In the extended position, the needle guard 3 distally protrudes from the distal end of the housing 3 and surrounds the needle 8, whereby the needle is concealed from the user's sight and protected. The retracted position is proximally spaced from the extended position and corresponds to the condition of pressing the device against an injection site for firing the device.

In association with the needle guard 20, the device includes a needle guard spring 21, which is in this embodiment a helical compression spring, axially arranged between the housing 3 and the needle guard 20 for biasing the needle guard in the distal direction.

The device 1 further comprises a cap 22 detachably mountable onto a distal portion of the housing 3 for covering the needle guard 20 and limiting the axial movements thereof. As will be seen in the following, the cap 22 is also provided with gripping features for the needle sheath 15 to be removed when the cap 22 is detached from the housing 3.

For driving the plunger 9 within the barrel 6 and thus expelling the medicament 7 through the needle 8, the device 1 further comprises, arranged within the housing 3, an injection drive mechanism 25.

The injection drive mechanism 25 includes a plunger rod 31 axially movable within the housing 3 for driving the plunger 9 within the barrel 6, a retaining member 33 fixed within

the housing 3, an injection spring 34 in the form of a helical compression spring axially arranged between the retaining member 33 and the plunger rod 31 for forwardly biasing the plunger rod 31, and a trigger member 35 axially movable within the housing 3 for triggering an injection phase when moved rearwardly.

5 Furthermore, the device 1 comprising a trigger spring 37 in the form of a helical compression spring axially arranged between the housing 3 and the trigger member 35 for distally biasing the trigger member 35.

10 With reference to FIG.3, 3A and 3B, it will be seen that the front housing 3a has an elongated cylindrical external wall 41, a coaxial cylindrical internal wall 42 forming a receptacle for the syringe barrel 6 and a coaxial front-end sleeve 43 for detachable connection with the cap 22. The front housing is further provided with radial connecting ribs 44, four in number in the illustrated embodiment, rigidly connecting the external wall
15 41 to the internal wall 42 and regularly distributed about the longitudinal axis X.

The external wall 41 has, in the represented embodiment, an overall oval shape in cross-section, whereby the device is prevented from rolling on a flat surface. It comprises, in a rear portion, a pair of opposing bores 45 for rigid attachment of the rear housing 3b to the
20 front housing 3a. On its inner surface, the external wall 41 is formed with a stop surface 46 for engagement by a complementary feature of the needle guard 20 for limiting the displacement of the needle guard 20 in the distal direction. The external wall 41 is also provided, on an outer surface of a front portion thereof, with ridges 47 or corrugations for enhanced handling by the user.

25 The internal wall 42 is generally circular in cross-section, dimensioned for matching the external dimensions of the syringe barrel 6, and is provided at the front with a stop portion 48 of smaller diameter. The stop portion 48 is provided for engagement with the shoulder 11 of the syringe barrel 6, whereby the syringe 5 can be coaxially inserted into the front
30 housing 41, received in the cavity defined by the internal wall 42 and held in axial position against forward movement by the stop portion 48.

The front-end sleeve 43, which defines the distal end of the housing 3, has a rib thread section 49 for cooperating with a complementary feature of the cap 22, those connecting

features being designed such that the cap 22 can be detached from the front housing 41 by rotating the cap by a fraction of a turn and then axially removing it.

Preferably, the front housing 41 is made integral by molding of a synthetic material.

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Referring now more particularly to FIG.1 and 4, the needle guard 20 has a sheath portion 50 with a front annular rim 51 for, in its extended position, surrounding the needle 8, and a pair of opposing legs 52 axially and proximally projecting from the sheath portion 50.

10 The sheath portion 50 is formed as a cylinder having, delimited by the rim 51, a through hole 53 at its distal end for the passage of the needle 8 when the needle guard 20 is retracted into the housing 3. The sheath portion 50 is also provided, at its distal end, with a pair of diametrically opposed radial projections 54 designed for engagement with complementary features of the cap 22 for limiting the axial movement of the needle guard
15 20 when the cap 22 is attached to the housing 3. This arrangement aims to prevent accidental triggering of the device, for example in case of a shock.

Each leg 52 has a free end 55 for, as will be described in the following, engaging and displacing the trigger member 35 when the needle guard 20 is retracted into the housing
20 3. Each leg 52 is formed with a notch, distally spaced from the free end 55 and forming a transverse edge 56, and an axial edge having a section 57 extending between the sheath portion 50 and the notch.

The transverse edge 56 defines a stop surface for, in a final state of the injection device
25 after the injection, preventing the needle guard 20 from being proximally retracted. The section 57 of the axial edge defines a guiding element for engagement with a corresponding feature of the retaining member 33 during the axial displacement of the needle guard 20.

30 Each leg 52 is further provided with a flexible deflectable flap 58 having a radially projecting front flap edge 59 for engagement with the corresponding stop surface 46 of the external wall 41, as visible on FIG.2. The engagement of the flap 58 with the stop surface 46 defines the extended position of the needle guard 20 with respect to the housing 3, with the needle guard 20 being prevented from further distal relative
35 displacement.

As visible on FIG.2 and 2A, the needle guard spring 21, arranged between the needle guard 20 and the housing 3, bears at the proximal end on the stop portion 48 of the front housing 3a and at the distal end on the annular rim 51.

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Referring now to more particularly FIG.1, 2 and 2A, the cap 22 includes a substantially cylindrical wall 61 designed to fit over the front end sleeve 43 of the front housing 2a and a front end annular wall 63 partially closing the cylindrical wall 61 at the front. The inner surface of the cylindrical wall 61 is formed with a recess 64, forming the complementary
10 feature of the rib thread section 49 for threaded connection therewith.

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The cap 22 further comprises, rearwardly extending from the front end wall 61, a coaxial grip sleeve 65 for engaging the needle sheath 15. At the free end (proximal end), the grip sleeve 65 is formed with a pair of opposing jaws 67 engaging a rear annular surface of
the enlarged base 17 of the needle sheath 15 when the cap 22 is attached to the housing 3 (FIG.2), whereby the sheath 15 is removed from the syringe 5 when the cap 22 is detached from the housing 3.

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On the outer surface of the cylindrical wall 61, the cap 22 is provided with a main rib 68 extending from the front end to the rear end of the cylindrical wall 61, said rib 68 being continuously formed with a substantially axial portion and a substantially helical portion, and a ridged surface 69. The main rib 68 and the ridged surface 69 are designed to enhance handling by the user, in particular to make it easier for the user to rotate the cap 22 by a fraction of a turn (for example $\frac{1}{4}$ turn) corresponding to the threaded connection
25 between the cap 22 and the housing 3, and then axially draw the cap 22 for detaching the cap from the housing. The ridged surface 69, in conjunction with the ridges 47 of the front housing 3a, may also define a visual indicator of the angular position of the cap 22 with respect to the housing 3.

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In the illustrated embodiment, the cap 22 is made as an integral molded piece from a synthetic material. In particular, the grip sleeve 65 is made integral with the rest of the cap 22. However, in other embodiments, the grip sleeve 65 may be a separate component from the rest of the cap and attached thereto. The grip sleeve may also be made in a different material, such as metal.

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The inner surface of the cylindrical 61 is formed with a constriction 70 defining a stop surface for engagement by the radial projections 54 of the needle guard for preventing retraction of the needle guard 20 when the cap 22 is attached to the housing 3. In this configuration, the axial displacement of the needle guard is thus limited to a small distance between the constriction 70 and the front end annular wall 63 (FIG.2A).

Still referring to FIG.1, 2 and 2A, the rear housing 3b is formed as a plug for closing the internal volume defined by the front housing 3a at the rear end thereof. It mainly comprises a generally cylindrical body 71 fitting in the external wall 41 of the front housing 3a and, at a proximal end thereof, a radial closing wall 73. The outer surface of the cylindrical body 71 is formed with a pair of opposed radial latches 75 for engagement with the respective bores 45 and rigid attachment of the rear housing 3b to the front housing 3a.

The inner surface of the cylindrical body 71 of the rear housing 3b is formed with opposed recesses 77 provided to be engaged by complementary features of the retaining member 33 for rigid attachment thereof to the rear housing 3b. The inner surface of the body 71 of the rear housing 3b is further formed with diametrically opposed recesses defining radial stops 79 for engagement by features of the trigger member 35, as will be seen in the following.

Still referring to FIG.1, 2 and 2A, the plunger rod 31 is formed as an integral part that has a main elongated solid body 81 provided with a radial plate 83 at its distal end, and a pair of parallel resilient arms 85 axially and proximally extending from the solid body 81. The plate 85 is designed to engage the plunger 9 and transfer thereto the expelling force of the injection spring 34.

The arms 85 are spaced one from the other, thus defining a gap 87, and are flexible such that they can be inwardly deflected in a radial direction. Each arm 85 is formed, at its free proximal end, with a protrusion 89 for engagement with a stop surface of the retaining member 33. The protrusion 89 radially and outwardly protrudes from the respective resilient arm 85. The resilient arms 85 define latching features for axially retaining the plunger rod 31 against the biasing action of the injection spring 34.

Particular reference is now made to FIG.1, 2, 2A and 5. The retaining member 33 comprises a substantially cylindrical hollow body 101 and, at the proximal end thereof, a radial wall formed with a central axial bore 102 with a circumferential rim 103. The rim 103 defines a stop surface for engagement by the protrusions 89 (as visible on FIG.2) and thus defines a corresponding latching feature.

The cylindrical hollow body 101 is designed for housing the injection spring 34, the radial wall defining a seat for the injection spring 34. As visible on FIG.2, the injection spring 34, which is compressed in the initial state illustrated on this figure, bears at its distal end on the plate 83 of the plunger rod 31 and, at its proximal end, on the radial wall of the hollow body 101.

