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(71) Applicant: **MERCK PATENT GMBH** [DE/DE]; Frankfurter Str. 250, 64293 Darmstadt (DE).

(72) Inventor: **JACOBSEN, Peter Blaabjerg**; Medicom Innovation Partner a/s, Gimsinglundvej 20, 7600 Struer (DK).

(74) Agent: **ZACCO DENMARK A/S**; Arne Jacobsens Allé 15, 2300 København S (DK).

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(54) **Title:** AUTO INJECTOR WITH HOLLOW PLUNGER ROD

(57) **Abstract:** Disclosed herein is a reloadable auto injector having a housing for accommodation of a syringe with a needle, the syringe being movably positioned in the housing between a first position in which position the needle is accommodated inside the housing and a second position in which position the needle protrudes outside the housing, a plunger rod configured to be advanced in the syringe for delivering at least one dose of medicament, a plunger rod tube having two or more deflectable locking members configured to interact with a plunger rod stop to normally lock the plunger rod to the plunger rod tube, a syringe driver configured to apply a force to the syringe thereby moving the syringe from the first position to the second position, the syringe driver being further configured to advance the plunger rod tube with the plunger rod to the second position, a plunger rod driver being configured to apply a force to the plunger rod to advance the plunger rod in the syringe for delivering one dose of medicament upon unlocking of each of the two or more deflectable locking members, and a reload mechanism configured to retract the syringe from the second position to the first position and reload the syringe driver to allow a repeated activation of the syringe driver.

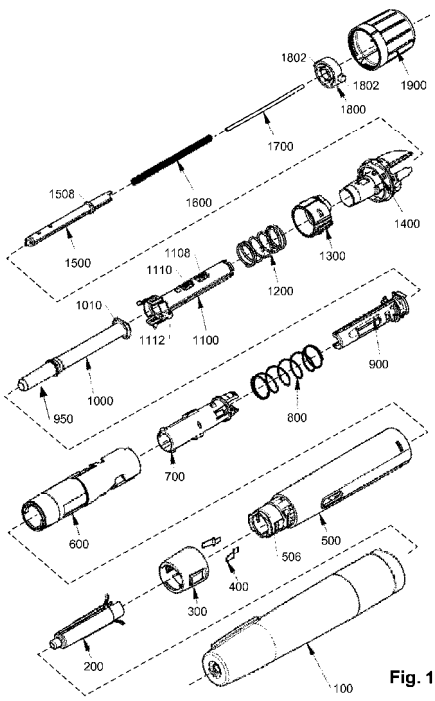

Fig. 1

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AUTO INJECTOR WITH HOLLOW PLUNGER ROD

The present disclosure relates to auto injectors, such as medical auto injectors, and especially to reloadable auto injectors which may be capable of delivering one or more individual doses from a medicinal cartridge or a pre-filled syringe containing medicine wherein the auto injector comprises an improved configuration for emptying the medical cartridge. The auto injectors may be configured for single or multi-use.

BACKGROUND OF THE INVENTION

Auto injectors are well-known in the art, and are often preferred by users for self-administration of medicine, such as for subcutaneous injection of medicines such as insulin, medicine to treat or alleviate multiple sclerosis, rheum, lupus, etc. or for emergency injection of e.g. adrenaline or epinephrine, such as injection in to muscle tissue.

The needles used for injection subcutaneously and for injection into muscle tissue are typically of different lengths. Typically, needles used for subcutaneous injections are about 12 mm (so-called "half-inch" needles) whereas needles used for injection into muscle tissue may have a length of 20-25 mm (so-called "inch" needles), to ensure that muscle tissue is reached.

The selected needle bore may also affect the degree of patient discomfort during injection. Smaller bore diameters, typically provide more patient comfort, whereas larger bore diameters enable more rapid delivery of the liquid through the needle and with a lower force. A compromise is therefore needed in selecting needle bore to provide acceptable patient comfort and liquid delivery through the needle characteristics.

Allergic reactions tend to become an ever increasing problem and for the treatment of severe allergic reactions (anaphylaxis) to foods, insect stings or bites, drugs and other allergens, as well as idiopathic or exercise induced anaphylaxis, adrenaline or epinephrine is typically used.

Epinephrine works quickly to reverse the symptoms of an anaphylactic reaction and epinephrine injected into the muscle of the front of the upper outer thigh is typically used for the emergency treatment of anaphylaxis.

Typically, epinephrine auto-injectors are single use injectors for injecting a pre-measured single dose of epinephrine for the emergency treatment of anaphylaxis.

However, when administering some drugs, such as epinephrine, a single dose may not be sufficient to treat the anaphylaxis. In order for one patient to be able to receive full treatment including one, two or more doses with a single injector, different auto injectors have been suggested.

Different possibilities for the injection of two doses from a same syringe have been suggested and in US 7,927,303 and EP700307, two-dose auto injectors are disclosed allowing the automatic delivering of a first dose of a medicament and the manual refitting of the auto injector so that the once used syringe may be re-inserted into the auto injector for administration of a second dose.

In WO 2011/111006, an auto injector is disclosed in which the locking and releasing of the drive spring of the auto injector is controlled by providing stepped guide means with ramps for two successive slidings there along of slide means operated by the spring and connected with the syringe and relevant plunger. Thus, after a first dose has been delivered, a further dose may be delivered using the same spring and slide the syringe further along the slide means.

of the above mentioned auto injector requires more space as the length of the device increases significantly when a second dose is delivered.

Furthermore, auto injectors have been disclosed focusing on reducing the risk of wet injection. For example, WO 2012/045827 discloses an auto injector having an arrangement for coupling a plunger rod to either a syringe or a stopper arranged in the syringe. However, it is a disadvantage of the auto injector as disclosed that a single compression spring is applied for injecting the needle and for injecting the

medicament, in that the resistance of the needle penetrating the skin may tend to force the syringe backwards in a syringe carrier, whereby the stopper may contact the forward moving plunger rod and expelling the medicament prematurely which may result in a wet injection.

US 7,785,292 discloses an auto injector comprising a housing wherein a single driving mechanism is used to insert the needle and to inject the medicament. The syringe is moved to a forward position before the piston is allowed to move forward to inject the medicament. A locking mechanism engages the drive with the syringe when the syringe is not in the forward position and engages the syringe with the housing when the syringe is in the forward position.

WO 2013/034986 discloses a reloadable auto injector comprising a housing wherein a reload mechanism allows a repeated activation of a syringe driver thereby allowing to the delivery of a double dose of epinephrine. The reload mechanism requires an operator input in order to be reloaded. When using the auto injector of WO 2013/034986, emptying the syringe fully has shown to be a challenge leaving residues of the medication inside the syringe.

There is therefore a need for an auto injector which allows for selectively delivery of one or more full and predetermined doses, wherein subsequent doses are also delivered automatically and with an improved efficiency and which is both compact in size and highly robust with respect to the avoidance of wet injections.

SUMMARY OF THE INVENTION

Disclosed herein is in one aspect of the disclosure is a reloadable auto injector having a housing for accommodation of a syringe with a needle, the syringe being movably positioned in the housing between a first position in which position the needle is accommodated inside the housing and a second position in which position the needle protrudes outside the housing.

The reloadable auto injector may be used for the delivery of adrenaline or ephendrine.

The housing of the reloadable auto injector further accommodates a plunger rod configured to be advanced in the syringe for delivering at least one dose of medicament, and a plunger rod tube having two or more deflectable locking members configured to interact with a plunger rod stop to normally lock the plunger rod to the plunger rod tube.

Also accommodated inside the housing is a syringe driver configured to apply a force to the syringe thereby moving the syringe from the first position to the second position, the syringe driver being further configured to advance the plunger rod tube with the plunger rod to the second position.

A plunger rod driver being configured to apply a force to the plunger rod to advance the plunger rod in the syringe for delivering one dose of medicament upon unlocking of each of the two or more deflectable locking members is further accommodated inside the housing. The plunger rod is hollow and the plunger rod driver extends inside the hollow plunger rod.

In accordance with the the present disclosure that the plunger rod driver is accommodated inside the plunger rod as this allows for a longer and stronger plunger rod driver. This ensures that a predetermined doses of medication may always delivered to a patient, i.e. the before seen issues with weaker plunger rod drivers, which results in an amount of residue medication not being delivered to the patient contrary to the expectations, are avoided.

In a further aspect, the auto injector may further comprise a reload mechanism configured to retract the syringe from the second position to the first position and reload the syringe driver to allow a repeated activation of the syringe driver. The reload mechanism may be configured to unlock a first deflectable locking member upon a first movement of the syringe from the first position to the second position to thereby release the plunger rod from the plunger rod tube for delivering a first dose of medicament, and unlock a further deflectable locking member upon a further movement of the syringe from the first position to the second position to thereby release the plunger rod from the plunger rod tube for delivering a further dose of medicament.

The reload mechanism, the reload mechanism comprising activation of the auto injector for a further injection, may require an operator input.

The auto injector of the present application may be used to deliver one or more doses of medicament, depending on the user or patient operation of the auto injector. Thus, one or more individual doses may be delivered from e.g. a medicinal cartridge or pre-filled syringe containing medicine.

in an aspect of the auto-injector, a clear operator or patient input is required in order to allow an additional dose to be delivered. The operator input may comprise operating a reload mechanism, and the reload mechanism may comprise activating the auto injector for a further injection.

As an effect of the above described auto injectors that the mechanism is fully reversible. Thereby, any sharps protection in the form of a skin sensor or the like may be locked in the intermediate position, i.e. after a first dose is delivered and before the auto injector is reloaded. Thereby, the patient and/or the operator is protected against the needle also in between dose deliveries. It is especially for the acute treatment of e.g. allergies, advantageous that the needle shield may be locked after the first dose delivery or first dose injection, as the patient may not need a further treatment and thus discard or re-use the auto injector after the first dose delivery.

Thus, to safely dispose of the auto injector or the syringe assembly, the skin sensor may shield the needle after a dose has been delivered and may furthermore be locked in the forward position immediately following a dose delivery.

It may be useful in some instances to provide syringe driver and plunger rod driver as separate driving means in that the risk of wet injection, i.e. liquid medicament leaking out of the needle during needle insertion, is reduced.

The present disclosure may provide an auto injector which enables a patient to have at least two individual injections from one single syringe, and the patient or operator may apply similar steps to perform the first, second and any further injection. The patient or operator may have to activate the auto injector to enable a second or further injection or delivery of medicament.

In one or more aspects of the present disclosure, the reloadable auto injector further comprises a plunger rod driver guide extending inside the plunger rod driver. The plunger rod driver guide may be configured for guiding the plunger rod driver inside the hollow plunger rod. Guiding the plunger rod driver further ensures an accurate delivery of the of medicament.

In one or more aspects of the present disclosure, the plunger rod driver guide is made from stainless steel, aslo other material able to withstand a certain pressure can be used.

In one or more aspects of the present disclosure, a reloadable auto-injector with a housing for accommodation of a syringe assembly is provided. The syringe assembly may comprise a syringe with a needle, and the syringe assembly may be movably positioned in the housing between a first position in which position the needle is accommodated inside the housing and a second position in which position the needle protrudes outside the housing. The syringe assembly may further comprise a plunger rod configured to be advanced in the syringe for delivering at least one dose of medicament, and a plunger rod driver being configured to apply a force to the plunger rod to advance the plunger rod in the syringe for delivering at least one dose of medicament.

Furthermore, a syringe driver may be accommodated inside the housing and be configured to apply a force to the syringe assembly thereby moving the syringe from the first position to the second position.

The housing may still further comprise a reload handle configured to reload the auto injector for injecting a further dose of medicament, wherein the reload handle may be connected to the syringe assembly so that user or patient operation of the reload

handle is configured to retract the syringe assembly to the first position and to simultaneously reload the syringe driver to thereby ready the auto injector for delivering a further dose of medicament.

In one or more aspects, the handle has a first opening configured to be aligned with the first deflectable member when the plunger rod tube is advanced to the second position a first time and a further opening configured to be aligned with the further deflectable locking member when the plunger rod tube is advanced to the second position a further time.

A syringe stopper may be movably positioned in the syringe and sealing syringe content and the plunger rod may be configured to engage the syringe stopper.

In one or more aspects of the present disclosure, a reloadable auto-injector with a housing for accommodation of a needle shield and a syringe assembly is provided.

In one or more aspects of the present disclosure, a method of reloading an auto injector is provided, wherein a reloadable auto-injector has a housing for accommodation of a needle shield and a syringe assembly. The syringe assembly may comprise a syringe with a needle and a plunger rod driver being configured to apply a force to a plunger rod to advance the plunger rod in the syringe for delivering at least one dose of medicament.

A syringe driver may be provided in the housing and configured to apply a force to the syringe assembly thereby moving the syringe from a first position to a second position in which position a dose may be delivered. The auto injector may furthermore comprise a reload handle configured to reload the auto injector for delivering a further dose of medicament, wherein the method comprises operating the reload handle to retract the syringe assembly to the first position, reload the syringe driver and release the needle shield to thereby ready the auto injector for delivering a further second dose.

In one or more further aspects of the present disclosure, a method of operating a reloadable auto injector is provided. The auto injector may comprise a housing for

accommodation of a syringe assembly. The syringe assembly may comprise a syringe with a needle, and the syringe assembly may be movably positioned in the housing between a first position in which position the needle is accommodated inside the housing and a second position in which position the needle protrudes outside the housing. The syringe assembly may further comprise a plunger rod driver being configured to apply a force to a plunger rod to advance the plunger rod in the syringe for delivering at least one dose of medicament and the housing may further accommodate a syringe driver configured to apply a force to the syringe assembly thereby moving the syringe from the first position to the second position, a skin sensor for activation of the auto injector, a syringe lock for locking the syringe assembly in the first position, and a reload handle, wherein the method may comprises the steps of activating the skin sensor to rotate the syringe lock and release the syringe assembly, moving the syringe assembly from the first position to the second position, releasing the plunger rod driver to deliver a dose of medicament, de-activating the skin sensor to cover the needle and locking the skin sensor in the de-activated position. The method may further comprise reloading the auto injector by operation of the reload handle, wherein the reloading may comprise moving the syringe assembly from the second position to the first position, reloading the syringe driver, locking the syringe assembly in the first position and unlocking the skin sensor whereby the auto injector is ready for delivering a further dose of medicament.

In some embodiments of the present disclosure, an auto injector for delivering at least one dose of medicament is provided. The auto injector may have a housing for accommodation of a syringe assembly comprising a syringe with a needle. The syringe assembly may be movably positioned in the housing between a first position in which position the needle is accommodated inside the housing and a second position in which position the needle protrudes outside the housing. The auto injector may further comprise a sound generator configured to emit a sound while dosing.

Throughout the present disclosure, the auto injector has a front or forward end in the end intended to be pushed against a patient's skin, and a back or backward end towards the other end of the auto injector. The terms "forward" or "downward", such

as forward or downward movement therefore means towards the forward end, or towards the skin of a patient when the auto injector is positioned in its intended operational position for injection. Likewise, backwards or upwards, such as backwards or upwards movement, means towards the back end of the auto injector, or away from the skin of a patient when the auto injector is positioned in its intended operational position for injection. Furthermore, a top end of the auto injector is the back ward end of the auto injector, i.e. the end furthest away from the skin of a patient when the auto injector is positioned in its intended operational position for injection.

Furthermore, the term "reload" means to ready the auto injector for a further injection using the same or a different syringe. The reloading of the auto injector is performed while the syringe is provided in the auto injector. When a driver, such as a spring, is reloaded or re-activated, power is transferred back to the driver. For example, the reloading or re-activation of a spring comprises the reloading of tension on the spring.

