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(54) **Titre : DISPOSITIF D'ADMINISTRATION DE MEDICAMENTS DOTE D'UN ELEMENT DE SUPPORT A ENCLIQUETAGE DE CARTOUCHE**
(54) **Title: DRUG DELIVERY DEVICE WITH CARTRIDGE SNAP HOLDING FEATURE**

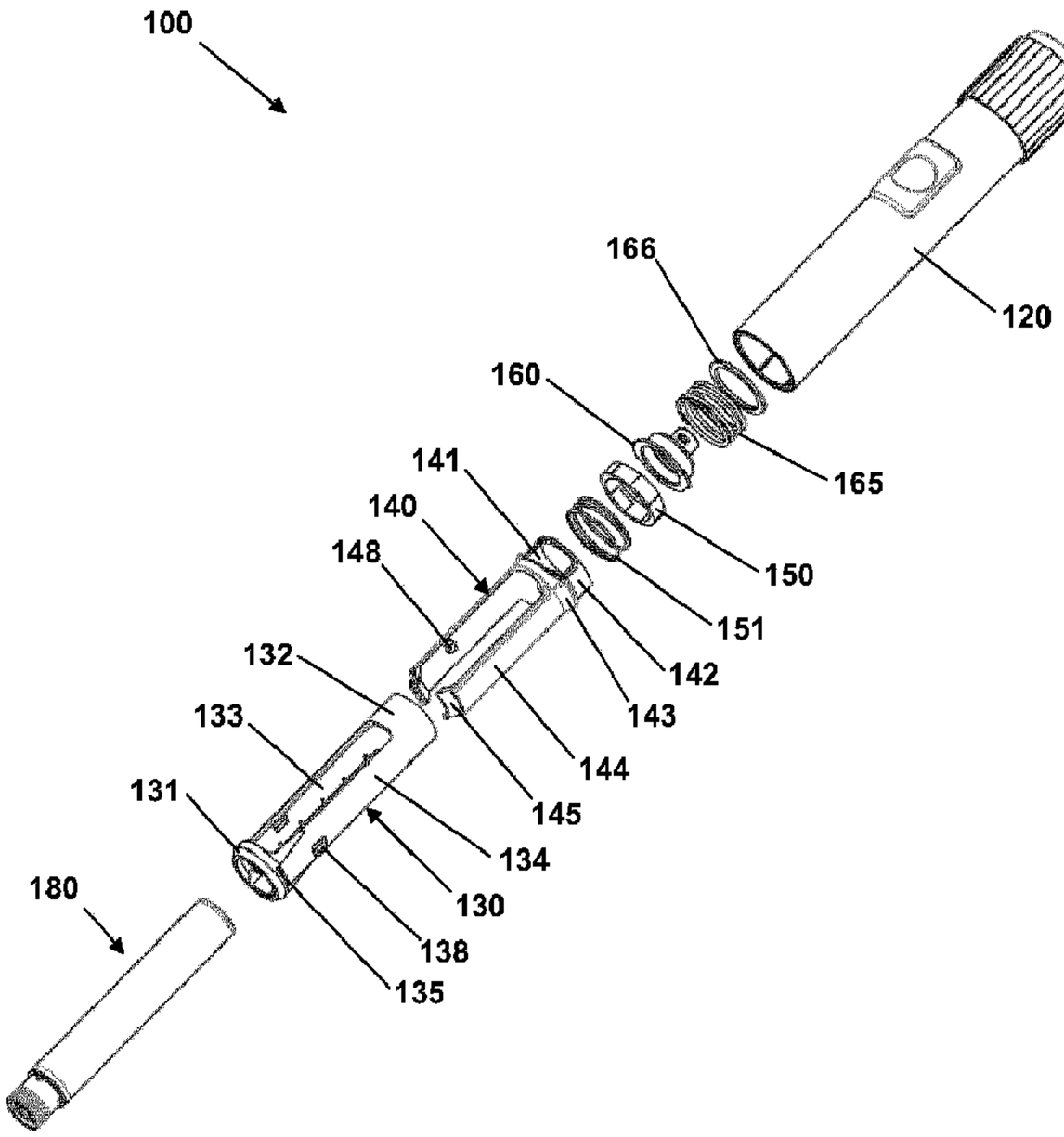

Fig. 3

(57) **Abrégé/Abstract:**
Drug delivery device comprising a cartridge holder adapted to receive and hold a cartridge in a loaded position,the cartridge holder comprising a distal opening adapted to receive the cartridge. The drug delivery device further comprises an expelling assembly

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(57) **Abrégé(suite)/Abstract(continued):**
adapted to engage and axially displace a piston in a loaded cartridge to thereby expel a dose of drug from the cartridge, and snap locking means acting on a cartridge being inserted in the cartridge holder, the snap locking means having a locked state in which the cartridge is held in the loaded position and an un-locked state in which the cartridge can be removed from the cartridge holder.

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[Continued on next page]

(54) **Title**: DRUG DELIVERY DEVICE WITH CARTRIDGE SNAP HOLDING FEATURE

(57) **Abstract**: Drug delivery device comprising a cartridge holder adapted to receive and hold a cartridge in a loaded position,the cartridge holder comprising a distal opening adapted to receive the cartridge. The drug delivery device further comprises an expelling assembly adapted to engage and axially displace a piston in a loaded cartridge to thereby expel a dose of drug from the cartridge, and snap locking means acting on a cartridge being inserted in the cartridge holder, the snap locking means having a locked state in which the cartridge is held in the loaded position and an un-locked state in which the cartridge can be removed from the cartridge holder.

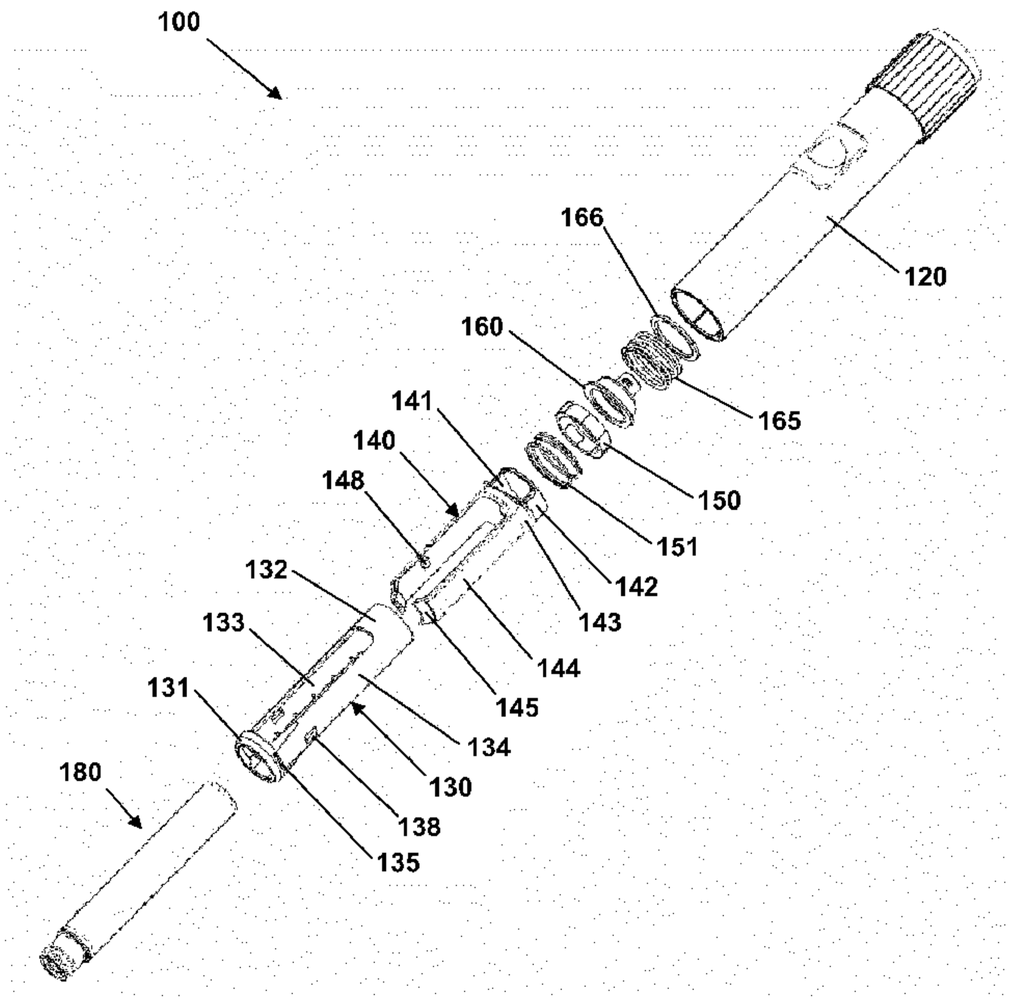

Fig. 3

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DRUG DELIVERY DEVICE WITH CARTRIDGE SNAP HOLDING FEATURE

The present invention generally relates to a drug delivery device adapted to receive a drug filled cartridge and expel a dose therefrom.

BACKGROUND OF THE INVENTION

In the disclosure of the present invention reference is mostly made to the treatment of diabetes, however, this is only an exemplary use of the present invention.

The most common type of injection devices adapted to receive a drug filled cartridge and expel a dose therefrom are generally pen-formed and utilizes a so-called cartridge holder adapted to receive and mount a cartridge in the device. Correspondingly, most pen-formed drug delivery devices comprises a generally cylindrical cartridge holder for receiving and holding a generally cylindrical drug-filled cartridge in a mounted position, the cartridge comprising a proximally facing and axially displaceable piston, and a main body with a housing in which a drug expelling mechanism is arranged, the mechanism comprising an axially displaceable piston rod adapted to engage the piston of a mounted cartridge to thereby expel a dose of drug from the cartridge. Between the cartridge holder and the main body a connection means is provided allowing a user to remove the cartridge holder from the main body and reattach it when a used cartridge has been exchanged with a new cartridge. The cartridge is in most cases inserted in the cartridge holder by axial movement through a proximal opening, see e.g. WO 2011/124631, EP 0 937 474 and WO 2011/092326. The connection means may be in the form of a threaded connection or a bayonet coupling. Depending on the design of the drug delivery device the piston rod has to be moved proximally (i.e. “reset”) by rotation when an empty cartridge is exchanged with a full cartridge, or the piston rod can be reset by being pushed axially, e.g. by unlocking the piston rod when the cartridge holder is removed from the main body, this as disclosed in e.g. US 2009/0275914 and WO 2011/051366.

Alternatively, the drug delivery device may comprise an integrated (i.e. for the user non-removable) cartridge holder adapted to axially receive a cartridge through a distal opening. Such a device is often named “front loaded”, see e.g. WO 2004/020026. The cartridge holder may be provided with gripping means adapted to hold and release an axially inserted cartridge.

Having regard to the above, it is an object of the present invention to provide a drug delivery device adapted to receive a drug-filled cartridge in a simple and effective way, the arrangement being cost-effective and reliable and, if intended for the end-user, also user-friendly.

DISCLOSURE OF THE INVENTION

In the disclosure of the present invention, embodiments and aspects will be described which will address one or more of the above objects or which will address objects apparent from the below disclosure as well as from the description of exemplary embodiments.

Thus, in accordance with a first aspect of the invention a drug delivery system is provided comprising a cartridge comprising a cylindrical body portion having opposed distal and proximal portions, a distal outlet portion and an axially displaceable piston, and a drug delivery device comprising a front-loaded cartridge holder adapted to axially receive and hold the cartridge in a loaded position, the cartridge holder comprising a distal portion with a distal opening adapted to receive the cartridge in a proximal direction, and an expelling assembly adapted to engage and axially displace the piston in a loaded cartridge. The assembly further comprises snap locking means provided between the cartridge and the cartridge holder to hold an inserted cartridge in the loaded position. The expelling assembly may be arranged in a housing providing an outer shell of a drug delivery device or it may be in the form of an assembly formed integrally with the housing. The cartridge holder may be formed integrally with the housing or be attached. By this arrangement a user or a manufacturer can easy and safely insert a cartridge in the cartridge holder. It should be noted that the snap locking means not necessarily provides an absolute lock against movements between the cartridge and cartridge holder. For example, the cartridge may still be allowed to rotate or be pushed proximally, e.g. against a spring force.

A snap lock will typically comprise the “active” snap locking means *per se* which undergoes a transformation during the engaging locking procedure as well as a cooperating “passive” means which typically does not transform. Correspondingly, the snap locking means of the invention may be provided as part of the drug delivery device, corresponding cooperating means being provided as part of the cartridge, as part of the cartridge, corresponding cooperating means being provided as part of the drug delivery device, or the snap locking means may be provided as part of both the cartridge and the drug delivery device, corresponding cooperating means being provided as part of the drug delivery device and the cartridge respectively.

The drug delivery system may comprise user operated release means for unlocking the snap locking means to thereby allow a loaded cartridge to be removed from the cartridge holder, e.g. when a user has to exchange an empty cartridge with a new cartridge. Alternatively the snap locking means may be adapted to irreversibly lock a cartridge in the cartridge holder, this being relevant e.g. during manufacture of pre-filled disposable pens allowing a drug-filled cartridge to be inserted late or as the last step in a manufacturing process.

For a re-useable system, the snap locking means may comprise one or more flexible locking arms each having a distal gripping portion reversibly actuatable between a locked and un-locked state.

In an exemplary embodiment the snap locking means comprises a pair of opposed flexible locking arms each having a distal gripping portion adapted to engage a cartridge and being reversibly actuatable between a locked and un-locked state. Each distal gripping portion may comprise an inclined proximal surface adapted to engage a corresponding distal actuation surface on the cartridge holder, whereby movement of the flexible locking arms in the proximal direction results in the distal gripping portions being moved outwards corresponding to their un-locked state. Each distal gripping portion may further comprise an inclined distal surface adapted to engage a corresponding proximal actuation surface on the cartridge holder, whereby movement of the flexible locking arms in the distal direction results in the distal gripping portions being moved inwards corresponding to their locked state. At least one of the actuation surfaces may be in the form of a surface inclined corresponding to the corresponding surfaces on the gripping portion, or an edge surface on which the gripping portion slides. Alternatively, another number of locking arms may be used.

In exemplary embodiments the cartridge holder comprises a distal form-stable opening adapted to axially receive a cartridge. The snap locking means may in both the locked and an un-locked state be arranged proximally of or corresponding to the form-stable distal opening. In this way the risk that protruding locking means jams or get entangled with other objects is minimized just like an uncluttered appearance may support the users' impression of a simple device being correspondingly simple to use.

Exemplary embodiments may comprise first biasing means adapted to engage a loaded cartridge and provide a distally directed axial force thereon to thereby bias the cartridge into engagement with the snap locking means. Second biasing means may be provided for holding the snap locking means in the locked state.

The snap locking means may be arranged partly or fully in the locked state when no cartridge is arranged in the cartridge holder, the snap locking means being moved to a receiving state when a cartridge is inserted into the cartridge holder, this allowing the cartridge to be inserted into the cartridge holder and snap into engagement with the snap locking means. The receiving state may correspond to the un-locked state or represent an intermediate state.

The above-described snap locking means may be actuated by axial movement of the cartridge relative to the cartridge holder, i.e. the snap locking means will lock when the cartridge is inserted in the axial direction with the application of only an axially directed force. Indeed, the actual design of the snap locking means may provide that the cartridge is rotated to a certain degree during insertion.

In accordance with a second aspect of the invention a drug delivery device is provided comprising a cartridge holder adapted to receive and hold a cartridge in a loaded position, the cartridge holder comprising a distal portion with a distal opening adapted to receive the cartridge, the cartridge comprising a cylindrical body portion, a distal outlet portion and an axially displaceable piston. The drug delivery device further comprises an expelling assembly adapted to engage and axially displace a piston in a loaded cartridge to thereby expel a dose of drug from the cartridge, and snap locking means acting on a cartridge being inserted in the cartridge holder, the snap locking means having a locked state in which the cartridge is held in the loaded position and an un-locked state in which the cartridge can be removed from the cartridge holder, as well as user operated release means for unlocking the snap locking means to thereby allow a cartridge to be removed from the cartridge holder. The drug delivery device may comprise the same features as described above in respect of a drug delivery system.

In accordance with a further aspect of the invention a drug delivery assembly is provided comprising a cartridge with a cylindrical body portion, a distal outlet portion and an axially displaceable piston, a cartridge holder adapted to receive and hold the cartridge in a loaded position, the cartridge holder comprising a distal portion with a distal opening adapted to receive the cartridge, and an expelling assembly adapted to engage and axially displace a piston in a loaded cartridge to thereby expel a dose of drug from the cartridge. The assembly is further provided with snap locking means arranged on the cartridge for locking a cartridge being inserted in the cartridge holder, the snap locking means having a locked state in which the cartridge is held in the loaded position and an un-locked state in which the cartridge can

be removed from the cartridge holder, and user operated release means for unlocking the snap locking means to thereby allow a cartridge to be removed from the cartridge holder.

