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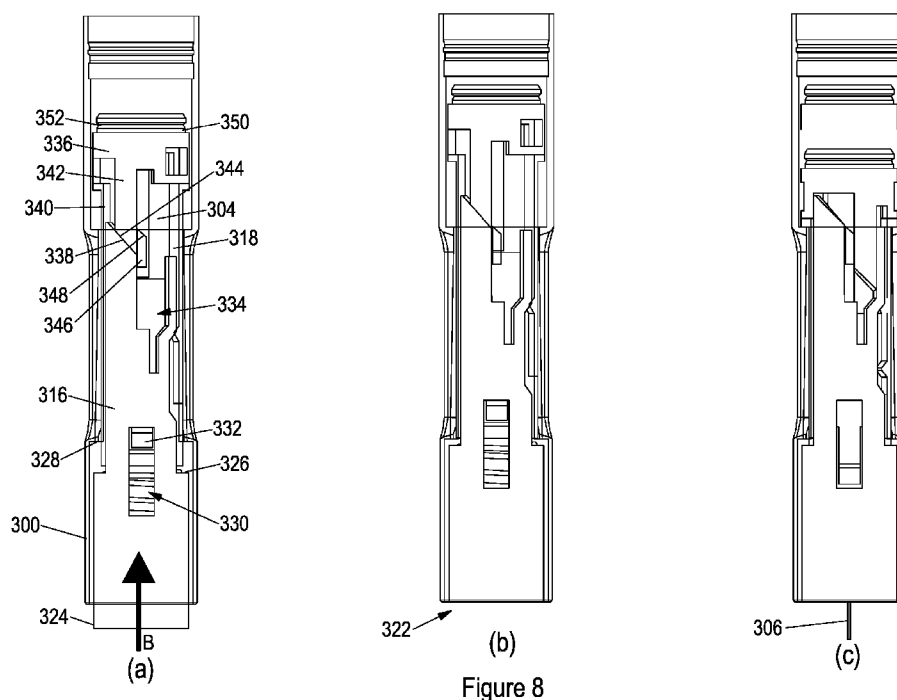
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(57) Abstract: An injection device for receiving a syringe (204, 304) therein and for delivering a dose of medicament from the syringe, the injection device comprising: an insertion driver configured to drive the syringe forwards within the injection device for inserting a needle (206, 306) of the syringe into an injection site; an interlock mechanism configured to retain the insertion driver in a primed state and, when actuated, to allow the insertion driver to drive the syringe forwards; and an interlock actuator (316, 318, 350) configured to be displaced rearwards within the injection device to cause corresponding rearward displacement of the a barrel (304) of the syringe to actuate the interlock.

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INJECTION DEVICE

Technical field

- 5 This invention relates to injection devices for delivering a dose of medicament from a syringe. In particular, but not exclusively, the invention relates to an autoinjector type device which facilitates powered or power assisted needle insertion and injection.

Background

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Injection devices are used for the convenient administration of medicaments. For example, injection devices (which may typically be in the form of a pen injector) may be used for providing a single metered dose of a medicament, for example such as Epinephrine in an emergency or for providing regular metered doses of a medicament
15 such as Insulin. Such devices may be either single use "disposable" devices in which the device is typically provided with a syringe already installed, and which is not user-replaceable, or "reusable" devices which allow the user to replace the syringe when the medicament has been used.

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It is noted that whilst the term "syringe" is used herein for clarity and consistency, this term is not intended to be limiting. In some arrangements the syringe may for example be a cartridge (which, for example, may be arranged to receive a disposable needle) or other medicament container. In some arrangements the syringe/cartridge/medicament container may be formed integrally with the (or part of the) injection device.

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Injection devices may be provided in the form of an "autoinjector" device, in which, in addition to automating the delivery of the medicament, the device is also arranged to automate the insertion of a needle into the skin prior to the delivery of the medicament.

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Injection devices generally comprise a delivery arrangement which is arranged to automatically deliver a dose from the syringe, and optionally (in the case of an autoinjector) to first displace the syringe within the housing to cause needle penetration. The delivery arrangement generally acts via a plunger which includes or engages a piston (also referred to as a "bung") which is slidably provided within the syringe. In the case of an autoinjector the initial static friction or "stiction" between the
35 bung and syringe resists forward movement of the piston relative to the syringe such

that initially the delivery arrangement moves the syringe and piston forward into the needle insertion position. Here, further movement of the syringe is blocked and the delivery arrangement will continue to move forward, overcoming the stiction, and moving the piston and the bung through the syringe.

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A common form of delivery arrangement includes a driver mechanism which biases the plunger forwardly and a trigger mechanism which holds the plunger (directly or indirectly) against the force of the driver mechanism until the trigger is released. For example the driver mechanism may comprise a drive spring (for example a compression spring) which is held in an energised (or primed position) prior to release by the trigger.

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An injection device of the autoinjector type is described in WO2016/189286.

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At least some embodiments of the invention seek to provide an improved injection device which may help to address some of these problems.

Summary

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According to an aspect of the invention, there is provided an injection device for receiving a syringe therein and for delivering a dose of medicament from the syringe, the injection device comprising: an insertion driver configured to drive the syringe forwards within the injection device for inserting a needle of the syringe into an injection site; an interlock mechanism configured to retain the insertion driver in a primed state and, when actuated, to allow the insertion driver to drive the syringe forwards; and an interlock actuator configured to be displaced rearwards within the injection device to cause corresponding rearward displacement of the a barrel of the syringe to actuate the interlock.

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Optionally, one or more features of the interlock actuator are configured to linearly couple to the barrel such that rearward displacement of the one or more features causes rearward displacement of the barrel, and wherein the one or more features of the interlock actuator are configured to linearly decouple from the barrel after actuation of the interlock to allow forward displacement of the barrel relative to the one or more features of the interlock actuator.

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Optionally, the interlock actuator comprises a syringe carrier configured to be linearly coupled to the barrel, and wherein linear decoupling of the barrel from the one or more features of the interlock actuator comprises linear decoupling of the syringe carrier from the one or more features of the interlock actuator.

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Optionally, the syringe carrier is configured to linearly decouple from the one or more features of the interlock actuator by rotation relative to the one or more further features of the interlock actuator.

10 Optionally, the syringe carrier is configured to rotate relative to the one or more features of the interlock actuator under a force applied to the syringe carrier and originating from the insertion driver.

15 Optionally, the syringe carrier comprises a main body and a collar rotatable relative to the main body, and wherein rotation of the syringe carrier comprises rotation of the collar relative to the main body.

20 Optionally, the one or more features of the interlock actuator comprise a lock out shroud configured, when the interlock actuator is in an operable position, to extend from a forward end of the injection device.

25 Optionally, the lock out shroud comprises a guiding surface configured to urge the collar to rotate on rearward displacement of the lock out shroud, and wherein the injection device is further configured to prevent rotation of the collar until after the interlock actuator has actuated the interlock

30 Optionally, the injection device further comprises a rib configured against which the collar is urged during rearward displacement of the lock out shroud to prevent rotation of the collar until the interlock actuator has actuated the interlock.

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Optionally, the guiding surface is ramped such that a relative force between the lock out shroud and the syringe carrier urges the collar to rotate.

35 Optionally, the collar comprises a ramped surface corresponding to the guiding surface of the lock out shroud and configured to abut the guiding surface during rearward displacement of the lock out shroud.

Optionally, the injection device further comprises a syringe, wherein the interlock actuator comprises the barrel of the syringe.

- 5 According to an aspect of the invention, there is provided an interlock actuator for use in an injection device for receiving a syringe therein and for delivering a dose of medicament from the syringe, the injection device comprising an insertion driver configured to drive the syringe forwards within the injection device for inserting a needle of the syringe into an injection site; and an interlock mechanism configured to
- 10 retain the insertion driver in a primed state and, when actuated, to allow the insertion driver to drive the syringe forwards, the interlock actuator being configured to be displaced rearwards within the injection device to cause corresponding rearward displacement of the a barrel of the syringe to actuate the interlock.
- 15 Optionally, the interlock actuator comprises a lock out shroud configured to be linearly coupled to a syringe carrier during rearward displacement of the interlock actuator.

- Optionally, the syringe carrier is configured to linearly decouple from the lock out shroud after actuation of the interlock to allow forward displacement of the barrel
- 20 relative to the lock out shroud.

According to an aspect of the invention, there is provided a forward section of an injection device comprising the interlock actuator of any preceding claim.

25 Brief description of the drawings

- Figure 1 is a cross-sectional view of an injection device;
- Figure 2 is an exploded view of a rear section of an injection device;
- Figure 3 is a cross-section view and partial end view of an actuation mechanism
- 30 including a velocity regulator, in a pre-fired state;
- Figures 4 to 6 are sequential views corresponding to Figure 3 during the activation of an autoinjection device;
- Figures 7a-b show part of an exemplary injection device at various stages of operation;
- Figures 8a-c show an exemplary forward section of an injection device at various
- 35 stages of operation;

Figures 9a-e show an exemplary rear section of an injection device at various stages of operation; and

Figures 10a-d show features of an exemplary rear section of an injection device.

5 Detailed description

In the following embodiments, the terms "forward" and "front" refer to the patient facing end of the injection device or component thereof. In other words, the front end of the injection device is the end proximal to the injection site during use. Likewise, the term

10 "rear" refers to the non-patient end of the injection device assembly or component thereof. In other words, the term "rear" means distant or remote from the injection site during use. Further, the terms up, down and vertical refer to the situation in which an injection device is held so that the forward end is lowermost and the injection device itself is held vertically. Axial, radial and circumferential are used herein to conveniently

15 refer to the general directions relative to the longitudinal direction of the injection device (or components thereof).

The skilled person will, however, appreciate that these terms are not intended to be narrowly interpreted (and for example, the injection device may have a non-circular and/or irregular form). Typically, regardless of the chosen injection device external

20 profile the syringe or cartridge will have a conventional, generally cylindrical, elongate form and will include or be associated with a needle extending longitudinally from a forward end thereof. Thus, the longitudinal axis of the injection device will typically substantially coincide with (or be parallel to) the axial direction of the syringe or

25 cartridge.

Figure 1 shows a cross-sectional view of a prior art autoinjector 1 as disclosed in WO2016/189286. The autoinjector comprises a housing 10 within which is provided a syringe 5 of medicament. The housing 10 has a generally elongate tubular shape with

30 a generally oval cross-sectional profile (and has a longitudinal axis running through the centre of the syringe).