In one or more aspects of the present disclosure, the reloadable auto injector may be activated upon unpacking or unwrapping the device. Especially for emergency injections of medicament, it is beneficial for an operator or patient that no further steps are necessary after unwrapping the device to put the autoinjector in the “ready to use” state. The auto injector according to the present disclosure is ready to be used, when unwrapped and a protective cap is removed without further steps. By pushing the skin sensor against the skin of a patient it is activated

In one or more aspects of the present disclosure, the syringe driver and the plunger rod driver are separate drivers. Thus, the syringe driver may separate from the plunger rod driver, and in some aspects, the syringe driver may contain a resilient device, such as a spring, such as a compression spring. Likewise, the plunger rod driver may be a resilient device, such as a spring, such as a compression spring. The syringe driver may be configured to act on the syringe assembly, to drive the syringe assembly from the first position to the second position. The syringe driver may be provided in the housing and the housing may guide or stabilized the syringe driver.

In one or more aspects, the plunger rod driver and the syringe driver are partly displaced. The plunger rod driver may be longer than the syringe driver. By having the plunger rod driver being longer than the syringe driver enhances the force of the plunger rod driver compared to that of the syringes driver thereby facilitating a precise delivery of the medicament.

The auto injector may in some aspects further comprise a syringe lock configured to lock the syringe in the first position, and a skin sensor configured to release the syringe lock upon engagement with the skin of a patient wherein the skin sensor is activated by pressing the skin sensor onto a patient's skin.

The skin sensor may thus be of a cylindrical shape encompassing at least a part of the syringe assembly, and the skin sensor may be configured to connect to a skin sensor driver. The skin sensor driver may be a resilient driver, such as a spring. In one or more embodiments, the skin sensor driver is a spring, and the spring may be configured to be in the relaxed position when the skin sensor is positioned in a forward position. The skin sensor may for example be activated upon pressing the skin sensor against the skin of a patient. Hereby, the operator may compress the skin sensor driver, such as the spring, and move the skin sensor backwards away from the skin. The compressed skin sensor driver, such as the spring, may be released as soon as the auto injector is removed from the skin and the skin sensor will thereby be pushed forward by the skin sensor driver.

In one or more aspects of the present disclosure, the auto injector may further comprise safety features, such as a needle protection element, such as a needle shield, to shield the needle and prevent accidental contact with the needle. In some embodiments, the skin sensor may shield the needle and thus act as a skin sensor configured to release the syringe driver as mentioned above, and further act as needle protection element configured to shield the needle.

It is however envisaged that the needle protection element, such as the needle shield, may be an element separate from the skin sensor. In the following, reference may be made to the skin sensor, however, it will be clear for a person skilled in the

art that corresponding needle protection features could be evenly applied to a needle protection element separate from the skin sensor.

The needle protection element, such as the skin sensor, may be able to lock in a forward position so as to prevent accidental contact with the needle. The needle protection element may for example be locked after a dose has been injected, and in between multiple injections. The needle protection element may for example comprise a locking protrusion and the locking protrusion may be configured to rest on a ledge in the syringe lock when a first dose has been delivered locking the needle protection element in the forward position and preventing backward motion of the needle protection element. It is envisaged that the locking of the needle protection element also may be implemented using any other locking mechanism.

The skin sensor may likewise have a locked forward position and an unlocked forward position, and the skin sensor may for example be locked after each injection cycle has been completed. Locking the skin sensor after an injection cycle has been completed may reduce the risk of accidental activation of the auto injector for a further injection prior to reloading. It does also preven accidental stitches with the exposed needle.

By locking the skin sensor in the locked forward position, it requires a clear operator or patient input to re-activate the auto injector and prepare it for a further injection cycle. The skin sensor may for example comprise a locking protrusion and the locking protrusion may be configured to rest on a ledge in the syringe lock when a first dose has been delivered locking the skin sensor in the forward position and preventing backward motion of the skin sensor. It is envisaged that the locking of the skin sensor may be implemented using any other locking mechanism.

The reloading handle may be configured to further interact with the needle protection element and/or the skin sensor to unlock the needle protection element and/or the skin sensor upon reloading, and in one or more embodiments, rotation of the reload handle rotates the syringe lock to thereby unlock the needle protection element and/or the skin sensor. In the unlocked position, backward motion of the

needle protection element and/or the skin sensor may be enabled to thereby ready the auto injector for a further injection.

In one or more aspects, the needle protection element and/or the skin sensor is in an unlocked position upon unpacking of the device and locked after a dose of medicament has been delivered.

is may simplify usage when providing the auto injector in a ready-to-use state right out of the package in that the auto injector may be applied for emergency injections of medicament, such as by an anaphylaxis allergy reaction, etc. Thus, for a patient or user, it is of utmost importance that no considerations or user manual as to the functioning of the auto injector is required, but that the device may inject the medicine directly be pushing the auto injector against the skin.

A locking of the needle protection element and/or the skin sensor after the delivery of a dose in that the auto injector in this state may either be discarded or await a further injection of medicament may be usefuls, asit limits or reduces the risk for a patient, a user nor anyone handling the discarded auto injector to contact the needle and/or to accidentally activate the auto injector to perform a further dose injection cycle.

Using the reload mechanism to further unlock safety features, such as the needle protection element, the skin sensor, etc., provides the effect of having an auto injector with safety features which is fully reversible upon reloading of the device. Thereby an auto injector may be provided with the safety features of a standard auto injector provided in a fully reversible reloadable auto injector.

The syringe may be locked in the first position when the auto injector is in a position ready for delivering a dose. The syringe may thus be locked in the first position initially, i.e. when the auto injector is unpacked, and after each reload action. The syringe may be locked in the first position by a syringe lock. The syringe lock may for example be released upon activation of the skin sensor.

The activation of the skin sensor may be configured to cause a backward movement of the skin sensor whereby a skin sensor angled surface may be configured to engage with a syringe lock angled surface translating the lateral motion of the skin sensor into angular motion of the syringe lock. The skin sensor may for example be activated by pressing the skin sensor against the skin of a patient to thereby force the skin sensor backwards. The syringe lock may have a cylindrical shape and may be configured so that the skin sensor, upon moving backward, slides inside the syringe lock. The skin sensor angled surface may thus be a protrusion on an outer side of the skin sensor, and the syringe lock angled surface may be a protrusion on a syringe lock inner side, so that when the skin sensor slides inside the syringe lock the skin sensor angled surface and the syringe lock angled surface may engage so that the skin sensor angled surface thereby forces the syringe lock to rotate.

The syringe lock may further comprise a resting ledge, and the syringe assembly may rest on the resting ledge in the syringe lock to thereby lock the syringe assembly in the first position. The angular motion of the syringe lock may release the syringe assembly by turning the syringe lock and thereby free the syringe assembly from the resting ledge.

In one or more embodiments, the syringe lock may further comprise a syringe lock guide slot, and the syringe assembly may comprise a syringe assembly tap; the syringe assembly tap may be configured to move in the syringe lock guide slot. The syringe lock guide slot may comprise the resting ledge, and the rotation of the syringe lock may move the tap in the guide slot from the resting ledge to a released position in which the syringe assembly tap may follow a downward guide slot path from the released position adjacent the ledge to a syringe lock end stop thereby moving the syringe assembly from the first position to the second position. Thus, the syringe assembly may be moved from the first position to the second position when the syringe assembly end stop travels in the syringe lock guide slot from the released position to the syringe lock end stop.

At least a part of the guide slot may comprise an inclined guide slot so that the syringe lock may be further rotated upon the movement of the syringe assembly from the first position to the second position.

The syringe assembly may thus be locked in the first position where forward movement is restricted by the syringe lock, such as by the resting ledge. As the syringe lock is rotated, the syringe assembly may be free to move forward and the syringe driver may thereby be released to move the syringe assembly from the first position to the second position. The forward motion may thus be restricted by the syringe assembly tap engaging a syringe lock end stop. A distance along the longitudinal axis of the auto injector from the resting ledge to the end stop may thus indicate the travel of the needle from the first position to the second position and thereby, the end stop may define the insertion depth for the needle.

It is seen that the syringe lock may control the movement, such as the forward movement, and for example the movement from the first position to the second position, of the syringe and/or the syringe assembly. Thus, the syringe lock may control the needle insertion.

A friction ring may be encircling the front end of the syringe lock. The friction ring is for reduce friction between the syringe lock and the housing when the syringe lock is rotated in connecting with reloading of the device. The friction ring may be fully clipped to syringe lock so that it does not move relative to syringe lock.

The syringe assembly may comprise a syringe tube co-axially encompassing the syringe and a plunger rod tube co-axially encompassing the plunger rod, the syringe tube and the plunger rod tube being interconnected via syringe tube connectors engageable with plunger rod connectors.

The plunger rod driver may extend through the hollow plunger rod. The plunger rod driver may be locked while the syringe assembly is moved from the first position to the second position, and thus, the plunger rod may be kept in the same position while the syringe assembly is moved from the first position to the second position. Thus, the plunger rod driver, the hollow plunger rod and the plunger rod tube may be moved forward by the syringe driver.

In one or more aspects, the syringe driver is provided outside the plunger rod tube and the hollow plunger rod accommodating the plunger rod driver is provided inside the plunger rod tube.

The hollow plunger rod may be configured to be released when the syringe assembly is in the second position thereby activating the plunger rod driver to move the hollow plunger rod forward. Hereby, the hollow plunger rod may engage the syringe stopper and thereby forcing the syringe stopper forward and deliver a dose of medicament. The hollow plunger rod may typically move forward a predetermined distance in the syringe before a plunger rod stop engages the plunger rod and prevents further forward movement of the plunger rod. The predetermined distance may indicate the amount of medicament delivered, depending on syringe size.

The plunger rod driver may be configured to move the plunger rod a first predetermined distance upon a first activation of the plunger rod driver, a second predetermined distance upon a second activation of the plunger rod driver, a further predetermined distance upon a further activation of the plunger rod driver, etc., before engaging a first plunger rod stop, a second plunger rod stop and/or any further plunger rod stops. The first, the second and/or further predetermined distances may be different distances to allow for different doses of medicament to be delivered following first, second and/or further activations of the auto injector.

The second or further activation of the plunger rod driver may follow a reload of the auto injector, and thus follow any movement of the syringe assembly from the first position to the second position. The movement of the syringe assembly from the first position to the second position may thus comprise moving the plunger rod, the plunger rod driver and the plunger rod tube with the syringe assembly. Thereby, the plunger rod may remain locked upon any plunger rod stop, and the plunger rod driver may not be able to drive the plunger rod forward while moving the syringe assembly from the second position to the first position. The plunger rod may, after a first injection cycle has been completed, not be released until the syringe assembly, following activation of the auto injector, is moved from the first position to the second position a second and/or further time.

In one or more aspects of the present disclosure an auto injector having sequential control of needle insertion and dose injection is provided. The auto injector may have a housing for accommodation of a syringe with a needle, and the syringe may be movably positioned in the housing between a first position in which position the needle is accommodated inside the housing and a second position in which position the needle protrudes outside the housing. The housing may furthermore accommodate a hollow plunger rod configured to be advanced in the syringe for delivering at least one dose of medicament, and a plunger rod tube. The plunger rod tube may have at least one locking member configured to interact with a plunger rod stop to normally lock the plunger rod to the plunger rod tube. A syringe driver may be configured to apply a force to the syringe thereby moving the syringe from the first position to the second position and the syringe driver may further be configured to advance the plunger rod tube with the plunger rod to the second position. A plunger rod driver may be configured to apply a force to the plunger rod to advance the plunger rod in the syringe for delivering at least one dose of medicament. The housing may be configured to unlock the locking member and release the plunger rod from the plunger rod tube when the syringe and the plunger rod tube is advanced to the second position. Thereby the plunger rod driver may be activated to advance the plunger rod in the syringe for delivering of at least one dose of medicament. Thus, the syringe driver and the plunger rod driver may be separate drivers.

According to some aspects of the present disclosure, an auto injector having sequential control of needle insertion and dose injection is provided. The auto injector may have a housing for accommodation of a syringe with a needle, and the syringe may be movably positioned in the housing between a first position in which position the needle is accommodated inside the housing and a second position in which position the needle protrudes outside the housing. The housing may furthermore accommodate a plunger rod configured to be advanced in the syringe for delivering at least one dose of medicament, and a plunger rod tube. The plunger rod tube may have at least one locking member configured to interact with a plunger rod stop to normally lock the plunger rod to the plunger rod tube. A first spring may be configured to apply a force to the syringe thereby moving the syringe from the first position to the second position and the first spring may further be configured to

advance the plunger rod tube with the plunger rod to the second position. A second spring may be configured to apply a force to the plunger rod to advance the plunger rod in the syringe for delivering at least one dose of medicament. The housing may be configured to unlock the locking member and release the plunger rod from the plunger rod tube when the syringe and the plunger rod tube is advanced to the second position. Thereby the second spring may be activated to advance the plunger rod in the syringe for delivering of at least one dose of medicament.

Providing a first spring configured to advance the syringe in the housing and a second spring configured to advance the plunger rod in the syringe allows for larger flexibility as the spring characteristics may be selected according to the purpose. For example, to drive a needle into the skin a significantly smaller force may typically be needed than when injecting a medicament from a syringe, depending on needle bore. Thus, especially, when the initial force is lower than the force needed for the injection of the medicament, the design of the springs may be complex, and difficult obtainable by a single spring.

In particular when injecting a medicament into muscle tissue, a longer needle is typically used compared to needles used for subcutaneous injections. In consequence of the long needle size and still the requirement of a minimum force to facilitate injection of the medicament into the muscle tissue, a significant force may have to be stored in the spring. A high potential energy stored in the spring during the entire shelf life of the auto injector, also adds to the requirements for the surrounding parts of the auto injector in particular relating to strength and hence cost of manufacturing.

It is seen that the locking member cooperating with the housing or an intermediate member, such as the reload handle, may control the movement of the plunger rod. Thus, the movement of the plunger rod and thereby the injection of medicament is controlled by the housing or the intermediate member.

It may be suitable, that the means for releasing the syringe to allow insertion of the needle are decoupled from the means for releasing the plunger rod for injection of medicament. Thus, there is no direct coupling between the end stop for the needle

insertion, which is provided on the syringe lock, and the release of the plunger rod, which is provided by alignment of plunger rod tube and housing or the intermediate member, such as the reload handle. Thereby, an inaccuracy in the needle insertion procedure will not inherently be transferred to the injection of medicament. Thus, while the release of the syringe may be configured to release the plunger rod, the release of the syringe may be mechanically decoupled from the plunger rod release.

The locking member may comprise at least one deflectable member and the housing may be configured to allow for the at least one deflectable member to enable deflection away from the plunger rod when the syringe and the plunger rod tube has been advanced to the second position.

In one or more aspects, the plunger rod tube and the syringe may be interconnected so that the plunger rod tube may not be able to move with respect to the syringe and vice versa.

The housing may have an opening, such as a window or a widened portion, configured to be aligned with the at least one deflectable member when the plunger rod tube is advanced to the second position. By aligning the at least one deflectable member with the opening, the at least one deflectable member may be configured to deflect through or towards the opening. When the plunger rod tube with the at least one deflectable member is not in the second position, an inner surface of the housing may prevent the at least one deflectable locking member from deflecting, such as from deflecting outwards, i.e. deflecting radially with respect to a longitudinal axis of the syringe and/or the plunger rod tube. Hereby, the plunger rod may be locked to the plunger rod tube and the plunger rod driver, such as the second spring, will remain in a compressed state and not be able to force the plunger rod forwards in the syringe. Only when the plunger rod tube is aligned with the housing openings will the at least one deflectable member be able to deflect and thereby release or unlock the plunger rod from the plunger rod tube. As the plunger rod is released from the plunger rod tube, the plunger rod driver will be activated and force the plunger rod to advance in the syringe to thereby deliver a dose of medicament.

Thus, upon release of the plunger rod, the plunger rod driver may advance the plunger rod within the syringe in that the plunger rod stop is able to pass the deflected locking member. Thereby, the forward end of the plunger rod is advanced in the syringe, and the plunger rod stop may move forward to an end-of-dose stop in the plunger rod tube. Thereby, the dose to be injected may be determined by the distance from the release of the plunger rod, to the end-of-dose stop times a diameter of the syringe.