In an exemplary embodiment the snap locking means is in the form of one or more flexible fingers, e.g. two opposed fingers, extending proximally from the distal end of the cartridge, the fingers being provided with protrusions snapping into engagement with corresponding openings in the cartridge holder. The fingers may be released by simply pressing them inwardly. If the assembly further is provided with biasing means providing a distally directed force, actuation of the fingers will result in the cartridge being automatically pushed out of the cartridge holder when released. A brake may be provided between the cartridge and the cartridge holder preventing that the cartridge will be pushed out too vigorously. Specific brake components may be arranged on the cartridge holder, the cartridge or both.

In accordance with a further aspect of the invention a cartridge is provided comprising a cylindrical body portion, a distal outlet portion and an axially displaceable piston, and snap locking means in the form of one or more flexible fingers extending proximally from the distal end of the cartridge, the fingers being provided with protrusions adapted to snap into engagement with corresponding structures in the cartridge holder.

In accordance with a further aspect of the invention a drug delivery assembly is provided comprising a cartridge comprising a cylindrical body portion, a distal outlet portion and an axially displaceable piston, a cartridge holder adapted to receive and hold the cartridge in a loaded position, the cartridge holder comprising a distal portion with a distal opening adapted to receive the cartridge, an expelling assembly adapted to engage and axially displace a piston in a loaded cartridge to thereby expel a dose of drug from the cartridge, and irreversible snap locking means locking the cartridge being inserted in the cartridge holder. The snapping structures may be provided on either or both of the cartridge and cartridge holder. Such an arrangement would allow the assembly to be used for the manufacture of a pre-filled drug delivery device. An advantage of such a system would be that a drug-filled cartridge, which is normally the most expensive part of a pre-filled drug delivery device, could be inserted in a final step of the manufacturing process.

In accordance with a further aspect of the invention a drug delivery device is provided comprising a cartridge holder adapted to receive and hold a cartridge in a loaded position, the cartridge holder comprising a distal portion with a distal opening adapted to receive the cartridge, the cartridge comprising a cylindrical body portion, a distal outlet portion and an axially

displaceable piston, and an expelling assembly adapted to engage and axially displace a piston in a loaded cartridge to thereby expel a dose of drug from the cartridge. The device further comprises locking means locking a cartridge being inserted in the cartridge holder, the locking means having a locked state in which the cartridge is held in the loaded position and an un-locked state in which the cartridge can be removed from the cartridge holder, as well as user operated release means for unlocking the locking means to thereby allow a cartridge to be removed from the cartridge holder. The device is further provided with biasing means adapted to engage a loaded cartridge and provide an axial distally directed force thereon, this providing that a loaded cartridge is moved distally and thereby at least partially out of the cartridge holder when the release means is operated to unlock the locking means. The biasing means may further serve to bias the cartridge into engagement with the snap locking means.

The above described drug delivery devices in accordance with aspects of the invention may be provided in combination with a cartridge comprising a cylindrical body portion, a distal outlet portion and an axially displaceable piston, the cartridge holder and the cartridge having cooperating coupling means.

In accordance with a yet further aspect of the invention a method of operating a drug delivery system is provided, comprising the steps of (i) providing a cartridge comprising a cylindrical body portion having opposed distal and proximal portions, a distal outlet portion and an axially displaceable piston, (ii) providing a drug delivery device comprising a front-loaded cartridge holder adapted to axially receive and hold the cartridge in a loaded position, the cartridge holder comprising a distal portion with a distal opening adapted to receive the cartridge in a proximal direction, and an expelling assembly adapted to engage and axially displace the piston in a loaded cartridge, and (iii) inserting a cartridge in the cartridge holder thereby actuating snap locking means provided between the cartridge holder and the cartridge to lock and hold the cartridge in a loaded position. The method of operating a drug delivery system may comprise the further steps of releasing the snap locking means, and removing the cartridge from the cartridge holder.

As used herein, the term "drug" is meant to encompass any flowable medicine formulation capable of being passed through a delivery means such as a cannula or hollow needle in a controlled manner, such as a liquid, solution, gel or fine suspension, and containing one or more drug agents. The drug may be a single drug compound or a premixed or co-formulated multiple drug compounds drug agent from a single reservoir. Representative drugs include

pharmaceuticals such as peptides (e.g. insulins, insulin containing drugs, GLP-1 containing drugs as well as derivatives thereof), proteins, and hormones, biologically derived or active agents, hormonal and gene based agents, nutritional formulas and other substances in both solid (dispensed) or liquid form. In the description of the exemplary embodiments reference will be made to the use of insulin and GLP-1 containing drugs, this including analogues thereof as well as combinations with one or more other drugs.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following the invention will be further described with reference to the drawings, wherein

fig. 1 shows an embodiment of a drug delivery device and a drug cartridge,

fig. 2 shows the embodiment of fig. 1 with the drug cartridge loaded in the delivery device,

fig. 3 shows a partially exploded view of the embodiment of fig. 1,

fig. 4A shows a detail view of the locking member of fig. 3,

fig. 4B shows a cross-sectional view of a modified cartridge holder,

figs. 5A and 5B show cross-sectional views of the cartridge holder of fig. 1,

figs. 6A and 6B show cross-sectional views of a further embodiment of cartridge holder,

figs. 7A and 7B show cross-sectional views of a further embodiment of cartridge holder,

figs. 8A and 8B show a further embodiment of a cartridge holder,

figs. 9A and 9B show a further embodiment of a drug delivery device with respectively without a drug cartridge mounted,

figs. 10A and 10B show detail views of the cartridge holder of fig. 9A in an open respectively closed state,

fig. 11 shows a cross-sectional view of the cartridge holder of fig. 10A,

figs. 12A-12D show a first display in different modes,

figs. 13A-13C show a second display in different modes,

figs. 14A-14C show a third display in different modes, and

figs. 15A-15D, 16A-16C and 17A-17C show a third display in different modes.

In the figures like structures are mainly identified by like reference numerals.

DESCRIPTION OF EXEMPLARY EMBODIMENTS

When in the following terms such as “upper” and “lower”, “right” and “left”, “horizontal” and “vertical” or similar relative expressions are used, these only refer to the appended figures and not to an actual situation of use. The shown figures are schematic representations for

which reason the configuration of the different structures as well as their relative dimensions are intended to serve illustrative purposes only.

Referring to fig. 1 a pen-formed drug delivery device 100 will be described. More specifically, the pen device comprises a cap part (not shown) and a main part having a proximal body or drive assembly portion with a housing 120 in which a drug expelling mechanism is arranged or integrated, and a distal cartridge holder portion in which a drug-filled transparent cartridge 180 with a distal needle-penetrable septum 187 can be arranged and retained in place by a cartridge holder 110 attached to the proximal portion, the cartridge holder having openings allowing a portion of the cartridge to be inspected. The cartridge may for example contain an insulin, GLP-1 or growth hormone formulation. The device is designed to be loaded by the user with a new cartridge through a distal receiving opening in the cartridge holder, the cartridge being provided with a piston driven by a piston rod 128 forming part of the expelling mechanism. A proximal-most rotatable dose ring member 125 serves to manually set a desired dose of drug shown in display window 126 and which can then be expelled when the release button 127 is actuated. Depending on the type of expelling mechanism embodied in the drug delivery device, the expelling mechanism may comprise a spring which is strained during dose setting and then released to drive the piston rod when the release button is actuated. Alternatively the expelling mechanism may be fully manual in which case the dose ring member and the release button moves proximally during dose setting corresponding to the set dose size, and then moved distally by the user to expel the set dose. The drug delivery device may also be provided with electronic means adapted to display a set dose and/or to detect and store information in respect of one or more expelled doses of drug, e.g. in the form of an electronic module integrated in the proximal end of a *per se* mechanical device as in NovoPen Echo® from Novo Nordisk, the electronic module comprising a display arranged in the release button. The cartridge is provided with distal coupling means in the form of a needle hub mount 182 having, in the shown example, an external thread 185 adapted to engage an inner thread of a corresponding hub of a needle assembly. In alternative embodiments the thread may be combined with or replaced by other connection means, e.g. a bayonet coupling. The shown exemplary hub mount further comprises a circumferential flange 186 with a number of distally facing projections 189 serving as a coupling means for the cartridge holder as will be described in detail below. A hub mount of the shown type is described in US 5,693,027. The cartridge holder is adapted to receive and hold the cartridge in a loaded position, the holder having a generally tubular configuration with a distal opening adapted to axially receive the cartridge in a proximal direction, the holder and the cartridge being provided with corresponding coupling means allowing a cartridge to be mounted and subse-

quently released. The shown embodiment comprises a main cartridge holder portion 130 on which an axially sliding locking member 140 is arranged, the locking member comprising two opposed arms 144 each having distal gripping means 149 adapted for engagement with the cartridge flange 186. Different embodiments of a cartridge holder will be described in greater detail in the following. An example of an expelling mechanism allowing a user to set a desired dose as well as comprising a cartridge actuated coupling allowing the piston rod to be pushed back by a cartridge during loading is disclosed in e.g. US 2004/0210199 hereby incorporated by reference. Fig. 2 shows the cartridge 180 mounted in the cartridge holder 110.

Fig. 3 shows a partly exploded view of the drug delivery device of fig. 1, the view showing the individual components of the cartridge holder as well as components associated therewith. More specifically, fig. 3 shows a pen-formed drug delivery device 100 comprising a drive assembly portion with a housing 120, a generally tubular main cartridge holder portion 130 (tube member) defining a longitudinal main axis and adapted to receive a cartridge 180, a locking member 140, a mounting ring 150, a first coil spring 151, a coupling member 160, a second coil spring 165 and a ring-formed spring support 166. The main cartridge holder portion 130 comprises a distal ring portion 131 defining an insertion opening for a cartridge, a proximal ring-formed base portion 132, and two opposed longitudinal window openings 133 formed between two opposed walls 134, the windows allowing the user to inspect the content of a loaded cartridge. Alternatively the main cartridge holder portion may be manufactured fully or partly from a transparent material. The main cartridge holder portion further comprises two opposed transversely oriented actuation slots 135 just proximally of the distal ring portion, as well as two opposed axially oriented slots 138 arranged proximally of the first mentioned slots, the two pair of slots being adapted to engage corresponding structures on the locking member. The locking member comprises a proximal ring portion 142 adapted to be arranged in sliding engagement with the proximal portion of the tube member, as well as a pair of opposed axially arranged flexible arms 144 having a free distal end, the proximal ring portion being provided with a pair of opposed windows 141 arranged corresponding to the gap between the opposed arms, as well as a pair of opposed protrusions 143 arranged just proximally of each arm. The distal end of each arm is provided with an inclined inwardly-distally oriented shoulder portion 145 provided with a plurality of gripping teeth 149, each shoulder portion being adapted to be received in one of the transversely oriented slots 135. As will be explained in further detail below, the engagement between the slots and the shoulders serve to move the distal ends of the flexible arms in and out of locking engagement with a loaded cartridge as the locking member is moved distally respectively proximally. Each arm is further provided with an inner guiding protrusion 148 adapted to be received in

one of the axially oriented slots 138 thereby limiting axial and rotational movement between the two members. The mounting ring 150 has an inner surface mounted on the proximal-most end of the tube member 130 and an outer surface mounted on an inner surface of the housing 120, thereby attaching the tube member to the housing. In the circumferential gap between the mounting ring and the mounted locking member the first coil spring 151 is arranged providing a distally directed biasing force on the locking member. The spring as well as the proximal-most portion of the locking member is arranged respectively guided inside the housing. Guided axially inside the housing a coupling member is arranged, the coupling member being biased distally by a second coil spring 165 arranged between the coupling member and the spring support 166 mounted in the housing. When in the distal-most position the coupling member provides that the piston rod 128 (see fig. 1) can be moved proximally (either by rotational or non-rotational movement). When a cartridge is inserted in the cartridge holder the proximal end of the cartridge engages the coupling member and moves it proximally against the biasing force of the spring, whereby the coupling member provides that the piston rod can engage, directly or indirectly, the expelling mechanism in which state it can be moved distally. At the same time the coupling member serves to provide a distally directed biasing force on a mounted cartridge.

Fig. 4A shows a detail view of the distal portion of the locking member 140 and cartridge 180 of fig. 3. The inclined shoulder portion 145 comprises an inner curved surface 146 and an outer curved surface 147, the outer surface being adapted to engage a correspondingly curved distal actuation surface 137 of the actuation slot 135, the inner surface being adapted to engage a proximal edge surface 136 of the actuation slot. The distal edge of the shoulder portion is provided with a plurality of gripping teeth 149 spaced circumferentially to provide a plurality of gaps, each tooth having a triangular configuration with a proximally oriented pointed end, thereby creating a plurality of gaps having a distally oriented pointed configuration. The cartridge 180 is provided with a hub mount 182 comprising a circumferential flange 186 with a number of distally facing pointed projections 189 adapted to be received between the teeth 149 to thereby serve as a gripping means when the locking member is arranged in its locking state.

Fig. 4B shows an alternative embodiment in which the guiding protrusions 148 have been replaced with flexible arms 148' serving as a brake for the cartridge, this preventing that the cartridge will be pushed out too vigorously by the biasing spring 151 when the cartridge is released. To allow for ease of insertion the arms are directed proximally to provide less resistance during cartridge insertion.

Referring to figs. 5A and 5B cross-sectional views of the cartridge holder of fig. 4A are shown. The locking member is mounted in sliding engagement on the tube member with the inclined shoulder portions positioned in the corresponding actuation slots. As can be seen, the mounting ring and corresponding part of the housing are shown as formed integrally with the tube member. As the locking member is biased distally by the first coil spring, the outer shoulder surface engages the inclined actuation surface whereby the distal ends of the flexible arms are forced inwardly with the teeth protruding into the opening of the distal ring portion 131. With the arm protrusions 148 received in the axially oriented slots 138 rotational movement between the two members is prevented. Fig. 5A also shows the piston rod 128 with a distal piston-engaging foot or washer 129. As the cartridge holder is empty the piston rod is free to be pushed proximally when a cartridge is inserted and the piston 183 engages the piston rod foot. When a new cartridge is to be loaded, the user simply inserts the proximal end of the cartridge axially through the distal cartridge holder portion where it engages the inwardly protruding gripping teeth 149 whereby the flexible arms 144 are pushed proximally against the biasing force of the first coil spring. As the arms are moved proximally the inner inclined shoulder surfaces 146 will engage the proximal edges 136 of the actuation slots and thereby force the shoulder portions outwardly, this allowing the cartridge to be introduced between the now open arms, the teeth being in sliding engagement with the outer surface of the cartridge during insertion. When the circumferential flange 186 with its projections 186 has passed the gripping teeth the shoulders will snap back in place due to the shoulders being biased inwardly by the combined action of the first coil spring and the engagement between the outer inclined shoulder surfaces 147 and the inclined actuation surfaces 137. Normally the user will push the cartridge slightly deeper into the cartridge holder against the biasing second coil spring 165, this allowing the pointed protrusions to securely seat between the pointed gripping teeth when the user stops pushing the cartridge. The teethed engagement is not essential for the axial fixation of the cartridge in the cartridge holder, however, the rotational fixation provided makes it easier to mount and de-mount a needle assembly relying on a rotational coupling such as a thread as shown or a bayonet coupling. As appears from fig. 5B, due to the shoulder portions being positioned between the engaging surfaces of the actuation slot, the shoulders cannot easily be pulled apart by inadvertent actions, this providing a secure locking engagement between the cartridge and the cartridge holder. When the user desires to release and remove the cartridge the cartridge holder is moved proximally against the biasing force of the first coil spring and the second coil spring, e.g. by gripping the protrusions 143, this moving the shoulders proximally-outwardly and thus the gripping teeth out of engagement with the cartridge flange 186, this

allowing the second coil spring via the coupling member 160 to partly push out the cartridge in a “popping” action, this allowing the user to easily grip and remove a cartridge.

Referring to figs. 6A and 6B cross-sectional views of a further embodiment of a cartridge holder 210 are shown corresponding essentially to the figs. 5A and 5B embodiment with the main difference that two opposed push buttons 270 are provided in the proximal base portion 232 of the cartridge holder 230 instead of the gripping protrusions. The push buttons interact with surfaces 243 on the locking member in such a way that actuation of the buttons result in the locking member and the flexible arms 244 are moved proximally and the shoulders 245 are moved out of engagement with the cartridge 280 as also described with reference to figs. 5A and 5B, this releasing the cartridge. Insertion takes place as described above.

Referring to figs. 7A and 7B cross-sectional views of a further embodiment of a cartridge holder 310 are shown corresponding partly to the figs. 5A and 5B embodiment with the main difference that the flexible arms 344 are moved proximally and distally, and thereby the gripping shoulders 345 out and in of the actuation slots 335, by rotation of an actuation ring 370 mounted in rotational engagement on the tube member base portion 332. More specifically, the actuation ring 370 is provided with a pair of opposed oblique slots 371 adapted to engage corresponding protrusions 343 arranged on the proximal portion of the locking member, whereby rotation of the ring results in axial movement of the locking member. In the shown embodiment the slot has an angle relative to longitudinal axis which provides a locking engagement, i.e. axial movement of the locking member is not able to rotate the ring. However, in alternative embodiments the angle could be chosen to allow insertion of a cartridge 380 as well as the spring force of the coil spring 351 to turn the ring, this providing a snap coupling as described above.