The syringe 5 is a conventional syringe having a bung 7 within its body and a needle 6 at its forward end which may be initially protected (so as to remain sterile) by a

35 removable needle shield or "boot" 8. The illustrated autoinjector 1 is generally intended to be a single use device (although the skilled person will appreciate that the invention

is not limited to such devices) and, therefore, the view of Figure 1 may typically represent a fully assembled, ready to use device as provided to an end user. A cap 20 is provided which closes the forward end of the autoinjector 1 prior to use. The cap 20 may include an internal formation, comprising rearward extending members 21, arranged to engage the removable needle shield 8 of the syringe 5 such that removal of the cap 20 from the housing 10 during use also removes the removable needle shield 8 from the syringe 5.

The autoinjector 1 may conveniently be considered to comprise a forward subassembly in a forward portion of the housing 10 and a rearward assembly in a rearward portion of the housing 10. The two housing portions may be snap fit together during assembly. The forward subassembly may comprise the components which surround and/or are initially forward of the syringe 5. The rearward subassembly may comprise those components which are initially rearward of the syringe 5.

A forward portion of the housing 10 may contain a syringe carrier 30 for movably mounting the syringe within the housing 10 to enable automatic needle penetration. It may be noted that prior to the removal of the cap 20, the rearward extending members 21 of the cap 20 underlie spring fingers 31 of the syringe carrier 30. This arrangement thus prevents inward movement of the spring fingers 31 prior to removal of the cap 20 and, therefore, blocks unlatching of the syringe carrier 30 and prevents movement relative to the housing 20.

A needle shroud (or lock out shroud) 35 is also provided and arranged to shroud the needle after use (when the syringe 5 and syringe carrier 30 are in a forward position) to prevent needle stick injuries. The shroud 35 may be activated by a pair of side-by-side shroud springs 36a, 36b carried on respective spring guides 37a, 37b. Operation of the shroud 30 and carrier 35 is not described here in any detail. However, it may be noted that the arrangement substantially corresponds to the arrangement described in WO2012/085580.

A rearward portion of the housing 10 includes a trigger button 40 which is inserted into the rearward portion of the housing 10 from the rearward end so as to substantially close the rearward end of the housing 10. The trigger button 40 has a cup-like profile with side walls which are arranged to fit within (and be substantially concentric with) the rearward housing 30 and an end wall which closes the rear end of the housing. The

trigger button 40 includes a pair of forwardly extending resilient arms 41a and 41b which are arranged to provide an engagement between the trigger button 40 and the injector 1.

5 The rearward portion of the housing 10 also includes a drive mechanism 100, best seen in Figure 2. The drive mechanism 100 includes a plunger 110 which is arranged to engage the bung 7 of the syringe 5 in use. The plunger 110 is driven forwards in use by a pair of concentric drive springs 120 and 122 (although it will be appreciated that in other embodiments a single spring may be used). An intermediate drive
10 member in the form of a collar 150 (which also functions as part of the velocity regulator as described below) is provided between the first 120 and second 122 drive springs. A pair of thrust washers 121, 123 are provided respectively between the first 120 and second 122 springs and the drive member/collar 150. A latch 130 is arranged concentrically around the drive springs 120, 122, intermediate member/collar 150 and
15 plunger 110. The latch 130 is arranged to hold the plunger 110 against the bias of the springs 120, 122 until the latch is released via the trigger button 40. The latch 130 comprises a rear body portion 132 having a split cylinder profile and defining a latch aperture at its rear end and a forward connecting body portion 134. The basic functional operation of the drive mechanism 100 is substantially as described, for
20 example, in the applicants' earlier International Patent Applications WO2012/049484 and WO2015/011488.

The driver mechanism will now be described in further detail with particular reference to Figures 2 and 3. Figure 2 shows an exploded view of a rearward subassembly of the
25 autoinjector device 1 (in which it may be noted that the housing 10 includes a discreet rearward housing component 12). In Figure 3a the housing is omitted for clarity and in Figures 3b and 3c only the components directly associated with the velocity regulator are shown for further clarity. As noted above, the driver mechanism includes a latch member 130 which is removably fixed into the housing 10 (by a snap fit arrangement)
30 and initially retains the plunger 110 against the forward biasing force of the actuation springs 120 and 122 (which act via the intermediate member 150). At the rear of the injection device 1 is provided a trigger button 40 which may initially be retained in position by the pair of arms 41a, 41b. In a central portion of the inner surface of the rearward face of the button 40 a forwardly extending boss 44 is provided which may act
35 to urge the plunger 110 out of engagement with the latch member 130 during activation

(in a manner such as that described in the applicants earlier patent applications referred to above).

5 The boss 44 comprises an arrangement which is in splined engagement with the rearward head 112 of the plunger 110. It will be seen that the rearward end of the plunger 110 is provided with a pair of axially extending radial slots which extend forwardly from the head 112 and the boss 44 comprising a corresponding pair of projections. As will be explained in further detail below, this arrangement ensures that the plunger 110 is rotationally fixed relative to the trigger button 40. In turn the trigger
10 button 40 is non-rotationally engaged with the housing 10 (for example, due to the non-circular shape of the housing 10 and trigger button 40 and/or the engagement between the legs 41a, 41b of the trigger button 40 and the latch 130).

15 The driver mechanism 100 of the autoinjector device 1 also includes a velocity regulator arranged to control or limit the initial velocity of the plunger 110 upon release of the driver mechanism. The velocity regulator utilises a cam member 152 which travels along a cam surface 162 which provides an inclined plane along which the cam member 152 will travel during actuation.

20 The cam surface 162 is conveniently provided on a cam body 160 which is engaged with the forward portion 134 of the latch 130 by a snap-fit arrangement including, for example, at least one latch member 166. To ensure proper alignment between the cam body 160 and the latch member 130 an alignment flange 167 may also be provided on the cam body 160 to abut a corresponding shoulder 135 in the latch 130.
25 The cam body 160 may comprise a generally annular body with an external profile which matches the required internal profile of the latch 130. A pair of helical cam surfaces 162a, 162b are defined at the rearward end of the cam body and are forwardly sloped to define a pair of parallel cam paths which extend circumferentially around the interior of the injection device 1 whilst also being inclined forwardly in the manner of a partial screw thread. A correspondingly profiled shoulder may be provided
30 rearward of the cam surface 162 on the interior surface of the latch 130 such that when the cam body is assembled with the latch 130 a slot or track 138 as defined (and configured to receive the cam members 152). Each cam surface 162 is provided with a stop 163 at its rearward end (which acts to separate the separate cam paths defined by the cam body 160) and ends with a cut-out or aperture 164 at the forward most end of
35 the cam surface 162.

The collar 150 acts as an intermediate drive member between the first compression spring 120 and second compression spring 122. Accordingly, the collar 150 includes an external radial flange 151 at its forward end which provides a seat for the first compression spring 120 and an internal radial flange 154 at its rearward end which provides a seat for the second compression spring 122. The thrust washers 121, 123 are disposed on the seats between the radial flanges 151, 154 of the collar and the springs 120, 122. The collar 150 is a generally cylindrical body and is provided with a pair of radially opposed outwardly extending lugs 152a, 152b. The lugs 152a, 152b are provided on a radially outer surface of the outwardly extending flange 151 (such that they do not impede either of the compression springs 120, 122). The internal flange 154 at the rear of the collar 150 includes an aperture 155 through which the head 112 of the plunger extends when the driver mechanism 100 is in the pre-fired (or primed) condition as shown in Figure 3.

The aperture 155 is provided with a keyed profile defined by a cylindrical central aperture portion 155a and a pair of opposed radial slots 156. The cylindrical side walls of the collar 150 extend rearward slightly beyond the flange 154 so as to define a cylindrical cup which surrounds the flange 154 and the aperture 155. Inwardly radially extending stop members 157a, 157b may be provided adjacent to one side of the radial slots 156a and 156b.

A rearward portion of the plunger 110 which is axially rearward of the aperture 155 in the pre-fired configuration is provided with a profiled cross-section for engagement with the keyway defined by the aperture 155. This profiled portion is immediately forward of the head 112 of the plunger which is configured to be engaged by the latch 130. The profiled portion is defined by a pair of radially outwardly extending projections 116a, 116b which provide a forward facing shoulder 117 is initially engaged with the rearward face of the flange 154. The radial projections 116a, 116b are configured such that they may pass through the radial slots 156a, 156b when the slots 156 and projections 116 are aligned.

The actuation sequence of the mechanism 100 and velocity regulator will now be described with reference to Figures 3 to 6. The pre-firing configuration of the driver mechanism 100 is shown in Figure 3. In this configuration the head 112 of the plunger 110 is retained in the aperture of the latch 130. As such both the first compression

spring 120 and the second compression spring 122 are in a compressed, energised, state. The trigger button 40 is in splined engagement with the rearward end of the plunger 110 via the boss 44 being positioned within the slots 114 at the rear of the plunger 110. The rearward portion 132 of the latch 130 is unable to expand to release
5 the head 112 of the plunger 110 as part of the trigger button abuts an outer surface of the rearward section of the latch 132.

In this position the radial projections 116 of the plunger 110 are rearwardly positioned relative to the aperture 155 of the collar 150 and the relative rotational position of the
10 plunger 110 and the collar 150 has been set during assembly such that the projections 116 are misaligned with the slots 156 and, in fact, it will be noted that the projections 116 may be abutting against the stops 157 of the collar 150. In this initial position the cam members 152 are positioned at a rearward end of the cam surfaces 162 and essentially abut against the stops 163 at the rearward most end of the cam surfaces
15 162.

In order to activate the device the user urges the trigger button 40 forward relative to the housing 10 of the autoinjector device 1 (having firstly carried out any required initiation steps such as removal of the cap from the forward end of the autoinjector
20 device 1 and/or releasing any safety mechanisms, such as an interlock). The forward movement of the trigger button 40 moves the blocking arrangement of the cap 40 out of alignment with the rearward section 132 of the latch 130 and may also directly transmit a forward force onto the rear of the plunger 110 via the engagement of the boss 44 with the head 112 of the plunger 110. As the result of this trigger action, the head 112 of
25 the plunger 110 is released from the trigger 130 freeing the rearward spring 120 to urge the plunger forwardly, in the direction of arrow A, via the outer flange 151 or the collar 150.

This forward movement causes the cam members 152a, 152b to travel along the
30 inclined path of the cam surface 162a, 162b. As the first spring 120 expands its axial force is transmitted by the collar 150 through the fully compressed second compression spring 122 to the forward end of the plunger 110. However, initially the plunger 110 is unable to travel beyond the collar 150 as the radial projections 116 engage the internal flange 154 at the rear of the collar 150.

Due to the splined engagement between the trigger button 40 and the plunger 110 the collar 150 must rotate relative to the plunger 110, in the direction of the arrow B, as the cam members 152a, 152b travel along the cam surfaces 162a, 162b. The thrust washers 121, 122 prevent or reduce any frictional resistance to the rotation of the collar 150 by the springs 121, 122. As best seen in the end view of Figure 4c, the resulting relative rotation of the collar 150 causes the aperture 155 to rotate relative to the radial projections 116a, 116b moving the projections off the stop surface 157 and towards the radial slots 156a, 156b.