The plunger rod stop may have an angled surface normally pressing against an angular surface of the deflectable locking member. Hereby, the plunger rod forces the deflectable locking member to deflect towards the opening when the plunger rod is being pushed forward by the plunger rod driver

In one or mere aspects, the at least one deflectable locking member may be hinged to the plunger rod tube in a downward position with respect to the movement of the plunger rod. Hereby, the at least one deflectable locking member is stronger in that push forces, and not pull forces, are exerted on the at least one deflectable locking member. Further, hinging the deflectable locking member in a downward position may ensure that the deflectable locking member may deflect only when the entire length of the deflectable locking member opposes the full opening. This further implies that the auto injector is more robust in the control of ensuring strict sequential execution of medicament injection only after a fully established needle insertion. In particular, for acute medications with very fast injection of a drug, i.e. when a large bore needle is used, it is of outmost importance that the sequential control is robust.

As mentioned above, the plunger rod driver may comprise a spring, such as a compression spring, and in some embodiments, the plunger rod spring may in one end be fixedly connected inside the hollow plunger rod tube.

As the plunger rod driver extends inside the hollow plunger rod, it may apply a force directly to the lower inside surface of the hollow plunger rod so as to drive only the plunger rod forward. Applying the driving force directly onto the plunger rod do not require complex parts to shift the loading between different parts, and furthermore,

the force may be applied in a controlled manner, with substantially no or significantly reduced uncertainty as to how much force will actually be applied to the plunger rod, and thereby, how fast the medicament will be expelled.

The syringe driver, such as the first spring, may be provided outside the plunger rod tube.

The housing may further accommodate a syringe tube for holding the syringe, and the syringe may have a syringe flange which may then be locked between the syringe tube and the plunger rod tube. Hereby, a syringe assembly comprising the syringe, the syringe tube interconnected to the plunger rod tube in which the plunger rod and the plunger rod driver are positioned, may be moved as one entity. Locking the syringe, the syringe tube and the plunger rod tube together has the effect that no accidental movement of the parts in relation to each may influence the delivery of the medicament.

In one or more embodiments, the auto injector may be a reloadable auto injector.

In some some, the auto injector may be configured to deliver more than one dose of medicament, such as two doses of medicament, such as a plurality of doses of medicament, etc., such as two separate doses of medicament, etc. In some embodiments, the delivery of a second or any further doses may require a clear operator input to activate the auto injector for the further injection. The plunger rod tube may comprise at least a first and a second locking member to enable delivering of a first and/or a second dose, or the plunger rod tube may comprise a plurality of locking members to enable delivery of a first, second and/or plurality of doses. Each of the first, second and/or plurality of locking members may be configured to consecutively engage with the plunger rod stop. The first, second and/or plurality of locking members may be a first, second and/or plurality of deflectable locking members. The two windows for release of the plunger rod tube can be provided on a same component, i.e. on the reload handle, and thus manufacturing tolerances are better controllable.

The housing may comprise a first, a second and/or a plurality of openings configured to align with the first, second and/or plurality of locking members, respectively, when the syringe is the second position.

It is envisaged that the opening(s) may be provided in any intermediate element, such as in a handle, positioned between the housing and the plunger rod tube. Thus, the deflectable locking members may be restricted by an inner side of such an intermediate element and the opening(s) may be provided in the intermediate element only or in any intermediate element and the housing, to e.g. allow for a full deflection of the locking members.

It is envisaged that the principle as set out allow for any number of injections, and the auto injector may comprise one, two and/or a plurality sets of locking members and corresponding openings wherein each locking member and corresponding opening may be provided at independent positions on the perimeter of the housing and/or any intermediate element and the plunger rod tuber, respectively.

Providing the openings in one element, such as in the housing or in an intermediate element, may reduce the requirement on tolerances in that substantially only the tolerances in the manufacturing of the one element influences the dose delivery control. Thereby, the first and any further doses delivered may be aligned with each other, and thereby highly controllable.

To deliver more than one dose, the auto injector may be activated more than once, thus, also the plunger rod driver may be activated one or more times. The plunger rod driver may be configured to move the plunger rod a first distance upon a first activation of the plunger rod driver and a further distance upon a further activation of the plunger rod driver.

The plunger rod stop may engage the second or further locking member after a first or further medicament injection has been performed. Thus, for example, when a first dose has been delivered, the plunger rod stop will engage the second deflectable locking member, and thereby be ready for delivering of a second dose as soon as

the second deflectable locking member is aligned with the second opening in the housing.

In one or more aspects, the second activation of the plunger rod driver may follow a reload of the auto injector, and a repeated movement of the syringe and/or the syringe assembly from the first position to the second position.

In one or more aspects, the user operation of the reload handle, so as to for example activate the auto injector and thereby ready the auto injector for a second and/or further delivery of medicament, may comprise a rotational movement.

The reload handle may be configured for a rotational movement, and the auto injector may further comprise an intermediate component, such as a torsion ring, transferring the rotational movement of the reload handle to a translational movement of at least the syringe assembly.

The intermediate component which may be interconnected to the syringe assembly may have a tap configured to move longitudinally along a guide or surface of the reload handle to thereby retract the syringe assembly from the second position to the first position upon user operation of the reload handle. The guide or surface of the reload handle may in some embodiments be an inclined guide or surface of the reload handle, and the tap may move along the inclined surface upon operation of the reload handle. Thereby, the syringe assembly may be forced along the inclined surface to move the syringe assembly from the second position to the first position, and may further rotate the syringe assembly. Hereby, the syringe assembly may follow the guide in the syringe lock into the first position.

A complete operation of the reload handle may force the tap on the intermediate component over an inclined surface top and into a second or further reload handle slot. Thus, after the retraction of the syringe assembly, the syringe assembly is further rotated. This rotational movement may allow for the syringe assembly to be rotated onto the syringe lock ledge and lock the syringe assembly in the first position and thereby ready the device for a further delivery. Thus, when the intermediate

component tap reaches the second or further reload handle slot, the syringe assembly is rotated onto the syringe lock ledge.

The second and/or any further reload handle slots may have an inclined surface to allow for continuous reloading of the auto injector. In one or more embodiments, the reload handle comprises two inclined reload handle slots to allow for continuous reloading of the auto injector.

The second reload handle slot may be a slot substantially parallel with a longitudinal axis of the auto injector, with no inclined surface tops, thus, the second and/or further reload handle slot may allow for longitudinal movement only to thereby prevent further reload of the auto injector. Thus, the reload handle may not be able to reload the auto injector and ready it for a further injection as the intermediate component will not be able to translate the rotational movement of the handle to translational movement of the syringe assembly.

The reload operation may be configured to reverse the operation of the auto injector and may for example reverse syringe driver, syringe lock, skin sensor, etc.

In one or more embodiments, the auto injector housing may further comprise an indication of a "ready" state and a "not ready" or "done" state. The "ready" state may indicate a first rotational position of the syringe lock in which position the syringe assembly is locked in the first position. As the syringe assembly may be rotated upon injection with respect to the housing, and further moved forward with respect to the housing, the "ready" state may not be shown in the window unless the syringe assembly is in the first locked position. The "ready" state may furthermore only be indicated to an operator or patient when the skin sensor is in the unlocked state. Thus, the "ready" state may indicate that the auto injector is ready to use when unpacked, and indicate that the auto injector is ready to use after reloading of the auto injector.

The indication may be provided as a label window which may reveal information provided in for example the syringe lock or any other structural element beneath the housing in which a "ready" state is indicated, either by inscription, by color coding,

etc. The indication may also be provided be an inspection window which may be a window provided so that the drug or medicine in the syringe is visible when the auto injector is in the ready state, and wherein the view of the drug or medicine is obscured when the auto injector is in any "not ready" or "done" state.

The inspection window may further provide a view of the medicine before the auto injector is used for injection of medicine to thereby provide a visible check of medicine availability, medicine color, quality, etc.

The skin sensor and/or needle shield may extend over the length of the needle when the syringe assembly is in the first position to hide the needle from a patient's or user's view and the skin sensor and/or needle shield may further be configured to extend over the length of the needle as the needle is withdrawn after a dose has been delivered.

In one or more aspects, the syringe assembly may further comprise an anti-tamper component, such as a tamper protection, and the anti-tamper component may for example comprise protection mechanism to ensure that backward movement of the plunger rod is prevented, such as a ratchet mechanism, such as a ratchet mechanism allowing for forward motion of the plunger rod only.

In one or more aspects, the auto injector may be re-usable, thus, a user may be able to disassemble the auto injector to replace the syringe. For example, a user may be able to replace the syringe with needle only, or a user may be able to replace the syringe assembly with a new syringe assembly.

Typically, the auto injector may be provided in a casing and the casing may have to be removed before the auto injector is ready to be used.

A medicinal cartridge or pre-filled syringe is typically provided with a needle. To protect the needle during transportation and to enable sharps protection, the syringe needle is typically provided with a soft protective part and a rigid protective part, i.e. the rigid needle shield, RNS. To ready the auto injector for injection, typically, both the soft protective part and the rigid protective part needs to be removed. However,

both for safety reasons, and because the protective parts may be difficult to access for a user, a rigid needle shield removal part may be implemented. The rigid needle shield removal part may at least partly enclose the rigid protective part and for example grip a ridge on the rigid protective part so that the rigid protective part may be removed with the removal of the rigid needle shield removal part.

The casing, such as a transportation housing, may be removed by for example a straight pulling motion, a twist, a combination of these, or in any other way as known by a person skilled in the art. In some embodiments the casing may surround the syringe assembly, but not the reload handle. The casing may be held in place by a ring snap mechanism provided between the reload handle and the casing. The casing and the reload handle assembly may be sealed by a piece of adhesive tape wrapped around the casing and the reload handle assembly. The casing may be removed from the auto injector by twisting the casing slightly against the reload handle, utilizing for example a tapered knob on the auto injector to translate the rotational force into a longitudinally movement which breaks, partly by the rotation and partly by the axial displacement in the longitudinal direction, the ring snap mechanism. Also due to the longitudinal displacement the RNS removal part may start to pull off the RNS where the remaining dismantling of the RNS is carried out by the operator. The gearing by the rotation over the tapered knob helps the operator to more easily overcome potential high stick-forces for the RNS after longer time of storage, once moved a small distance the operator may easily pull off the RNS the remaining distance at much less force input. The twisting of the reload handle relative to the casing may generate a longitudinal movement in any know way, e.g. by a tapered knob to translate the rotational force into a longitudinal movement, or by an internal thread where unscrewing in one predetermined rotational direction would yield longitudinally separation between the handle and casing, etc.

The RNS (Rigid Needle Shield) may cover the injection needle on the syringe and may be pre-mounted on the syringe before assembling the auto injector. The step of readying an auto injector for injection, may comprise the step of removing the rigid needle shield whereby the injection needle becomes exposed. In some embodiments, the removal of the RNS may be an integrated part of the auto injector

device activation process and hence automated in view of the operator, user or patient. The RNS removal part may be provided so that the auto injector including the RNS is not tampered with during storage, and furthermore, the RNS may be protected so that any significant physical dislocation from its initial sealing position of the RNS is avoided. Such physical dislocation may be e.g. be a radial or a longitudinal displacement or caused by rocking motions etc. and such physical dislocation may have a serious impact on auto injector performance. The process of removing the RNS may be robust and reliable but at the same time, the seal provided by the RNS should be efficient. Thus, the automated removal of the RNS upon device activation may ensure none or minimal physical interaction from outside forces to the RNS during the storage period. Still, upon device activation the RNS removal may be highly robust as otherwise it may potentially be difficult for the operator to gain access for manual removal. Thus, the mechanism interfacing to the RNS may have to satisfy two opposite requirements. Furthermore, the assembly of the auto injector with the RNS removal part may be easy and intuitive.

In some embodiments, the RNS removal part may have a general cylindrical shape but may have slits along its side to allow for insertion of the entire RNS. Furthermore, the RNS removal part may have a U-shaped cut-out on the end surface towards the syringe in order to allow the presence of the syringe, and the diameter/size of the U-shaped cut-out may be designed to be smaller than the maximum diameter of the RNS but large enough to not be in physical contact during storage, i.e. not touch upon syringe or upper portion of the RNS. With the RNS removal part in place, a longitudinal force pulling away from the syringe will now ensure engagement between RNS removal part and the larger diameter rime on the RNS and may thereby force the RNS to be pulled off of the syringe.

The RNS removal part may be applied sideways to the RNS and syringe assembly, or the RNS removal part may be applied longitudinally, thereby pushed onto the RNS and syringe assembly from the front. A number of extended hooks may grip behind the RNS to facilitate pulling off of the RNS by exertion of pull forces on the RNS removal part. In another embodiment, a number of deflectable extended fingers with hooks to reach behind the RNS may be envisioned both allowing for sideways assembly or longitudinal or axial assembly.

In one or more embodiments, the RNS removal part may furthermore cooperate with the skin sensor so that e.g. deflectable parts, such as deflectable finger hooks, may be forced inside the skin sensor during removal through a tight diameter fit. For example, the skin sensor may have an internal diameter, such as 12 mm, to just allow the hooks to pass through but any potential radial deflection of the hooks, i.e. when subjected to the stress exerted from the pulling force, may be minimized due to marginal available space between the deflectable parts outer radial extension (diameter) and the inner diameter of the skin sensor.

The present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which exemplary embodiments of the invention are shown. The invention may, however, be embodied in different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Like reference numerals refer to like elements throughout. Like elements will, thus, not be described in detail with respect to the description of each figure.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows an exploded view of an auto injector,

Figs. 2A-G show exemplary a view of the auto injector in various states as seen from a user perspective,

Figs. 3A-C show indicators in different states,

Figs. 4A-C show an auto injector handle top and corresponding casing,

Figs. 5A-G show a cross sectional view of an auto injector according to the invention during different stages of operation,

Figs. 6A-F show a reload handle, plunger rod tube and plunger rod in various stages,

Figs. 7A-C show details of a skin sensor,

Figs. 8A-B show a detailed view of an inspection window,

Figs. 9A-F show a reloading mechanism according to the present invention,

Figs. 10A-E show a syringe lock guiding trail in various stages,

Figs. 11A-B show a reload handle for single or repeated delivery of doses,

Fig. 12 shows a syringe assembly in more detail,

Fig. 13 shows a cross-sectional view of the protective casing,

Figs. 14A-C show the recap prevention cap and the recap prevention spring.

Fig. 15 shows a view of the lower part of the auto injector.

DETAILED DESCRIPTION OF THE DRAWING

In the following an auto injector according to any of the above described aspects of the disclosure will be described in more detail and with reference to the drawings. A reloadable auto-injector 10 with a housing 500 for accommodation of a syringe assembly 20 is provided. The syringe assembly 20 may comprise a syringe 1000 with a needle 1002, and the syringe assembly 20 may be movably positioned in the housing 500 between a first position in which position the needle 1002 is accommodated inside the housing 500 and a second position in which position the needle 1002 protrudes outside the housing 500. The syringe assembly 20 may further comprise a syringe stopper 1004 movably positioned in the syringe 1000 and sealing the syringe content 1006. The auto-injector further comprises a plunger rod 1500 configured to engage the syringe stopper 1004, and a plunger rod driver 1600 being configured to apply a force to the plunger rod 1500 to advance the plunger rod 1500 in the syringe 1000 for delivering at least one dose of medicament. Furthermore, a syringe driver 1200 may be accommodated inside the housing 500

and be configured to apply a force to the syringe assembly thereby moving the syringe 1000 from the first position to the second position. The housing 500 may still further comprise a reload handle 1400 configured to reload the auto injector 10 for injecting a further dose of medicament, wherein the reload handle 1400 may be connected to the syringe assembly 20 so that user operation of the reload handle 1400 is configured to retract the syringe assembly 20 to the first position and to simultaneously reload the syringe driver 1200 to thereby ready the auto injector 10 for delivering a further dose of medicament.

In Fig. 1 an exploded view of an auto-injector according to an embodiment of the present disclosure is provided. A protective cap in the form of a casing 100 is provided as a transport casing and is configured to be removed by the user before use of the auto injector 10. A rigid needle shield remover 200 preferably cooperates with the casing 100 and the rigid needle shield 950 so that the rigid needle shield remover 200 may be easily removed with the casing 100.