In the embodiment of figs. 1-5A a loaded cartridge is released by moving a locking member proximally, however, as an alternative to such a user interface the cartridge may be released in the same way as it is loaded and locked in place. More specifically, instead of an external actuation member the device may be provided with a pen-type mechanism in which a first push locks the cartridge in place as described above, and a second push on the cartridge releases the gripping shoulders allowing the cartridge to pop out. In this way a very simple and intuitive cartridge mechanism is provided in which the cartridge is loaded and unloaded by the same type of operational input, i.e. pushing the cartridge proximally. Further, as operation is very similar to the operation of a conventional ball pencil easy learning and adaptation for new users is further enhanced.

Figs. 8A and 8B show an alternative embodiment of an assembly comprising a cartridge 480 with a cylindrical body portion 481 and a cartridge holder 430 adapted to receive the cartridge in snap-locking engagement. In contrast to the above described embodiments, the axially actuated coupling is a snap coupling comprising flexible arms (in the following denoted fingers) arranged on the cartridge, the cartridge holder merely comprising a stationary tube member with a distal opening 431 and means adapted to engage the arms. More specifically, the needle hub mount 482 is provided with coupling means in the form of a pair of opposed proximally extending flexible fingers 483 each comprising a proximal outwards locking protrusion 484 with a distally facing edge 485 and a proximally facing inclined surface 486. Distally of each finger a distal protrusion 488 with a proximally facing edge 489 is arranged. The cartridge holder 430 has on the inner distal surface coupling means in the form of a pair of opposed axially extending slots 433, each slot having a distal opening adapted to axially receive the above-described locking protrusions, each slot communicating at the proximal end with an opening 434 adapted to receive a locking protrusion, each opening having a proximally facing edge 435. Corresponding to each slot the distal circumferential edge of the cartridge holder is provided with a pair of cut-outs 438 each having a distally facing edge 439 with an associated inclined surface 436 adapted to initially engage the inclined surface 486 on a flexible finger. When the cartridge is axially inserted in the cartridge holder the fingers engage the slots and flexes inwardly until the fingers' protrusions snap outwardly into the openings, the distal edge on each protrusion thereby facing the corresponding proximal edge of the opening. At the same time the cartridge distal protrusions 488 snap into the corresponding cut-outs 438, the proximal edge 489 on each distal protrusion thereby facing the corresponding distal edge 439 of the cut-out. In this way the cartridge is locked in the cartridge holder both axially and rotationally. Corresponding to the above described embodiments a biasing distally directed force acts on the inserted cartridge. To release the cartridge holder the user forces the two finger protrusions inwardly after which the cartridge "pops out" where after it can be gripped and axially removed from the cartridge holder. As appears, the finger protrusions also serve as user operated release means for unlocking the snap locking means, however, alternatively the release means could be arranged on the cartridge holder. In the figs. 8A and 8B embodiment the active snap lock elements are arranged on the cartridge, however, alternatively they may be arranged on the cartridge holder. Further, instead of being purely axial the snap lock may comprise a rotational component.

In the fig. 7A embodiment rotation of an actuation ring 370 is used to move the gripping shoulders proximally and distally, and thereby the gripping shoulders 345 out and in of en-

gagement with a mounted cartridge. Based on the concept of using a rotatable member to control cartridge locking means incorporated in a front loaded cartridge holder, an alternative embodiment of a front loaded cartridge holder will be described with reference to figs. 9A-11.

More specifically, fig. 9A shows a drug delivery device 500 comprising a cap part (not shown) and a main part having a proximal body or drive assembly portion with a housing portion 520 in which a drug expelling mechanism is arranged or integrated, and a distal cartridge holder portion in which a drug-filled transparent cartridge 580 with a distal needle-penetrable septum and a needle hub mount 582 can be arranged and retained in place by a cartridge holder 510 attached to the proximal portion, the cartridge holder having openings allowing a portion of the cartridge to be inspected. The device is designed to be loaded by the user with a new cartridge through a distal receiving opening in the cartridge holder. The cartridge as well as the expelling mechanism may be of the same type as described with reference to fig. 1.

As shown, the cartridge holder has the same general appearance as a traditional cartridge holder which is detachably coupled to the housing by e.g. a threaded coupling or a bayonet coupling and into which a new cartridge can be received as well as removed through a proximal opening, i.e. it comprises no additional user operated release means such as the opposed protrusions 143 shown in fig. 3. Instead, what appears merely to be the cartridge holder *per se* is in fact user operated coupling means in the form of an outer rotatable tube member 570 operated by the user to control movement of an inner gripping member 540 (see fig. 10A) to thereby open and close gripping shoulders 545 configured to grip and hold a cartridge in essentially the same way as shown in figs. 1-7. In this way an easy-to-use front loaded drug delivery device is provided which appears as a traditional rear loaded device and which is also actuated by rotational movement to mount and remove a cartridge, the resemblance providing for ease of acceptance and adaptation among users accustomed to traditional types of rear loaded drug delivery devices.

When it is time to mount a new cartridge the outer tube member is rotated e.g. 15 degrees by which action the gripping shoulders 545 are moved distally and slightly outwards, this allowing the cartridge to be removed. For ease of operation the cartridge may be moved distally a certain distance as the shoulders are moved, e.g. by engagement with the arms forming the gripping shoulders and/or by additional spring means providing a biasing distally directed force. Fig. 9B shows the device with the cartridge removed and the gripping shoulders in their un-locked “open” position in which a cartridge can be removed and a new inserted. Depending on the design of the locking and actuation mechanism the gripping shoulders may

be able to be left in the open position or they may be retracted automatically as the outer tube member is rotated backwards by return spring means. Whether or not a spring is provided the cartridge holder may be provided with locking means allowing the outer tube member may to be securely parked in either the open or closed position, e.g. by a rotational snap lock.

The mechanical arrangement providing the above-described user-interface, i.e. rotation of the outer tube member moves the gripping shoulders in and out, can be provided in numerous ways. In the fig. 10A embodiment the cartridge holder comprises two opposed flexible arms extending from a proximal ring portion 542 arranged in axially guided sliding and thus non-rotational engagement with the outer tube member, each arm being provided with a gripping shoulder corresponding to the fig. 1 embodiment. By this arrangement the gripping shoulders will rotate together with the outer tube member and thus relative to the housing as they are moved axially. By this arrangement the two opposed windows 541 formed in the gripping member as well as in the outer tube member will move together in rotational alignment. Alternatively the gripping member and the outer tubular member may be manufactured fully or partly from a transparent material. Corresponding somewhat to the configuration of the fig. 4 embodiment each arm comprises an outer curved surface 547 adapted to engage a correspondingly curved distal actuation edge 577 of the outer tube member 570, as well as a pair of inclined edge portions 546 adapted to engage a pair of corresponding inclined actuation surfaces 576. By this arrangement the inclined actuation surfaces 576 will force the gripping shoulders outwardly to their open position as the inclined edge portions 545 are moved distally and into sliding contact with the actuation surfaces. Correspondingly, when the arms are moved proximally the outer curved surfaces 547 engage the actuation edges 577 and are thereby forced inwardly into their locked position.

Fig. 11 shows a cross-sectional view of the cartridge holder shown in figs. 9 and 10. As described above, the inner gripping member 540 comprising opposed arms 544 with distal gripping shoulders 544 is housed inside the outer tube member 570. The outer member is provided with a proximal circumferential flange 572 guided in a corresponding circumferential groove 522 formed in the housing portion, this allowing the outer member to rotate relative to the housing. The outer member is further provided with two opposed proximal openings 573 allowing control protrusions 543 provided on the gripping member to engage a helical groove 523 formed in the housing portion, this engagement controlling axial movement of the gripping member as the outer tube member is rotated. A spring member 525 arranged in the housing provides a distally directed biasing force on a mounted cartridge. The housing por-

tion is further provided with a coupling mechanism 529 controlled by the rotational actuation of the cartridge holder to lock and unlock engagement between the piston rod and the expelling mechanism. By providing a coupling mechanism controlled by rotation of the cartridge holder the mechanism can be designed to be activated after a cartridge has been locked in place and with the piston rod 528 in proper contact with a cartridge piston, this ensuring that neither an air gap is formed between the piston and the piston rod, nor that the piston is elastically deformed during the mounting procedure.

As indicated above, the drug delivery device of fig. 1 may be provided with electronic means adapted to detect, store and display information in respect of one or more expelled doses of drug, e.g. in the form of an electronic module integrated in the proximal end of the device as in NovoPen Echo® from Novo Nordisk, the electronic module comprising a display arranged in the release button, see WO 2010/052275. In the following different user related aspects of an electronic dose logging module adapted to store and display information in respect of one or more expelled doses of drug will be described.

In one embodiment of such a module a display is integrated in the proximal-most release button. Consequently, the display is relatively small and will for a pen-formed device typically be close to circular. Further, to provide a simple user interface and appearance no additional buttons are provided this making it a challenge to recall and display dose history information in a simple, effective and reliable way. In the following examples are shown for a display adapted to show information in respect of the last dose expelled from the device, i.e. the size of the dose in units of insulin, and the time since it was expelled. Alternatively, other units may be displayed when the device is adapted for other drugs, e.g. mg for a GLP-1 formulation or growth hormone.

Figs. 12A-12D show an embodiment of a display 600 using a two-line LCD based on numeric 7-segment characters, this type of display as well as the corresponding display driver being relatively inexpensive. The letters “u” for units, “h” for hour(s) and “d” for day(s) may be shown using pre-formed characters or also be formed from segments. In fig. 12A all information is shown at the same time, i.e. in the upper line number of units from 1 to 99 and in the lower line the number of days from 0-9 days (for zero days no day information may be shown) and the number of hours from 0-23. Alternatively, the display may be controlled to display dose size or time separately as shown in figs. 12B-12D. The display may be toggled between the two states either automatically or by user actuation.

As appears especially from figs. 12A and 12C when two lines of information have to be displayed then the characters become rather small. Addressing this issue the display 610 of figs. 13A-13C comprises two layers of 7-segment LCDs, the upper display being transparent when not utilized, this allowing the lower display to be viewed, this design allowing larger digits to be displayed still relying on the relatively inexpensive segment-type LCD. More specifically, when displaying the number of units or the number of hours only, then the first display (which may be the upper or lower) is used, whereas the second display comprising two lines of smaller digits is used only when periods counted in both days and hours have to be shown. In this way most information will be shown using the larger digits. The toggling may be automatic or manual. The display 620 of figs. 14A-14C is a conventional two-line display similar to the fig. 12A display with both lines active. In fig. 14A time is shown using a HH:MM:SS stop watch design, this providing that the time since the last dose expelled from the device can be shown with a running second counter allowing a user to easily identify the shown information as a counting time value. After 24 hours the display may continue to display time in the HH:MM:SS format or change to a day and hour format. In fig. 14B time is shown as in fig. 12A, whereas in fig. 14C days and hours are indicated by icons. In figs. 12A, 13A and 14A the displays are provided with a “horizon” 601, 611, 621 which may be both a cover for wiring and an indicator for how to read the display.

As an alternative to use one or two 7-segment display portions a matrix display 630 may be utilized, however, both the display and the corresponding driver are more expensive. In the displays shown in figs.15A-15D, 16A-16C and 17A-17C the digits are formed to mimic a 64x64 matrix display. As appears, when two lines of information are shown as in the display 630 of fig. 15A then the size of the digits are proximately the same as in the fig. 12A embodiment, however, it may be argued that the “nicer” formed digits improve readability. In figs. 15B-15D the matrix display 631 is controlled to display the information in the same way as the two-layer display of figs. 13A-13C, i.e. one line of larger digits and two lines of smaller digits. Also here it may be argued that the matrix display improves readability. As appears, for both types of information the digits are shown dark on a lighter background, however, one type of information, e.g. units of insulin or time, may be displayed by controlling the display 640 to show such information in an inverted mode as shown in figs. 16A-16C and 17A-17C, which may help a user to better identify the displayed information.

As a display used for the above-described intended purpose is expected to be watched only a few times every day, the display should be turned on only when needed to save energy. The display may be actuated and controlled either by “inherent” control means already pro-

vided and used to set and expel a dose of drug or by additional input means provided only to control the display. The inherent input means for a mechanical-type drug delivery device are typically the dose setting member which mostly is in the form of a rotatable member and the release button which may be arranged at the proximal end of the device as shown in fig. 1 or elsewhere. The dose setting member can normally be rotated away from its zero position, however, to provide an additional type of input it may be adapted to be rotated a few degrees backwards from the zero position as well as be allowed to be pulled back or pushed forwards. Correspondingly and depending on the actual design the release push button may be adapted to be additionally pulled slightly out to provide an additional type of input.

In an exemplary embodiment a drug delivery device with dose logging feature may be operated in the following way. During normal use of a *per se* mechanical drug delivery device a user will set a dose using the mechanical display 126 (see fig. 1) and expel the set dose by pushing the release button on a spring-driven device or by pushing in the button on a manually driven device. During setting and expelling of a dose the display is muted. The expelled dose may be logged during setting and/or expelling, however, as a set dose may not be fully expelled (e.g. an injection may be paused by the user and the remaining dose cancelled by dialling back the dose setting member), the dose is here logged during actual actuation of the expelling mechanism. When the dose has been fully expelled (or paused for a given amount of time) the display will show the amount of insulin in number of units as e.g. in fig. 12D, 13C or 15D. As the dose has just been expelled it is not necessary to display units of time.

When a user desires to check the dose log a user input has to be provided in order to control the electronics to shift to display mode, i.e. displaying the log information using either a single or two display views as discussed above. A simple and to many intuitive input would be to just press the actuation button to turn on the display, however, if a dose inadvertently has been dialled in a spring driven device this action will release the mechanism and start expelling of drug which indeed is not desirable. To avoid this and still use inherent input means the user may dial up a dose and then dial back the dose to zero, this bringing the electronics in display mode. Alternatively, the delivery device may be provided with input means to be used exclusively for bringing the electronics into display mode. For example, the dose ring member 125 may be pushed forward or pulled backward a slight distance or rotated slightly backwards (by which action the mechanical dose display does not have to be moved correspondingly backwards). Correspondingly, if the logging electronics is provided with a memory for a number of dose events then different combinations of input for the mentioned input types can be used to control the display, e.g. to show data for only the last dose event the user may

push forward the dose ring member whereas pulling the member backwards will step the user through log data for previous injections. This mode may then time out or be cancelled by pushing forward the dose ring member. In order to provide the user with information in respect of older log data the display may be provided with additional indicia, e.g. peripheral “5 minutes” segments may each indicate one of 12 memory positions. As a further alternative, the electronic module may be provided with other types of input means, e.g. a motion sensor which would allow a user to turn on the display by shaking or tapping, or a touch sensor integrated in the display as is well known from e.g. smartphones which would allow a user to turn on the display by swiping a finger across the display.

In the description of exemplary embodiments of the invention a drug delivery device of the general pen type has been shown, however, the drug delivery device may have other form-factors, e.g. box-formed as the Innovo® device from Novo Nordisk, and may also be provided with a motorized expelling mechanism.

In the above description of exemplary embodiments, the different structures and means providing the described functionality for the different components have been described to a degree to which the concept of the present invention will be apparent to the skilled reader. The detailed construction and specification for the different components are considered the object of a normal design procedure performed by the skilled person along the lines set out in the present specification.

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CLAIMS

1. A drug delivery system comprising:

(i) a cartridge (180, 480) comprising a cylindrical body portion (181, 481) having opposed distal and proximal portions, a distal outlet portion and an axially displaceable piston (183),

(ii) a drug delivery device (100) comprising:

- a front-loaded cartridge holder (130, 430) adapted to axially receive and hold the cartridge in a loaded position, the cartridge holder comprising a distal portion with a distal opening (131, 431) adapted to receive the cartridge in a proximal direction, and
- an expelling assembly adapted to engage and axially displace the piston in a loaded cartridge,

wherein snap locking means (140, 145, 483) is provided between the cartridge and the cartridge holder to hold an inserted cartridge in the loaded position.

2. A drug delivery system as in claim 1, wherein the snap locking means (140, 145) is provided as part of the drug delivery device, corresponding cooperating means (186) being provided as part of the cartridge.

3. A drug delivery system as in claim 2, comprising user operated release means (143, 270, 370) for unlocking the snap locking means to thereby allow a loaded cartridge to be removed from the cartridge holder.

4. A drug delivery system as in claim 3, wherein the snap locking means comprises one or more flexible locking arms (144) each having a distal gripping portion (145) reversibly actuatable between a locked and un-locked state.

5. A drug delivery device as in claim 4, wherein each distal gripping portion comprises an inclined proximal surface (146) adapted to engage a corresponding distal actuation surface (136) on the cartridge holder, whereby movement of the flexible locking arms in the proximal direction results in the distal gripping portions being moved outwards corresponding to their un-locked state.

6. A drug delivery device as in claim 4 or 5, wherein each distal gripping portion comprises an inclined distal surface (147) adapted to engage a corresponding proximal actuation surface (137) on the cartridge holder, whereby movement of the flexible locking arms in the

distal direction results in the distal gripping portions being moved inwards corresponding to their locked state.