As the plunger 110 and collar 150 continue to move forwardly, the collar 150 reaches its fully rotated position as shown in Figure 5. In the illustrated example the fully rotated position corresponds to approximately one half turn of the collar 150 (although the skilled person will appreciate that the particular configuration may vary depending on the profile of the cam surface and the required sequencing of the actuation mechanism 100). In this position the radial slots 156a, 156b have rotated into alignment with the radial projections 116a, 116b and the cam members 152a, 152b have also reached the end of the cam surface 162a, 162b and have moved into alignment with the cut-out/aperture 164 at the end of the cam path.

Accordingly, as shown in Figure 6, the velocity regulator may now disengage so as to allow the plunger to continue freely forward (continuing in the direction of arrow A). In this forward movement the plunger 110 moves forward relative to the collar 150 due to the radial projections 116a, 116b passing through the radial slots 156a, 156b and the collar 150 is also allowed to pass forwardly of the cam body 160 due to the cam members 152a, 152b passing through the cut-outs 164. In other words, both the collar 150 and plunger 110 are disengaged and the collar 150 and cam body 160 are disengaged. In the illustrated embodiment the disengagements both occur substantially simultaneously (although the skilled person will appreciate that this may depend on the particular sequencing required). Once the velocity regulator is disengaged the forward motion of the plunger 110 is no longer regulated (but the skilled person will appreciate that the plunger may now be pressing against the medicament within the syringe 5 such that its motion is naturally damped).

Although the device has been described above with reference to one embodiment, it will be appreciated that various changes or modifications may be made. For example, the skilled person will appreciate that the timing of the disengagement between the

components of the velocity regulator may depend on the particular configuration of the device. For example, the velocity regulator may be intended to slow/control the movement of the plunger 110 only during an initial movement in which the plunger 110 is brought into contact with the bung 7 of the syringe 5 (since manufacturing tolerances will usually make it necessary for the forward end of the plunger 110 to be initially spaced from the rearward end of the bung 7) so as to reduce impact thereto. Alternatively, or additionally, the velocity regulator may be configured to control the speed of movement of the actuation mechanism until the needle insertion step of the actuation process has been completed. Whilst the illustrated example includes two opposing counter-surfaces the skilled person will appreciate that more or less features may be utilised in embodiments of the invention.

In the illustrated device the cam surface defines a substantially constant helical cam path but the skilled person will appreciate that the surface may have other sloped profiles (for example, a variable angle of incline) depending upon the velocity profile required for the forward movement of the plunger 110. Whilst an arrangement having two compression springs is advantageous in providing a compact actuation mechanism the skilled person will appreciate that in some embodiments only a single compression may be utilised. For example, in a single spring arrangement, the cam members could be formed on a portion of the plunger and the plunger may be allowed to rotate relative to the housing.

Exemplary autoinjector devices are disclosed herein that may incorporate one or more of the features of the autoinjector 1 discussed above and also incorporating one or more features discussed below.

Figures 7a-b show an exemplary injection device 200 at different stages of operation. The injection device 200 is configured to receive a syringe 202 therein. The syringe 202 comprises a barrel 204, a needle 206 and a bung 208 moveable within the barrel 204 to deliver a dose of medicament from a forward end of the needle 206.

The injection device 200 comprises a forward section 210 and a rearward section 212. The forward section 210 is configured to receive at least part of the syringe 202. The rearward section 212 comprises an insertion driver and an interlock. Although the insertion driver and the interlock are not shown in Figures 7a-b, a skilled person will

understand how to implement such features and they are, in any case, discussed above in relation to Figures 1-6.

5 The insertion driver may be a compression spring, such as the first spring 120 discussed above, and is configured to drive the syringe 202 forwards within the injection device 200 such that the needle 206 protrudes from a forward end of the injection device 200 and is inserted into an injection site, typically on a patient. The interlock is configured to prevent firing of the insertion driver until such time as the interlock is actuated, allowing the insertion driver to drive the syringe 202 forwards.

10 The interlock may retain a force (such as a biasing force of a spring or similar) applied by the insertion driver until it is actuated, after which the insertion driver acts upon the syringe 202 to drive the syringe forwards. Rearward movement of an interlock actuator into a volume 214 rearward of the syringe barrel actuates the interlock to release the insertion driver. It is noted, however, that in certain arrangements, actuation of the

15 interlock alone might not fire the insertion driver and some other action, such as actuation of a trigger, may be required.

In known injection devices, the interlock actuator may comprise a lock out shroud. Depression of the lock out shroud against the injection site pushes the lock out shroud

20 rearwards into the injection device. The lock out shroud, or one or more other features of the interlock actuator linearly coupled to the lock out shroud, passes around the barrel and into the volume rearward of the barrel to actuate the interlock. The inventors have appreciated that by including the barrel as part of the interlock actuator there is no requirement for any feature of the interlock actuator to pass around the barrel. That is,

25 the barrel itself is driven rearwards on rearward displacement of the interlock actuator. An injection device having a slimmer profile may therefore be manufactured.

The forward section 210 of the injection device 200 comprises the interlock actuator. In the exemplary arrangement of Figures 7a-b, the interlock actuator comprises a lock out

30 shroud 216, a syringe carrier 218 and the barrel 204 of the syringe 202. The injection device 200 further comprises a cap 220 fitted to a forward end of the injection device 200. The cap 220 is configured to close a forward aperture 222 in the injection device 200. The cap 220 is further configured to provide a mechanical lock preventing movement of the lock out shroud 216 rearwards and preventing movement of the

35 syringe 202 forwards.

In the position shown in Figure 7a, the lock out shroud 216, syringe carrier 218 and the barrel 204 are linearly coupled in that rearward movement of lock out shroud 316 results in rearward movement of the remaining features of the interlock actuator. Therefore, displacement of the lock out shroud 216 in the direction of arrow A when it is pressed against the injection site results in corresponding rearward displacement of the syringe carrier 218 and the barrel 204. The barrel 204 is therefore pushed into the volume 214 for actuating the interlock.

It is noted that the lock out shroud 216 is further configured, after delivery of the dose of medicament to extend forwards to cover the needle 206.

The inventors have further appreciated that the syringe barrel 204 should be configured to decouple linearly from the lockout shroud 216 after actuation of the interlock to allow forward movement of the syringe 202 under a driving force applied by the insertion driver.

Figures 8a-c show a forward section of an exemplary injection device 300 at various stages of operation. The body of the injection device 300 is shown as translucent or transparent in order that the internal features of the injection device 300 are visible. It should be understood that in practical implementations the body of the injection device 300 may be opaque.

Generally, the injection device 300 comprises an interlock actuator configured to move linearly from an operable position to actuate an interlock. The interlock actuator comprises a lock out shroud 316, a syringe carrier 318 and a syringe barrel 304. When the interlock actuator is in the operable position, as shown in Figure 8a, the lock out shroud 316, the syringe carrier 318 and the barrel 304 are linearly coupled. This allows rearward travel of the barrel 304 on rearward travel of the lock out shroud 316, which activates an interlock to allow an insertion driver to drive the syringe forwards and insert the needle 306 into an injection site.

The lock out shroud 316 is configured such that, when the interlock actuator is in the operable position, a forward end 324 of the lock out shroud 316 extends from a forward opening 322 of the injection device 300.

Rearwards from the forward end 324, the lock out shroud 316 comprises a shoulder 326 that is configured to abut a limiting surface 328 of the body of the injection device 300 after rearward linear displacement of the lock out shroud 316. The limiting surface 328 provides a mechanical limit to the amount of rearward displacement.

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The lock out shroud 316 also comprises a coupling slot 330 that is configured to receive a coupling lug 332 of the syringe carrier 318. When the coupling lug 332 is received within the coupling slot 330, forward displacement of the syringe carrier 318 relative to the lock out shroud 316 is permitted, but relative rotation between the syringe carrier 318 and the lock out shroud 316 is not.

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The lock out shroud 316 comprises a collar receiving slot 334 that is configured to receive part of a collar 336 of the syringe carrier 318, as explained below.

15

The lock out shroud 316 comprises a collar guiding surface 338 that is configured to guide or bias the collar 336 laterally or rotationally. In the example shown in Figures 8a-c, the guiding surface 338 is ramped such that, on linear decoupling between the lock out shroud 316 and the syringe carrier 318 (and therefore the collar 336), the collar 338 moves along the guiding surface 338 and is laterally displaced. As discussed below, the lateral displacement of the collar 336 in the example of Figures 8a-c is a rotational displacement.

20

The syringe carrier 318 is configured to receive the barrel 304 of the syringe (not seen in full in Figures 8a-c). The syringe carrier 318 may be fixedly linearly coupled to the barrel 304 when the syringe is received therein. Therefore, forward or rearward displacement of the syringe carrier 318 would result in corresponding forward or linear displacement of the barrel 304.

25

The syringe carrier 318 comprises a main body 340 and a collar 336 that is linearly coupled to the main body 340 and is rotatable relative to the main body 340. The collar 336 comprises a guide leg 342 configured to interact with the guiding surface 338 of the lock out shroud 316 to laterally/rotationally displace the collar 336 on relative linear displacement of the syringe carrier 318 and the lock out shroud 316. In the exemplary arrangement of Figures 8a-c, the guide leg 342 comprises a ramped surface 344 corresponding to the ramped guiding surface 338 of the lock out shroud 316.

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The body of the injection device 300 comprises a rib 346 configured to prevent rotation of the collar 336. When the interlock actuator is in the operable position, as shown in Figure 8a, the forward end of the ramped guiding surface 338 of the lock out shroud 316 meets the rib 346 and a forward end of the ramped surface 344 of the guide leg 342 also meets the rib 346. The rib 346 comprises a further ramped surface 348 parallel with the guiding surface 338.

Operation of the injection device 300 will now be explained with reference to Figures 8a-c.

10

In Figure 8a, the interlock actuator is in the operable position in that rearward displacement thereof will actuate the interlock. The lock out shroud 316 extends from the opening 322 in the forward end of the injection device 300. A user presses the forward end 324 of the lock out shroud 316 against an injection site, which displaces the lock out shroud 316 rearward in the direction of arrow B. Rearward displacement of the lock out shroud 316 urges the collar 318 to rotate counter-clockwise (looking forward along the injection device 300) because of the ramped guide surface 338. The collar 336 is therefore biased against the rib 346 and is prevented from rotational displacement by the rib 346. Therefore, the lock out shroud 316 pushes the collar 336 rearwards. The collar 336 is linearly coupled to the syringe carrier 318, which is therefore also pushed rearwards. Further, a rearward end 350 of the syringe carrier 318 abuts a flange 352 of the barrel 304 and therefore pushes the barrel 304 rearwards.