The injection spring 34 and the latching features, defined on the one hand by the resilient arms 85 and the protrusions 89 and on the other end by the rim 103, are designed such that the force imparted by the injection spring 34 to the plunger rod 31, in its proximal position (same position as FIG.2), overcomes the retention force of the latching features when in mutual engagement if the resilient arms 85 are not prevented from inwardly deflecting.

The cylindrical hollow body 101 is formed with a prong 105 radially and outwardly projecting therefrom, the prong 105 defining a cam follower for engagement with a corresponding feature of the trigger member 35.

The retaining member 33 further comprises a pair of opposed fixing latches 107 that extend radially from the hollow body 101 and engage with the corresponding recesses 77 (as shown on FIG.2A), for securing the retaining member 33 to the rear housing 3a.

The retaining member 33 also includes a pair of parallel branches 108 that axially project from the hollow body 101 in the distal direction and are symmetrically spaced from the central axis X. Each branch is provided, at its free distal end, with an inclined edge 109 designed to bear and press on the syringe flange 10. The branches 108 and the respective inclined edges 109 provide some degree of elasticity that absorb potential residual play between the syringe and the device components due to manufacturing tolerances. The branches 108 and edges 109 are also designed to absorb shocks in the

event of dropping the device in the “needle up” orientation and minimize impact forces on the glass constituting the syringe barrel 6.

Furthermore, the retaining member 33 has an annular bearing flange 111 radially extending from the hollow body 101 for slidably bearing the legs 52 of the needle guard 20 and, further outwardly projecting from the bearing flange 111, two opposing pairs of guiding walls 113 each pair defining a passage for a respective leg 52. The guiding walls 113 are configured to slidably cooperate with the corresponding leg 52 so as to allow the needle guard 20 to axially slide and prevent relative rotation.

Referring now to FIG.1, 2, 2A, 6 and 6A, it will be seen that the trigger member 35 comprises a hollow sleeve body 131 that is open at its distal end and closed at its proximal end by a proximal closing wall 133. The sleeve body 131 fits over the cylindrical hollow body 101 of the retaining member 33, with the sleeve body 131 being able, depending on the axial displacement and position of the needle guard 20, to slide or rotate with respect to the cylindrical hollow body 101. Movements of the trigger member 35 relative to the retaining member 33 will be explained in the following.

The trigger member 35 includes an axial pin 135 distally protruding from the closing wall 133 such that, in the initial configuration illustrated on FIG.2 and 2A, the pin 135 is inserted in the gap 87 between the resilient arms 85 of the plunger rod 31, thus preventing inward radial deflection of the resilient arms 85 and hence disengagement of the protrusions from the stop surface of the rim 103.

The pin 135 thus defines a blocking feature that is axially displaceable with the trigger member 35 by the needle guard 20 when moving from its extended position to its retracted position. When the trigger member 35 is proximally moved from the blocking position wherein the pin 135 blocks the inward deflection of the arms 85, the pin 135 is removed from the gap 87 whereby it no longer interferes with the arms 85 and no longer blocks the deflection of the arms. This corresponds to a release position of the trigger member 35, wherein the resilient arms 85 are free to radially deflect. The protrusions are thus disengaged from the corresponding stop surface formed by the rim 103 under the biasing action of the injection spring 34.

The trigger member 35 further comprises, outwardly projecting from the sleeve body 131, a pair of opposed cantilever flexible arms 137, each provided with a radial tab 139 at the free end thereof. The tabs 139 are provided for releasable engagement with the respective radial stops 79 formed by recesses of the rear housing 3b (FIG.2).

5

Each tab 139 is biased by the respective flexible arm 137 into engagement within the corresponding recess, the arm 137 being inwardly deflectable by the needle guard 20 for the release of the tab 139 from the recess. Each cantilever flexible arm 137 comprises a ramp 141 for engagement with a corresponding leg 52 of the needle guard 20. The profile of the ramp 141 determines an inward deflection of the cantilever flexible arm 137 caused by an axial displacement of the needle guard 20, when the needle guard is moved in the proximal direction.

The tabs 139 and the corresponding radial stops 79 define locking features in mutual releasable engagement. These locking features are designed to maintain the trigger member 35 in its blocking position, and to be releasable by the needle guard 20 when moved from its extended position to its retracted position. The retraction of the needle guard 20 causes the release of the locking features 79, 139, the release of the latching features 89, 103 and thus the firing of the injection device.

20

The trigger member 35 further includes, radially and outwardly projecting from the sleeve body 131, a first rib 143 and, distally spaced therefrom, a second rib 145. In the illustrated embodiment, the trigger member 35 includes a pair of such first ribs 143, which are diametrically opposed, and a pair of such second ribs 145, which are also diametrically opposed.

25

The first rib 143 is provided for engagement with the corresponding free end 55 of the leg 52 when the needle guard 20 is retracted, whereby the trigger member 35 is caused to be proximally displaced.

30

The first rib has a stop surface for engagement by the free end 55 of the leg 52 at an axial location corresponding to the apex of the ramp 141, slightly distally spaced from the tab 139, such that the retraction of the needle guard 20 sequentially causes the deflection of the cantilever arm 137 and the engagement of the free end 55 of the leg 52 without contacting the tab 139.

35

The second rib 145 is provided for, during the retraction of the needle guard 20 toward its retracted position, engaging the corresponding guiding element defined by the axial edge 57 of the leg 52 and, in the final state of the injection device after the injection, engage the transverse edge 56 of the corresponding leg 52 and thus prevent the needle guard 20 from being proximally retracted.

The second rib 145 therefore provides a stop feature selectively engaging the needle guard 20 for, in a first phase of the operation of the device, allowing axial displacement of the needle guard 20 and, in a final state of the device, preventing the needle guard 20 from being proximally retracted. This will be further explained in the following.

The sleeve body 131 of the trigger member 35 is also provided, on an inner surface thereof, with a cam track 150 for receiving the prong 105 of the retaining member 33. The cam track 150 has, proximally extending from an open distal end 151, an axial channel 151 and a transversally oriented dead-end channel 155 connected with axial channel 151. As visible o FIG.6A, an internal rear wall of the dead-end channel 155 is inclined with respect to the main axis X while an internal front wall is perpendicular to the main axis X.

The cam system constituted by the prong 105 and the cam track 150 define lockout features of a lockout mechanism for locking the needle guard 20 in an extended position corresponding to the final state of the device after the injection i.e. for preventing retraction of the needle guard 20 once the device has been fired and once the needle guard 20 has been returned to its extended position by the needle guard spring 21.

Furthermore, the sleeve body 131 is provided, radially projecting therefrom in a proximal region, with a stop member in the form of a collar 160 that defines a seat for the trigger spring 37.

As visible on FIG.2 and 2A, the trigger spring 37, arranged between the needle guard 20 and the housing 3, bears at the proximal end on the closing wall 73 of the rear housing 3b and at the distal end on the collar 160.

Starting from the initial configuration of the injection device 10 (device as stored) illustrated on FIG. 2 and 2A, the main steps for operating the device will now be described with reference to FIG.7-11.

5 In the initial configuration of FIG.2, 2A, it will be noted that the plunger rod 31 is retained in its proximal position by the engagement of the protrusions 89 with the stop surface of the rim 103 against the biasing action of the pre-compressed injection spring 34. The resilient arms 85 axially project through the bore 102, with the protrusions 89 and the stop surface of the rim 103 being in mutual engagement, and are prevented from inwardly
10 deflecting by the engagement of the pin 135 between the resilient arms 85.

In this initial configuration, the trigger spring 37 is compressed between the rear housing 3b and the trigger member 35, whereby the trigger member 35 is biased to its blocking position wherein the pin 135 engages the gap 87 between the resilient arms 85.

15 The trigger member 35 is retained in this blocking position by the mutual releasable engagement of the locking features constituted by the tabs 139 and the radial stops 79, which in this position prevent the trigger member 35 from axial displacement in the proximal direction. Obviously, the trigger member 35 is also prevented from distally
20 moving by the arms 85 stopping the wall 73 of the trigger member 35.

In this initial configuration, the needle guard 20 is prevented from moving distally by the flap edge 59 engaging the stop surface 46. The needle guard 20 has also a limited ability of proximal displacement against the biasing action of the needle guard spring 21 due to
25 the interaction of the projections 54 with the constriction 70 of the cap 22.

Prior to using the device 1, the user needs to remove the cap 22 by twisting the cap 22 for releasing the threaded connection 49, 64 between the cap 22 and the front housing 3a, and then axially detach the cap 22 from the front housing 3a. In doing so, the user
30 removes the sheath 15 from the needle 8, the sheath 15 being retained in the grip sleeve 65 of the cap. The needle 8 remains protected by the needle guard 20, which is then in its fully extended position, and unexposed.

The device is then ready to proceed with an injection. When uncapped, the device is in the same configuration as the one shown on FIG.2, 2A, with only the cap 22 and the sheath 15 removed and the needle guard 20 free to move further proximally.

5 For triggering the device 1 and injecting the medicament 7 contained in the medicament container 5 (syringe), the user needs to press the distal end of the device, i.e. the tip constituted by the annular rim 51 of the needle guard 20, on the injection site. When pressed against the action of the needle guard spring 21, the needle guard 20 starts to be partially retracted within the housing 3.

10 In the configuration illustrated on FIG.7, 7A, 7B, the needle guard is partially retracted in the housing 3 thus exposing the tip of the needle 8 that penetrates the tissue of the user.