The auto injector has a housing 500 configured to enclose the further auto injector parts, including the syringe lock 600 and the skin sensor 700 which parts cooperate to release and lock the needle shield 950 and the syringe assembly 20. The skin sensor driver 800 may be a spring. The syringe tube is provided to accommodate the syringe 1000 with needle (not visible in figure 1), and is interconnected to the plunger rod tube 1100. A syringe driver 1200 is configured to act on the syringe 1000 in the syringe tube 900. Housing lock ring 1300 interconnects the housing 500 and reload handle top 1900. The reload handle 1400 is interconnected with the handle top 1900 and allows for reloading of the device, in co-operation with syringe lock 600 and skin sensor 700 as further described below. The plunger rod driver 1600 is configured to apply a force to the plunger rod 1500 and protrudes inside the hollow plunger rod 1500 in the assembled state.

Torsion ring 1800 transmits the rotational movement of the handle top 1900 to a translational movement of the syringe assembly. Handle top 1900 is positioned at an end of the auto injector, and is configured to be rotated with respect to the housing 500 upon reloading of the device.

The auto injector 10 may also comprise a recap prevention cap 300 and one or more recap prevention springs 400 positioned outside and around the front end 506 of the housing 500, i.e. the housing is partly protruding through the recap prevention cap (300) with the recap prevention springs (400). Inside the protective casing 100 is a first casing recess 102 (see Fig. 13) which is configured for interacting with the one or more recap prevention springs 400 if the protective casing 100 is pushed onto the auto injector again after removal of the casing 100. This is on order to prevent that the auto injector can be fully inserted inside the protective casing 100 once the protective casing has been removed from the auto injector.

Fig. 2 illustrates the auto injector in various use states as seen from the point of the user or patient. In Fig. 2A, the auto injector 10 is enclosed in casing 100 and the casing 100 is adjoining handle top 1900. In Fig. 2B, the casing 100 is removed and auto injector 10 has become visible. The auto injector 10 comprises housing 500 having an inspection window 502 and a skin sensor 700. A medicament 1006 in the syringe 1000 is visible through the inspection window 502, as indicated by the dark color of the window thereby indicating to a user that the auto injector is ready to use. The handle top 1900 is configured to interact with reload handle 1400 which is partly visible below the handle top 1900 in Fig. 2B. The skin sensor 700 is in an extended forwards position, completely shielding the needle. In Fig. 2C, the skin sensor 700 is pushed slightly backwards in relation to the skin of a patient, and the needle 1002 is visible in the skin sensor opening 702. The automatic needle insertion is not yet activated. In Fig. 2D, the skin sensor 700 is pushed backwards and is in the retracted position, and the automatic needle insertion has been activated so that needle 1002 protrudes from the skin sensor and the tip of the syringe 1000 is visible in the skin sensor opening 702. In this position, the needle 1002 is configured to be inserted into the skin of a patient. When the user removes the needle 1002 from the skin after injection, the skin sensor 700 is pushed forward and shields the needle 902. The needle sensor 700 is in a locked position. It is seen that in neither of the figures 2C to 2E is the medicament visible through the inspection window 502 thereby indicating to a user that the device is not in an initial position ready to deliver a dose. In Fig. 2F, the auto injector 10 is re-loaded by turning the handle top 1900 with respect to the housing 500, the skin sensor 700 is in an unlocked position and the medicament 1006 in the syringe 1000 is visible through the inspection window

502. In Fig. 2G, the skin sensor 700 is in a locked position after a second dose has been delivered, and the inspection window 502 indicates that the device is not in a ready position.

In Fig. 3, indicator windows 502, 504 are provided. The auto injector 10 may alternatively only have the inspection window 502. The inspection window 502 and the label window 504 of auto injector 10 is shown in more detail. In Fig. 3A, the auto injector 10 is in a ready state with the cap and casing removed. The inspection window 502 is open and thus exposes the medicament 1006 in the syringe 1000 and the skin sensor driver 800 is furthermore visible through the window. It is seen that the skin sensor 700 is in the unlocked forward position and the device is ready to deliver a dose, as is also indicated by label window 504 reading "READY". In Fig. 3B, the needle 1002 has been injected into a patient's skin 2000. The skin sensor 700 is fully retracted and the housing 500 is resting on the patient's skin 2000. The inspection window 502 is closed and does not reveal the medicament, and the label window 504 has the reading "DONE" when the dose has been injected. In Fig. 3C, the skin sensor 700 is fully extended and is in the locked forward position and skin sensor lock tabs 708 are visible. The inspection window 502 is closed and the label window 504 still has the reading "DONE". It is seen that during the injection process, the needle 1002 is not visible for the user or the operator activating the auto injector 10 and the skin sensor 700 also acts as a needle shield or needle shroud. It is seen from the figures 2 and 3 that the overall length of the auto injector is not significantly increased when delivering a further dose and it is a benefit of the present disclosure that a compact auto injector is provided which is capable of delivering one or more doses. The compact size is obtained due to the reversible features of the auto injector as further described below.

Fig. 4 shows the mechanism for removing casing 100 in more detail. As seen in Fig. 4A, the casing 100 is adjoining the handle top 1900. The casing may be held in place by a ring snap mechanism in place between the handle 1400 and the casing 100. The casing 100 and the handle top 1900 may be sealed by a piece of adhesive tape (not shown) wrapped around the casing 100 and handle top 1900 assembly. Upon activation, that is when the user unpack the auto injector 10, the casing 100 is removed from the auto injector 10 by twisting it slightly against the handle top 1900,

utilizing a tapered knob 1402 on the auto injector, such as on the reload handle 1400 to translate the rotational force into a longitudinally movement which breaks adhesive as shown in Fig. 4B. In Fig.4B, in which the casing is slightly turned to break the seal and disengage the ring snap mechanism. The casing 100 is removed partly by the rotation and partly by the longitudinal displacement following both the longitudinal movement initiated by the tapered knob 1402 and a pulling action initiated by the user.

Figs. 5A-G show cross sectional views of an auto injector in a number of injection stages. In Fig.5A, the auto injector is in a storing stage. The auto injector 10, apart from the handle top 1900 is encompassed in casing 100. The RNS 950 and the RNS remover 200 are in position to protect the needle 1002 and facilitate removal of the RNS 950, respectively. The hollow plunger rod 1500 is in an initial position and a forward end 1510 of the hollow plunger rod 1500 is positioned at a distance from a syringe stopper 1004 surface. Thereby, a slight accidental movement of the plunger rod 1500 will not impact the syringe stopper 1004.

In Fig.5B, the casing 100, the RNS 950 and the RNS remover 200 have been removed from the auto injector shown Fig. 5A.

In Figs. 5C and 5D, the auto injector is shown immediately before injection of a first dose and immediately after the injection of a first dose, respectively. In Fig. 5D, the needle 1002 is exposed and inserted into the skin of a patient (not shown) and the hollow plunger rod 1500 has been moved forward under influence of plunger rod driver, i.e. spring, 1600, so that the protrusion 1508 of the plunger rod rests against a first stop 1108 of the plunger rod tube 1100, see further details in Fig. 6. The stopper 1004 has been moved forward to expel a first dose of medicament and the skin sensor 700 is the retracted position.

After the needle 1002 has been retracted from the skin, in Fig. 5E, the skin sensor 700 is moved to a forward locked position by skin sensor driver 800. At the stage in Fig. 5E, the auto injector may be either discarded as it is or reloaded for delivering of a second or further dose.

Fig. 5F shows the auto injector 10 after reloading of the device and before firing of the second dose: The hollow plunger rod 1500 has been moved forward under influence of plunger rod driver, i.e. spring, 1600, so that the protrusion 1508 of the plunger rod 1500 rests against a second stop 1110 of the plunger rod tube 1100, see further details in Fig. 6. The stopper 1004 has been moved forward to expel a first dose of medicament and the skin sensor 700 is the retracted position.

The skin sensor 700 has been unlocked and is in the forward unlocked position, the syringe driver 1200 has been reloaded, i.e. retracted, into an initial compressed position and the syringe 1000, the syringe tube 900, the plunger rod tube 1100, the plunger rod 1500 and the plunger rod driver 1600 have been retracted without moving the mentioned parts in relation to each other.

In Fig. 5G, the auto injector is shown when the needle has been retracted from the skin after the second or further injection has been made. The plunger rod 1500 has been moved forward under influence of plunger rod driver, i.e. spring, 1600, so that the protrusion 1508 of the plunger rod rests against a second stop 1110 of the plunger rod tube 1100, see further details in Fig. 6. The stopper 1004 has been moved forward to expel a second or further dose of medicament. The skin sensor 700 is in the forward locked position and the auto injector may be discarded, a further injection may be performed or the auto injector may be re-used by for example re-fitting the auto injector with a new pre-filled syringe.

In Figs. 5A-G, it is seen that the plunger rod driver 1600 comprises a plunger rod spring 1600. It is seen that the plunger rod driver 1600 applies the driving force directly onto the plunger rod 1500, such as onto a lower inner surface of the hollow plunger rod. In Figs. 5A-G, it is seen that the plunger rod driver acts on the bottom of the hollow plunger rod 1500.

The housing further accommodates a syringe tube 900 for holding the syringe 1000, and the syringe has a syringe flange 1008 which is locked between the syringe tube 900 and the plunger rod tube 1100. In the present example, the syringe tube 900 and the plunger rod tube 1100 are provided as two separate units to ease assembly,

however, it is envisaged that the syringe tube and the driver rod tube may be one tube holding the syringe, the plunger rod and the plunger rod driver.

It is seen that the plunger rod driver 1600 is provided inside the hollow plunger rod 1500, which in turn is provided inside the plunger rod tube 1100, and the syringe driver 1200 is provided outside the plunger rod tube 1100.

In Figs. 6A-F, a reload handle 1400 and the cooperation with the plunger rod tube 1100 and the plunger rod 1500 is shown. Only a top portion of an auto injector as e.g. seen in any of the figures 1-5 above or any of the figures is seen in Figs. 6A-F. The auto injector as shown in Figs. 6A-F, is capable of sequentially control the needle insertion and dose injection. The function of the sequential control is illustrated in stages A through F

Figs. 6A-F show the reload handle 1400, the plunger rod tube 1100 and the plunger rod 1500 in various stages of the process. The plunger rod 1500 is configured to be advanced in the syringe (not shown in Figs. 6A-F) for delivering at least one dose of medicament. The plunger rod tube 1100 has a least one locking member 1108 configured to interact with a plunger rod stop 1508 (not visible in Figs. 6A-F) to normally lock the plunger rod 1500 to the plunger rod tube 1100. The syringe driver 1200 is not shown in Figs. 6A-F, however the activation of the syringe driver is illustrated by the arrows 42, 44, that is the plunger rod tube 1100 and the plunger rod 1500 are both moved forwards, i.e. from the first position to the second position. The plunger rod driver 1600 is not shown in Figs. 6A-F, however, the activation of the plunger rod driver 1600 is illustrated by single arrow 42 illustrating that only the plunger rod is moved forward, i.e. the force applied by the plunger rod driver 1600 forces the plunger rod 1500 to advance in the syringe (not shown) for delivering at least one dose of medicament. It is seen that the housing 500, or in the present case an intermediate element 1400, i.e. the reload handle 1400, comprises an opening or an aperture 1420. The housing or intermediate element 1400 is configured to unlock the locking member 1108 and release the plunger rod 1500 from the plunger rod tube 1100 when the syringe (not shown) and the plunger rod tube 1100 is advanced to the second position, thereby activating the plunger rod

driver (not shown) to advance the plunger rod 1500 in the syringe for delivering of at least one dose of medicament.

The locking member 1108 comprises at least one deflectable member 1108 and the housing 500 and/or the intermediate member 1400 is configured to allow for the at least one deflectable member 1108 to deflect away from the plunger rod 1500 when the syringe (not shown) and the plunger rod tube 1100 is advanced to the second position. Thus, it is seen in Fig. 6A that the plunger rod 1500 in the plunger rod tube 1100 is in an initial position, i.e. a first position, ready to deliver a dose of medicament. In the second position after forwards movement of the plunger rod tube 1100 and the plunger rod 1500, the plunger rod tube is in the second position. It is seen in Fig. 6B, that the plunger rod 1500 has not been moved with respect to the plunger rod tube 1100 and both the plunger rod tube 1100 and the plunger rod 1500 has been moved forwards relative to the housing or intermediate member 1400. The plunger rod driver is typically positioned inside the hollow plunger rod 1500 configured to apply a force to the bottom surface 1510 inside the hollow plunger rod 1500

The plunger rod tube 1100 and the syringe (not shown) are typically interconnected so that the plunger rod tube 1100 cannot move with respect to syringe 1000 and vice versa. The plunger rod tube 1100 may be interconnected to the syringe 1000 or the syringe tube 900, for example via plunger rod tube tabs 1110.

The housing 500 has an opening 1420, the opening 1420 being a window, or an aperture, configured to be aligned with the at least one deflectable member when the plunger rod tube 1500 is advanced to the second position. The first deflectable locking member 1108 is aligned with the window or aperture 1420 (see e.g. Fig. 6C) thereby allowing the locking member 1108 to deflect and allow passage of the plunger rod protrusion 1508, such as the plunger rod stop 1508. It is seen in Fig. 6C that upon release of the plunger rod 1500, the plunger rod driver 1600 advances the plunger rod 1500 within the syringe 1000 in that the plunger rod stop 1508 is able to pass the deflected locking member. A deflectable locking member 1108, 1110 is positioned at either side of the plunger rod, and thus also the openings 1420, 1422 are provided on either side.

In Fig. 6D, the handle 1400 is rotated as illustrated by arrow 1401 and the plunger rod tube 1100 with plunger rod 1500 is rotated and retracted to the same initial position as illustrated in Fig. 6A, while the plunger rod maintain the advanced position with respect to the plunger rod tube 1100, and the plunger rod driver (not shown in Figs. 6A-F) also maintaining a first extended position. From this position, a second dose delivery is performed, and Figs. 6E and 6F illustrate the repeated forward motion of the plunger rod tube with the plunger rod, as illustrated by arrows 42, 44 so as to align the second window 1422 with the second deflectable locking member 1110 and allow deflection of the locking member 1110. Thereby, the plunger rod driver 1600 is released or activated to push the plunger rod 1500 pass the second locking member 1110, for delivering of a second dose as illustrated by single arrow 42, and Fig. 6F illustrates the plunger rod in the advanced position within the syringe. The plunger rod driver is thus configured to move the plunger rod 1500 a first distance upon a first activation of the plunger rod driver 1600, and a further distance upon a further activation of the plunger rod driver 1600.

It is seen that the second activation of the plunger rod driver follows a reload of the auto injector, and thereby a repeated movement of the syringe assembly, i.e. such as syringe 1000, syringe tube 900, plunger rod 1500, and plunger rod tube 1100 from the first position to the second position.

Thus, the auto injector may deliver at least one or two separate doses of medicament.

The plunger rod stop may further have an angled surface normally pressing against an angular surface of the deflectable locking member 1108. The deflectable locking member 1108, 1110 is hinged to the plunger rod tube 1100 in a downward position with respect to the movement of the plunger rod. Hereby, the deflectable locking member may deflect only when the entire length of the deflectable locking member 1108, 1110 opposes the full opening 14.

The at least one deflectable member is configured to deflect upon being aligned with the opening in the housing 500 and/or the intermediate member 1400.

When the deflectable locking members 1108, 1110 are not aligned with the window 1420, the deflectable locking members 1108, 1110 are typically prevented from deflection by an inner surface of the handle 1400 or housing 500, such that the deflectable locking member 1108, 1110, is not entirely within the window 1420, 1422 and therefore not able to deflect.

The plunger rod tube 1100 may thus comprise at least a first and a second locking member 1108, 1110 configured to engage with the plunger rod stop 1508.