15

As shown in Figure 8b, rearward displacement of the barrel 304 moves it further into the injection device 300 to actuate the interlock. In addition, the collar 336 has been displaced rearward such that it is clear of the rib 346. That is, the forward end of the guiding surface 338 of the lock out shroud 316 is at least as far rearward as the rearward end of the further ramped surface 348 of the rib 346. Therefore, the guide leg 342 is no longer retained by the rib 346 and is free to be rotationally displaced by the guiding surface 338.

25

30

As shown in Figure 8c, after actuation of the interlock, the insertion driver applies a force to the barrel 304, which is transferred to the syringe carrier 318. Interaction between the guiding surface 338 and the ramped surface 344 of the guide leg 342 under the force applied by the insertion driver rotates the collar 336 to linearly decouple

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the lock out shroud 316 and the syringe carrier 318. The ramped surface 344 of the guide leg 342 passes over the further ramped surface 348 of the rib 346. Once the guide leg 342 is clear of the rib 346, the syringe carrier (and therefore the syringe) is driven forwards and the guide leg 342 is received within the receiving slot 334. The
5 needle 306 extends from a forward end 324 of the lock out shroud 316 and is inserted into the injection site.

Figures 9a-e show a rear section 400 of an injection device in various stages of operation. In exemplary injection devices, the rear section 400 may be fitted to the
10 forward section shown in Figures 8a-c. The rear section 400 accommodates an actuation system comprising an insertion tube 402, a rear body 404, an actuation collar 406 and an insertion driver 408, which in this case is a compression spring although other types of spring or driving means could be used. Each of these features is shown individually in Figures 10a-d.

15 The insertion tube 402 comprises a tubular body 410 and a pair of radially extending pips 412 (only one pip is visible in Figure 10b) on opposite sides of a sidewall of the insertion tube 402. Each pip 412 is configured to run through corresponding actuation tracks 414 of the actuation collar 406. Each pip is a generally teardrop shape with the
20 point 416 of the teardrop facing rearward. The teardrop shape is also skewed in one direction in order to guarantee a particular direction of travel of the pips 412 through the actuation tracks 414. In the exemplary insertion tube 402 of Figure 10a, the pip is partially rotated anticlockwise. It is noted that other shaped pips may also be used, for example the pip may have a generally rectangular shape with a chamfered corner
25 configured to guide the pip along the correct section of the actuation track. In a specific example, a rectangular pip may be elongate in a longitudinal direction of the injection device and one of the rear corners may be chamfered.

The insertion tube 402 also comprises insertion tracks 418 running substantially
30 longitudinally along opposite sides of the outer wall of the insertion tube 402. The insertion tracks 418 include dogleg sections approximately a quarter of the way forwards along the length of the tracks 418 from the rear of the track 418.

The rear body 404 has a broadly tubular shape having a number of features and tracks
35 thereon. In particular, the rear body 404 comprises driver tracks 420 on opposite sides of a sidewall of the rear body 404 and configured to support lugs 422 of an insertion

collar 424 fixed to one end of the insertion spring 408. The driver tracks 420 have a V-shape and also each include a vertical slot 426 extending forwards from an end of one arm of the "V".

5 When the rear section 400 is constructed, the insertion tube 402 is rotatably and slidably fitted within the rear body 404. The insertion spring 408 is positioned within the insertion tube such that the lugs 422 extend through the insertion tracks 418 and rest on the driver tracks 420. The actuation collar 406 is positioned at a rearward end of the rear body 404 and the pips 412 extend through the actuation tracks 414. The
10 actuation collar 406 is fixed in relation to the rear body 404.

Referring to Figures 9a-e, motion of the features of one side of the rear section 400 is described but it is noted that similar function is provided on the opposite side of the rear section 400. In Figure 9a, the pip 412 is positioned at an extreme end of the actuation
15 track 414, which forms a valley deep enough to receive the pip 412. The valley is configured to retain the pip 412 to prevent the insertion spring 408 from driving the insertion tube 402 forwards in the injection device. The lug 422 on the insertion collar 424 is biased forwards because the insertion spring 408 is compressed against a rearward surface of the device. The lug 422 is therefore urged to descend a declined
20 (or forwardly extending) extension ramp 430 of the driver track 420. Because the lug 422 is retained within the insertion track 418, motion of the lug 422 down the extension ramp 430 would rotate the insertion tube 402 and this is prevented by retention of the pip 412 in the valley of the actuation track. The force applied by the insertion spring 408 on the lugs 422 also holds the pip 412 in the valley by a similar process.

25 The rear section 400 also comprises a volume 432 into which a barrel of a syringe may be fitted and connections 424 configured to connect a front section of the injection device thereto, for example by snap fit.

30 In Figure 9b, a syringe barrel 436 has been inserted into the volume 432 and a front section 438 of the injection device fitted to the connections 434. The volume 432 is too short to receive the syringe barrel 436 completely and so a flange 440 of the syringe barrel 436 pushes the insertion tube 402 rearwards. The pip 412 is therefore moved rearwards out of the valley along a first inclined section 442 of the actuation track 414
35 which imparts a rotational force on the insertion tube 402. The rotation is clockwise

when looking forwards along the injection device and this frame of reference is used in the following to aid description of the operation of the device.

5 The clockwise rotation of the insertion tube 402 caused by movement of the pip 412 in the actuation track 414 allows the lug 422 of the insertion collar 424 to move part way down the declined extension ramp 430 of the driver track 420 towards the bottom of the "V". In other arrangements, the driver track may include an inclined section corresponding to the first inclined section 442 of the actuation track 414.

10 In this position, the interlock actuator is in a stowed position. The interlock actuator is at its most rearward position and has reached a mechanical limit because the pip 412 cannot move any further in the actuation track 414. Because of this rearward travel of the interlock actuator, the injection device is smaller than when it is ready for use because no clearance volume exists within the device for the interlock actuator to travel
15 into to actuate the interlock. The interlock actuator and/or any associated components such as the actuation system occupy the clearance volume.

The interlock actuator is prevented from forward motion by a stowage lock, for example by the cap at the forward end of the injection device as shown in Figures 7a-c. The
20 insertion spring 408 provides a biasing force urging the lug 422 and therefore the insertion tube 402 forwards.

The interlock actuator in the exemplary injection device of Figures 9a-e acts through the syringe barrel 436 in a similar way to that shown in Figures 7a-c. In a specific
25 arrangement, the interlock actuator includes the lock out shroud, the syringe barrel 436 and the syringe carrier 444, as explained above in respect of Figures 7a-c. The lock out shroud, syringe carrier 444 and syringe barrel 436 are linearly coupled such that linear axial movement of one is translated to linear axial movement of the others. However, as discussed above, this need not be the case and the skilled person will
30 appreciate that the interlock actuator could act around the side of the syringe barrel 436 to act upon the actuation system.

In Figure 9c, the cap has been removed from the injection device and the interlock actuator has therefore moved from the stowed position to an operable position. In the
35 exemplary arrangement of Figures 9a-e, movement of the interlock actuator to the

operable position is provided by the force exerted by the insertion spring 408 once the cap is removed.

5 The lug 422 is urged down the declined extension ramp 430 of the driver track 420 until it rests at the bottom of the "V". Movement of the lug 422 down the extension ramp 430 imparts a clockwise rotation on the insertion tube 402. The pip 412 therefore travels down a declined section 446 of the actuation track 414, which moves the insertion tube 402 and the interlock actuator forwards. In the exemplary arrangement of Figures 9a-e, this results in the lock out shroud extending from the forward end of
10 the device.

The interlock is now preventing the syringe from moving further forwards such that the needle extends from the forward end of the injection device. The interlock in the exemplary arrangement of Figure 9c is provided by the lug 422 sitting at the bottom of
15 the "V" formed in the driver track 420 and unable to move up a rearwardly extending (or inclined) interlock ramp 450 because of the force exerted by the insertion spring 408 on the lug 422. This, along with the pip 412 sitting at the bottom of a "V" formed by the declined section 446 and a second inclined section (an interlock section) 448 of the actuation track 414, prevents further clockwise rotation to release the insertion spring
20 408 fully. The interlock section 448 of the actuation track 414 corresponds to the interlock ramp 450 of the driver track 420 in that the pip 412 moves in the interlock section 448 while the lug 422 moves on the interlock ramp 450.

As can be seen in Figure 9c, a clearance volume 452 now exists between the rearward
25 end of the insertion tube 402 and the rearward surface of the injection device against which the insertion spring 408 acts. The interlock actuator may now move rearward within the injection device making use of that clearance volume 452. Because of the altered geometry of the actuation system (i.e. the altered positions of the pip 412 and the lug 422), the interlock actuator is now coupled to the actuation system and the
30 interlock. Coupling in this sense means that movement of the interlock actuator rearwards will result in movement of the actuation system. Movement of the interlock actuator back towards the stowed position now actuates the interlock and releases the insertion spring 408. In the exemplary arrangement of Figures 9a-e, forward axial linear movement of the interlock actuator moves it from the stowed position to the
35 operable position. Accordingly, rearward linear axial movement of the interlock actuator after movement to the operable position actuates the interlock.

Referring to Figure 9d, the lock out shroud is pressed against an injection site and is pushed rearwards. This moves the other features of the interlock actuator rearwards and engages the actuation system. The insertion tube 402 moves rearwards into the clearance volume 452. Because the pip 412 is skewed (i.e. rotated anti-clockwise) the point 416 of the pip 412 is directed towards the second inclined section 448 of the actuation track 414. This will guide the pip 412 into the second inclined section 448 of the actuation track 414 as the insertion tube 402 moves rearwards. The pip 412 therefore travels in the second inclined section 448 of the actuation track 414, which rotates the insertion tube 402 clockwise. Because the lug 422 is retained in the insertion track 418, it is moved up an interlock ramp 452 along the driver track 420 towards the vertical slot 426.

In Figure 9d, the lug 422 is aligned with the vertical slot 426 and is therefore free to move forwards under the force of the insertion spring 408. Further, the pip 412 is aligned with a vertical section 454 of the actuation track 414. In this position, the interlock has been actuated and the needle may be inserted into the injection site.

In Figure 9e, the lug has moved down the vertical slot 426 in the rear body 404 under the force exerted by the insertion spring 408. This moves the pip 412 down the vertical section of the actuation track 414 because the lug 422 is in contact with an angled face in the insertion slot 418 caused by the dogleg. The insertion tube 402 is prevented from rotating clockwise because of the vertical section 454 of the actuation track 414 until the pip 412 reaches a locking recess 456 at the end of the vertical section 454. At this point, the lug 422 acts on the angled surface of the dogleg in the insertion track 418 and rotates the pip 412 into the locking recess 456. The lug is now aligned with the forward portion of the insertion recess 418 that is forward of the dogleg and so the insertion spring 408 can extend fully and insert the needle into the injection site.