The legs 52 are axially guided between the guiding walls 113 with the axial edges 57
15 sliding on the respective second rib 145 of the trigger member 35. During this phase, the legs 52 slide over the respective ramps 141 of the cantilever arms 137, thus inwardly deflecting the arms 37 and releasing the tabs 139 from the corresponding radial stops 79 of the housing 3. In this configuration, the trigger member 35 has not moved with respect to the initial configuration, either axially or rotationally. The prong 105 is engaged in the
20 cam track 150 and positioned in the rearmost portion of the axial channel 153.

In this partially retracted configuration, it will be noted with reference to FIG.7 that, while the locking features 79, 139 are released, the trigger member 35 is still in its axial blocking position wherein the pin 135 is inserted in the gap 87 and prevents inward deflection of
25 the resilient arms 85, thus preventing the disengagement of the protrusions 89 from the stop surface of the rim 103. The trigger member 35 is maintained in its blocking position under the biasing action of the trigger spring 37.

By continued pressured applied to the device 1 against the injection site, the needle guard
30 is further retracted into the housing until it reaches its fully retracted position, thereby exposing the whole length of the needle to be inserted in the user's tissue.

This configuration is represented on FIG.8, 8A, 8B.

To reach this configuration, the needle guard 20 is retracted such that the free end 55 of the legs 52 bears on the respective first rib 143 and thus in turn pushes the trigger member 35 in the proximal direction against the action of the trigger spring 37. The pin 135 is therefore disengaged from the gap 87 in the fully retracted position of the needle guard 20 (as shown on FIG.8, 8A, 8B), whereby the latching features 89, 103 are released.

This configuration corresponds to the release position of the trigger member 35, wherein the resilient arms 85 are free to inwardly deflect and wherein, under the action of the injection spring 34, the protrusions 89 are disengaged from the stop surface of the rim 103.

During that phase of operation, the trigger member 35 is still prevented from rotating over the retaining member 33 due to the engagement of the prong 105 in the axial channel 153. In the fully retracted position of the trigger member 35, the prong 105 is located at the open end 151 of the cam track 150, at least partially within the axial channel 153, thus still preventing rotation of the trigger member 35 relative to the retaining member 33.

As the latching features are released, the plunger rod 31 can be driven forward to its distal position (as shown on FIG.9) under the action of the injection spring 34, thus pushing the plunger 9 forward in the medicament container and expelling the medicament.

It will thus be appreciated that the retraction of the needle guard 20 sequentially causes the release of the blocking features 79, 139 and then, upon further retraction, the axial displacement of the trigger member 35 from its blocking position to its release position. This in turn causes the latching features 89, 103 to be released and the firing of the injection device, wherein the injection spring 34 drives the plunger rod 31 to its distal position, thereby injecting the medicament.

The presence of the trigger spring 37 ensures that, after the blocking features 79, 139 are released, the free end 55 of the leg 52 and the first rib 143 stay mutually engaged. This ensures that the release of the latching features 89, 103 – and thus the activation of the device – occurs at the appropriate needle insertion depth, corresponding to the fully retracted position of the needle guard 20.

The configuration illustrated on FIG.9, 9A, 9B corresponds to the user starting to release the pressure on the device once the injection has been completed. The plunger rod 31 is in its distal position and the needle guard 20 is returned to a partially extended position under the action of the needle guard spring 21.

5 To reach that configuration, the legs 52 slide back distally over the ramps 141 thereby releasing the cantilever arms 137 that can flex back outward to their initial position as the trigger member 35 is biased in the distal direction by the trigger spring 37. Under the action of the trigger spring 37, the trigger 35 is thus moved axially forward, whereby the
10 axial channel 153 is moved so as to receive prong 105. In this relative motion, the prong 105 is brought in engagement at the end portion of the axial channel 153 with a transverse surface of the dead-end channel 155 (as visible on FIG.7B).

Under the action of the trigger spring 37, the mutual engagement of the prong 105 with
15 the cam track 150 causes the prong 105 to be biased toward the dead-end channel 155. However, the relative rotation of the trigger member 35 and the retaining member 33 is prevented as the second rib 145 bears on the axial edge 57 of the leg 52. The relative rotation is prevented until the needle guard 20 is returned to its fully extended position, corresponding to the second rib 145 reaching the proximal end of the edge 57.

20 In the final state of the device after the injection and once the user has fully withdrawn the device from the injection site and fully released the pressure on the device, the needle guard 20 is returned to its fully extended position, also corresponding to its position of FIG.2, wherein it fully covers the needle 8.

25 This final configuration is illustrated on FIG.10, 10A, 10B.

To reach this configuration, the needle guard 20 has distally moved over a distance such that the axial edge 52, after sliding on the second rib 145, reaches a position wherein the
30 notch 56 is located in correspondence with the second rib 145, thus allowing the trigger member 35 to rotate.

Under the action of the trigger spring 37 and the mutual engagement of the cam follower (the prong 105) in the cam track 150, the trigger member 35 is caused to rotate with the
35 inclined rear wall of the dead-end channel 155 being forced to slide on the prong 105.

The second rib 145 then engages the corresponding transverse edge formed by the notch 56, thereby locking out the needle guard 20 in its fully extended position. This prevents the needle guard 20 from being retracted again and, as a safety measure, the needle to be exposed for avoiding risks of injuries.

5 It will be appreciated that the cam system 105, 150 allows or prevents relative displacements, whether axial or rotational, of the trigger member 35 relative to the retaining member 33 depending on the axial displacement and position of the needle guard 20.

10 The trigger member 35 is preventing from rotating by the prong 105 riding within the axial channel 153. In both the blocking and release positions of the trigger member 35, the prong 105 is engaged within the axial channel 153, preventing relative rotation.

15 In order to enable the rotation of the trigger member 35 during lockout, the trigger member 35 must move distally, under action from the trigger spring 37, until the prong 105 is completely free from the axial channel 153. This state, shown in Figure 9B, can only be realized once the plunger rod 31 is released. Once the arms 85 can no longer interfere with the trigger member 35, the trigger member 35 will be able to move distally beyond
20 the initial position thereof (as shown on FIG.2), and the prong 105 will eventually exit the axial channel 153. This happens just before the prong 105 makes contact with the dead-end channel 155. Once the prong 105 exits the axial channel 153 and contacts the dead-end channel 155, the second rib 145 will make contact with the axial edge 57 of the needle guard 20, preventing rotation of the trigger member 35 until the needle guard has returned
25 to its fully extended state.

If the user pushes on the needle guard 20 in this state of the device, the transverse edge 56 of the needle guard 20 contacts the second rib 145 and the front wall of the dead-end channel 155 then pushes against the prong 105, which is rigidly fixed to the housing 3.
30 The front wall of the dead-end channel 155 is oriented such that no relative rotation can be caused by the front wall of the dead-end channel 155 axially pressing on the prong 105. In the illustrated embodiment, this is achieved by the front wall of the dead-end channel being perpendicular to the main axis X.

In alternative embodiments (not shown), the cam system may be inverted, with the cam follower being provided on the trigger member and the cam track being provided on the retaining member. In that configuration, the cam follower may be in the form of a prong that radially and inwardly projects from the sleeve body of the trigger member. The
5 illustrated embodiment is preferred though as the components are easier to manufacture with conventional injection molding methods.

In further alternative embodiments (not shown), the locking features corresponding to the radial stops 79 and the tabs 139 may be provided in a different arrangement, wherein the
10 radial stops are formed by recesses in the retaining member and the tabs are formed on cantilever arms radially projecting inward from the sleeve body of the trigger member. In such embodiments, the legs of the needle guard are slidably engaged radially between the retaining member and the trigger member. The retraction of the needle guard, in that
15 case, causes an outward deflection of the cantilever arms (as opposed to an inward deflection in the illustrated preferred embodiment) and the release of the locking features. Also, in such embodiments, the first and second ribs corresponding to the ribs 143, 145 project radially inward from the sleeve body of the trigger member.

It will be appreciated that the device according to the invention includes safety features,
20 such as preventing unintentional firing, that are achieved by relatively simple means eliminating the need for additional components and handling steps. The invention provides a high degree of robustness and reliability that is particularly essential for emergency devices that are used in combination with life-saving drugs.

CLAIMS

1. Injection device comprising

- an elongated housing (3) extending along a longitudinal axis (X) and configured to receive a medicament container (5) provided with a barrel (6) containing the medicament (7), a needle (8) attached thereto and a plunger (9) displaceable within the barrel to expel the medicament through the needle;

- a needle guard (20) telescopically mounted in the housing (3) and axially movable between an extended position, wherein the needle guard distally protrudes from the housing (3) and surrounds the needle (8), and a retracted position proximally spaced from the extended position corresponding to the condition of pressing the device against an injection site for firing the injection device (1);

- an injection drive mechanism (25) for driving the plunger (9) within the barrel (6) and thus expelling the medicament (7), the injection drive mechanism including

- a plunger rod (31) axially movable within the housing (3), between a proximal position and a distal position, for driving the plunger within the barrel;
- an injection spring (34) arranged for biasing the plunger rod (31) to its distal position;
- a retaining member (33) fixed within the housing (3) for, in an initial state of the injection device, retaining the plunger rod (31) in its proximal position against the biasing action of the injection spring (34), the retaining member (33) and the plunger rod (31) having corresponding latching features (85, 89, 103) including a stop surface (103) and a corresponding radially deflectable resilient arm (85) formed with a protrusion (89), whereby the plunger rod (31) is retained in its proximal position by the engagement of the protrusion (89) with the stop surface (103); and
- a trigger member (35) comprising a blocking feature (135), and being axially displaceable by the needle guard (20) when moving from its extended position to its retracted position, from a blocking position, wherein the blocking feature (135) prevents the radial deflection of the resilient arm (85) thus preventing the disengagement of the protrusion (89) from the corresponding stop surface (103), to a release position wherein the resilient arm (85) is free to radially deflect whereby the protrusion (89) is disengaged from the corresponding stop surface (103) under the biasing action of the injection spring (34),

wherein the trigger member (35) and the housing (3) comprise corresponding locking features (79, 139) in mutual releasable engagement for maintaining the trigger member (35) in its blocking position, and wherein said locking features are designed to be released by the needle guard (20) when moving from its extended position to its retracted position, whereby the retraction of the needle guard (20) causes the release of the locking features (79, 139), the release of the latching features (85, 89, 103) and thus the firing of the injection device.