7. A drug delivery system as in any of the previous claims, wherein the cartridge holder comprises a distal form-stable opening (131, 431) adapted to axially receive the cartridge, the snap locking means (140, 145) being arranged proximally of or corresponding to the form-stable distal opening.

8. A drug delivery system as in any of the previous claims, comprising first biasing means (160, 165) adapted to engage a loaded cartridge and provide a distally directed axial force thereon to thereby bias the cartridge into engagement with the snap locking means.

9. A drug delivery device as in any of the previous claims, comprising second biasing means (151) for holding the snap locking means in the locked state.

10. A drug delivery system as in claim 1, wherein the snap locking means (483) is provided as part of the cartridge (480), corresponding cooperating means (434) being provided as part of the drug delivery device.

11. A drug delivery system as in claim 10, comprising user operated release means (484) for unlocking the snap locking means to thereby allow a loaded cartridge to be removed from the cartridge holder.

12. A drug delivery system as in claim 1, wherein the snap locking means is provided as part of both the cartridge and the drug delivery device, corresponding cooperating means being provided as part of the drug delivery device and the cartridge respectively.

13. A drug delivery system as in any of claims 2, 10 and 12, wherein snap locking means is adapted to irreversibly lock the cartridge being inserted in the cartridge holder.

14. A drug delivery system as in any of the previous claims, wherein the snap locking means is actuated by axial movement of the cartridge relative to the cartridge holder.

15. A drug delivery device (100) comprising:

- a cartridge holder (130) adapted to receive and hold a cartridge (180) in a loaded position, the cartridge holder comprising a distal portion with a distal opening (131) adapted

to receive the cartridge, the cartridge comprising a cylindrical body portion (181), a distal outlet portion and an axially displaceable piston (183),

- an expelling assembly adapted to engage and axially displace a piston in a loaded cartridge to thereby expel a dose of drug from the cartridge,
- snap locking means (140, 145) acting on a cartridge being inserted in the cartridge holder, the snap locking means having a locked state in which the cartridge is held in the loaded position and an un-locked state in which the cartridge can be removed from the cartridge holder, and
- user operated release means (143) for unlocking the snap locking means to thereby allow a cartridge to be removed from the cartridge holder.

16. A method of operating a drug delivery system, comprising the steps of:

(i) providing a cartridge (180, 480) comprising a cylindrical body portion having opposed distal and proximal portions, a distal outlet portion and an axially displaceable piston,

(ii) providing a drug delivery device comprising:

- a front-loaded cartridge holder (130, 430) adapted to axially receive and hold the cartridge in a loaded position, the cartridge holder comprising a distal portion with a distal opening (131, 431) adapted to receive the cartridge in a proximal direction,
- an expelling assembly adapted to engage and axially displace the piston in a loaded cartridge, and

(iii) inserting a cartridge in the cartridge holder thereby actuating snap locking means (140, 145, 483) provided between the cartridge holder and the cartridge to lock and hold the cartridge in a loaded position.

17. A method of operating a drug delivery system as in claim 16, comprising the further steps of:

- releasing the snap locking means, and
- removing the cartridge from the cartridge holder.

18. A method of operating a drug delivery system as in claim 16 or 17, wherein the cartridge is inserted using an axially directed force only to thereby actuate the snap locking means.

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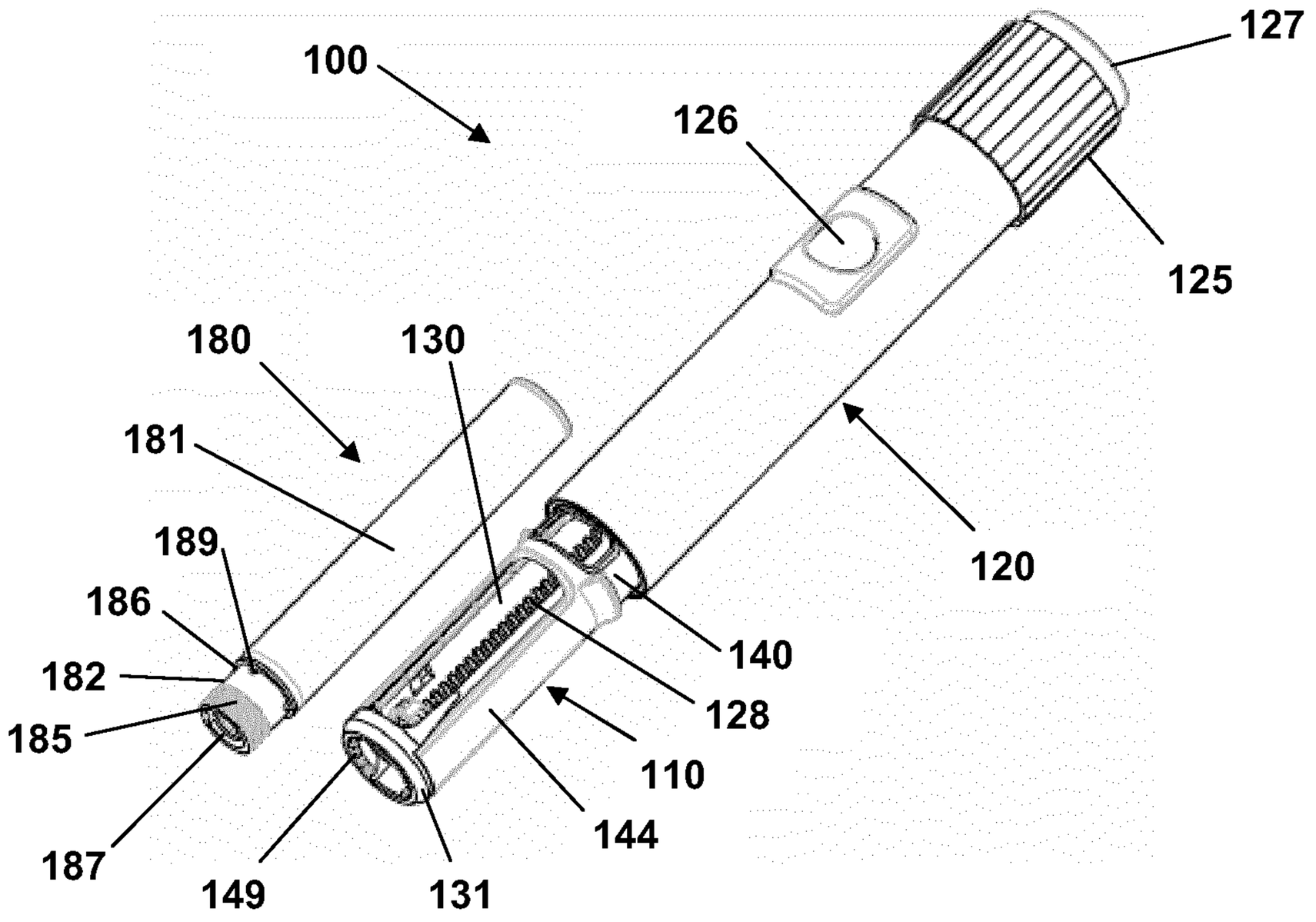
100
127
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130
181
189
186
182
185
187
149
131
144
110
128
140
120

Fig. 1

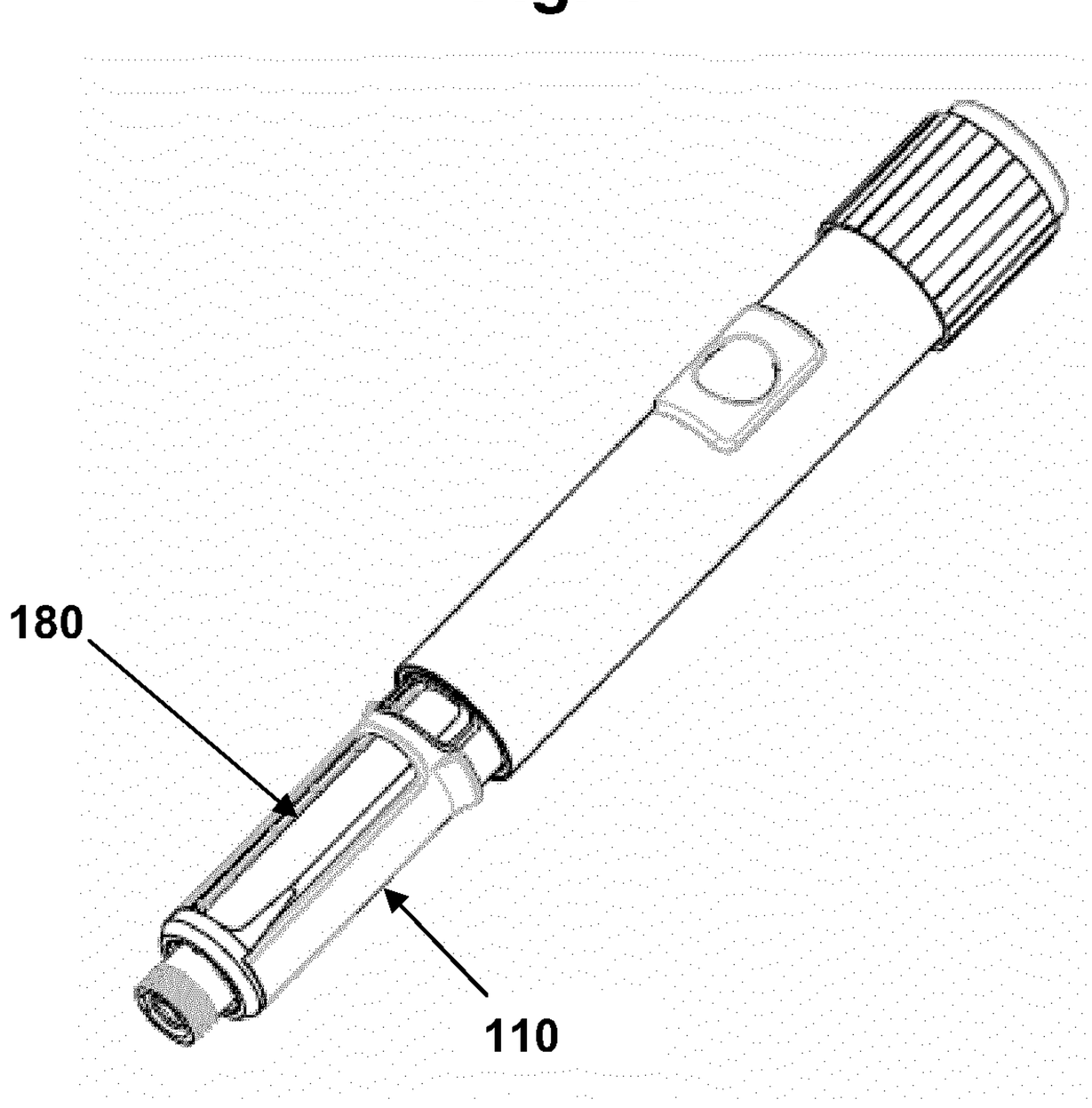
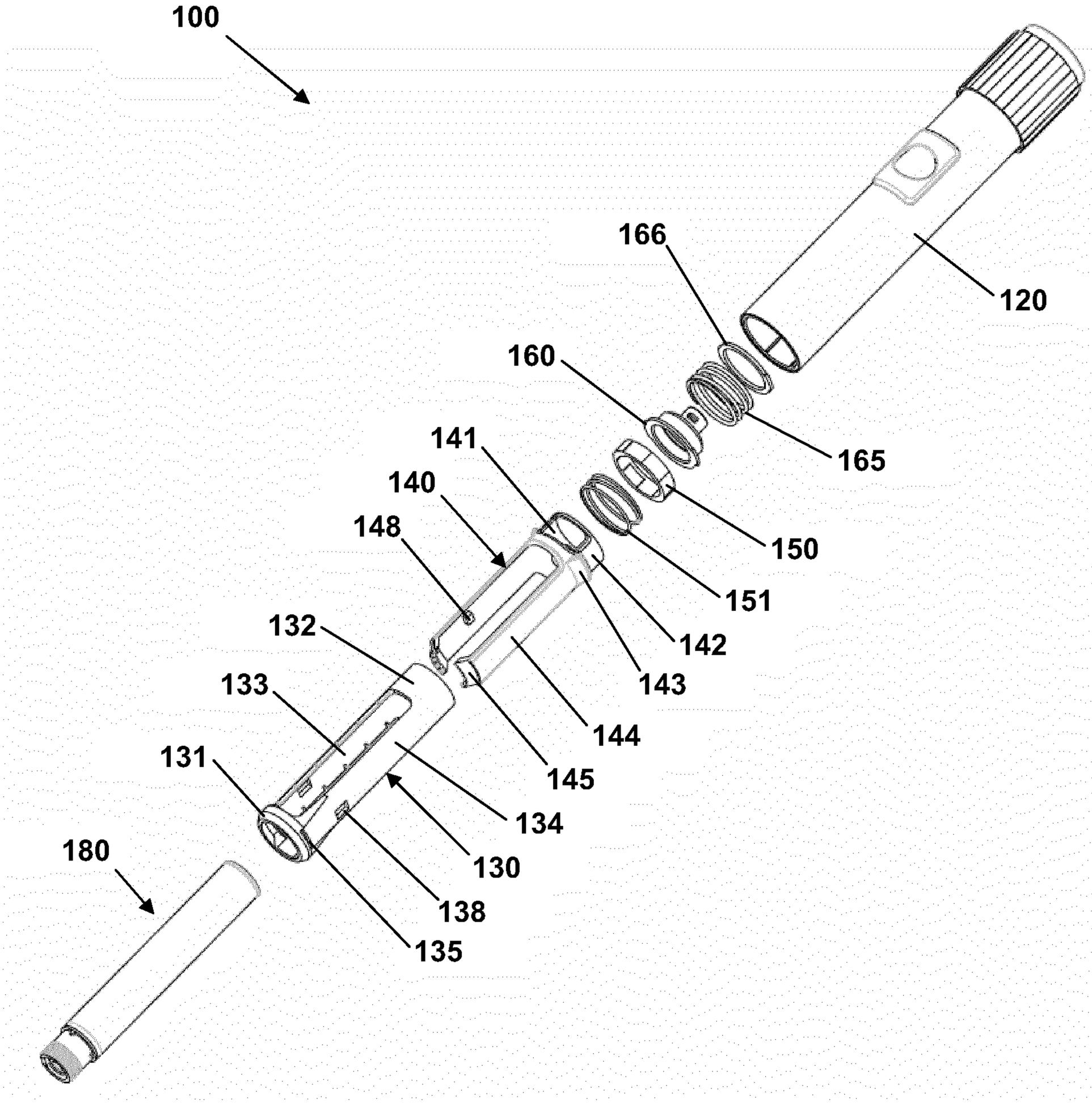

180
110

Fig. 2

*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166
120
160
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132
143
133
144
131
145
134
130
180
138
135