Fig. 7 shows the skin sensor 700 and the interaction of the skin sensor 700 with syringe lock 600 in more detail. In Fig. 7A, the skin sensor 700 and the syringe lock 600 are in their initial positions, and the skin sensor 700 is thus in the forward unlocked position. A protrusion 704 having an angled surface 706 is seen at the skin sensor 700. In Fig. 7B, the skin sensor 700 is activated, by e.g. pressing the skin sensor 700 against the skin of a patient, and the skin sensor 700 is moved towards the syringe lock 600. Hereby, the angled surface 706 engages with a syringe lock angled surface 612 to thereby force the syringe lock 600 to rotate while the skin sensor 700 is retracted. In Fig. 7C, the skin sensor 700 is fully depressed, i.e. fully retracted, and engaged with the syringe lock after rotation. Fig. 7D shows a detailed view of the syringe lock protrusion 704 and the angled surface 604 of the syringe lock 600.

Fig. 8 shows a detailed view of the inspection window 502. In Fig. 8A, housing inspection window 502, syringe tube inspection window 902 and syringe lock inspection window 602 are aligned and the medicament 1006 in the syringe 1000 is visible. Furthermore, the skin sensor driver 800 is visible through the housing inspection window 502 and the syringe lock inspection window 602. In Fig. 8B, it is seen that the inspection windows are not aligned and that only a part of the syringe lock 600 is visible behind the housing inspection window indicating that the device is not ready for delivering an injection dose.

Thus, a user or patient is able to see the medicament through the inspection windows 502, 602 and 902 at the time of injection of the medicament, as it gives the user a sense of what is injected.

In Figs. 9A-D, a reloading mechanism is shown in more detail. In Fig. 9A, the syringe 1000 with needle 1002 is seen projecting from syringe tube 900 in a first end, such as a forward end, 904. The syringe tube 900 is engaged with plunger rod tube 1100 and tabs 1110 on the forward end 1101 of plunger rod tube 1100 engages with the syringe tube 900 to interconnect the plunger rod tube 1100 and the syringe tube 900. Typically, during assembly, the pre-filled syringe 1000 with needle 1002 will be inserted into syringe tube 900 and plunger rod tube 1100, comprising hollow plunger rod 1500 and plunger rod driver 1600, will be mounted onto the syringe 1000 and syringe tube 900 and the lips 1010 of the syringe will be locked between the syringe tube 900 and plunger rod tube 1100. A tab 1112 on the plunger rod tube 1100 is configured to interact with syringe lock 600 (see Fig. 10 for further details).

The syringe tube 900 has a syringe tube inspection window 902 configured to interact with syringe lock inspection window 602 and housing inspection window 502. Syringe tube protrusions 906 may interact with skin sensor 700 and provide an initial force which must be overcome by the user when activating the auto injector. This is a further safety feature which reduces the risk of accidental activation of the auto injector.

Reload handle 1400 is slid onto the plunger rod tube 1100 and torsion ring 1800 interconnects reload handle 1400 and plunger rod tube 1100 via torsion ring tab 1802.

In Fig. 9A, a first dose has been delivered and it is seen that torsion ring tab 1802 is provided in a first reload handle slot 1404, and the torsion ring tab 1802 has moved forwards along slot side 1406 and is positioned at the bottom of the first reload handle slot 1404.

The reload handle 1400 as well as torsion ring 1800 may be symmetric, so as to evenly distribute the force applied, and that there is thus a torsion ring tab 1802 provided symmetrically on each side of the torsion ring, each torsion ring tab 1802 interconnecting each of the first reload handle slots provided symmetrically about the reload handle slot.

In Fig. 9B, the reload handle 1400 is rotated as indicated by arrow 1401, thereby forcing the torsion ring 1800 which cannot rotate itself, along the inclined slot side 1408 via torsion ring tab 1802. In Fig. 9B, it is seen that the torsion ring tab 1802 has moved slightly along the inclined slot side 1804 after having rotated the reload handle slightly, e.g. about 30 degrees. This pulls the syringe assembly comprising the syringe 1000, syringe tube 900, plunger rod tube 1100, as well as plunger rod 1500 and plunger rod driver 1600 (not shown in Fig. 9) backwards and into the reload handle 1400 as illustrated by arrow 24.

In Fig. 9C, the reload handle 1400 is further rotated, e.g. rotated 45 degrees in total, and the torsion ring tab 1802 has moved towards the top edge 1410 of the first reload handle slot 1404 further retracting the syringe assembly 20 comprising syringe 1000, syringe tube 900, plunger rod tube 1100, as well as plunger rod 1500 and plunger rod driver 1600 (not shown in Fig. 9) backwards and further into the reload handle 1400. While rotating the reload handle 1400 the plunger rod tube tabs 1112 also rotates towards a resting ledge 606 of the syringe lock 600, as may be seen from Fig. 10.

As seen in Fig. 9D, continued rotation of the reload handle 1400 lifts the torsion ring tab 1802 together with torsion ring 1800 and syringe assembly 20 over the top edge 1410 of the first reload handle top 1400 and into second reload handle slot 1414. The torsion ring 1800 including the torsion ring tab 1802 and the syringe assembly will move forward a short distance, such as a few mm, before the syringe assembly 20, and more specifically, the plunger rod tube tabs 1112 hang on the syringe lock resting ledge 606. The auto injector 10 is then in the initial position and ready to deliver a second or further injection. In that the second reload handle slot is a slot allowing only for movement longitudinally along an axis of the auto injector, the auto injector is locked after having delivered a second dose, and the auto injector is thus

not configured to deliver more than two doses. Thus, the auto injector may deliver no more than two doses. Also, alternative configurations have been.

Figs. 10A-F show a detailed view of the syringe lock guiding trail 604 enabling the skin sensor 700 to rotate the syringe lock 600 and control the dosing mechanism. Initially, as seen in Fig. 10A, the spring loaded syringe assembly 20 rests on a syringe lock resting ledge 606 in the syringe lock 600 by plunger rod tube tabs 1112, restricting forward movement of the syringe assembly 20. The skin sensor 700 is in the unlocked forward position.

In Fig. 10B, the skin sensor is pressed against the skin of a patient, and the syringe lock is rotated as indicated by arrow 24. Hereby, the syringe assembly 20 is lifted free of the syringe lock resting ledge 606.

In Fig. 10C, the syringe assembly 20 has moved downwards along syringe lock guiding trail 604, pushing the syringe assembly 20 forwards causing injection of needle 1002. During injection of the needle 1002, the syringe lock 600 is further rotated to align dosing clips with dosing windows to allow for injection of a medicament. After injection, as seen in Fig. 10D, and as the needle 1002 is retracted from the skin of a patient, the skin sensor 700 is pushed forward by skin sensor driver 800. At this point, the two clips of the skin sensor are resting on a shelf on the syringe lock, locking them in position to protect the needle. In Fig. 10E, the device is reloaded and the syringe assembly 20 is in the initial position and the skin sensor 700 in the forward unlocked position in Fig. 10F.

A friction ring may be encircling the front end 614 of the syringe lock 600. In the figures, the friction ring is not shown as a separate item, but should be understood as fitting around the small recess shown at the front end 614 of the syringe lock 600 The friction ring is for reduce friction between the syringe lock 600 and the housing 500 when the syringe lock 600 is rotated in connecting with reloading of the device. The friction ring may be fully clipped to syringe lock so that it does not move relative to syringe lock 600.

In Figs. 11A-B, a reload handle 1400 is shown having a reload handle slot 1414 having a straight side for the injection process and an inclined side 1416 which the torsion ring tab 1802 follows upon reloading. It is seen that the reload handle is provided with only two symmetric reload handle slots 1414, and that therefore an infinite number of reloads is possible as the rotation of the handle is never locked. This reload handle allows for re-fitting with for example a new syringe assembly. The number of reload slots is primarily limited by the size of the auto injector. The difference between Fig. 11A and 11B is the rotation of the re-load handle 1400 in relation to the torsion ring 1800 and the plunger rod tube 1100.

In Fig.12, a syringe assembly 20 is shown comprising syringe tube 900, syringe 1000 with a rigid needle shield, plunger rod tube 1100, hollow plunger rod 1500, plunger rod driver 1600 and plunger rod driver guide 950. It is envisaged that the parts may be assembled using various connector parts, and furthermore, the plunger rod tube 1100 and syringe tube 900 may be provided as one part. It is seen that the syringe assembly 20 may be moved as one element and either be pushed forward by a syringe driver (1200 not shown in Fig. 12) acting on syringe tube flange 906 and/or plunger rod flange 1114 or retracted by a reload handle action acting on the syringe assembly 20, such as on the syringe assembly tab 1112.

Fig. 13 shows a cross-sectional view of the protective casing 100 comprising the first casing recess 102. The casing recess 102 is a small protrusion inside the casing 100, which is configured for interacting with the one or more recap prevention springs 400 shown in Figs. 14B-C if a user tries to push the protective casing 100 onto the auto injector again after removal of the casing 100. This ensures that the second (or subsequent) dose of medication is not by mistake pushed out of the auto injector due to a user trying the push the casing 100 on to the auto injector again.

The recap prevention cap 300 and two recap prevention springs 400 are shown in Fig. 14A, and Figs. 14B-C, respectively. The recap prevention cap 300 comprises two openings 302 through which each of the two recap prevention springs 400 protrudes. The one or more recap prevention springs 400 are preferably made from a bio-compatible metal material. Examples of such are titan or stainless steel.

The recap prevention cap 300 shown in Fig. 13 comprises a front end 304 and a rear end 306 where in between is found two protruding portions 302. The protruding portions 302 are positioned in front of the recap prevention spring 400. When the protective casing 100 is removed from the auto injector, the recap prevention springs 400 push the protruding portions 302 outwardly as indicated with the arrows 308 in Fig. 15. This makes the protruding portions 302 extend outwardly such that the protrusions302 interact with the casing recess 102 whereby the casing is prevented from being pushed fully onto the auto injector after use.

In Fig. 15, the position of the recap prevention cap 300 and the recap prevention springs can be seen in the view of the lower part of the auto injector.

As shown in Fig. 14C, the recap prevention springs 400 will normally have two bending portions 402, 404 allowing the springs 400 to fit behind the recap prevention cap.

The recap prevention springs 400 are shown as separate springs in Figs. 14B-C, but may also be connected in a ring-shaped configuration.

References

10	auto injector
20	syringe assembly
100	casing / protective cap
102	first casing recess
200	rigid needle shield (RNS) remover
300	recap prevention cap
302	protruding portions in the recap prevention cap
304	front end of the recap prevention cap
306	rear end of the recap prevention cap
400	recap prevention spring
402	bending portion
404	bending portion
500	housing
502	indicator window
504	indicator window
506	front end of the housing
600	syringe lock
602	syringe lock inspection window
604	syringe lock guide slot/trail
606	syringe lock ledge
608	a release position
610	syringe lock end stop
612	syringe lock angled surface
614	front end of the syringe lock
700	skin sensor
702	skin sensor opening
704	protrusion
706	skin sensor angled surface
708	skin sensor lock tabs
800	skin sensor spring / skin sensor driver
900	tube syringe
906	syringe tube flange
950	rigid needle shield

1000	syringe with needle
1002	needle
1004	syringe stopper
1006	syringe content / medicament
1008	syringe flange
1100	plunger rod tube
1108	deflectable locking members / first stop
1110	deflectable locking members / second stopper
1114	plunger rod flange
1200	insertion spring / syringe driver
1300	lock ring housing
1400	handle
1402	tapered knob
1420	opening
1422	opening
1500	hollow plunger rod
1504	distal end of the plunger rod
1506	forward end of the plunger rod
1508	plunger rod stop/protrusion
1510	forward end of the plunger stop rod
1600	injection spring / plunger rod driver
1602	one end of the plunger rod driver
1700	pin for injection spring / plunger rod driver guide
1800	torsion ring
1900	handle top
2000	patient's skin

Claims

1. A reloadable auto injector having a housing (500) for accommodation of:

a syringe (1000) with a needle, the syringe being movably positioned in the housing (500) between a first position in which position the needle is accommodated inside the housing (500) and a second position in which position the needle protrudes outside the housing (500),

a plunger rod (1500) configured to be advanced in the syringe for delivering at least one dose of medicament,

a plunger rod tube (1100) having two or more deflectable locking members (1108) configured to interact with a plunger rod stop (1508) to normally lock the plunger rod (1500) to the plunger rod tube (1100),

a syringe driver (1200) configured to apply a force to the syringe (1000) thereby moving the syringe (1000) from the first position to the second position, the syringe driver (1000) being further configured to advance the plunger rod tube (1100) with the plunger rod (1500) to the second position,

a plunger rod driver (1600) being configured to apply a force to the plunger rod (1500) to advance the plunger rod (1500) in the syringe (1000) for delivering one dose of medicament upon unlocking of each of the two or more deflectable locking members (1108),

wherein the a plunger rod (1500) is hollow and the plunger rod driver (1600) extends inside the hollow plunger rod (1500).

2. A reloadable auto injector according to claim 1, further comprising:
a reload mechanism configured to retract the syringe from the second position to the first position and reload the syringe driver to allow a repeated activation of the syringe driver,
wherein the reload mechanism, the reload mechanism comprising activation of the auto injector for a further injection, requires an operator input,

3. A reloadable auto injector according to claim 2, wherein the reload mechanism is configured to unlock a first deflectable locking member (1108) upon a first movement of the syringe (1000) from the first position to the second position to thereby release the plunger rod (1500) from the plunger rod tube (1100) for delivering a first dose of medicament, and unlock a further deflectable locking member (1110) upon a further movement of the syringe (1000) from the first position to the second position to thereby release the plunger rod (1500) from the plunger rod tube (1100) for delivering a further dose of medicament.

4. A reloadable auto injector according to any of the preceedings claims , further comprising a plunger rod driver guide (1700) extending inside the plunger rod driver (1600), the plunger rod driver guide (1700) being configured for guiding the plunger rod driver (1600) inside the hollow plunger rod (1500).

5. A reloadable auto injector according to claim 4, wherein the plunger rod driver guide (1700) is made from stainless steel.

6. A reloadable auto injector according to any of claims 3 to 5, wherein the housing further comprises a reload handle (1400), wherein the handle (1400) has a first opening configured to be aligned with the first deflectable member when the plunger rod tube (1100) is advanced to the second position a first time and a further opening configured to be aligned with the further deflectable locking member when the plunger rod tube is advanced to the second position a further time.

7. A reloadable auto injector according to any of claims 2 to 6, wherein the reload mechanism is connected to the syringe and the plunger rod tube so that user operation of the reload mechanism is configured to retract the syringe and the plunger rod tube to the first position and to simultaneously reload the syringe driver to thereby ready the auto injector for delivering a further dose of medicament.

8. A reloadable auto injector according to any of the previous claims, wherein the plunger rod driver (1600) and the syringe driver (1200) are separate drivers.

9. A reloadable auto injector according to any of the previous claims, wherein the plunger rod driver (1600) and the syringe driver (1200) are partly displaced.

10. A reloadable auto injector according to any of the previous claims, wherein the plunger rod driver (1600) is longer than the syringe driver (1200).

11. A reloadable auto injector according to any of the previous claims, wherein the syringe driver (1200) is provided outside the plunger rod tube (1100) and the hollow plunger rod accommodating the plunger rod driver (1600) is provided inside the plunger rod tube (1100).

12. A reloadable auto injector according to any of the previous claims, wherein the auto injector is configured to deliver two separate doses of medicament.

13. A reloadable auto injector according to claim 12, wherein the plunger rod driver (1600) is configured to move the hollow plunger rod (1500) a first distance upon a first activation of the plunger rod driver, and a further second distance upon a second activation of the plunger rod driver.

14. A reloadable auto injector according to any of the previous claims, wherein the auto injector is activated upon unpacking of the device.

15. An auto injector according to any of the previous claims, wherein the syringe driver (1200) and/or the plunger rod driver (1600) comprises a resilient device, such as a spring, such as a compression spring.

16. An auto injector according to any of the previous claims, further comprising a skin sensor (700), the skin sensor having a locked forward position and an unlocked forward position.

17. A reloadable auto injector according to claim 16, wherein the skin sensor is unlocked in the forward position before a first injection and/or upon operation of the reload handle.