2. Injection device according to claim 1, wherein the needle guard (20) has a sheath portion (50) for surrounding the needle (8) in the extended position, the sheath portion (50) having a through hole (53) at the distal end for the passage of the needle (8) when the needle guard (20) is retracted, and a leg (52) axially and proximally projecting from the sheath portion (50), said leg having a free end (55) for engaging and displacing the trigger member (35) when the needle guard (20) is retracted.

3. Injection device according to claim 2, wherein the leg (52) has a notch (56) distally spaced from the free end (55) of the leg and forming a transverse edge that defines a stop surface for, in a final state of the injection device after the injection, preventing the needle guard (20) from being proximally retracted.

4. Injection device according to claim 3, wherein the leg (52) has an axial edge (57) with a section extending between the sheath portion (50) and the notch, that defines a guiding element slidingly cooperating with a corresponding guiding element (113) of the retaining member (33) during axial displacement of the needle guard (20).

5. Injection device according to any one of claims 1 to 4, wherein the latching features (85, 89, 103) include a pair of resilient arms (85) formed on the plunger rod (31) at the proximal end thereof and extending axially, respective protrusions (89) being formed at the free end of each resilient arm (85).

6. Injection device according to claim 5, wherein the retaining member (33) comprises a radial wall having an axial bore (102) with a circumferential rim (103) defining the stop surface of the latching features.

7. Injection device according to claim 6, wherein the protrusions (89) are radially and outwardly protruding from the respective resilient arms (85), the resilient arms axially projecting from the radial wall through the bore (102), with the protrusions and the stop surface mutually engaged, when the plunger rod (31) is in its proximal position.

5

8. Injection device according to claim 7, wherein the blocking feature includes an axial pin (135) that, in the blocking position of the trigger member (35), prevents the inward deflection of the resilient arms (85) and hence disengagement of the protrusions (89) from the stop surface (103).

10

9. Injection device according to any one of claims 1 to 8, wherein the housing (3) comprises at least a recess (79) and the trigger member (35) comprises a sleeve body (131) and, outwardly projecting from the sleeve body, at least a cantilever flexible arm (137) provided with a radial tab (139) at the free end thereof for releasable engagement with the recess (79) of the housing (3), the locking features including said tab (139) and corresponding recess (79).

15

10. Injection device according to claims 2 and 9, wherein the sleeve body (131) is provided with a first rib (143) for engagement with the free end (55) of the leg (52) when the needle guard (20) is retracted, whereby the trigger member (35) is caused to be proximally displaced.

20

11. Injection device according to claim 9 or 10, wherein the tab (139) is biased into engagement within the recess (79) by the cantilever flexible arm (137) and the cantilever flexible arm is inwardly deflectable by the needle guard (20) for the release of the tab (139) from the recess (79).

25

12. Injection device according to claim 11, wherein the cantilever flexible arm (137) comprises a ramp (141) for engagement with the needle guard (20), the profile of the ramp determining an inward deflection of the cantilever flexible arm (137) caused by an axial displacement of the needle guard (20), when the needle guard is moved in the proximal direction.

30

13. Injection device according to any one of claims 9 to 12, wherein the housing (3) and the trigger member (35) respectively have a pair of diametrically opposed recesses (79) and corresponding cantilever flexible arms (137).

14. Injection device according to any one of claims 9 to 13, wherein the trigger member (35) includes, radially projecting from the sleeve body (131), a second rib (145) for selective engagement with the needle guard (20) for preventing the needle guard from being proximally retracted.

15. Injection device according to claim 14, wherein the second rib (145) is arranged on the sleeve body (131) for, in the final state of the injection device after the injection, engaging the transverse edge (56) of the leg and thus preventing the needle guard (20) from being proximally retracted.

16. Injection device according to claims 9 and 15, wherein the second rib (145) is distally spaced from the first rib (143).

17. Injection device according to any one of claims 9 to 16, further comprising a trigger spring (37) arranged between the housing (3) and the trigger member (35) for distally biasing the trigger member, whereby the trigger member, in the initial state of the injection device, is biased to its blocking position.

18. Injection device according to claims 9 and 17, wherein the trigger member (35) includes, radially projecting from the sleeve body (131), a stop member (160) defining a seat for the trigger spring (37).

19. Injection device according to any one of claims 1 to 18, wherein the trigger member (35) and the retaining member (33) comprise lockout features in mutual engagement for locking the needle guard (20) in an extended position corresponding to the final state of the device after the injection, wherein the lockout features include a cam follower (105) provided on one and a cam track (150) provided on the other of the trigger member (35) and retaining member (33).

20. Injection device according to claims 9 and 19, wherein the retaining member (33) has a substantially cylindrical hollow body (101) and the sleeve body (131) of the trigger

member (35) fits over said cylindrical hollow body, with the sleeve body (131) being able, depending on the axial displacement and position of the needle guard (20), to slide or rotate with respect to the cylindrical hollow body (101).

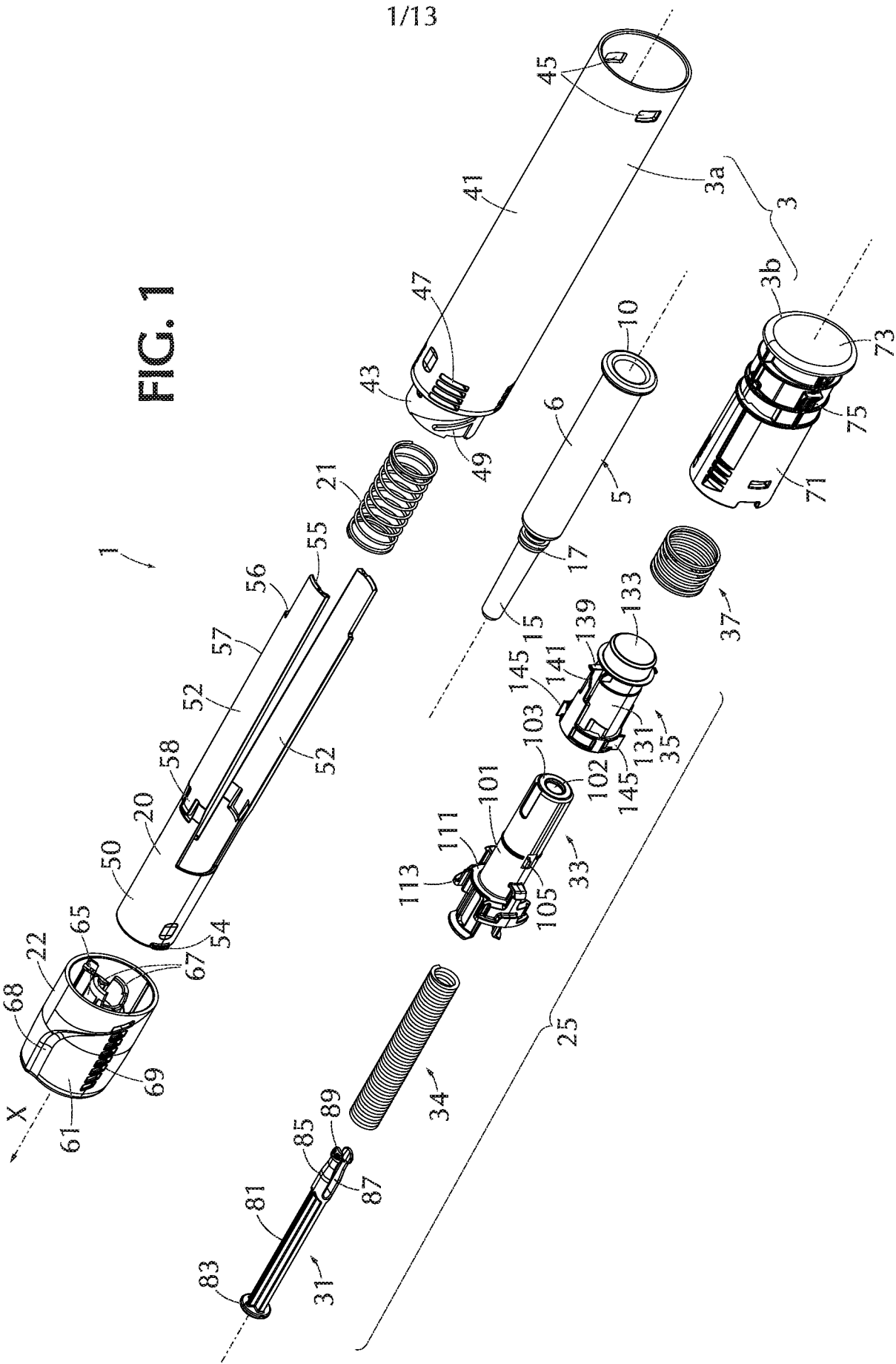
5 21. Injection device according to claims 19 and 20, wherein the cam follower (105) is provided on the retaining member (33) and includes a prong (105) radially and outwardly projecting from the cylindrical hollow body (101), and the cam track (150) is provided on the sleeve body (131) of the trigger member (35).