Fig. 3

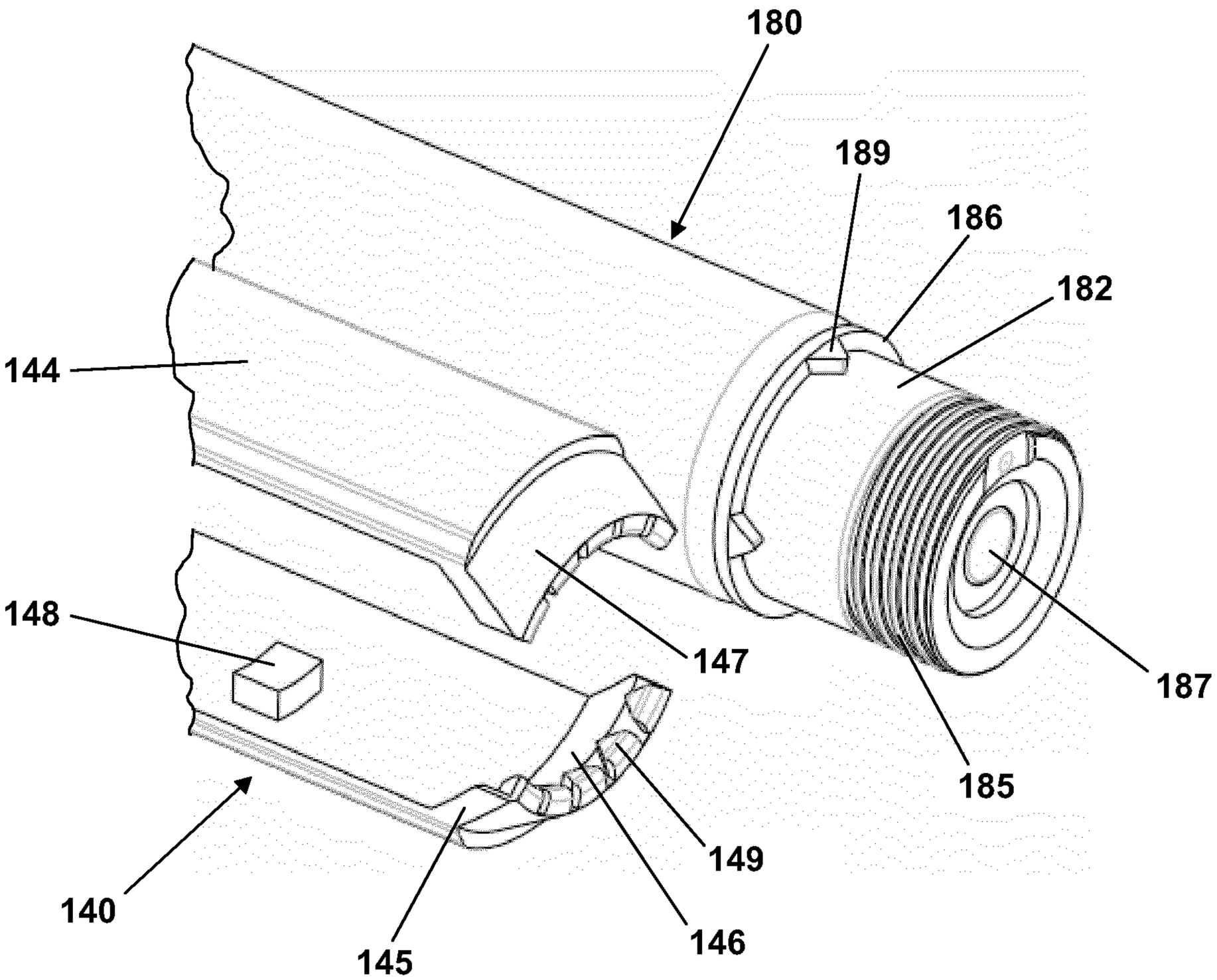

Fig. 4A

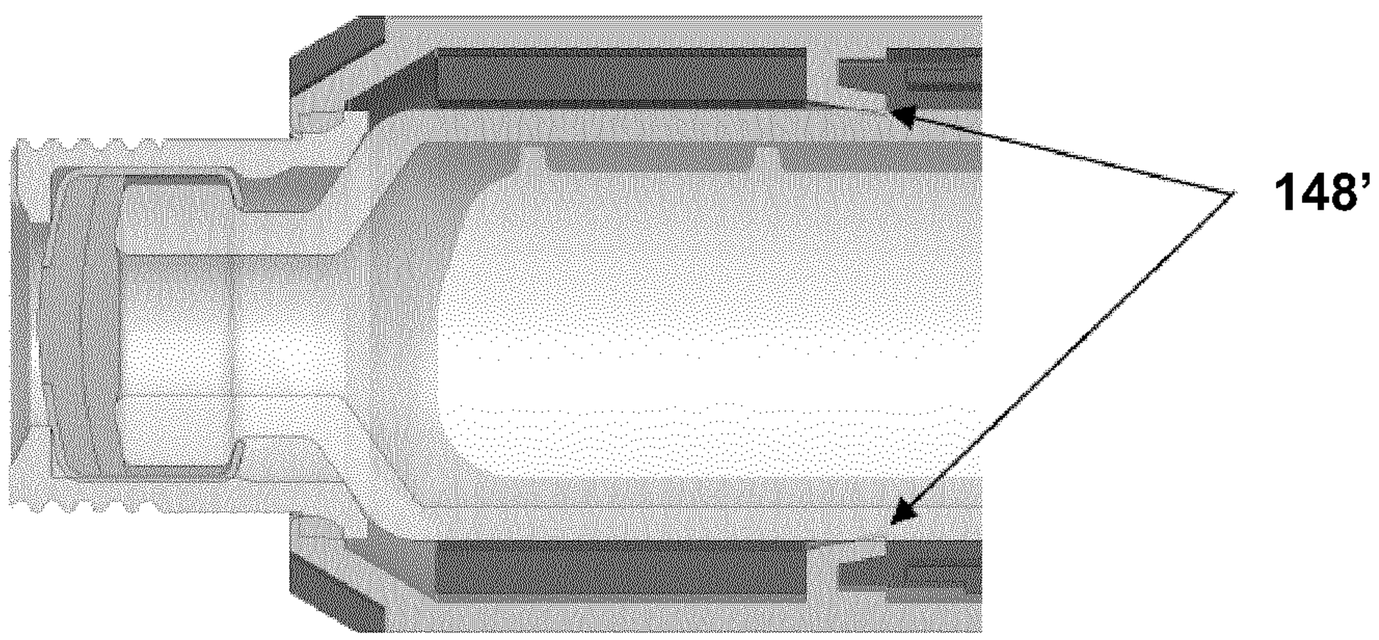

Fig. 4B

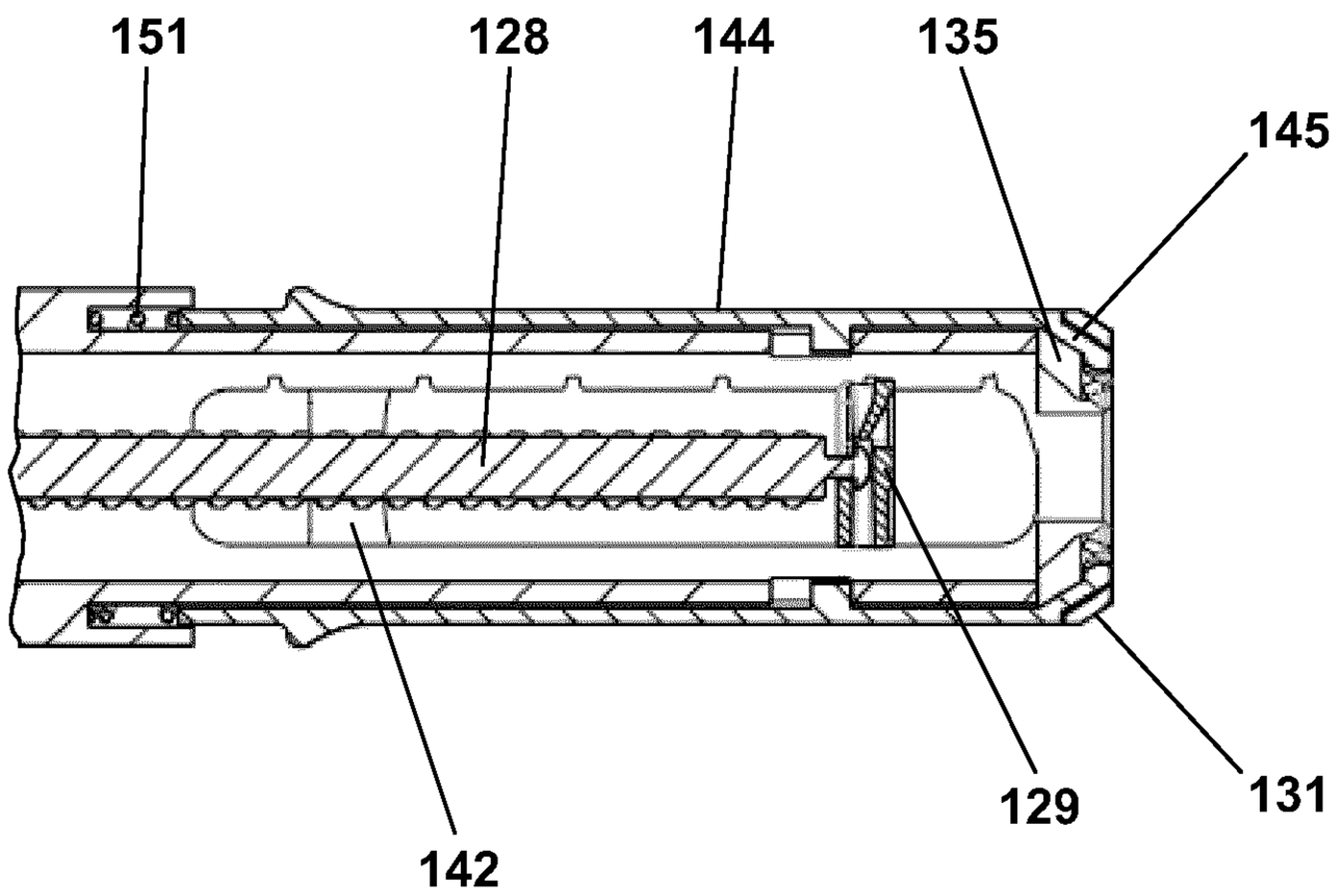

Fig. 5A

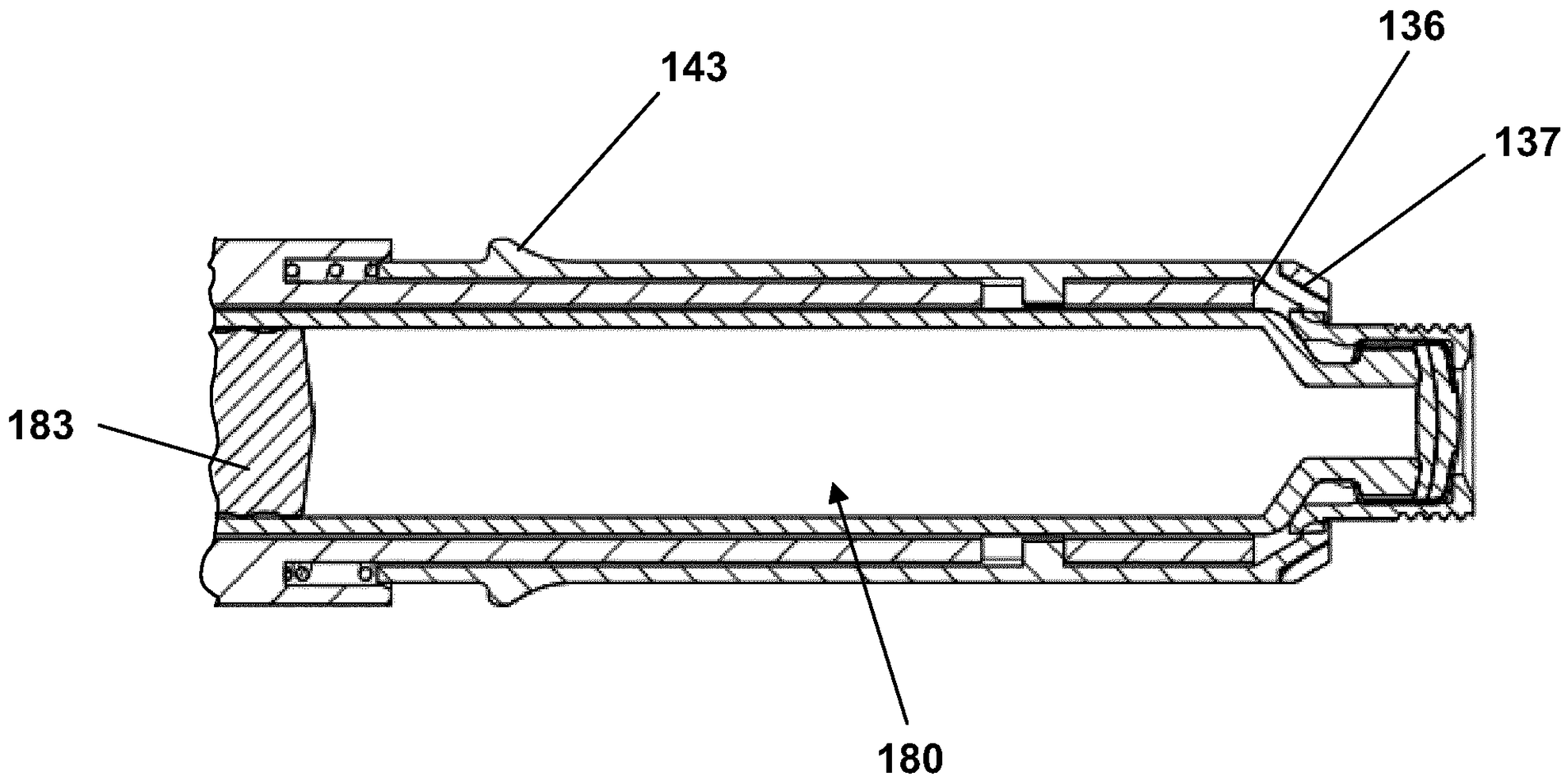

Fig. 5B

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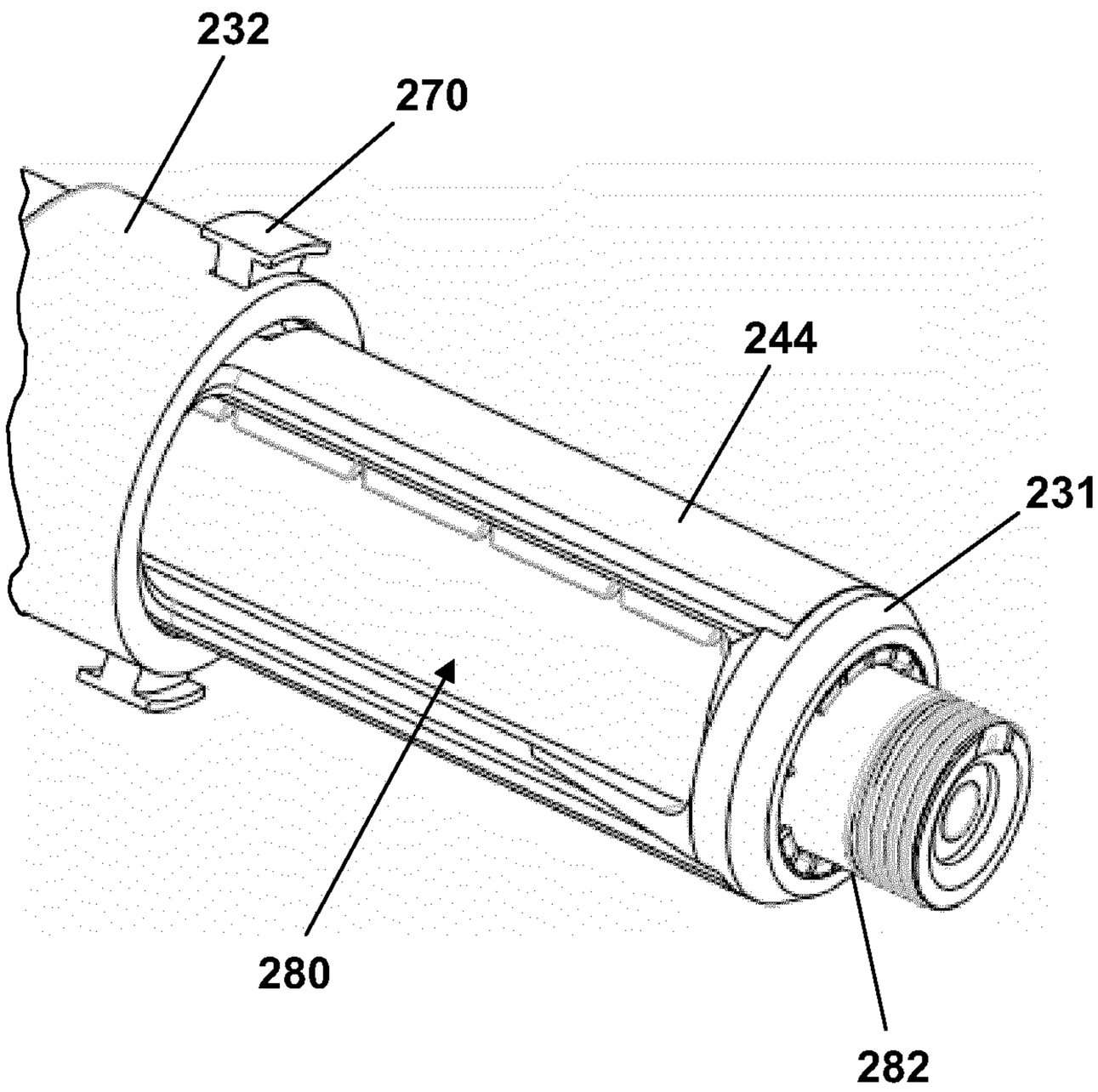