18. A reloadable auto injector according to any of the previous claims, further comprising a syringe lock (600) configured to lock the syringe (1000) in the first position, and a skin sensor (700) configured to release the syringe lock upon engagement with the skin of a user wherein the skin sensor is activated by pressing the skin sensor onto a user's skin.

19. A reloadable auto injector according to claim 18, wherein the syringe lock controls the injection of the needle.

20. A reloadable auto injector according to any of claims 18-19, wherein the plunger rod tube (1100) comprises a plunger rod tap being configured to move in a syringe lock guide slot from a released position adjacent the ledge to a syringe lock end stop and wherein the plunger rod tube, engaged with the syringe, is moved from the first position to the second position when the plunger rod tab travels in the syringe lock guide slot from the released position to the syringe lock end stop.

21. A reloadable auto injector according to any of claims 18-20, wherein a skin sensor driver (800) upon removal of the auto injector from a patient's skin is configured to push the skin sensor forward to shield the needle before and after each injection cycle.

22. A reloadable auto injector according to any of the previous claims, wherein the reload mechanism comprises a reload handle (1400) configured to rotate, the auto injector further comprising an intermediate component (torsion ring) (1800) transferring the rotational movement of the reload handle to a translational movement of at least the syringe assembly (1000) and wherein the intermediate component (1800) has a tap (1802) configured to move along an inclined surface of the reload handle (1402) upon operation of the reload handle (1400).

23. A reloadable auto injector according to claim 22, wherein a complete operation of the reload handle forces the tap over an inclined surface top and into a second reload handle slot (1404).

24. A reloadable auto injector according to claim 23, wherein the syringe and the plunger rod tube (1100) is configured to rest on a syringe lock ledge (1002) when the intermediate component tap reaches the second handle slot.

25. A reloadable auto injector according to claims 23 or 24, wherein the second reload handle slot (1404) has an inclined surface to allow for continuous reloading to the auto injector.

26. A reloadable auto injector according to claims 23 or 24, wherein the second reload handle slot (1404) allows for longitudinal movement only to thereby prevent further reload of the auto injector.

27. A reloadable auto injector according to any of the previous claims, wherein the reload operation is configured to reverse the operation of the auto injector.

28. A reloadable auto injector according to any of the previous claims, wherein the auto injector housing further comprises an inspection window for indicating a "ready" state and a "done" state of the auto injector.

29. A reloadable auto injector according to any of claims 16-28, wherein the skin sensor extends over the length of the needle when the syringe assembly is in the first position to hide the needle from a user's and/or patient's view.

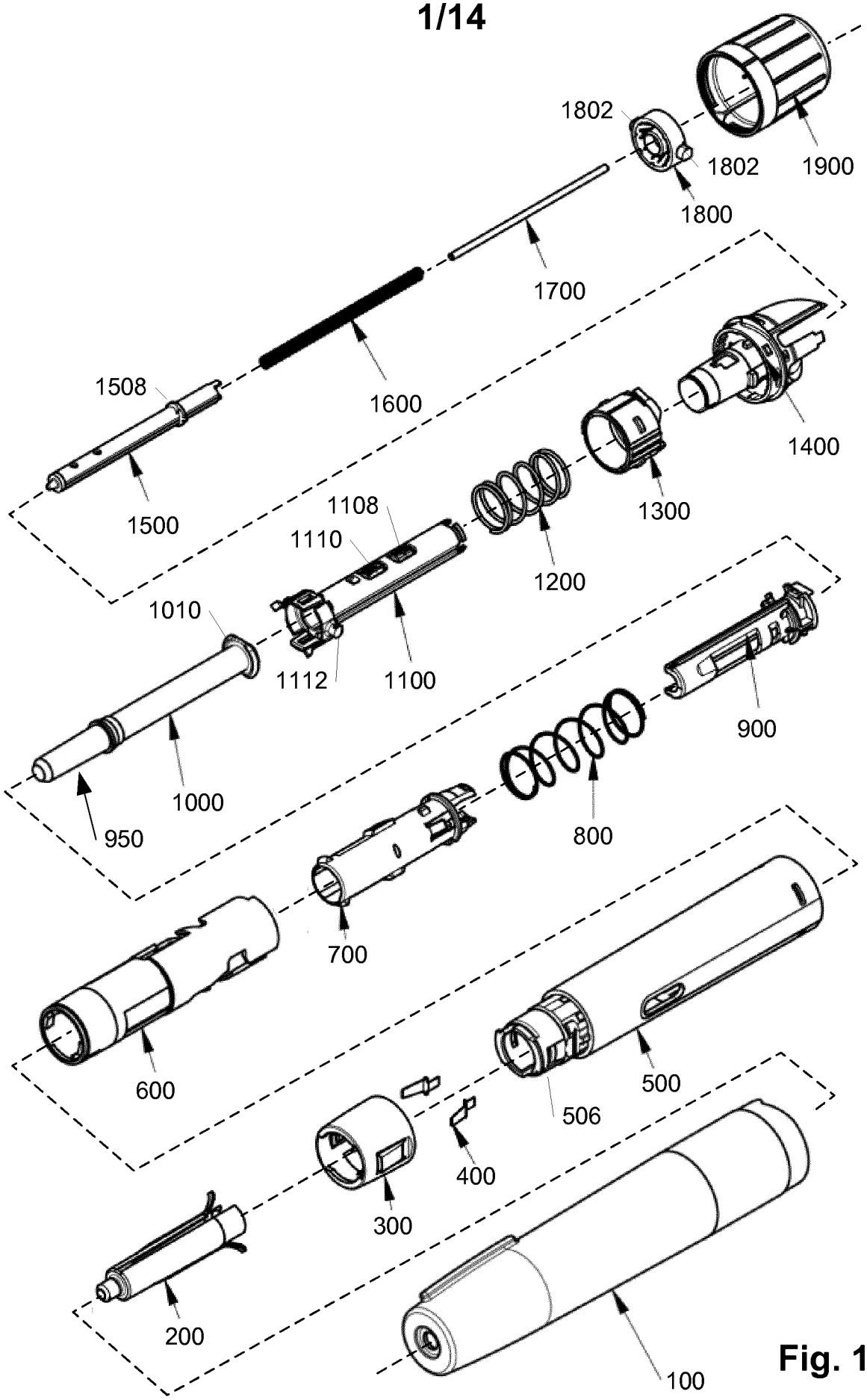
30. A reloadable auto injector according to claim 29, wherein the skin sensor is configured to extend over the length of the needle immediately after a dose has been delivered.

31. A reloadable auto injector according to any of the previous claims, wherein the auto injector further comprises an anti-tampering component.

32. A reloadable auto injector according to claim 311, wherein the anti-tampering component comprises a ratchet mechanism.

33. A reloadable auto injector according to claim 32, wherein the syringe is replaceable.

34. A reloadable auto injector for epinephrine injection comprising separate needle insertion driver and medicine injection driver wherein needle insertion driver action is configured to be re-activated upon reloading.