The declined section 430 of the driver track 420 corresponds to the declined section 446 of the actuation track 414 in that the lug 422 moves along the declined section 430 of the driver track 420 when the pip 412 moves along the declined section 446 of the actuation track 414. Further, the interlock ramp 450 of the driver track 420 corresponds to the second inclined section 448 of the actuation track 414 in that the lug 422 moves along the interlock ramp 450 of the driver track 420 when the pip 412 moves along the second inclined section 448 of the actuation track 414.

However, the steepness of the inclines and declines of the driver track is less than the steepness of the inclines and declines of the actuation track. That is, the angle of the declined section 430 of the driver track 420 is less than the angle of the declined section 446 of the actuation track 414, and the angle of the interlock ramp 450 of the driver track 420 is less than the angle of the second inclined section 448 of the actuation track 414.

This arrangement means that a geared or ratioed relationship exists between linear axial movement of the lug 422 and linear axial movement of the pip 412. Therefore, the biasing force exerted by the insertion spring 408 on the lug is overcome with less force, but greater linear motion, of the interlock actuator.

In other exemplary arrangements, there is no need for separate actuation tracks and driver tracks and only one of the pip or the lug need be used.

The skilled person will appreciate that other exemplary arrangements are possible within the scope of the appended claims.

CLAIMS:

1. An injection device for receiving a syringe therein and for delivering a dose of medicament from the syringe, the injection device comprising:
 - 5 an insertion driver configured to drive the syringe forwards within the injection device for inserting a needle of the syringe into an injection site;
 - an interlock mechanism configured to retain the insertion driver in a primed state and, when actuated, to allow the insertion driver to drive the syringe forwards; and
 - 10 an interlock actuator configured to be displaced rearwards within the injection device to cause corresponding rearward displacement of a barrel of the syringe to actuate the interlock via the barrel.
2. An injection device according to claim 1, wherein one or more features of the interlock actuator are configured to linearly couple to the barrel such that rearward displacement of the one or more features causes rearward displacement of the barrel,
 - 15 and wherein the one or more features of the interlock actuator are configured to linearly decouple from the barrel after actuation of the interlock to allow forward displacement of the barrel relative to the one or more features of the interlock actuator.
3. An injection device according to claim 2, wherein the interlock actuator comprises a syringe carrier configured to be linearly coupled to the barrel, and wherein linear decoupling of the barrel from the one or more features of the interlock actuator comprises linear decoupling of the syringe carrier from the one or more features of the interlock actuator.
 - 20
 - 25
4. An injection device according to claim 3, wherein the syringe carrier is configured to linearly decouple from the one or more features of the interlock actuator by rotation relative to the one or more further features of the interlock actuator.
 - 30
5. An injection device according to claim 4, wherein the syringe carrier is configured to rotate relative to the one or more features of the interlock actuator under a force applied to the syringe carrier and originating from the insertion driver.

6. An injection device according to claim 4 or 5, wherein the syringe carrier comprises a main body and a collar rotatable relative to the main body, and wherein rotation of the syringe carrier comprises rotation of the collar relative to the main body.
- 5 7. An injection device according to any of claims 2 to 6, wherein the one or more features of the interlock actuator comprise a lock out shroud configured, when the interlock actuator is in an operable position, to extend from a forward end of the injection device.
- 10 8. An injection device according to claim 7 when dependent on claim 6, wherein the lock out shroud comprises a guiding surface configured to urge the collar to rotate on rearward displacement of the lock out shroud,
and wherein the injection device is further configured to prevent rotation of the collar until after the interlock actuator has actuated the interlock
- 15 9. An injection device according to claim 8, wherein the injection device further comprises a rib configured against which the collar is urged during rearward displacement of the lock out shroud to prevent rotation of the collar until the interlock actuator has actuated the interlock.
- 20 10. An injection device according to claim 8 or 9, wherein the guiding surface is ramped such that a relative force between the lock out shroud and the syringe carrier urges the collar to rotate.
- 25 11. An injection device according to claim 10, wherein the collar comprises a ramped surface corresponding to the guiding surface of the lock out shroud and configured to abut the guiding surface during rearward displacement of the lock out shroud.
- 30 12. An injection device according to any preceding claim, further comprising a syringe, wherein the interlock actuator comprises the barrel of the syringe.
- 35 13. An interlock actuator for use in an injection device for receiving a syringe therein and for delivering a dose of medicament from the syringe, the injection device comprising an insertion driver configured to drive the syringe forwards within the injection device for inserting a needle of the syringe into an injection site; and an

interlock mechanism configured to retain the insertion driver in a primed state and, when actuated, to allow the insertion driver to drive the syringe forwards,

the interlock actuator being configured to be displaced rearwards within the injection device to cause corresponding rearward displacement of the a barrel of the syringe to actuate the interlock via the barrel.

14. An interlock actuator according to claim 13, comprising a lock out shroud configured to be linearly coupled to a syringe carrier during rearward displacement of the interlock actuator.

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15. An interlock actuator according to claim 14, wherein the syringe carrier is configured to linearly decouple from the lock out shroud after actuation of the interlock to allow forward displacement of the barrel relative to the lock out shroud.

15 16. A forward section of an injection device comprising the interlock actuator of any preceding claim.