10 22. Injection device according to claims 6 and 21, wherein the cylindrical hollow body (101) is provided for housing the injection spring (34) and the radial wall, arranged at the proximal end of the cylindrical hollow body (101), defines a seat for the injection spring.

15 23. Injection device according to anyone of claims 19 to 22, wherein the cam track (150) has a transversally oriented dead-end channel (155) connected with an axial channel (153) extending in the proximal direction, the axial channel having an open proximal end (151).

20 24. Injection device according to claims 15 and 23, further including a needle guard spring (21) biasing the needle guard (20) in the distal direction, wherein the prong (105) is forced toward the dead-end channel (155), whereby the trigger member (35) is caused to rotate and the second rib (145) to engage the transverse edge (56) of the leg (52), when the needle guard (20), under the action of the needle guard spring (21), moves back to an extended position corresponding to the final state of the device after the injection.

25 25. Injection device according to any one of claims 1 to 24, wherein the injection spring (34) is designed to impart to the plunger rod (31), in its proximal position, a force overcoming the retention force of the latching features in mutual engagement, whereby the release of the blocking feature (135) causes the latching features to disengage and
30 the injection spring (34) to drive the plunger rod (31) to its distal position.



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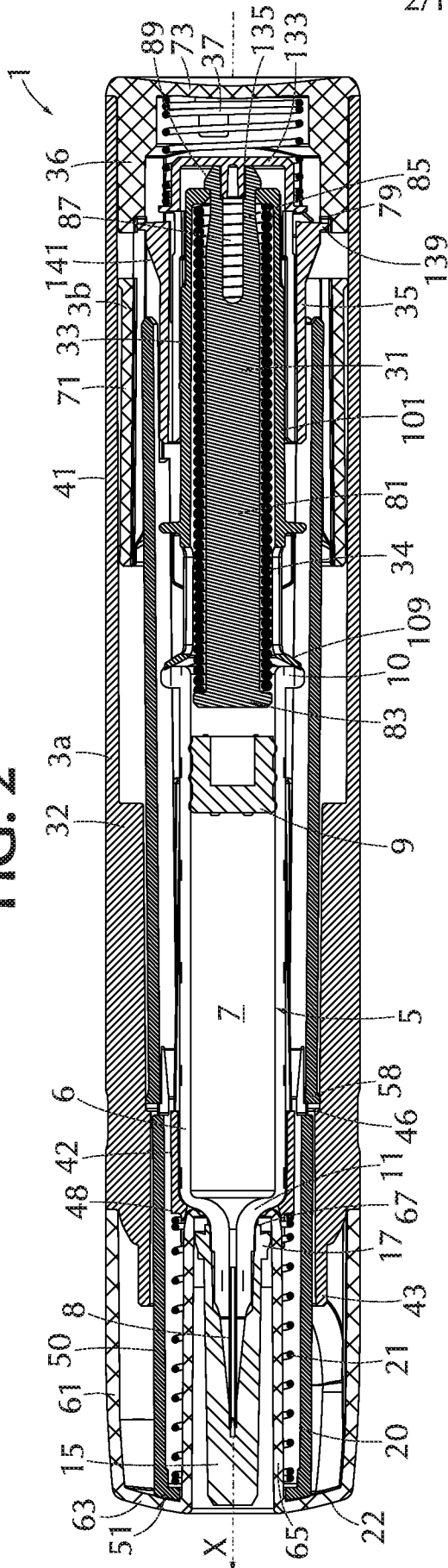


FIG. 2A

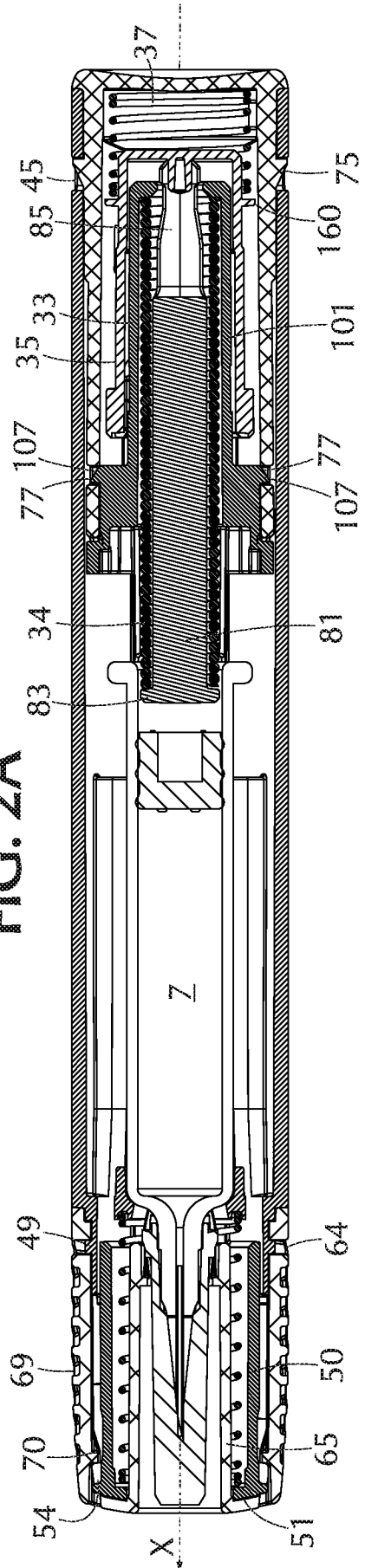


FIG. 3

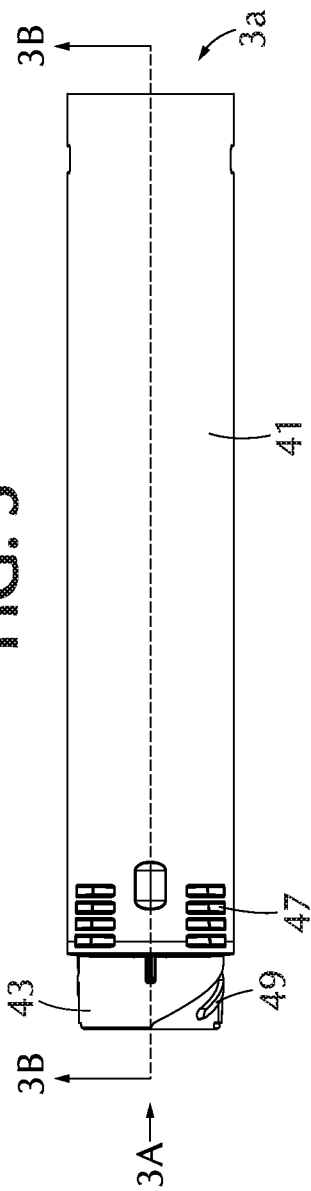


FIG. 3B

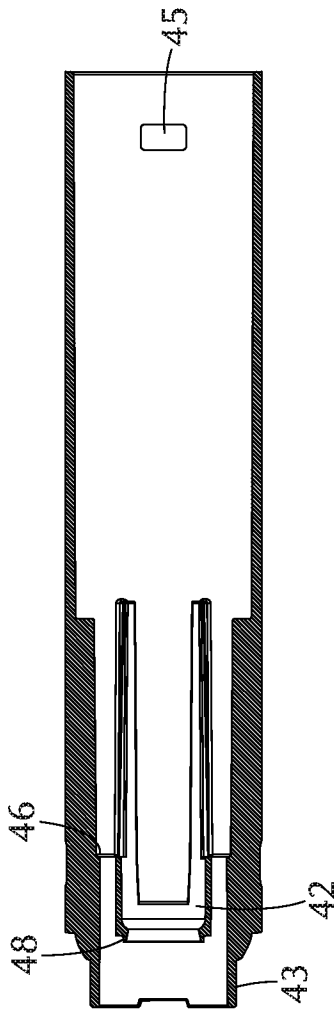
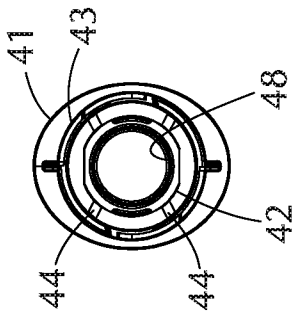
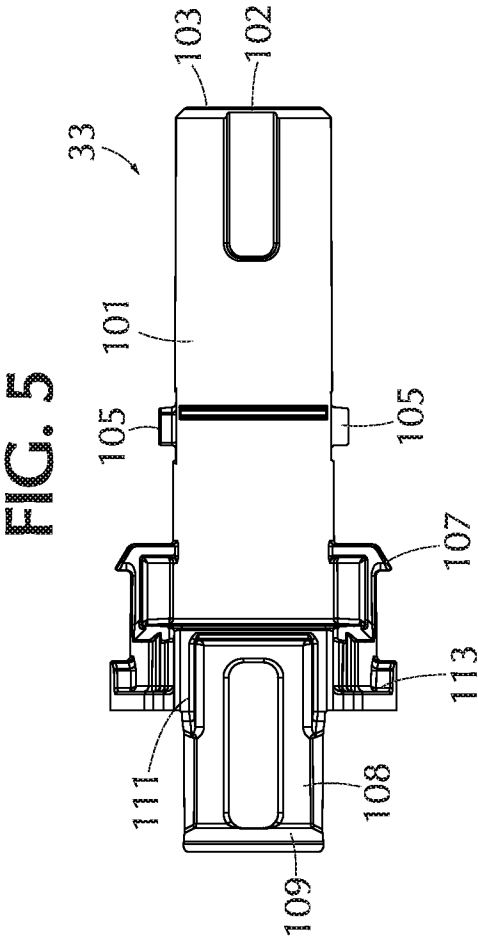
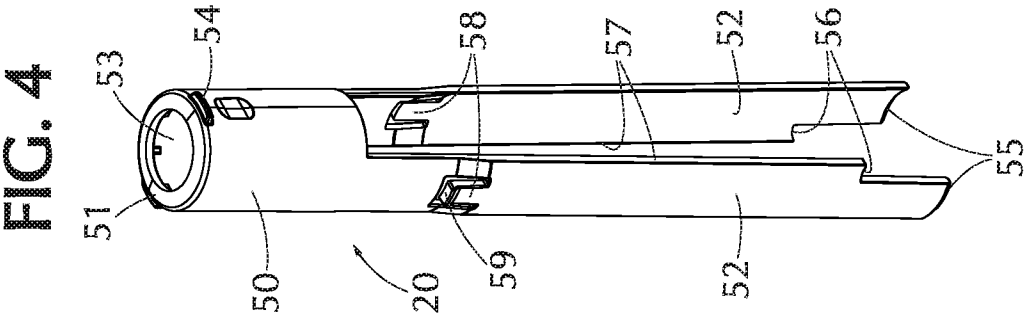
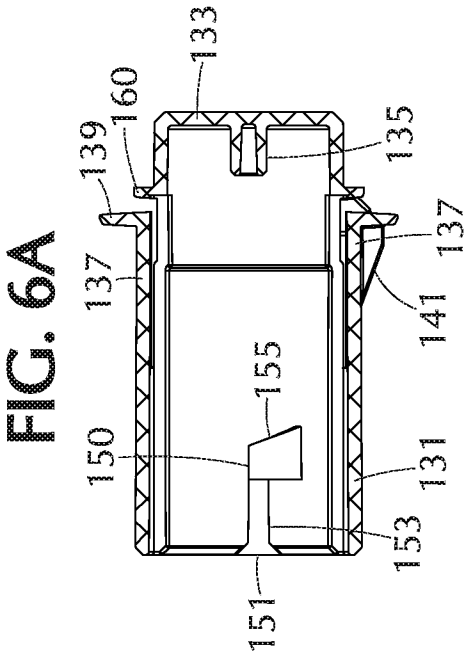
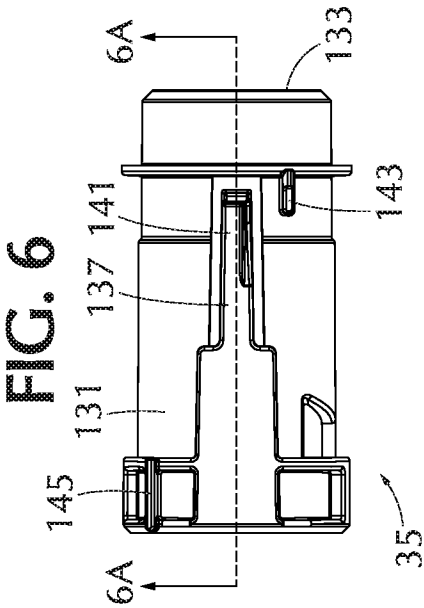