1802
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400
300
200
100

Fig. 1

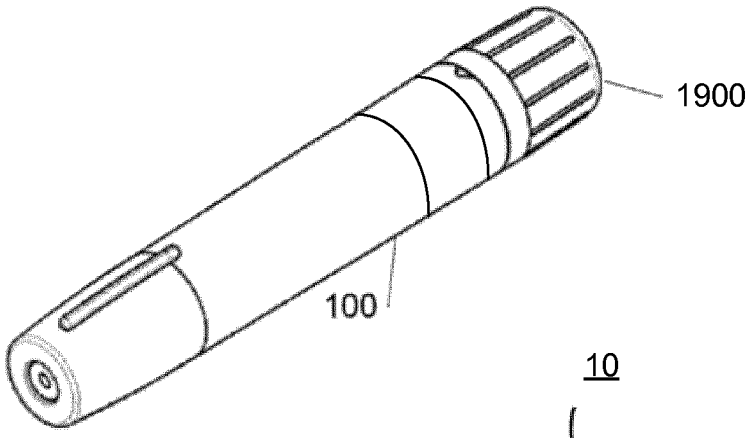

Fig. 2A

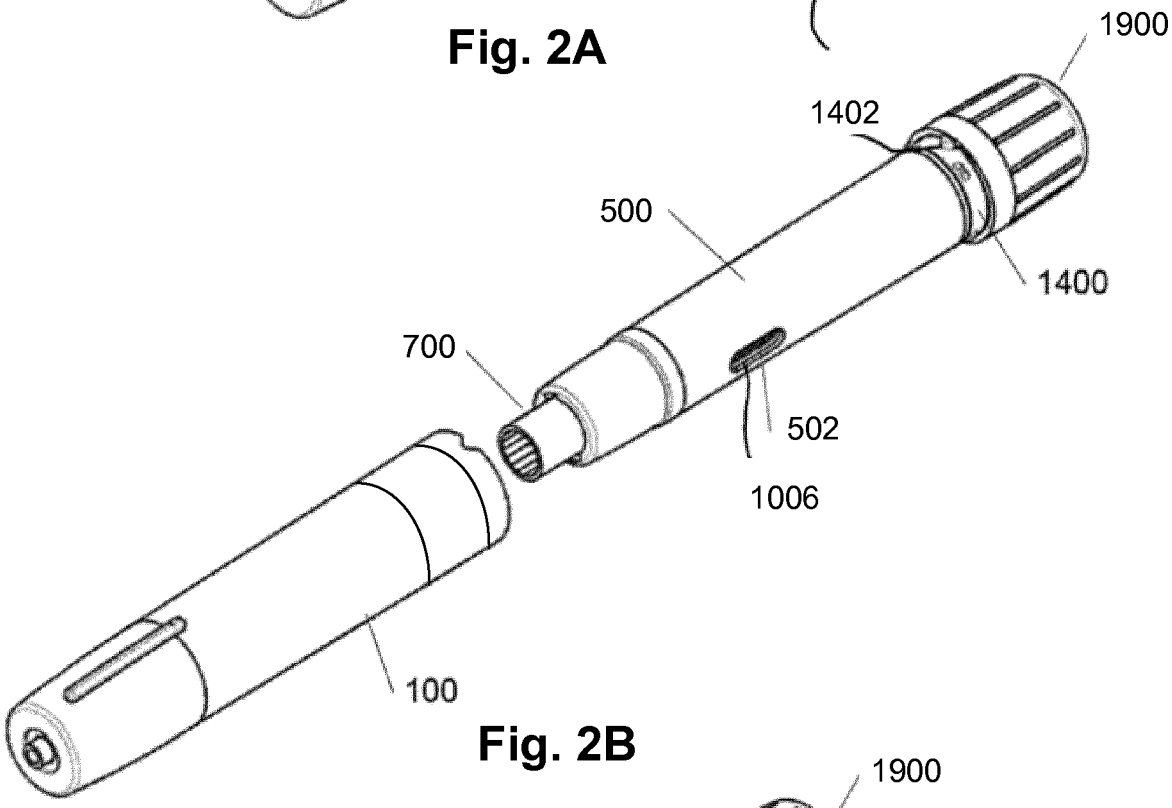

Fig. 2B

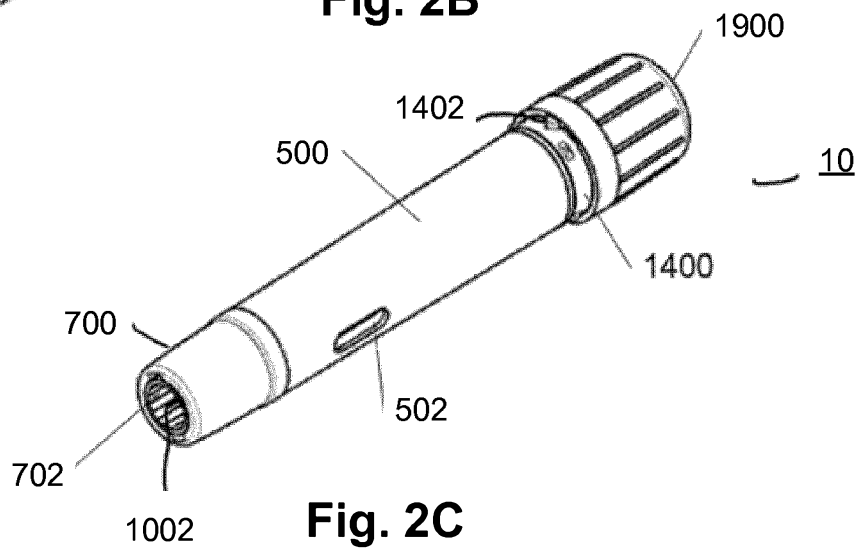

Fig. 2C

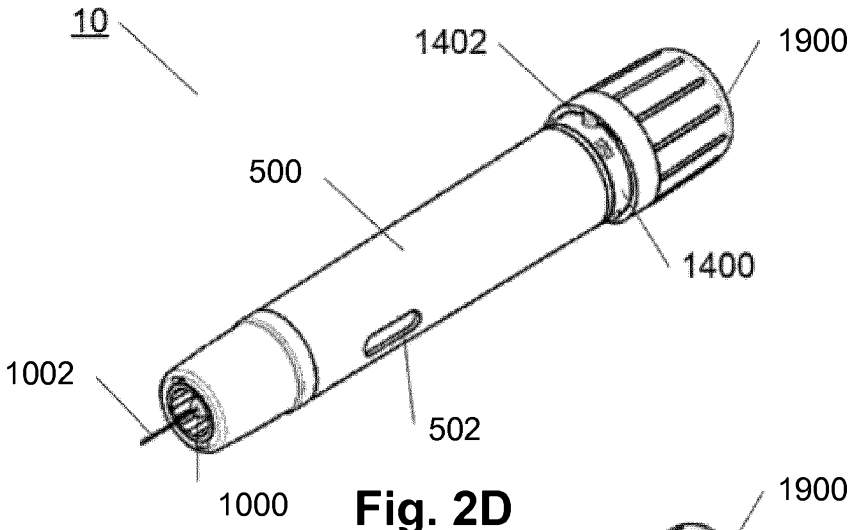

Fig. 2D

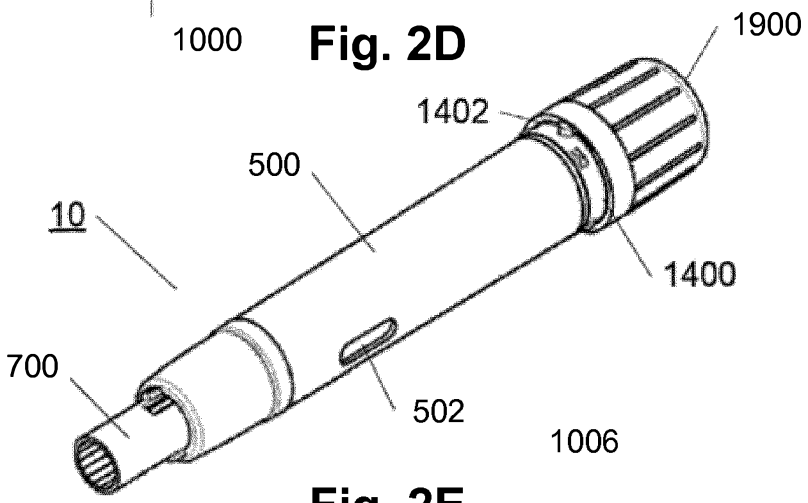

Fig. 2E

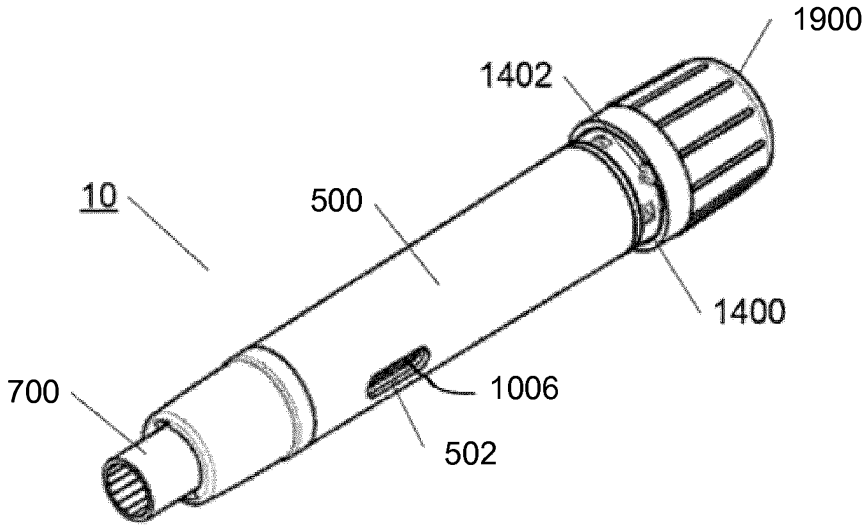

Fig. 2F

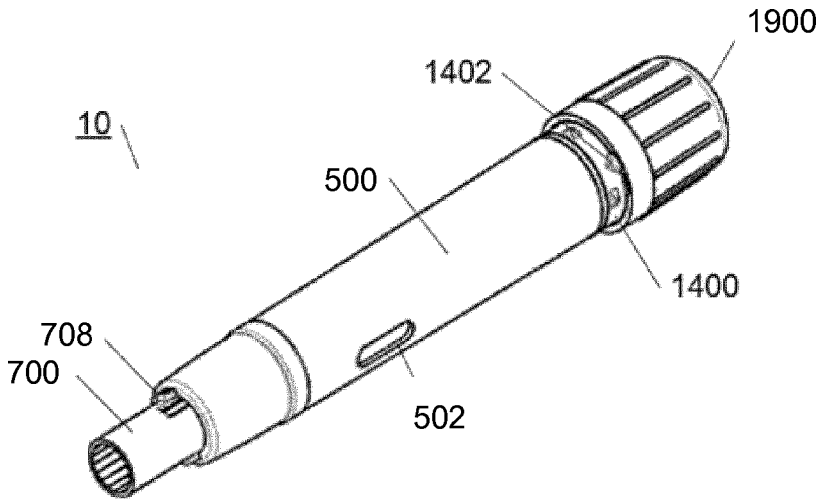

Fig. 2G

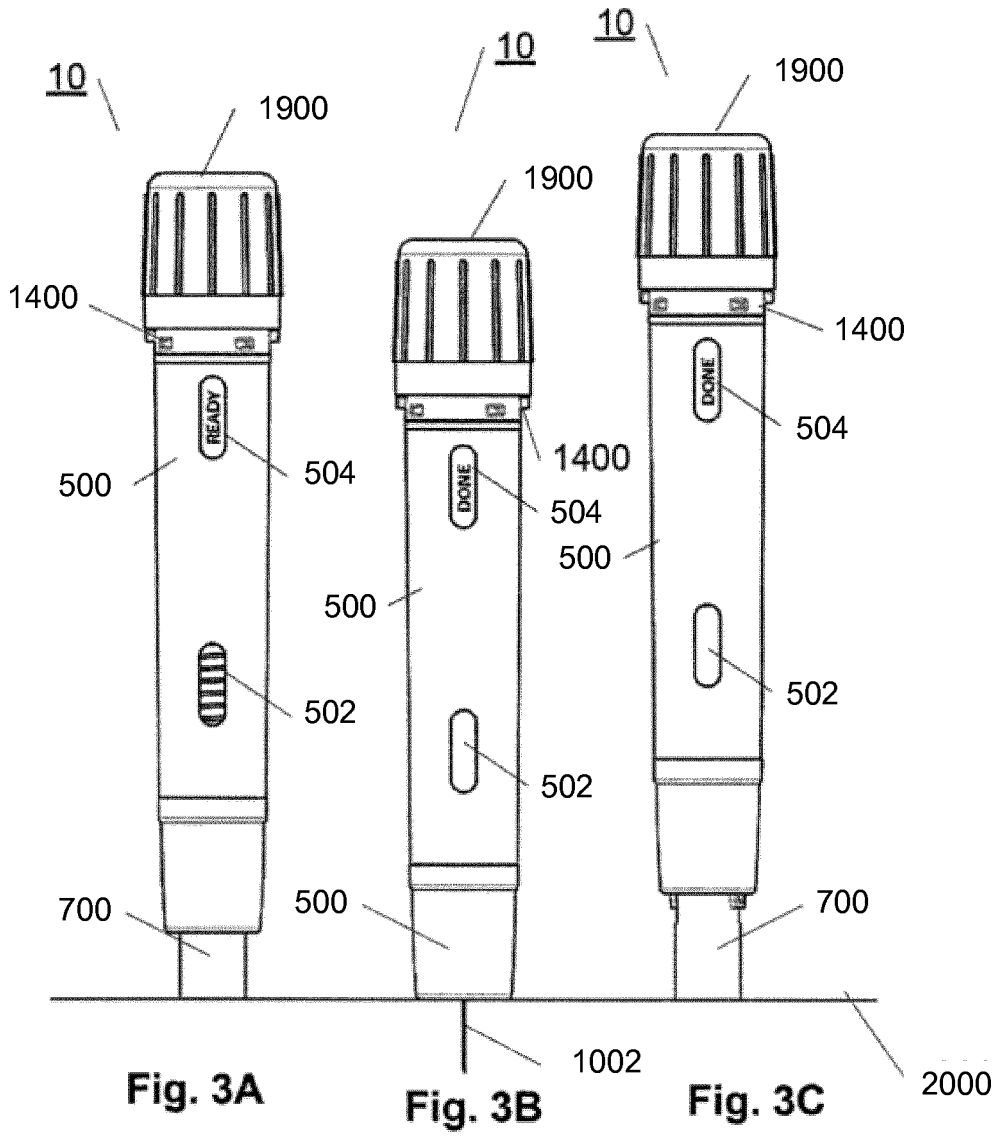

Fig. 3A Fig. 3B Fig. 3C

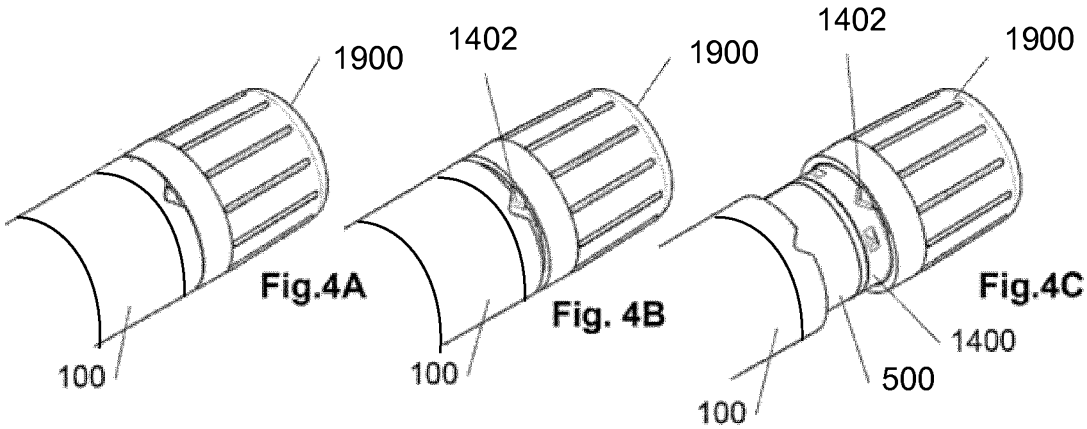

Fig.4A Fig. 4B Fig.4C

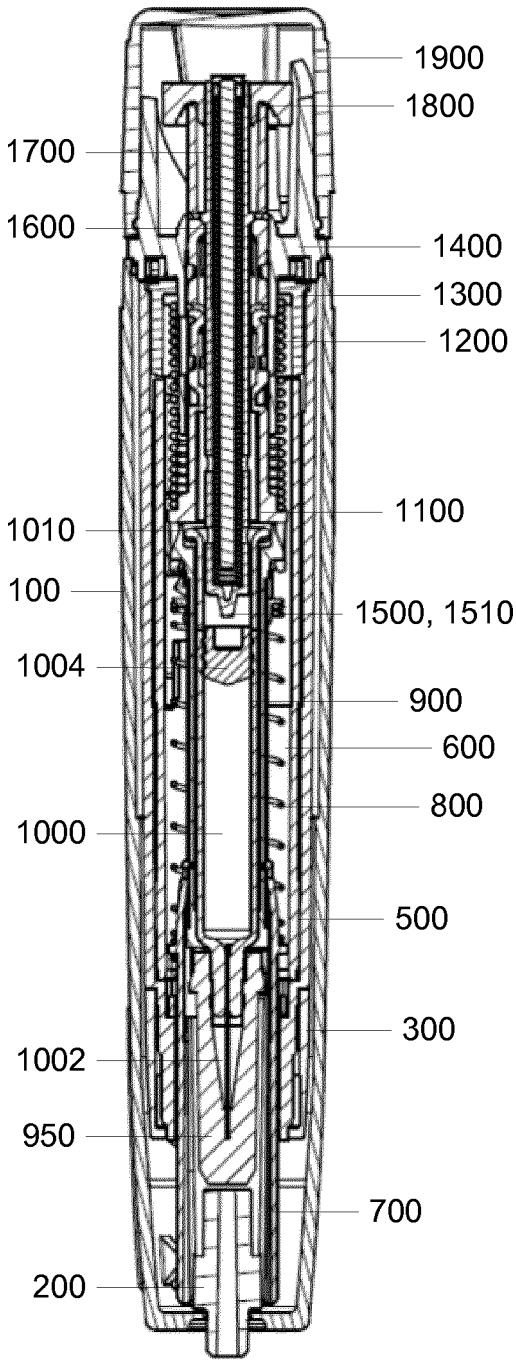

Fig. 5A

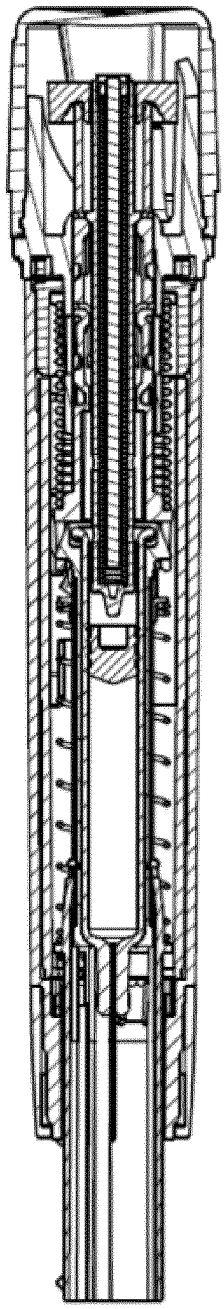

Fig. 5B

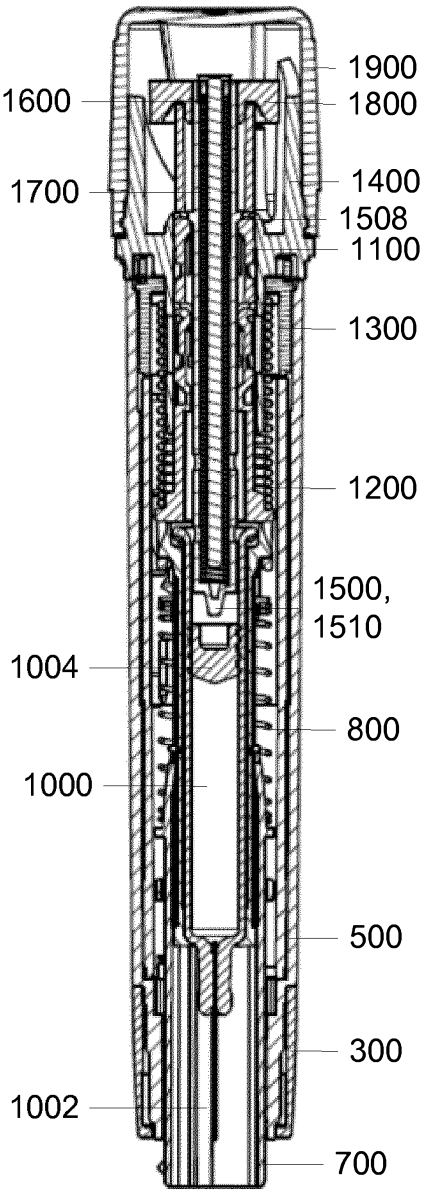

Fig. 5C

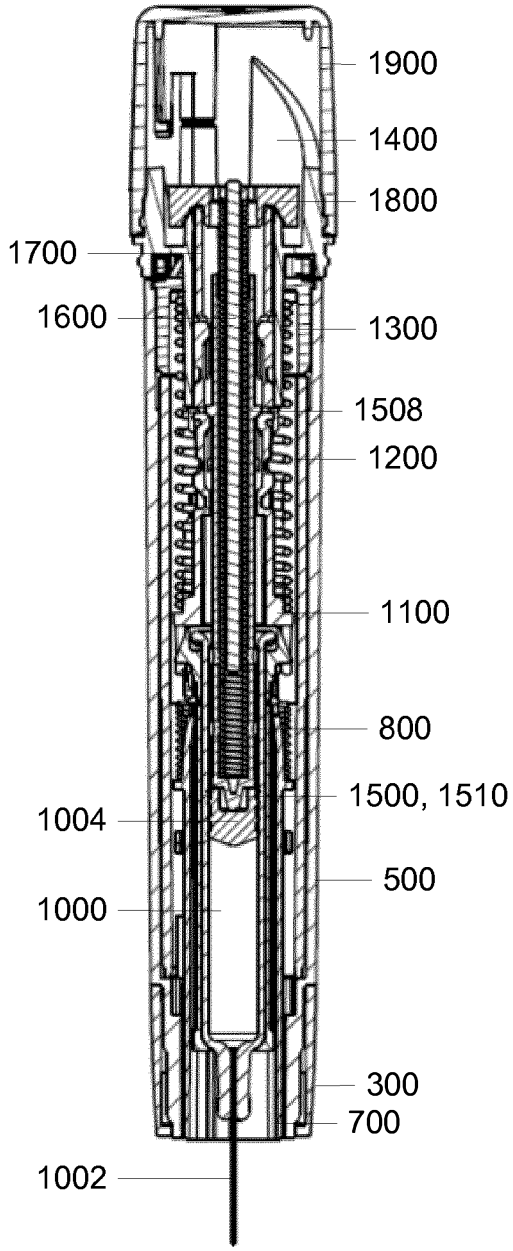
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Fig. 5D

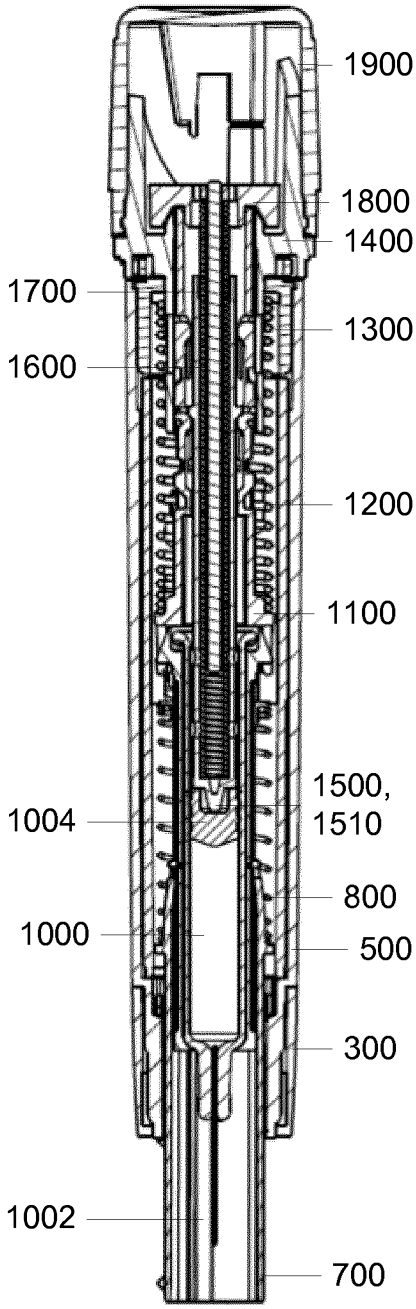
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Fig. 5E