Fig. 6A

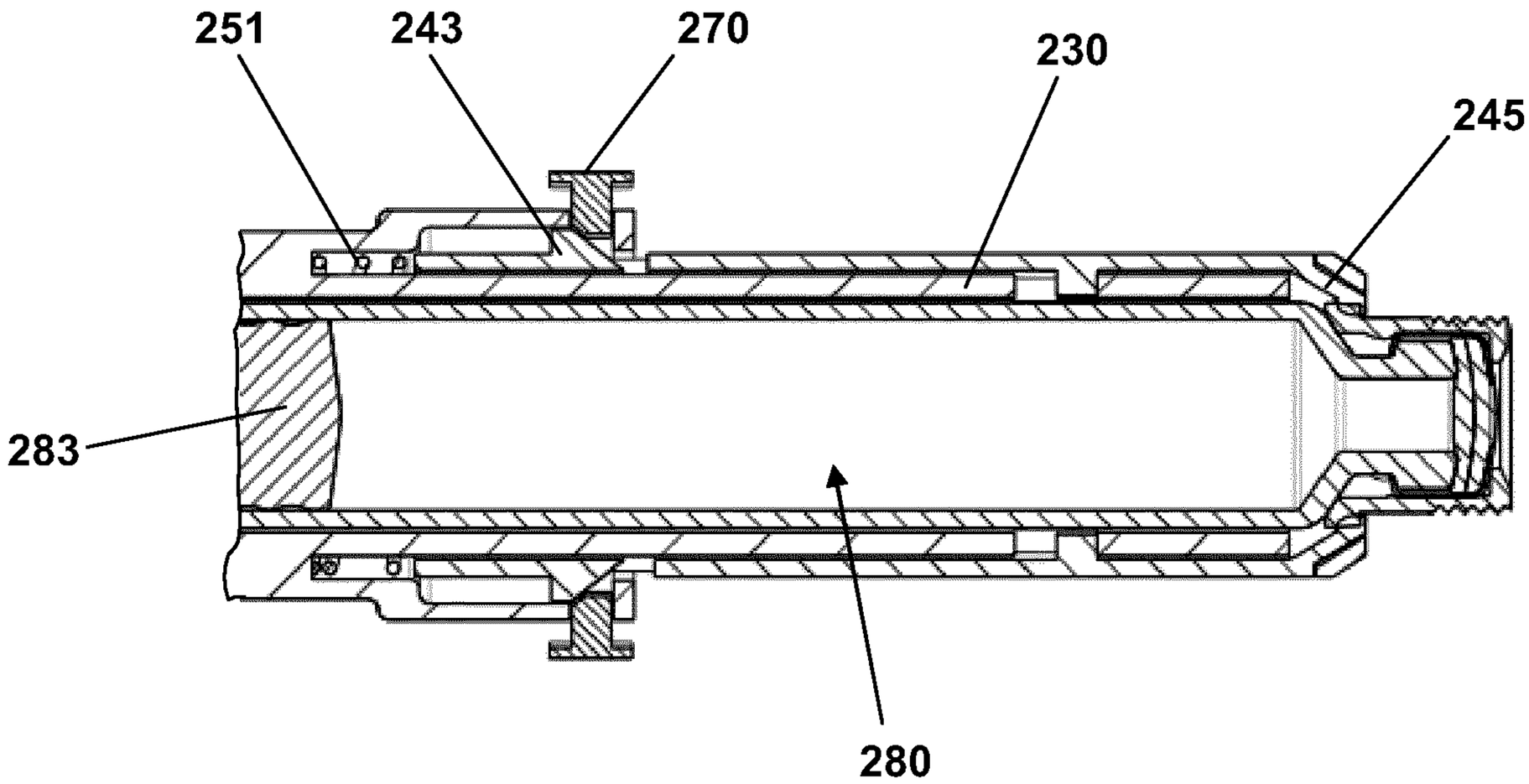

Fig. 6B

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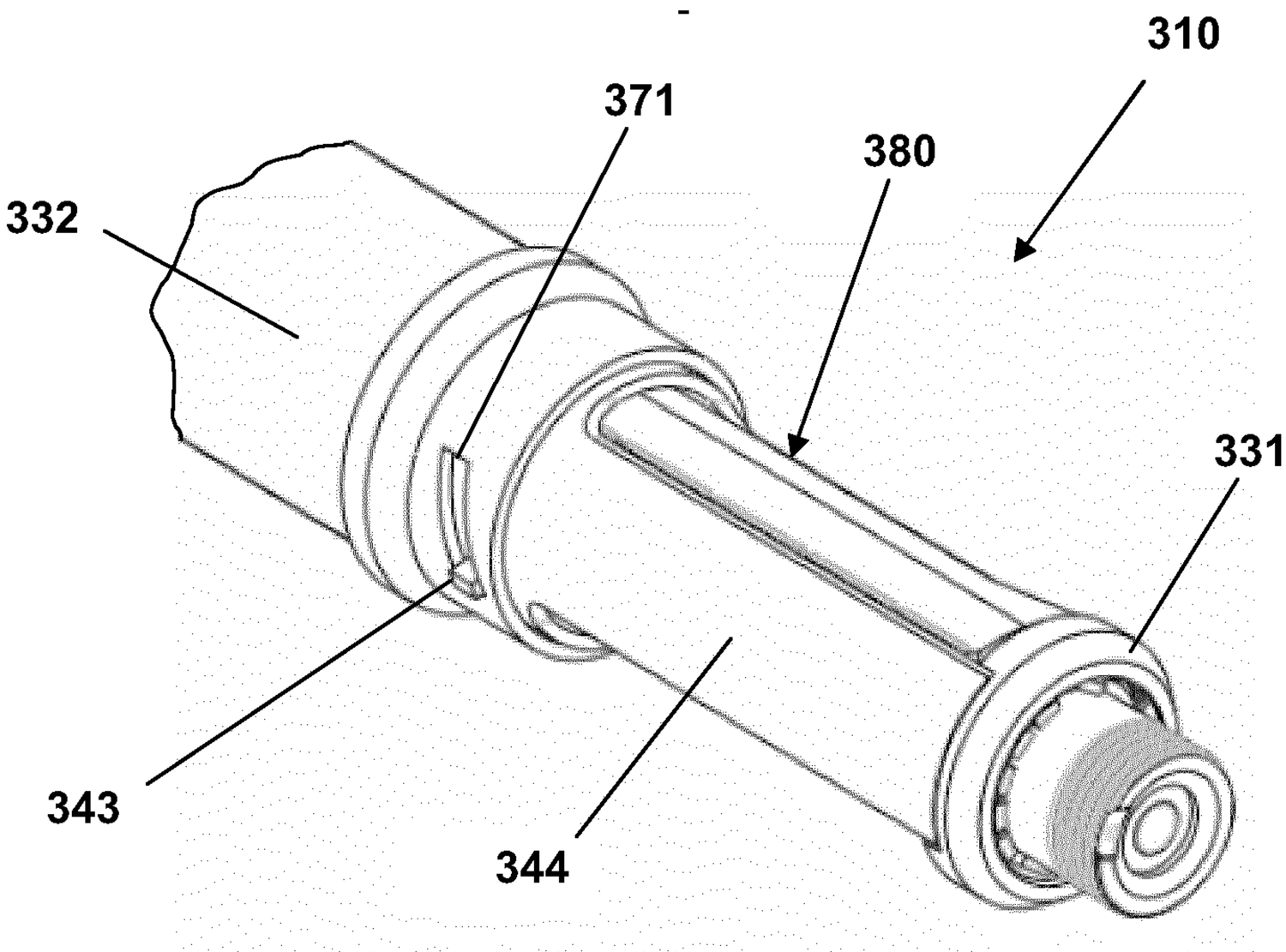

Fig. 7A

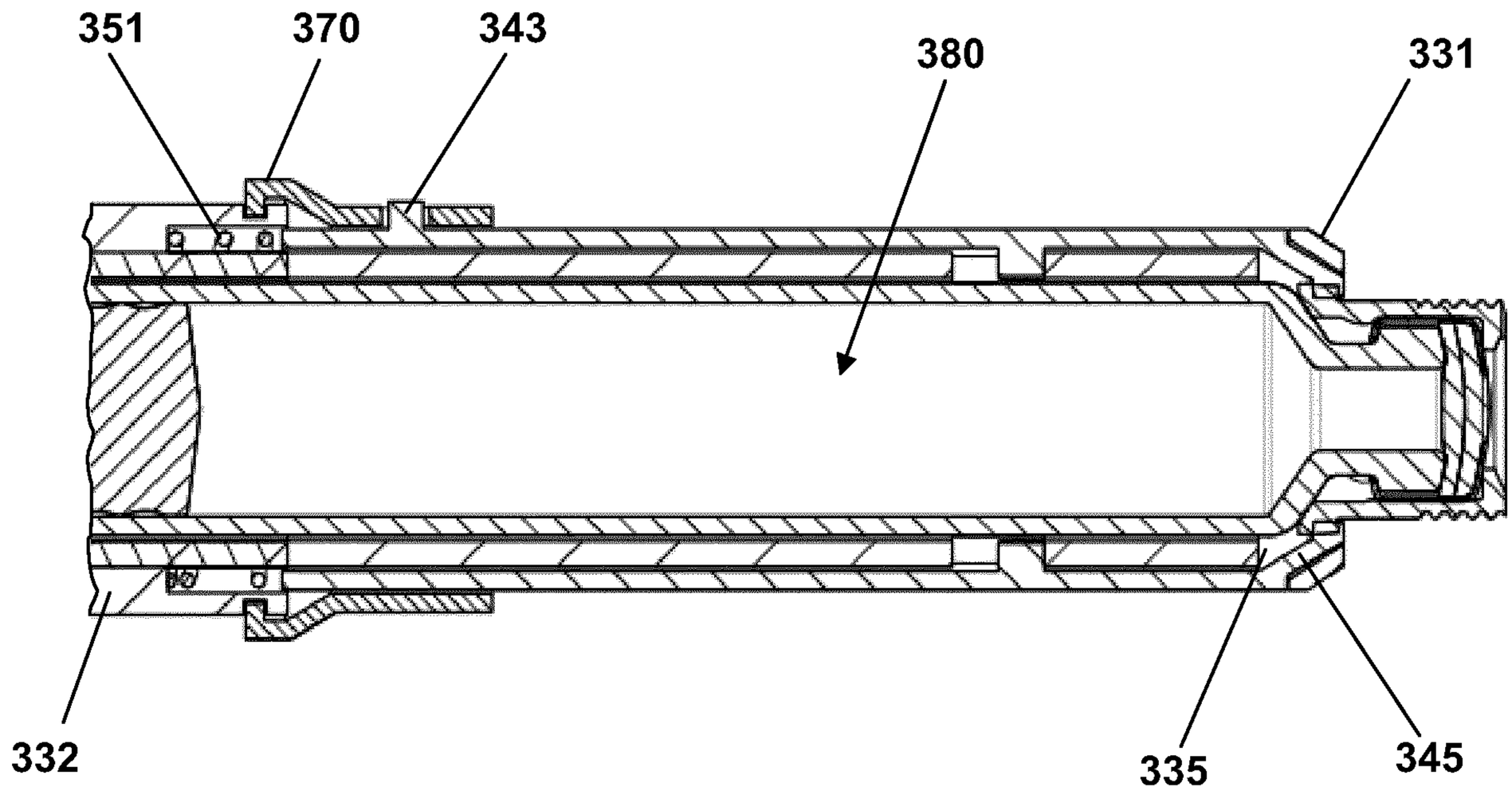

Fig. 7B

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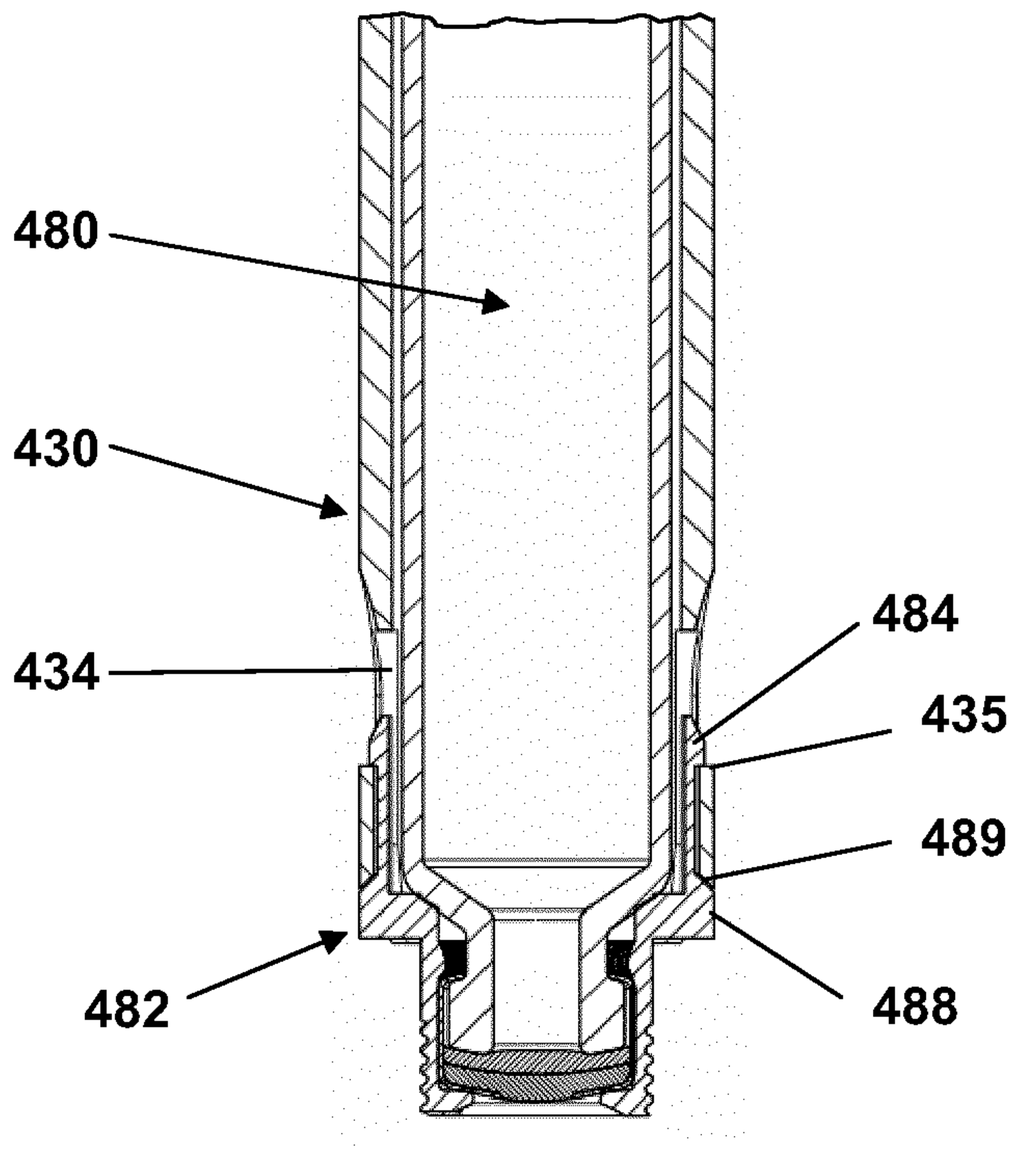
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Fig. 8A