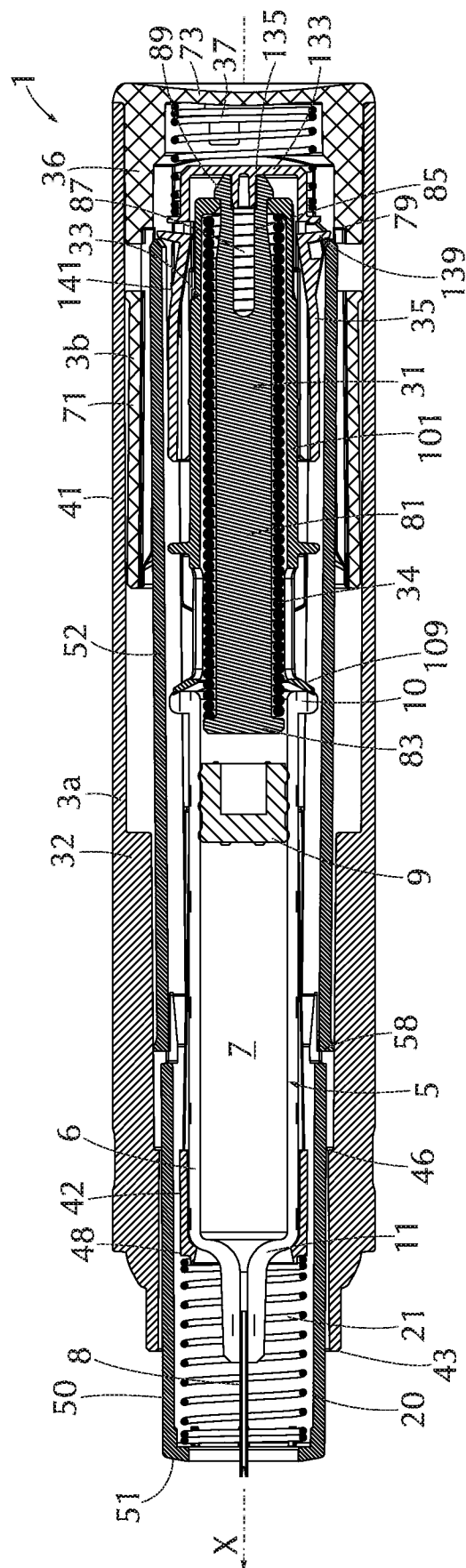
FIG. 3A







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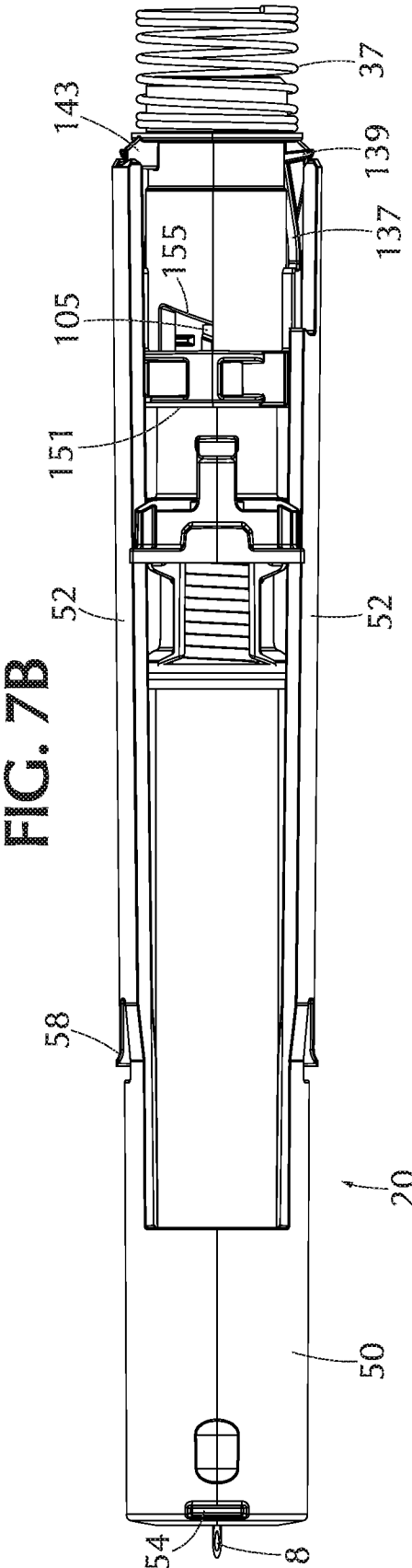
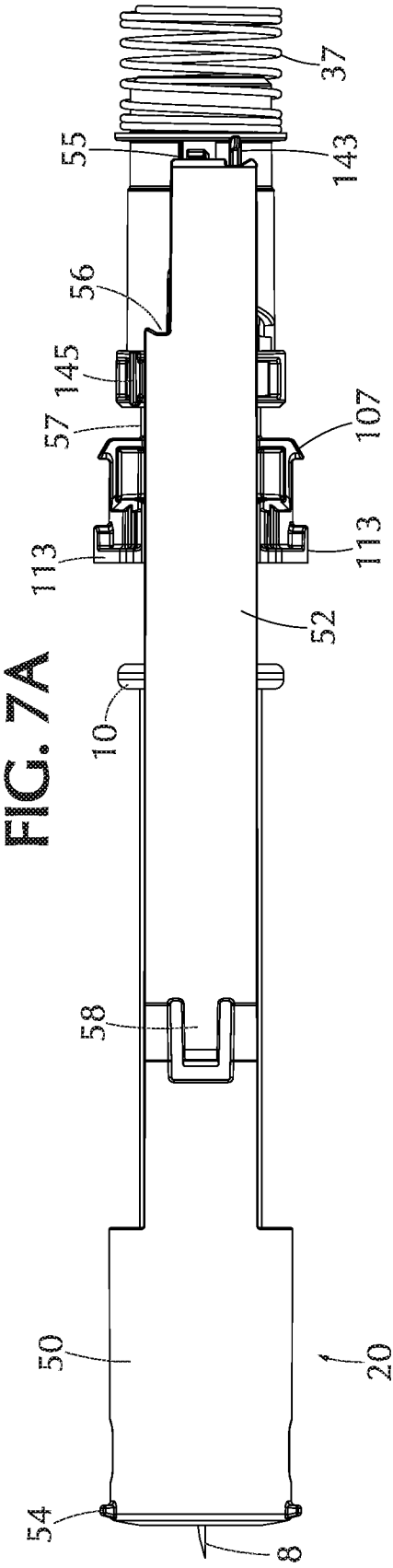