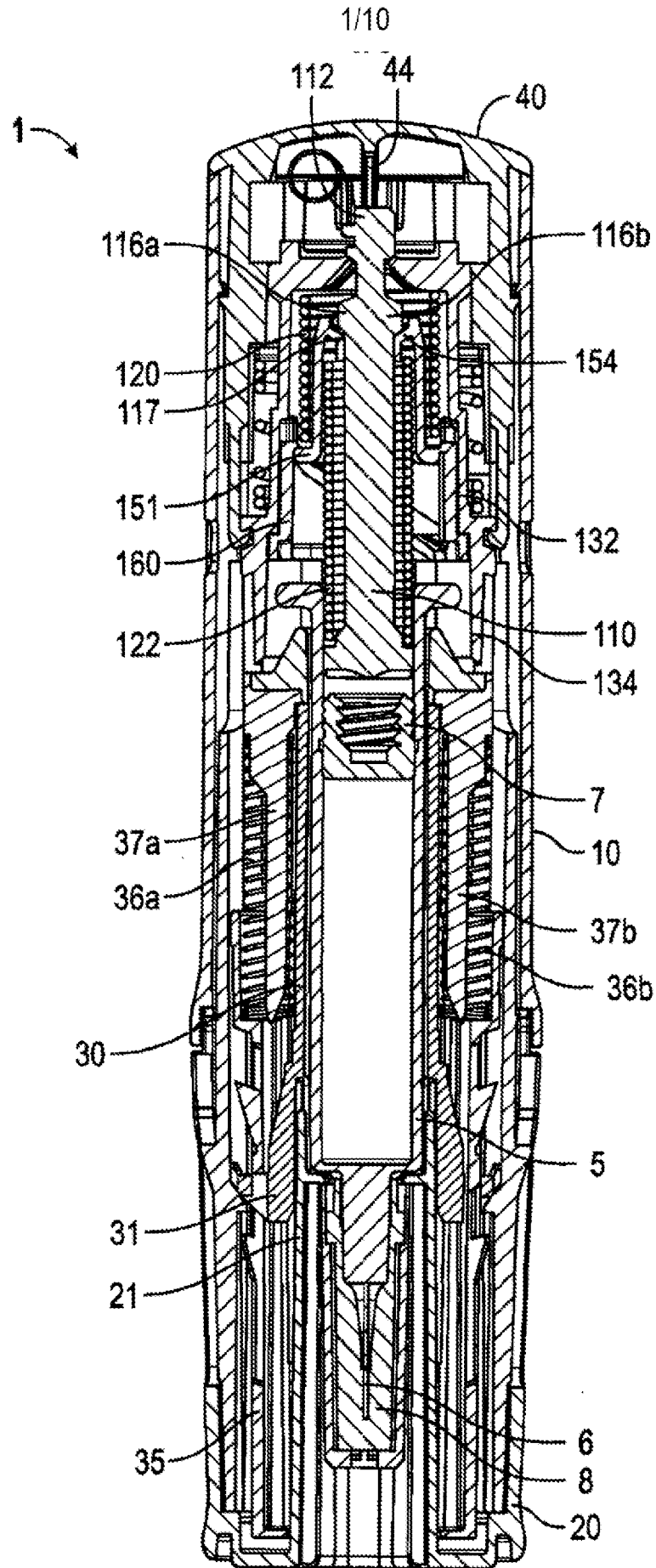


Figure 1

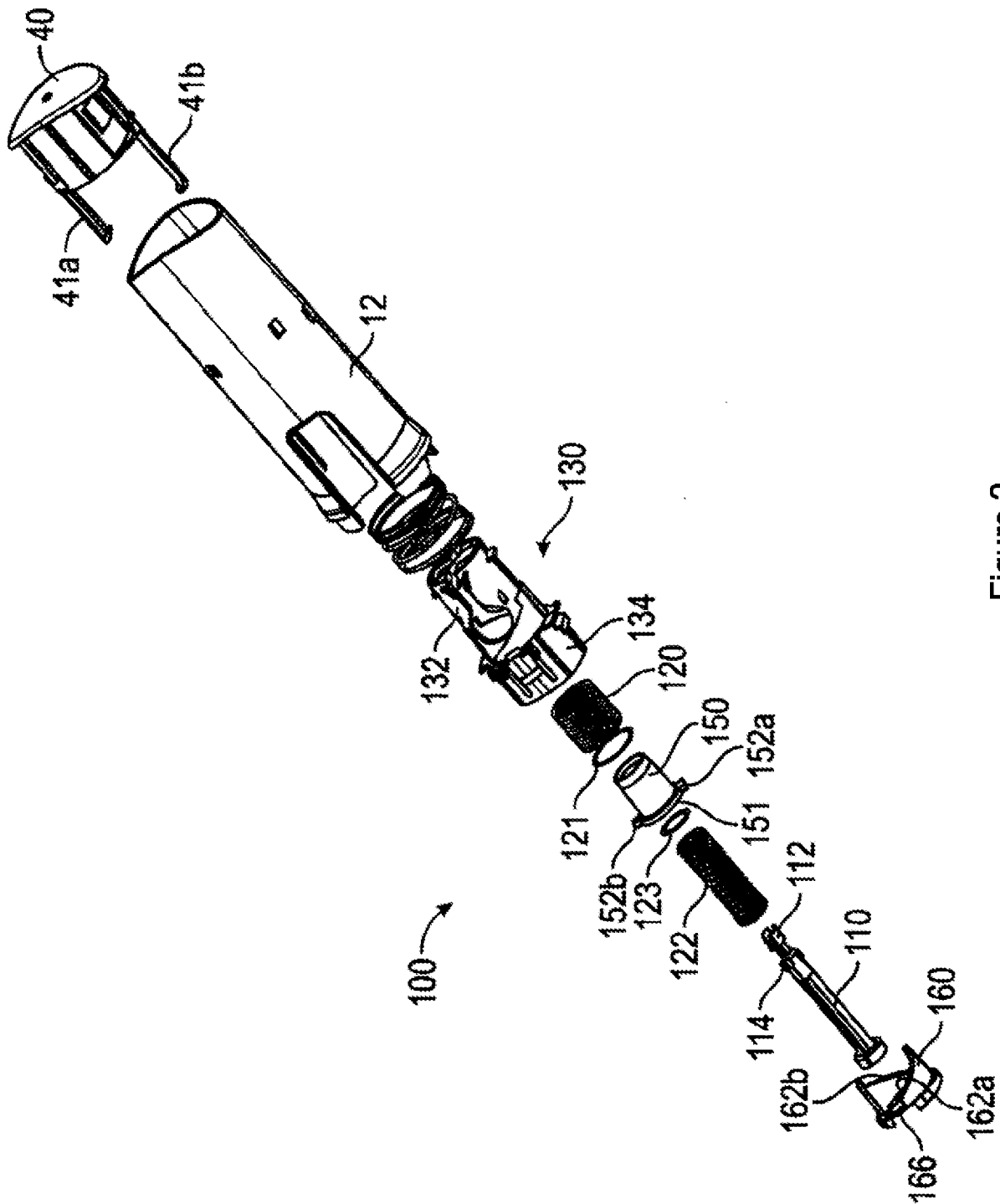


Figure 2

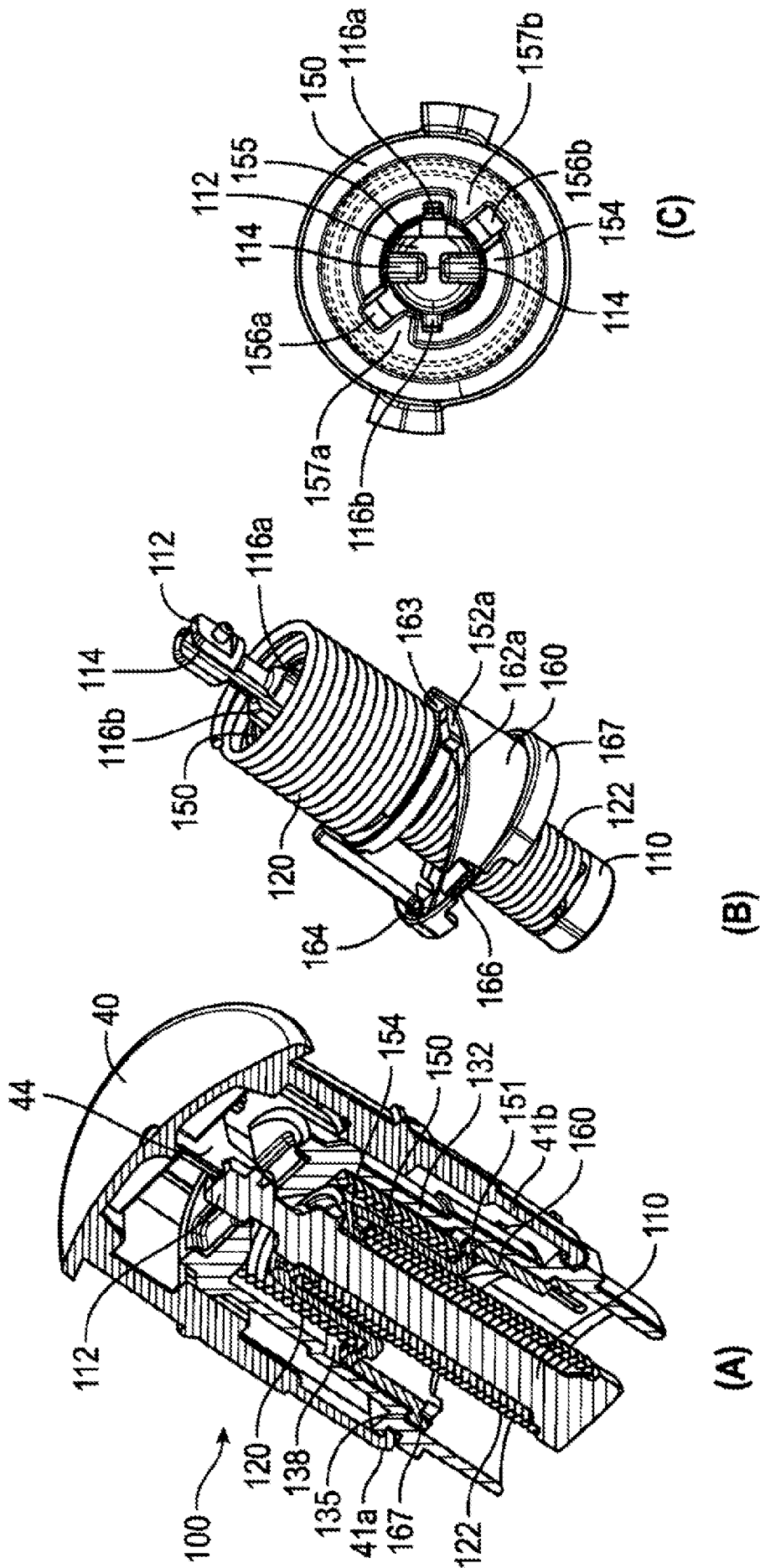


Figure 3

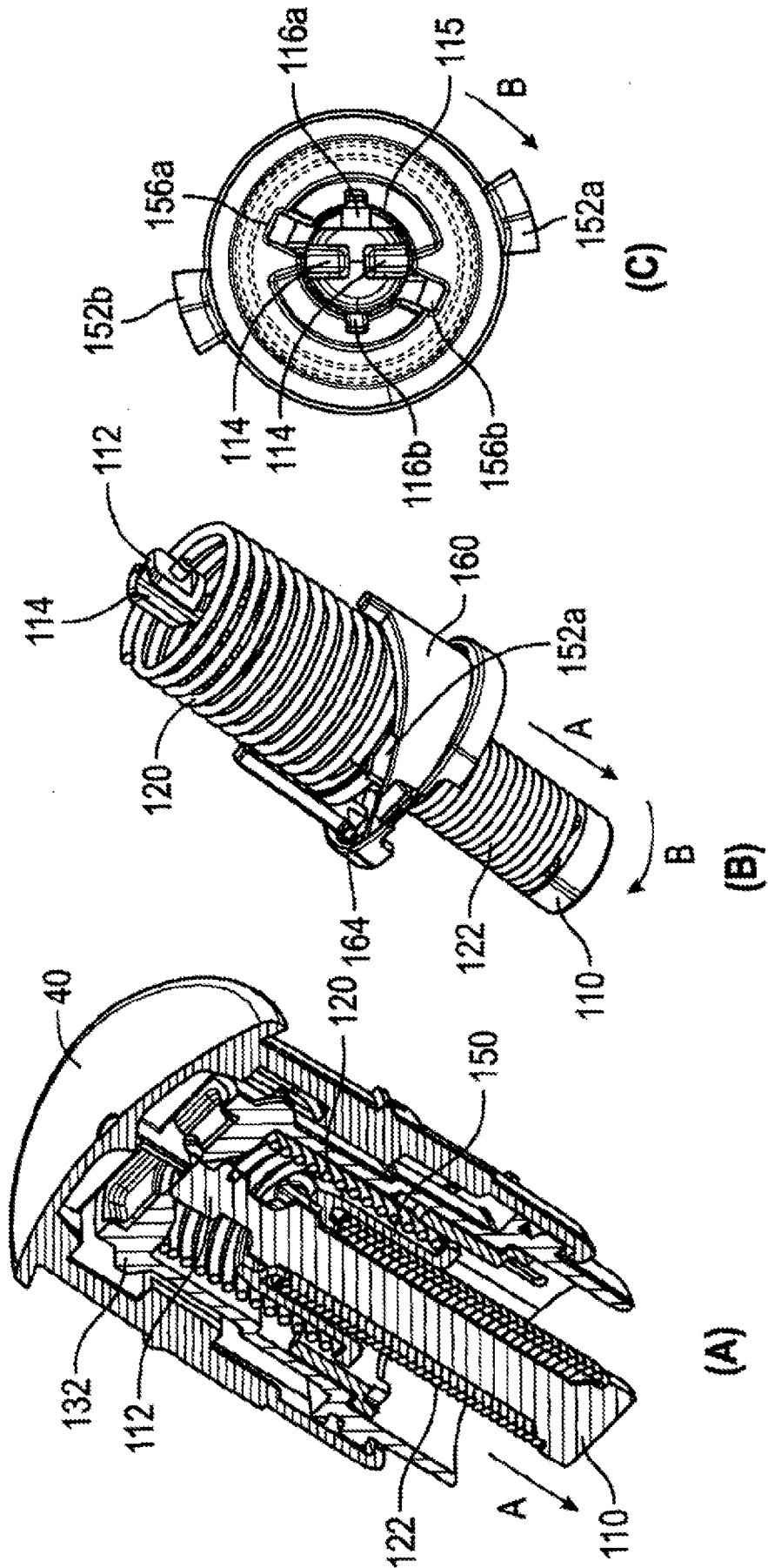


Figure 4

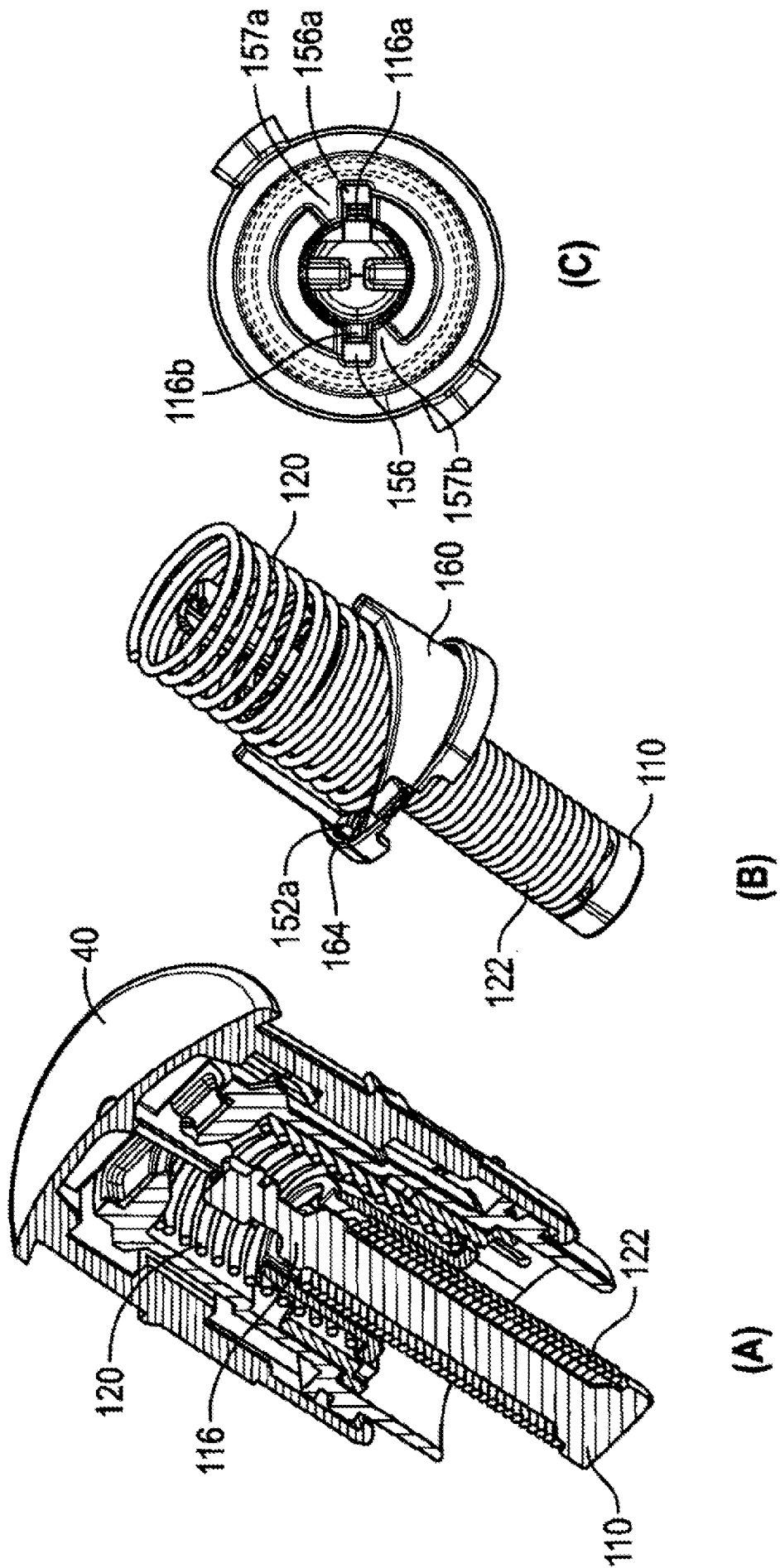


Figure 5

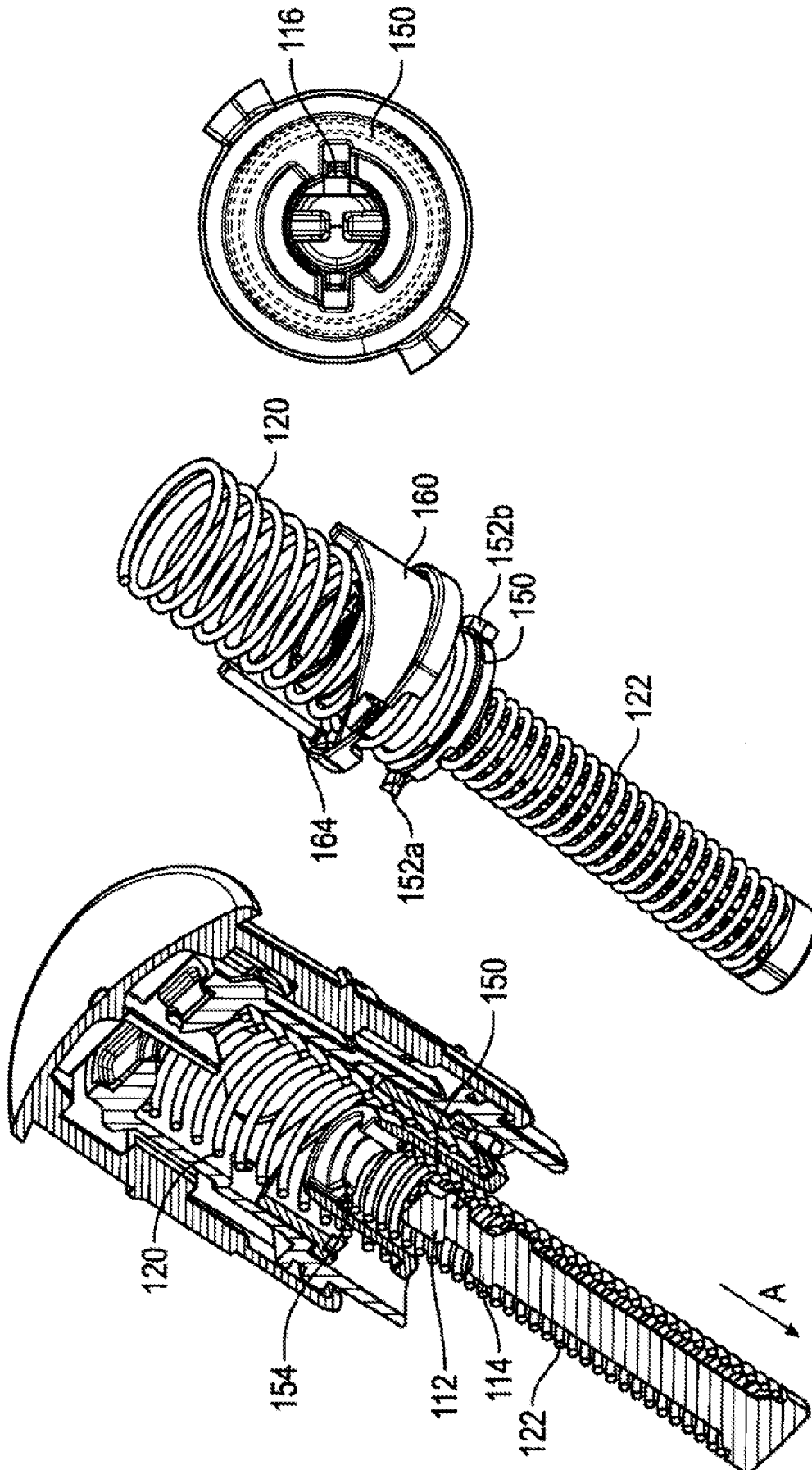


Figure 6

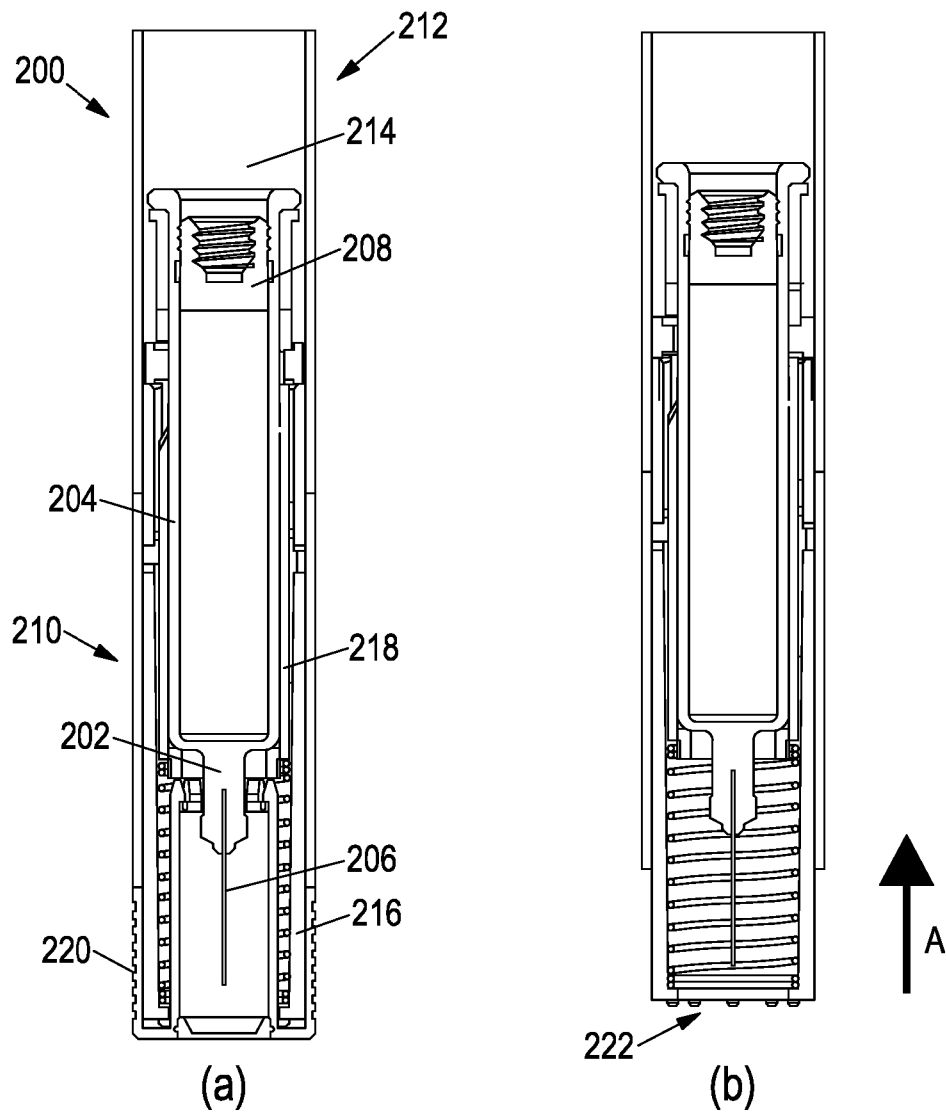


Figure 7

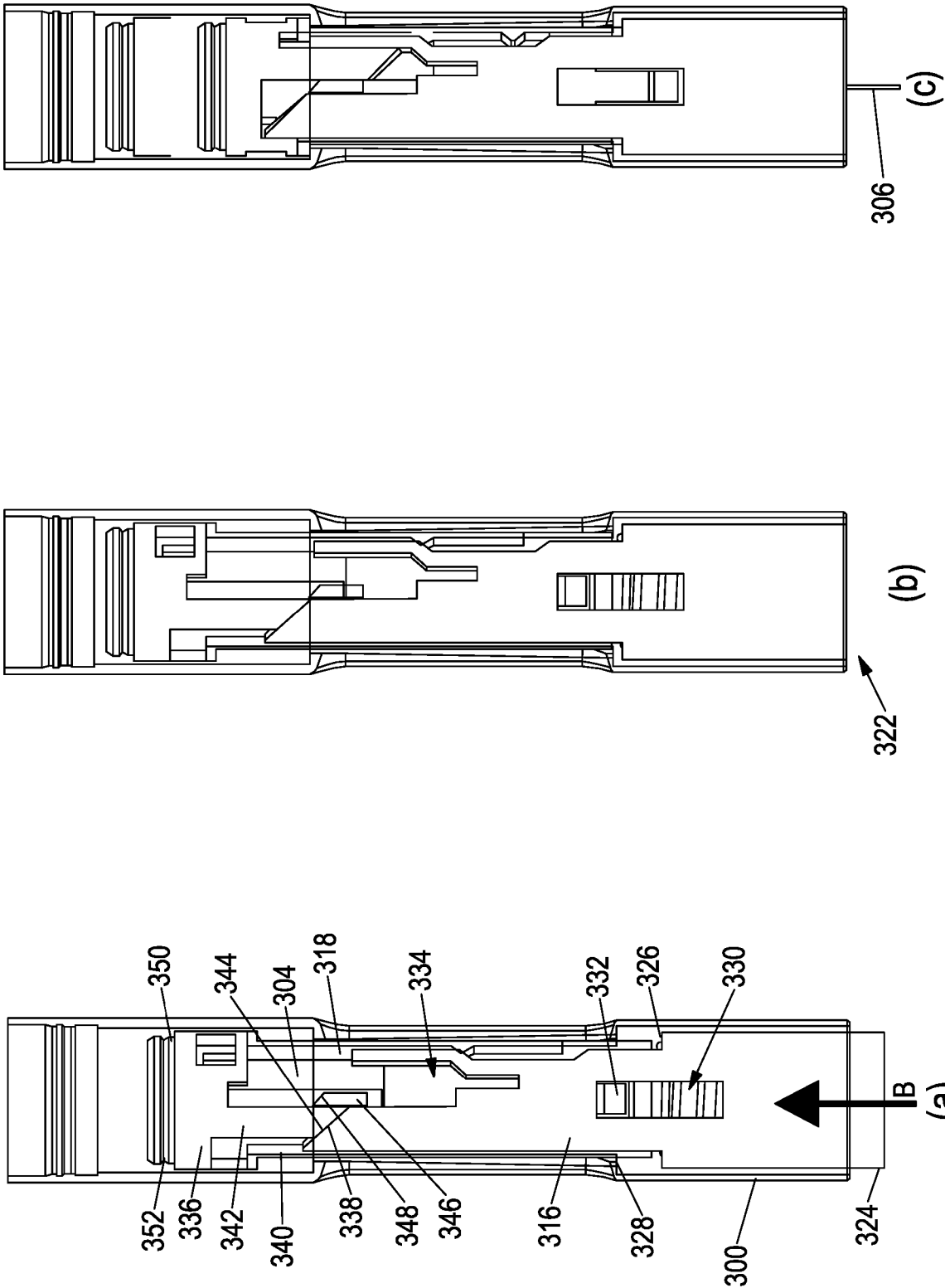


Figure 8

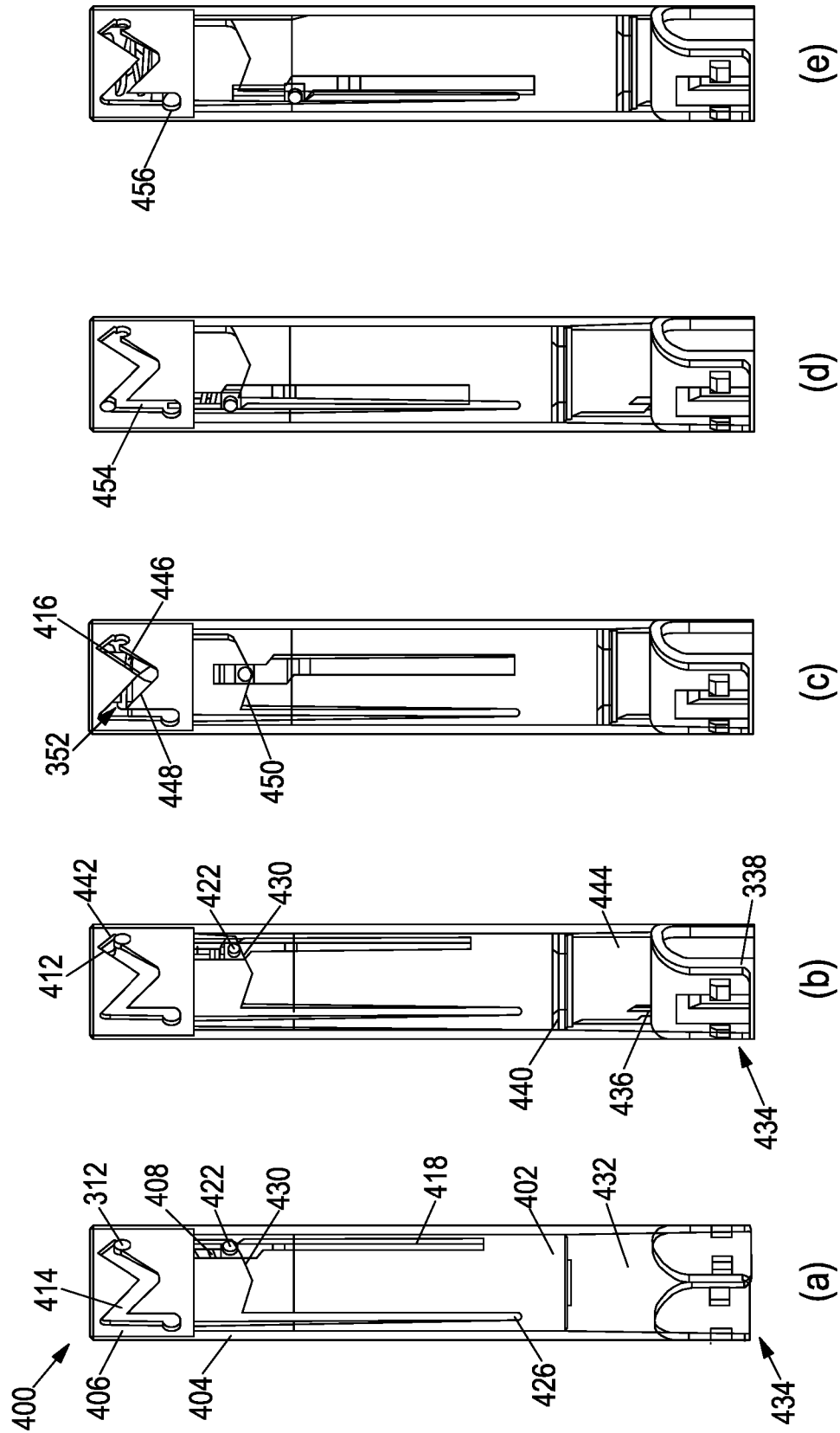


Figure 9

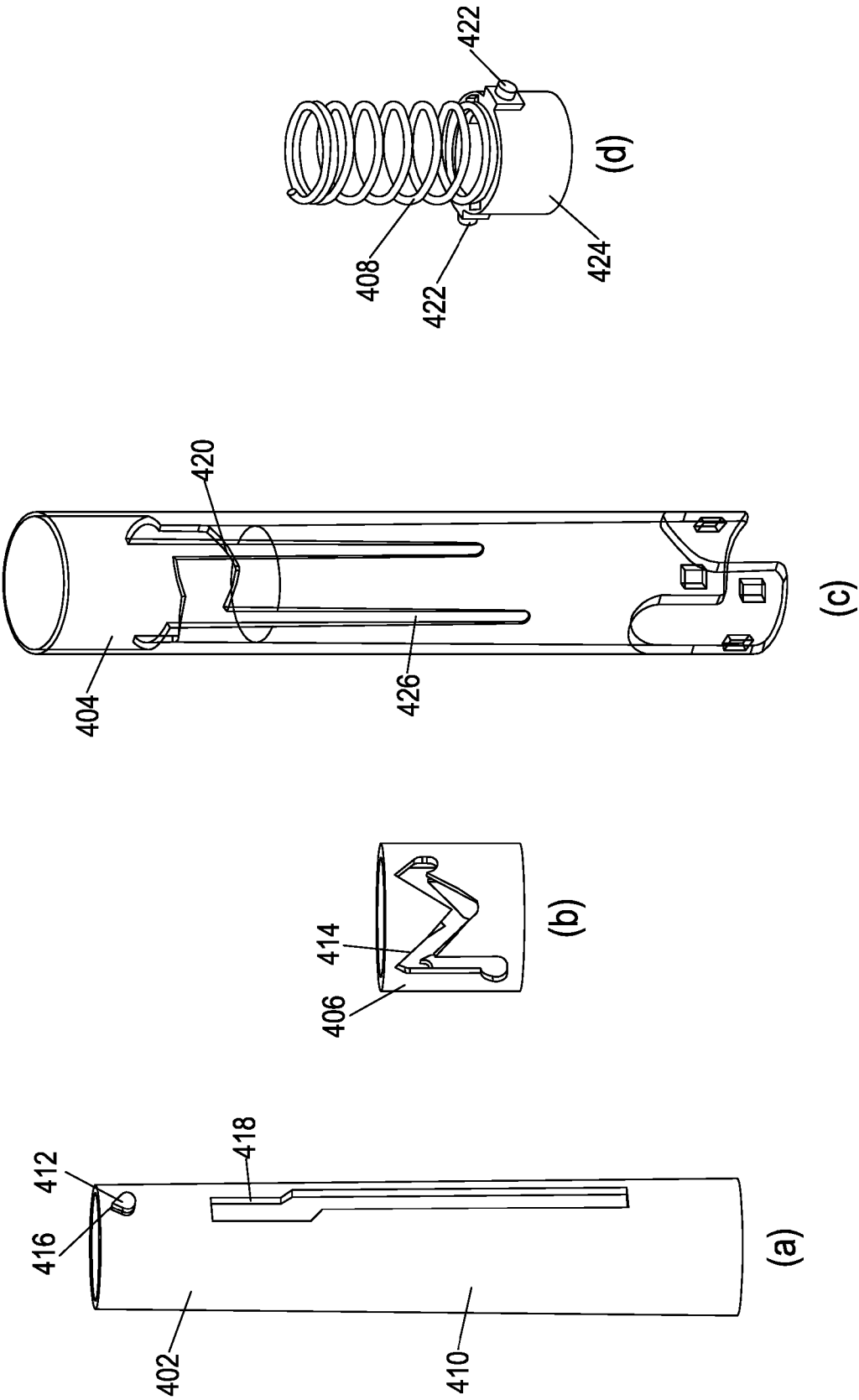


Figure 10

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2018/050665

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61M5/20 A61M5/32 A61M5/31
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, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X,P	WO 2017/187140 A1 (OWEN MUMFORD LTD [GB]) 2 November 2017 (2017-11-02) page 7, line 14 - page 8, line 18; figures 4-7	1-16
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Y	figures	2-12, 14-16
	----- -/-	



Further documents are listed in the continuation of Box C.



See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

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"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

26 June 2018

Date of mailing of the international search report

09/07/2018

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Ehrsam, Fernand

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2018/050665

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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