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Fig. 8B

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Fig. 9A

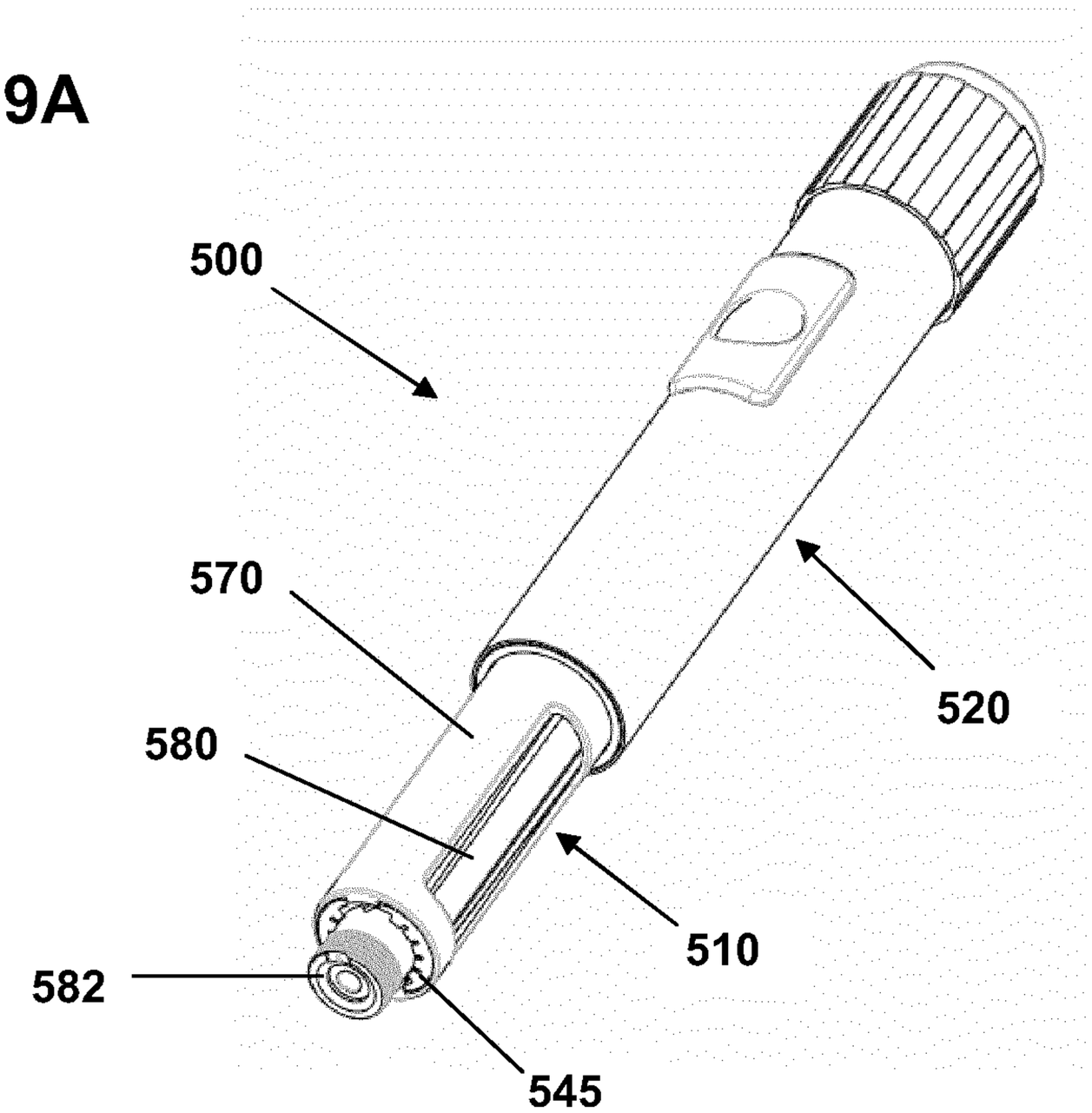

Fig. 9B

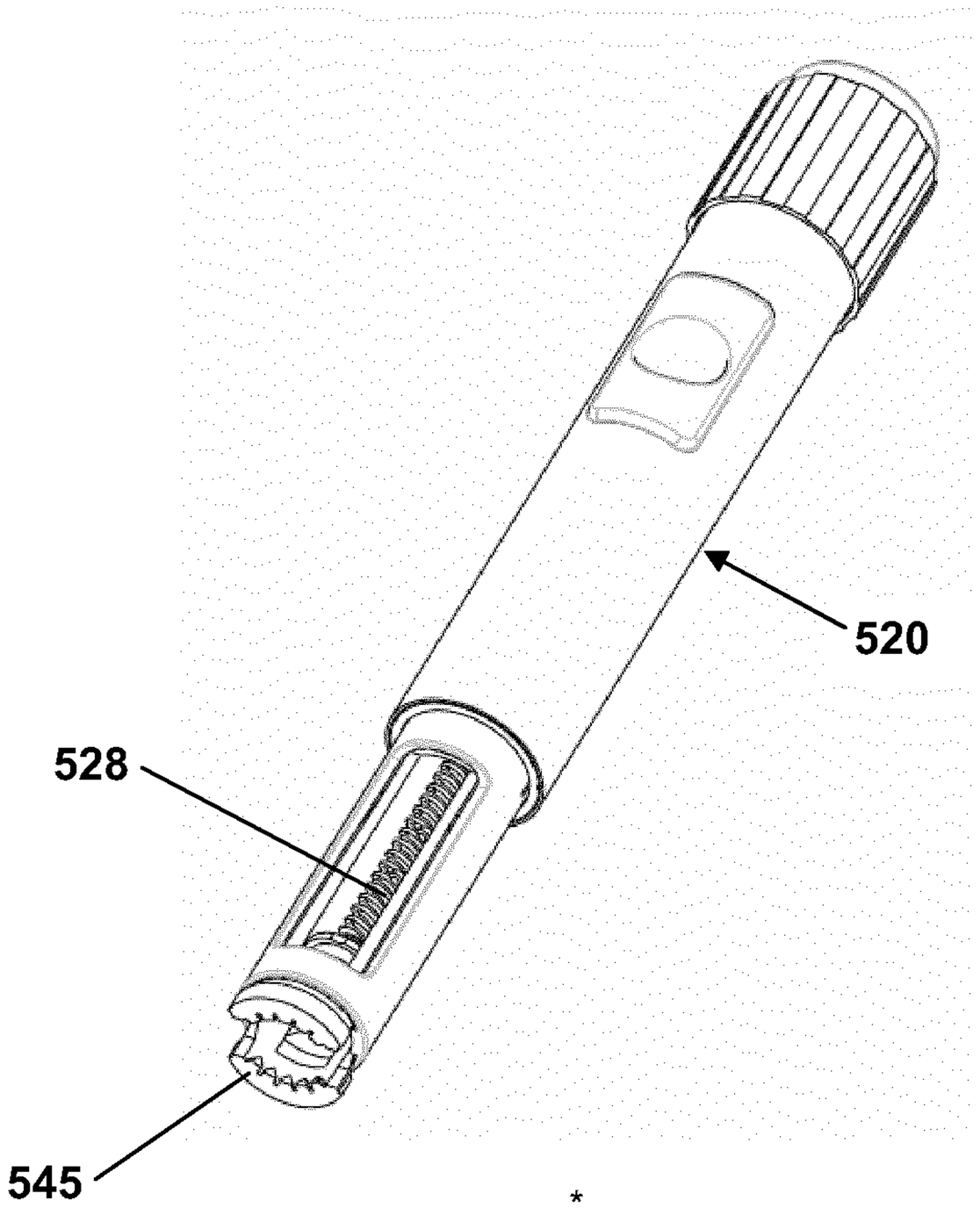

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Fig. 10A

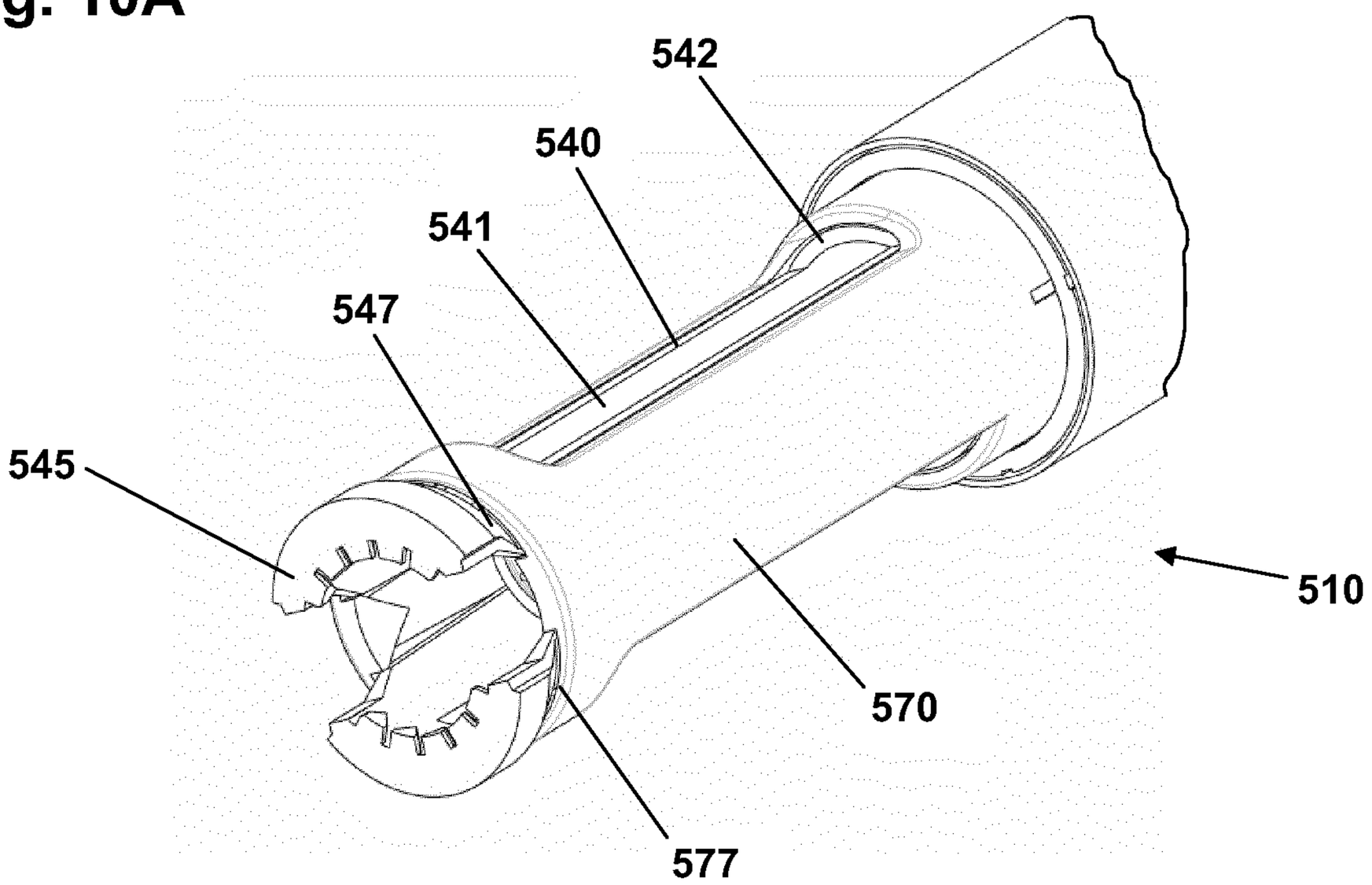
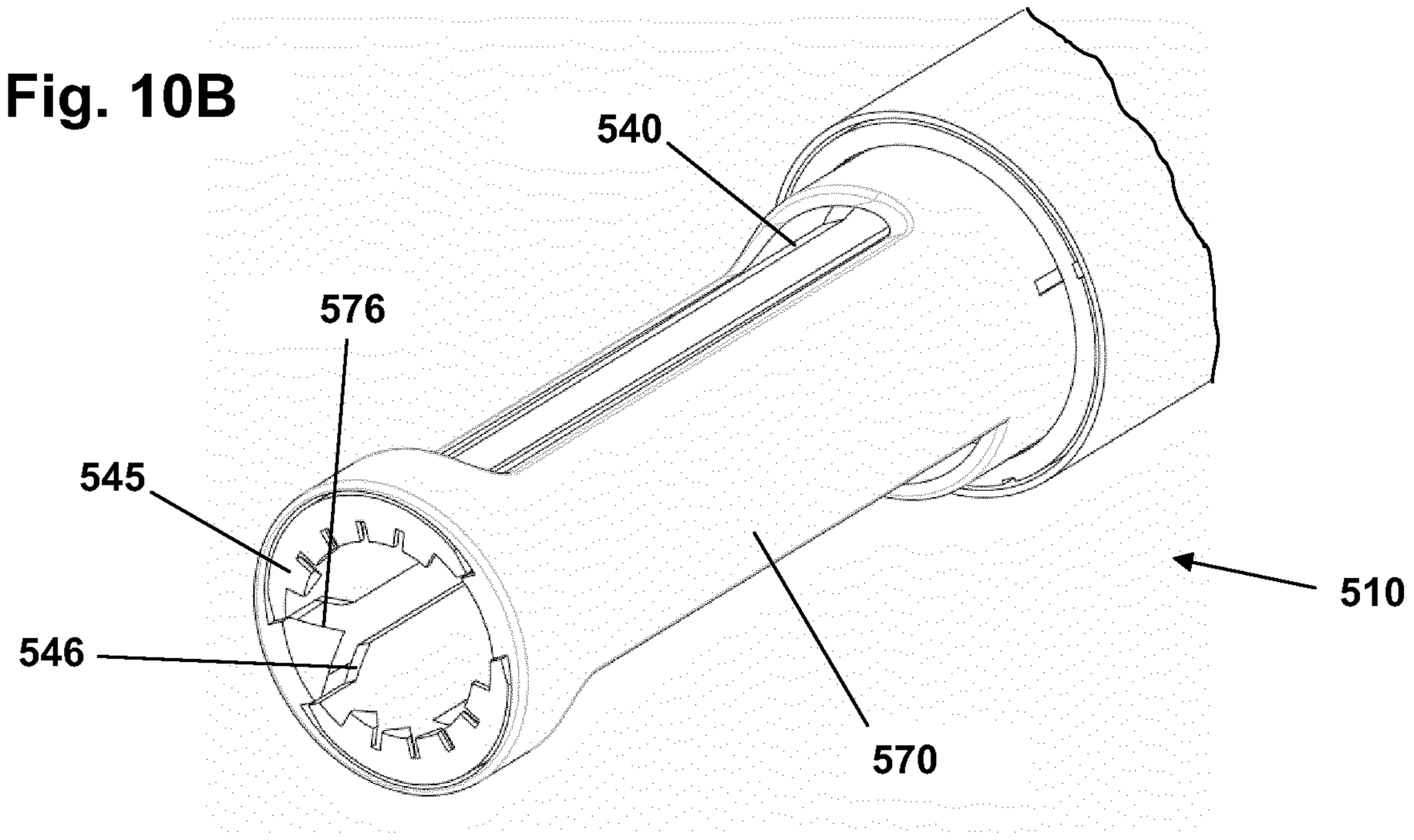


Fig. 10B



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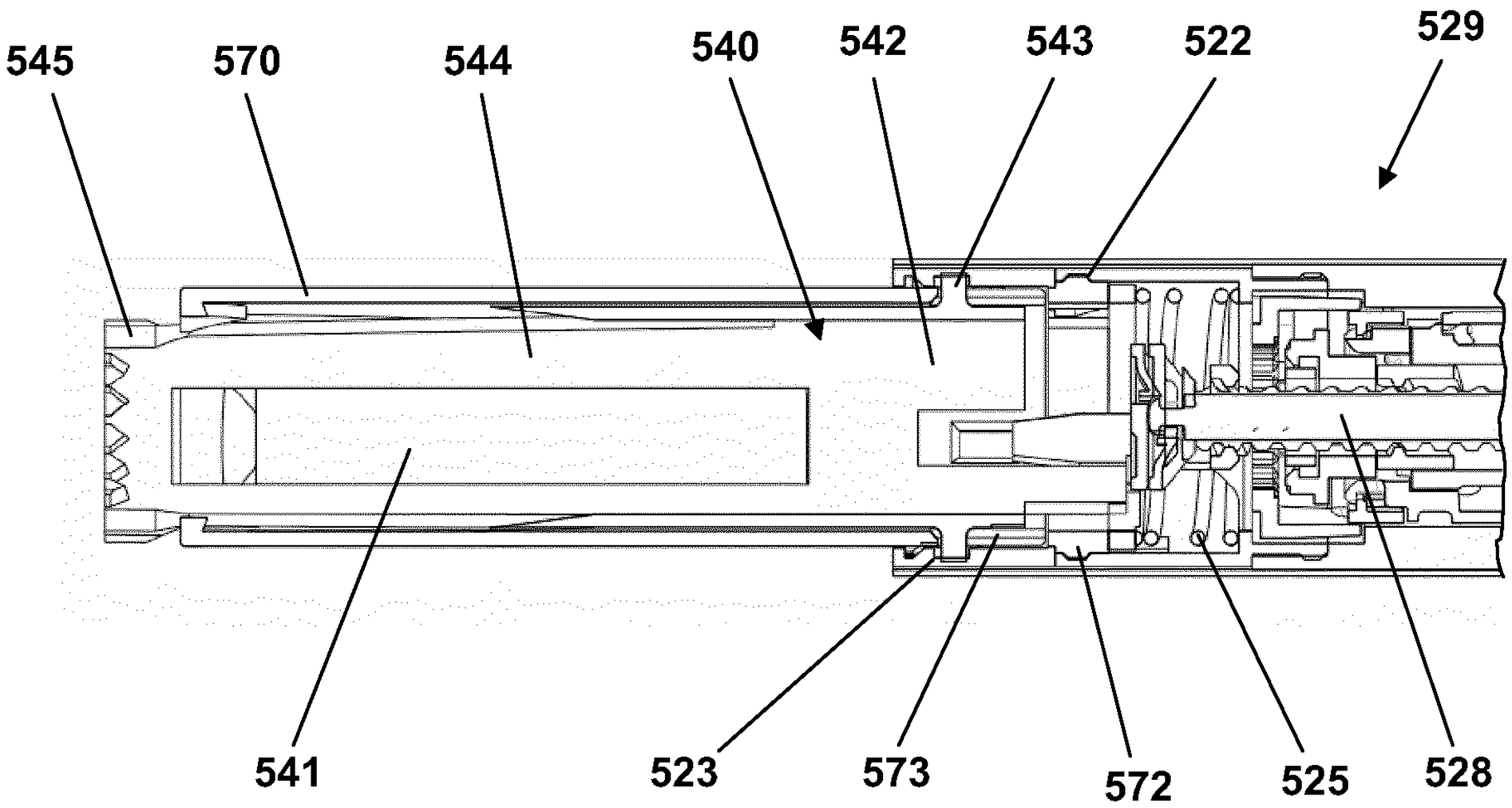

Fig. 11

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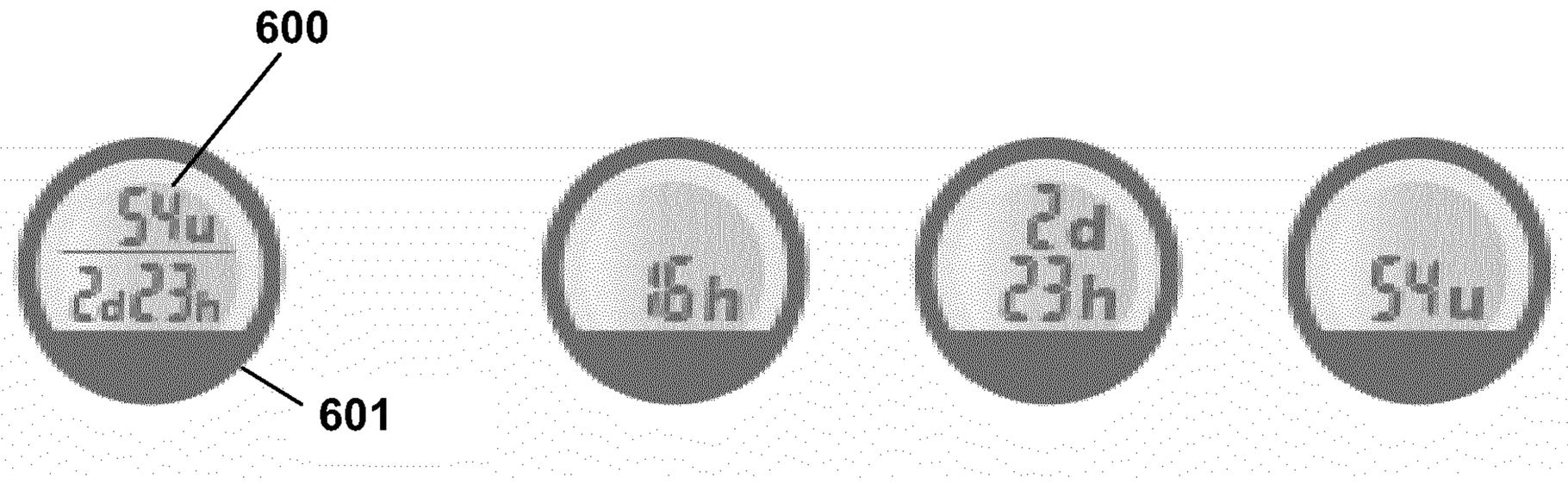