FIG. 8

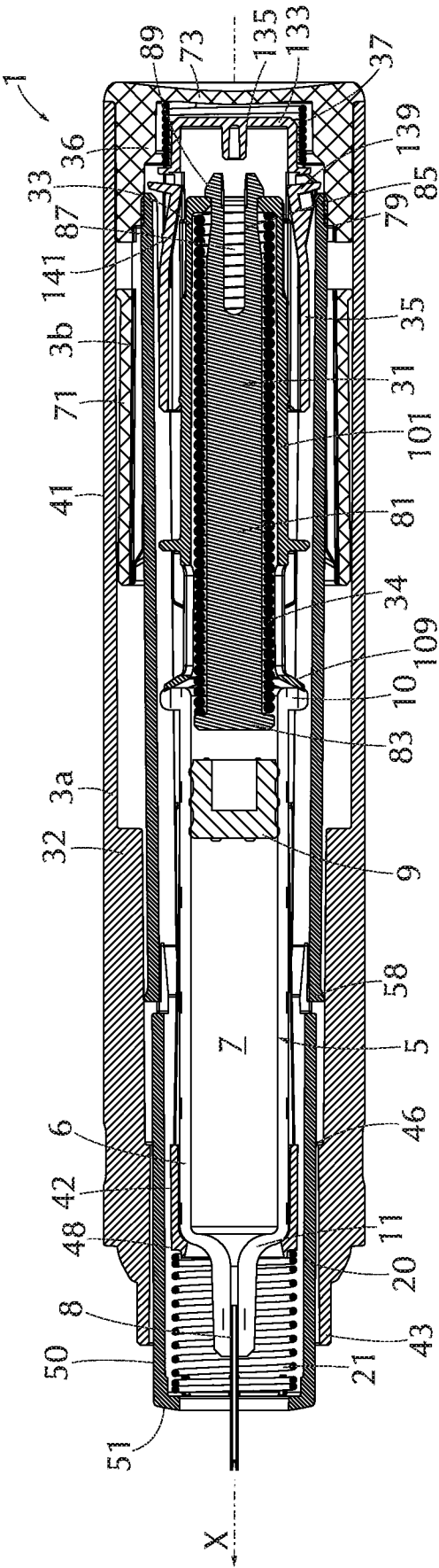


FIG. 8A

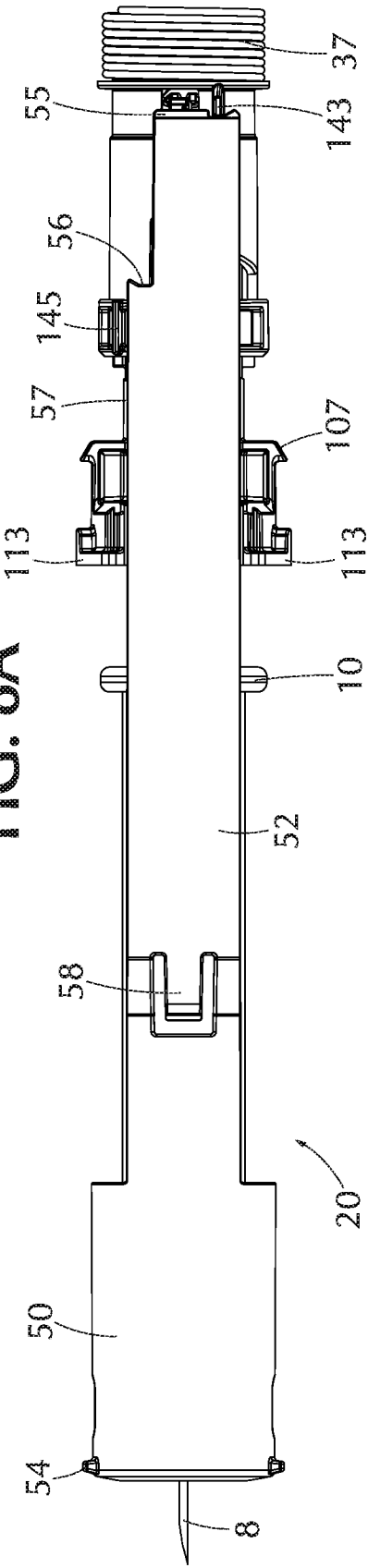


FIG. 8B

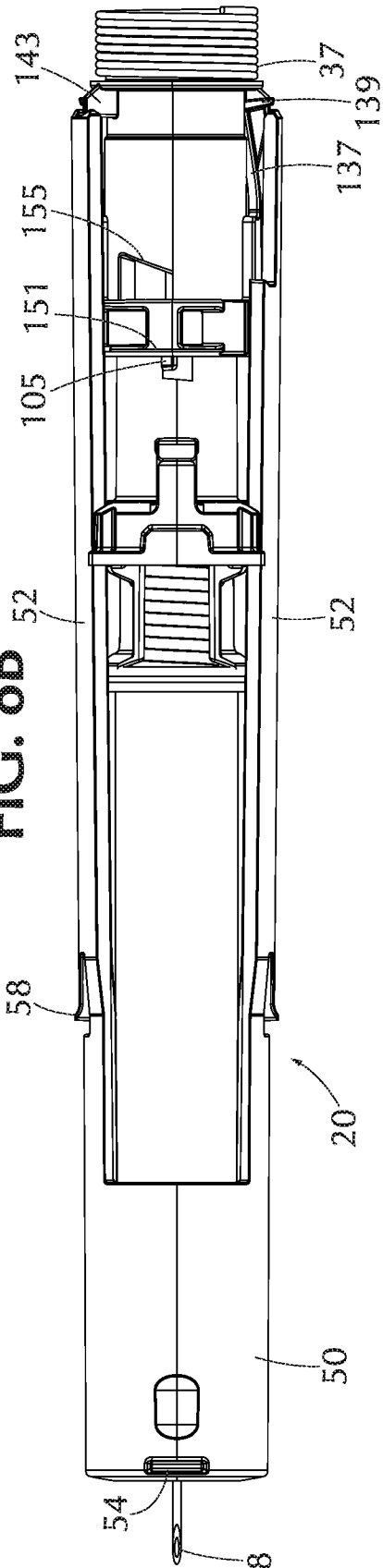
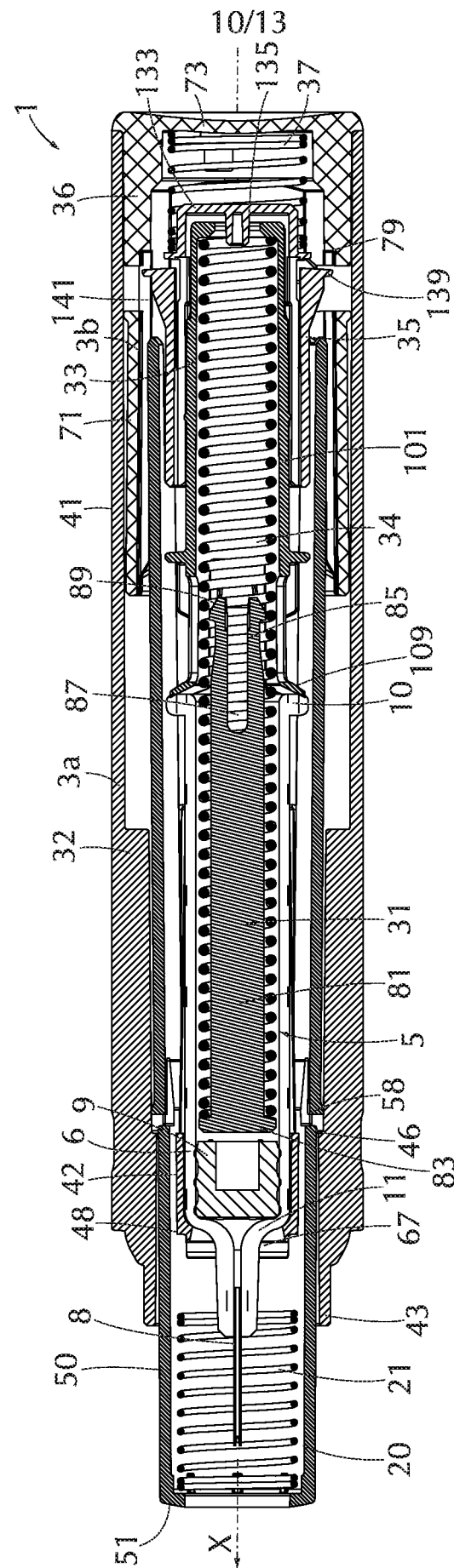
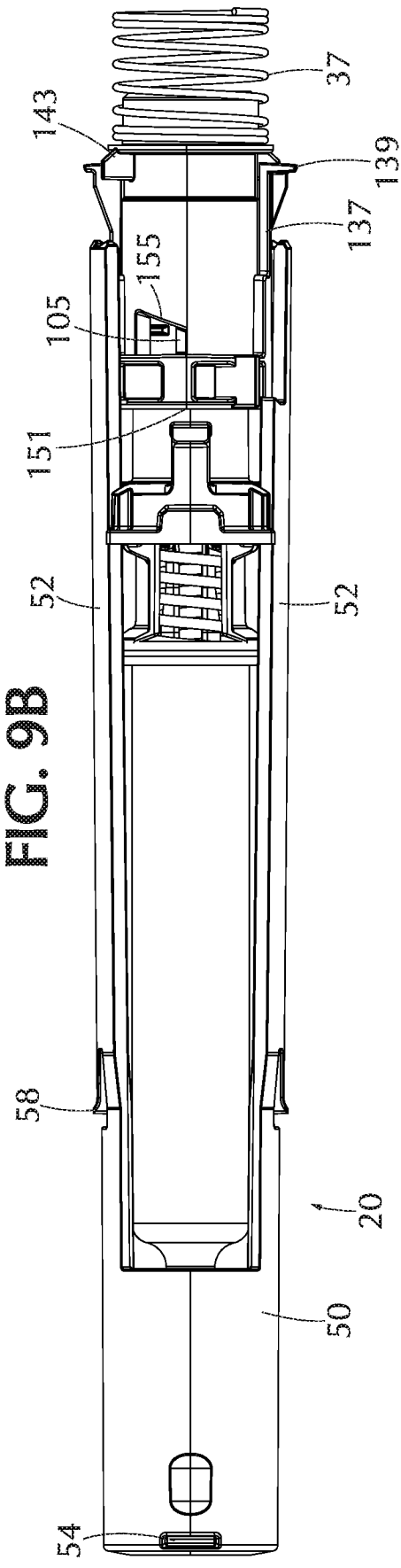
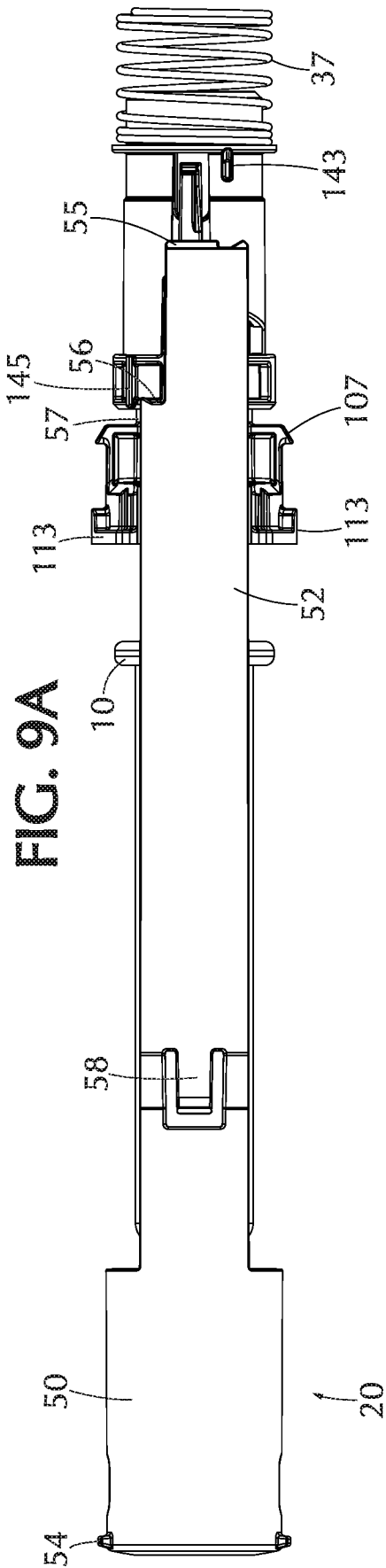
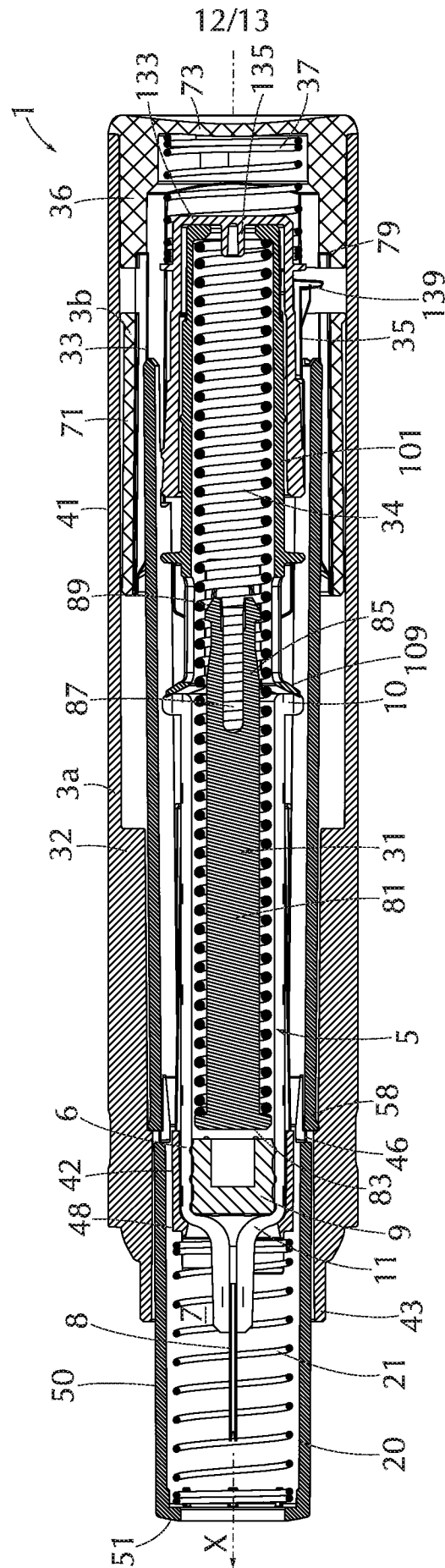