Fig. 12A Fig. 12B Fig. 12C Fig. 12D

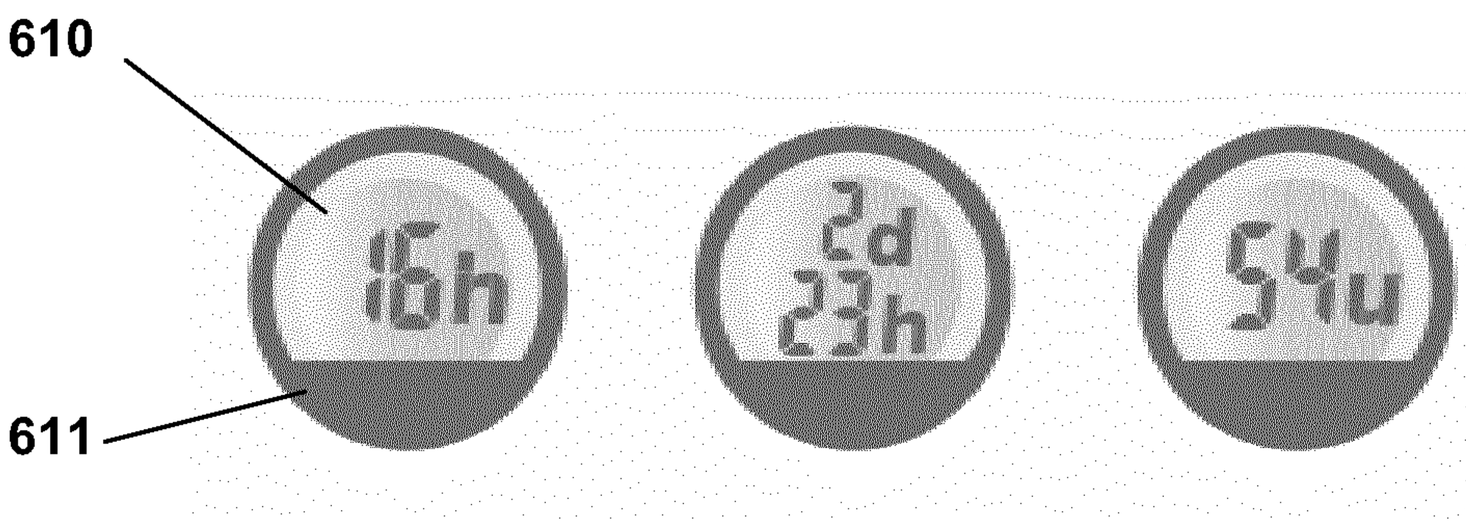

Fig. 13A Fig. 13B Fig. 13C

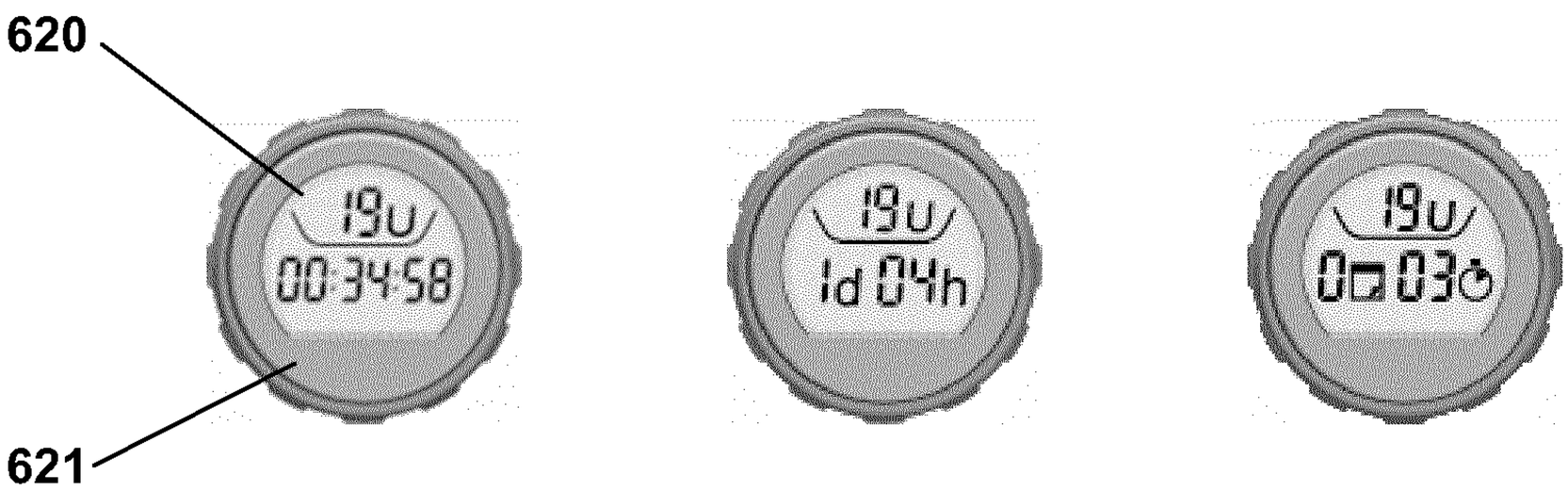

Fig. 14A Fig. 14B Fig. 14C

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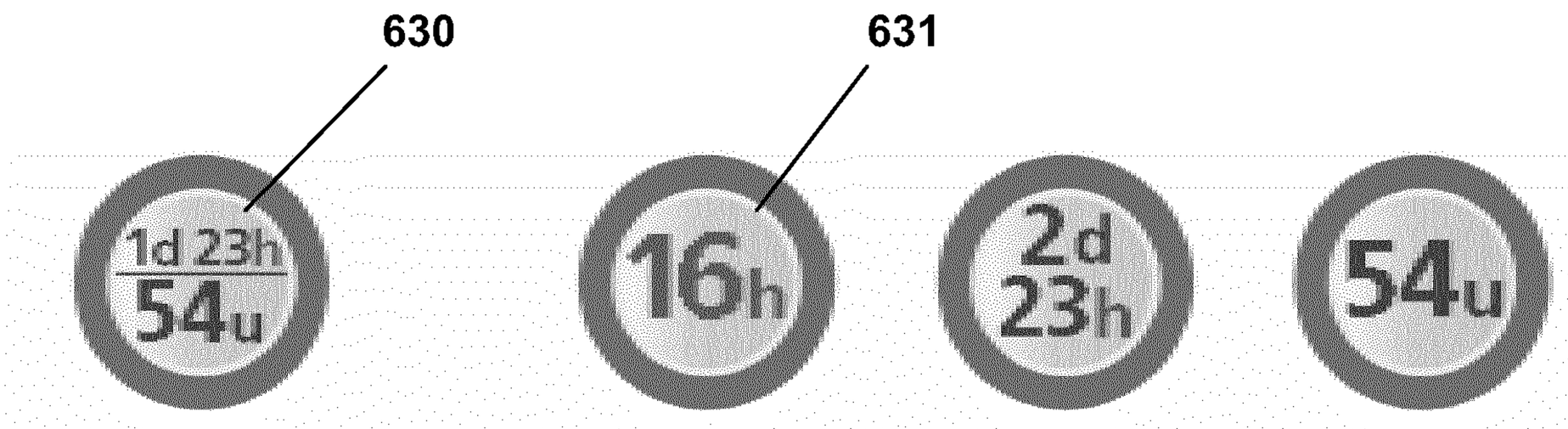

Fig. 15A Fig. 15B Fig. 15C Fig. 15D

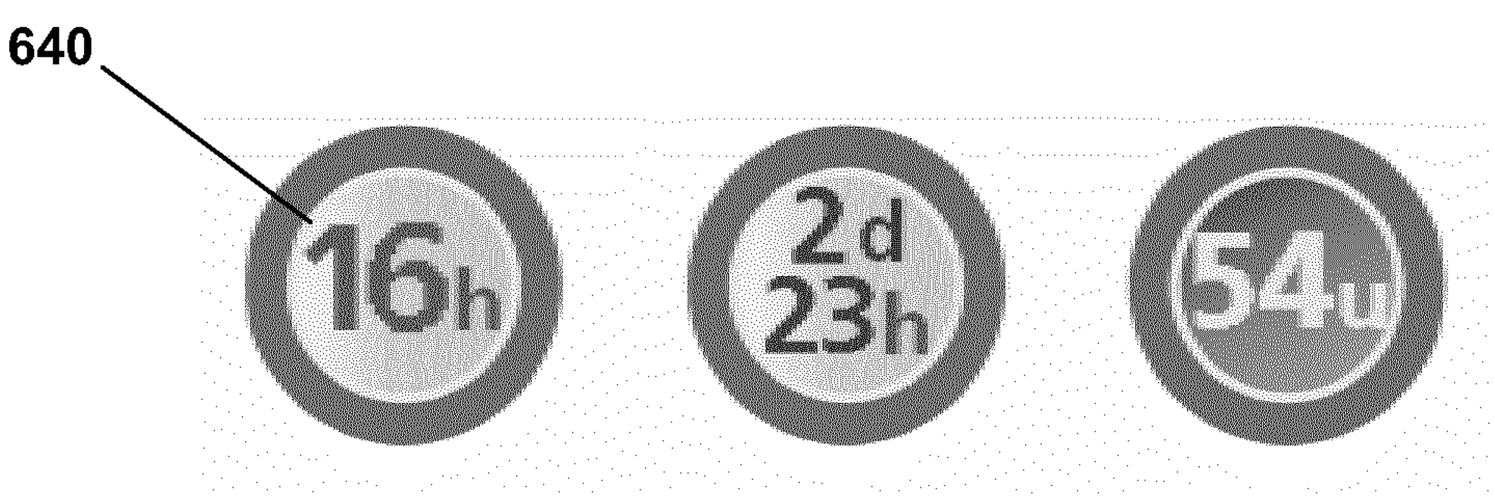

Fig. 16A Fig. 16B Fig. 16C

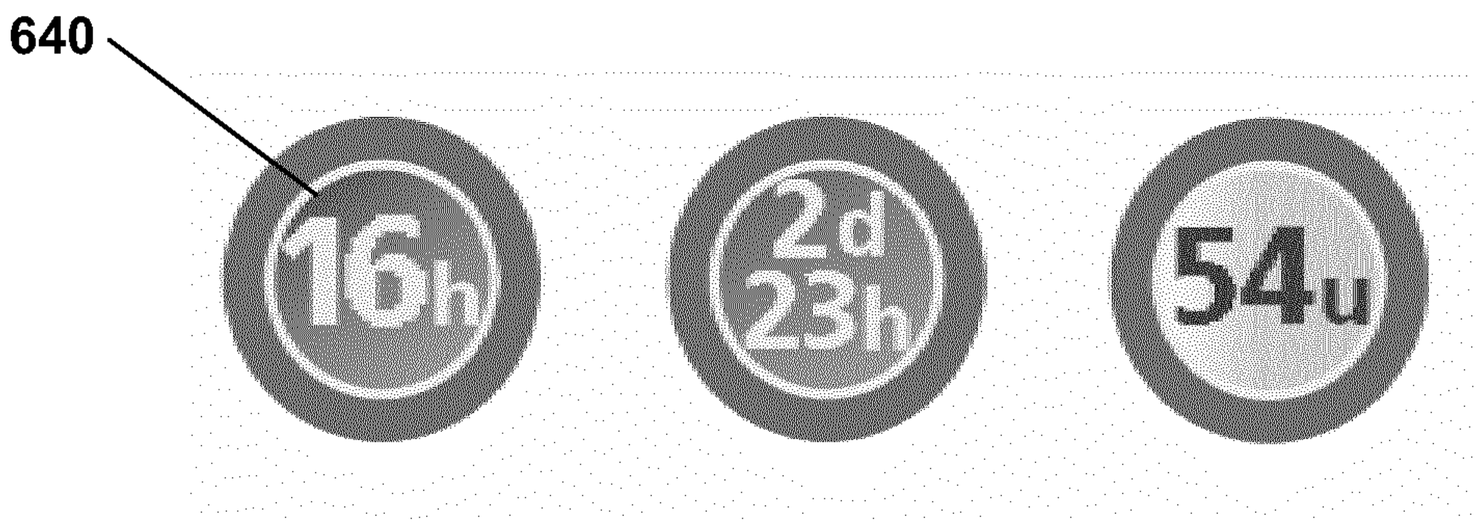

Fig. 17A Fig. 17B Fig. 17C

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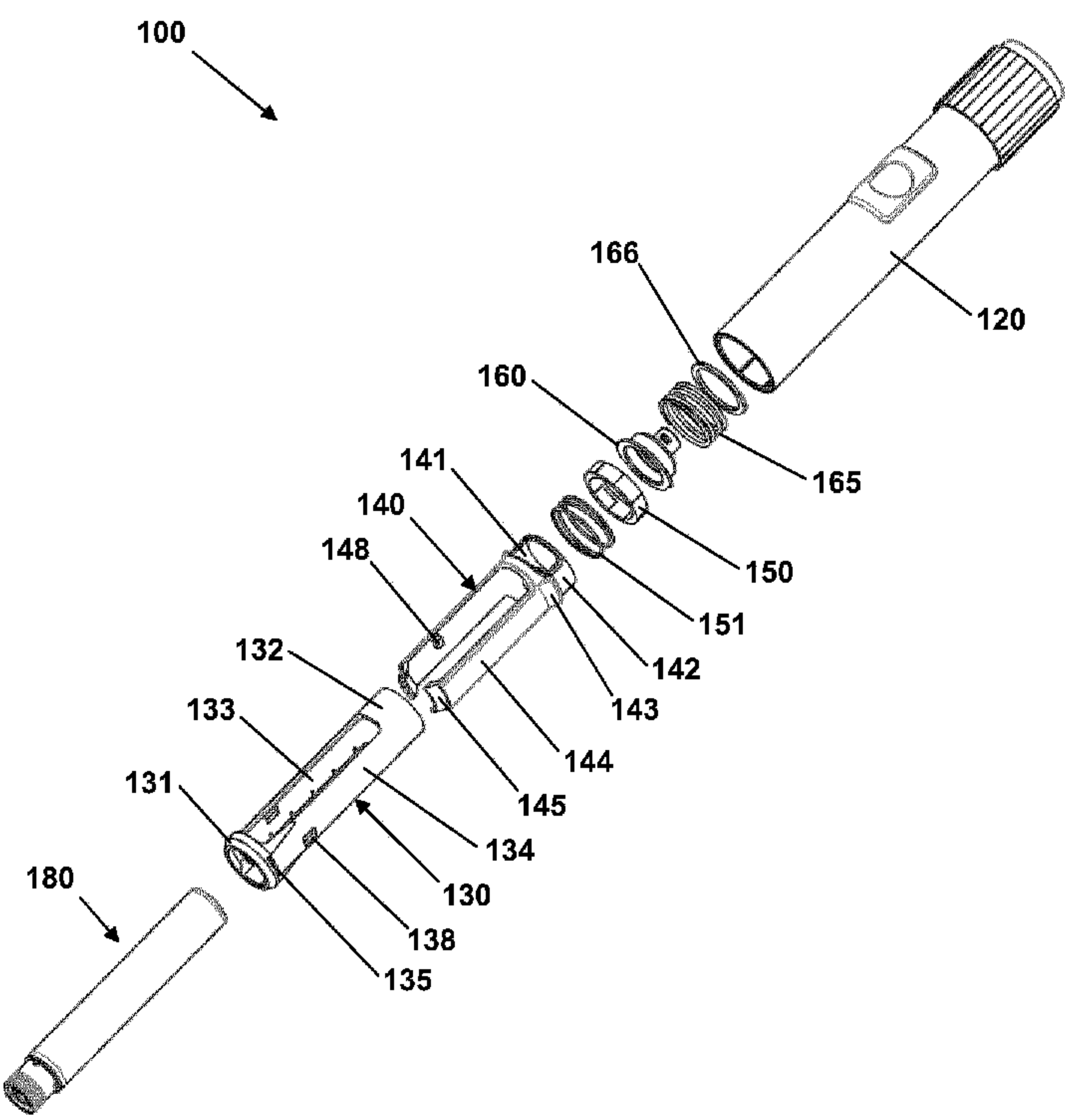
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Fig. 3