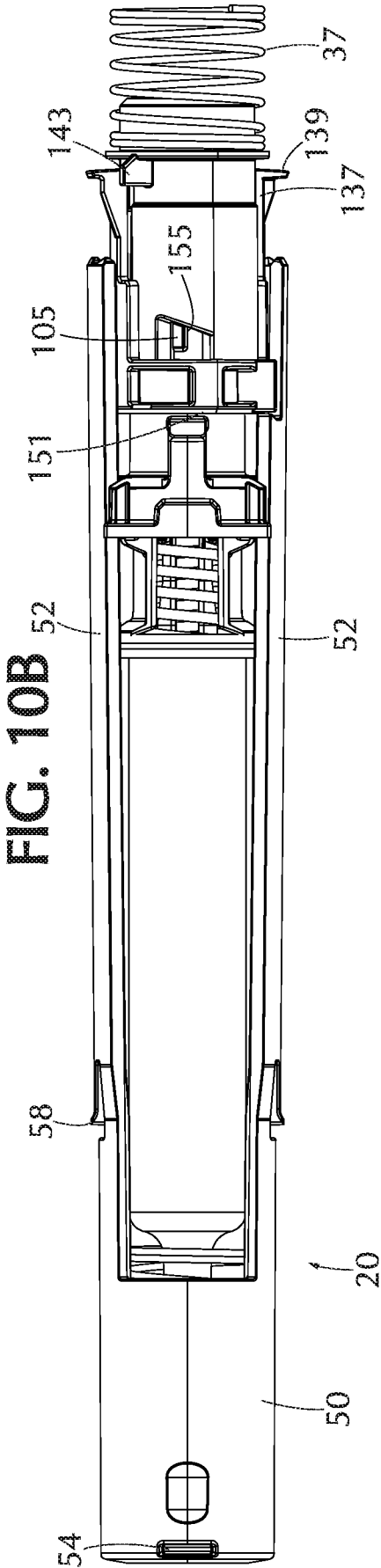
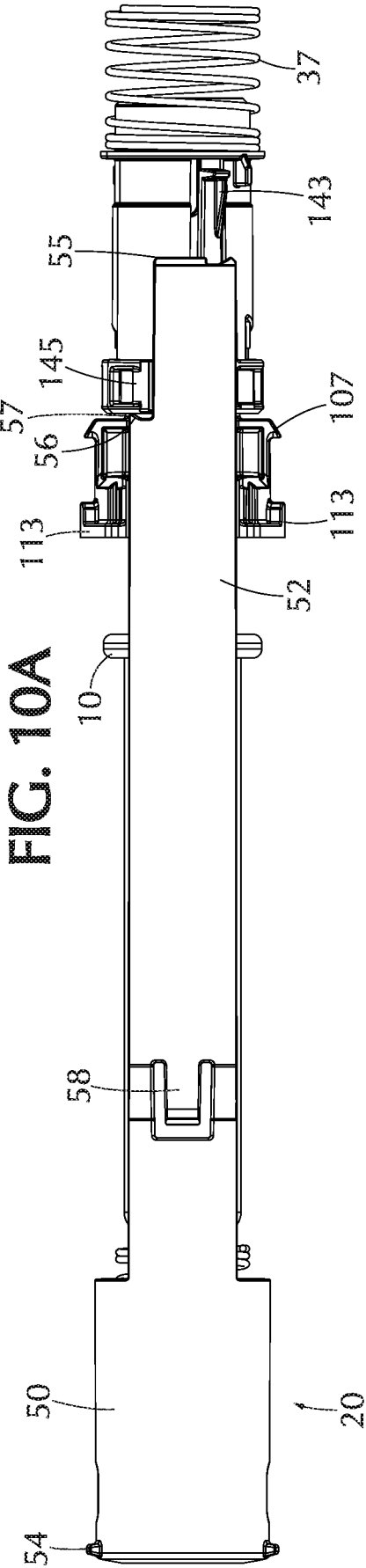
FIG. 9





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INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2024/051610

A. CLASSIFICATION OF SUBJECT MATTER INV. A61M5/20 A61M5/315 A61M5/32 ADD.		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) A61M		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2014/336589 A1 (SUND JULIUS C [US] ET AL) 13 November 2014 (2014-11-13) paragraphs [0051] - [0054] paragraphs [0066] - [0069] figures 7, 9, 11 -----	1-25
A	US 2013/237921 A1 (LANNAN JAMES W [US] ET AL) 12 September 2013 (2013-09-12) the whole document -----	1-25
A	US 2020/324051 A1 (ATTERBURY WILLIAM G [US] ET AL) 15 October 2020 (2020-10-15) paragraphs [0029] - [0031] figures 1-4 -----	19-23
☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 16 April 2024		Date of mailing of the international search report 07/05/2024
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Kollar, Julien Felix

INTERNATIONAL SEARCH REPORT

Information on patent family members

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