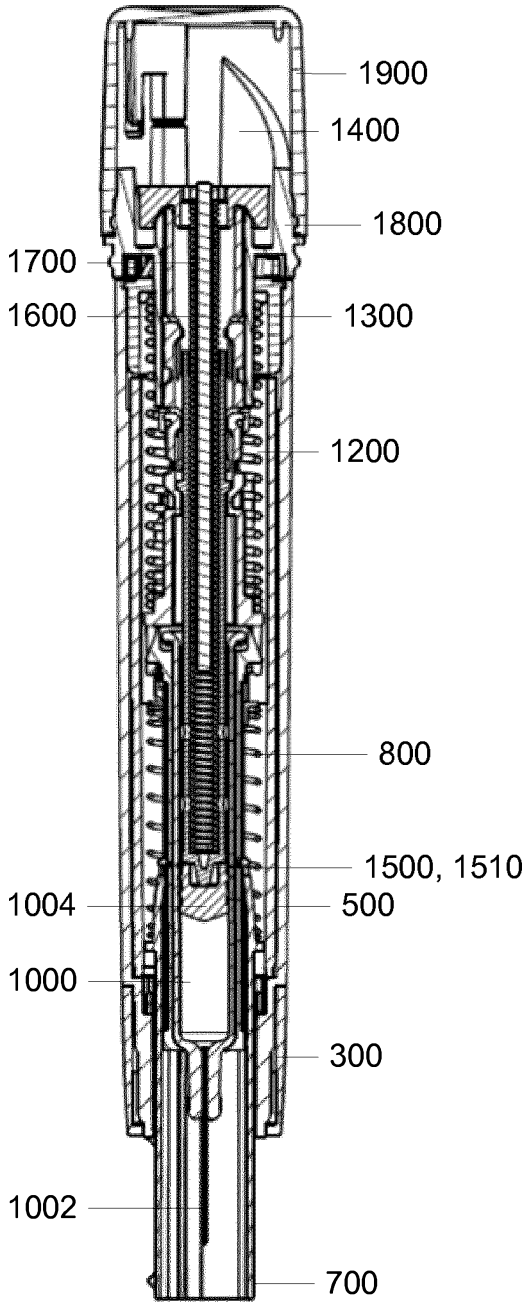
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Fig. 5F

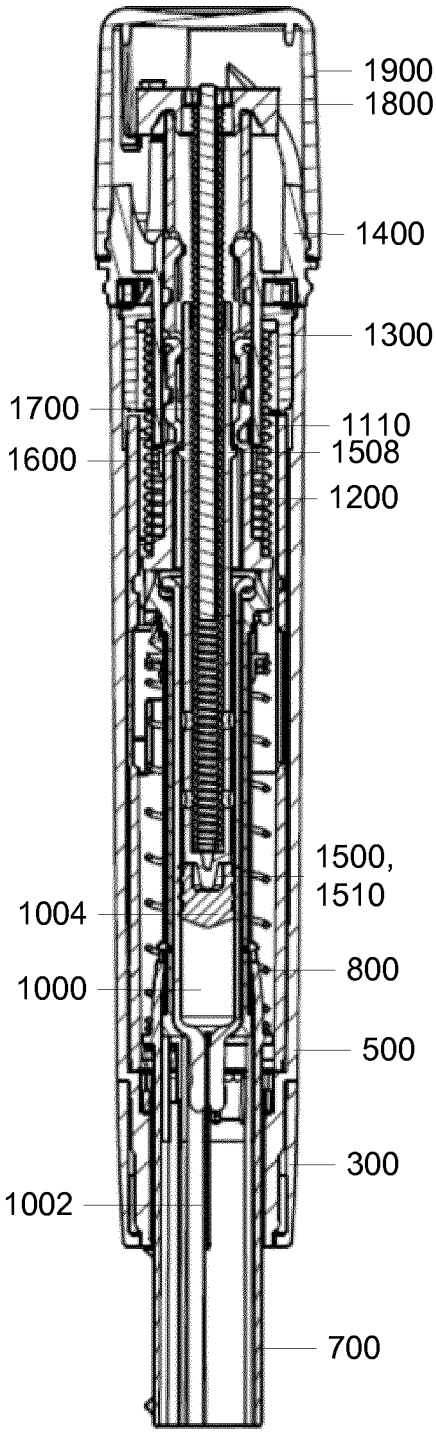
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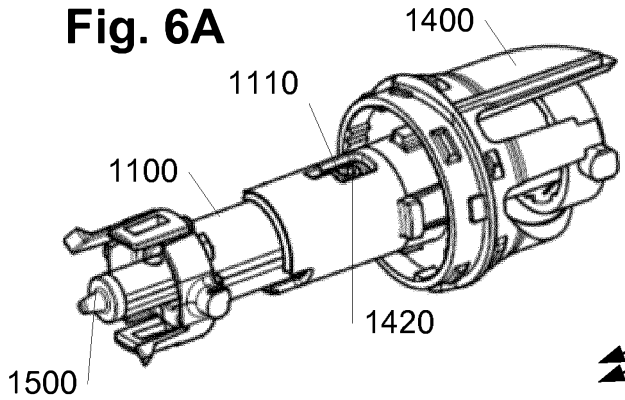
Fig. 5G

Fig. 6A



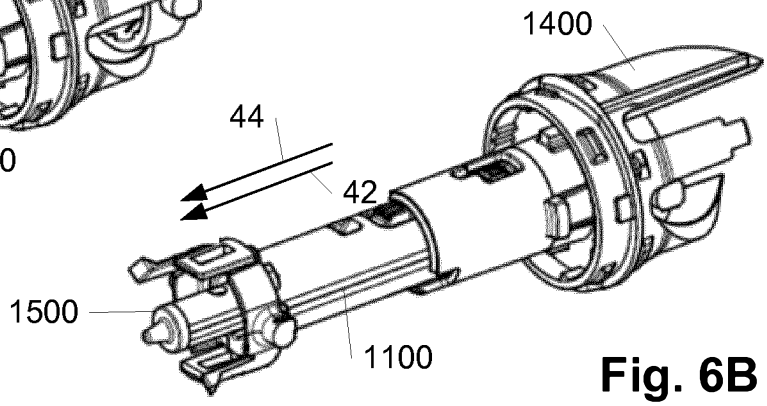
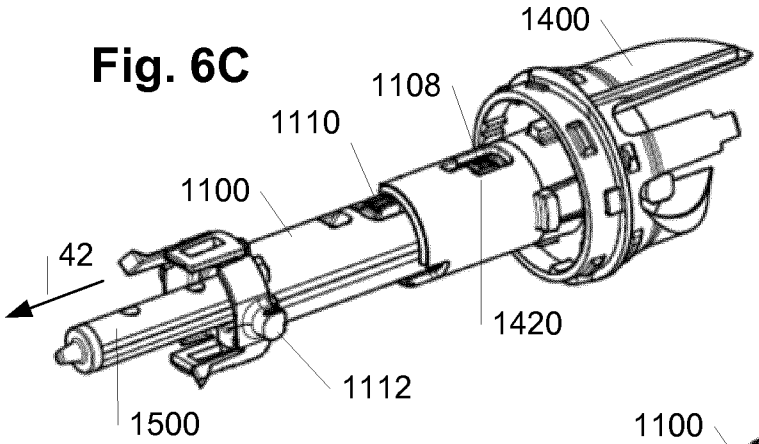


Fig. 6B

Fig. 6C



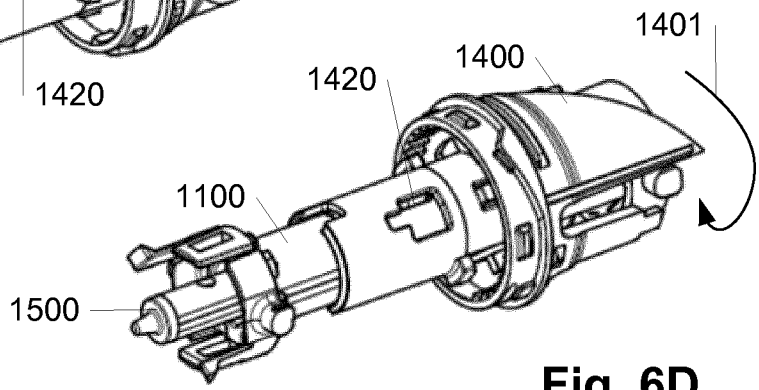
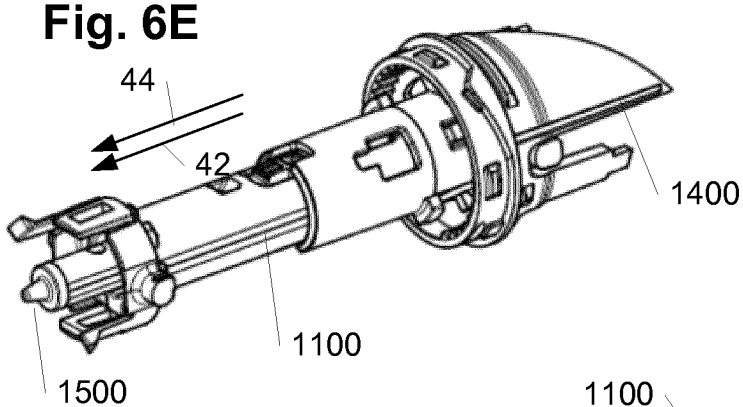


Fig. 6D

Fig. 6E



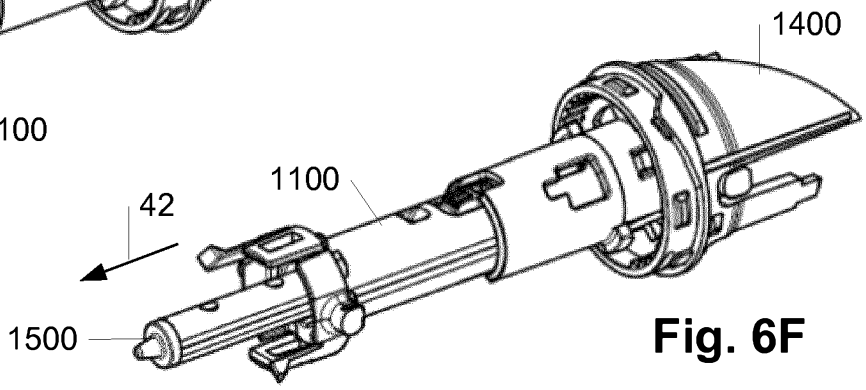


Fig. 6F

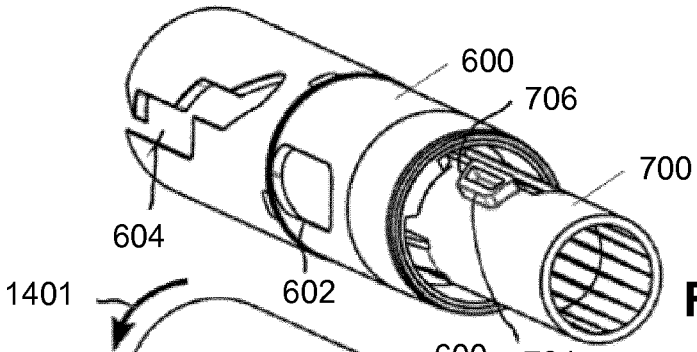


Fig. 7A

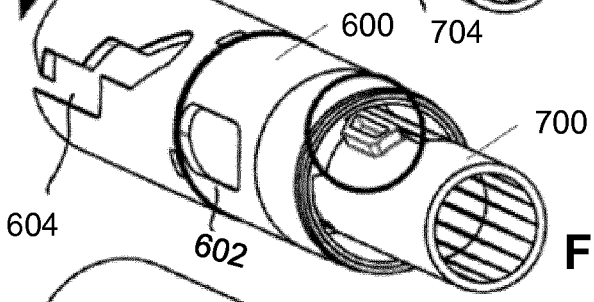


Fig. 7B

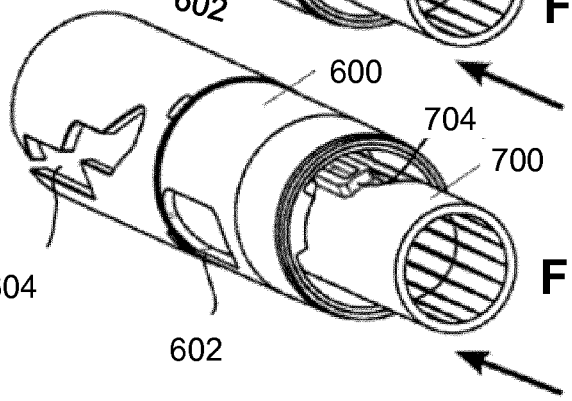


Fig. 7C

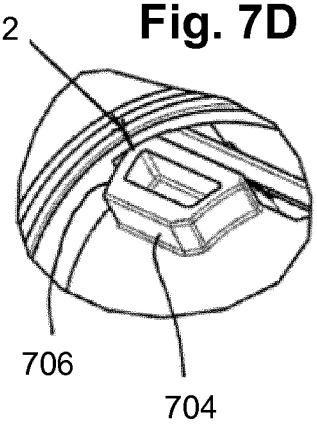


Fig. 7D

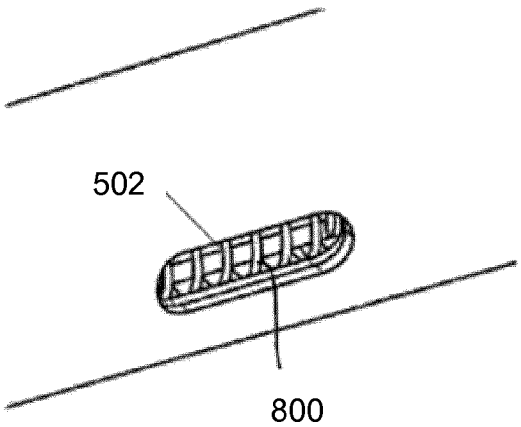


Fig. 8A

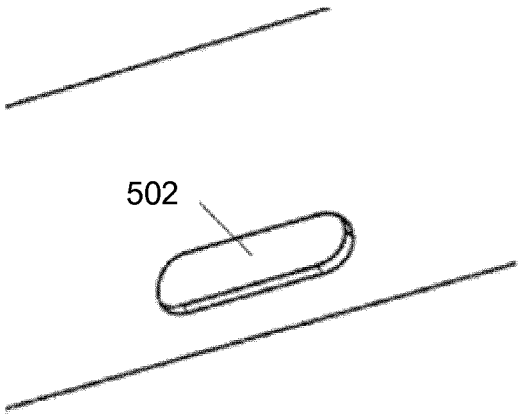


Fig. 8C

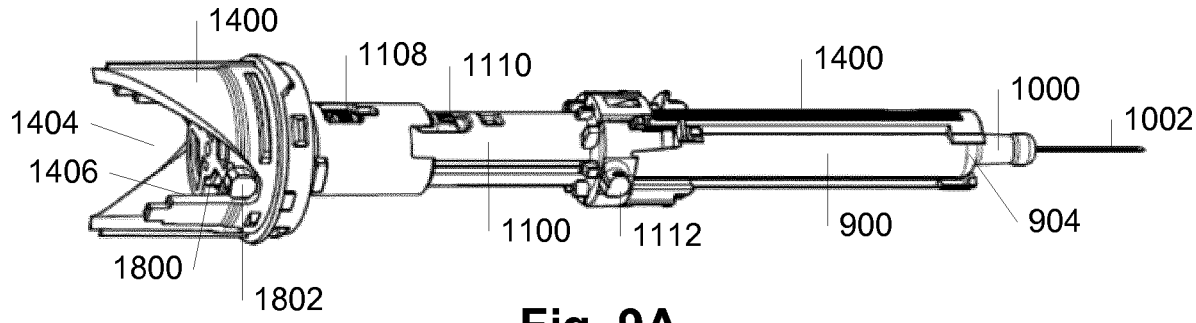


Fig. 9A

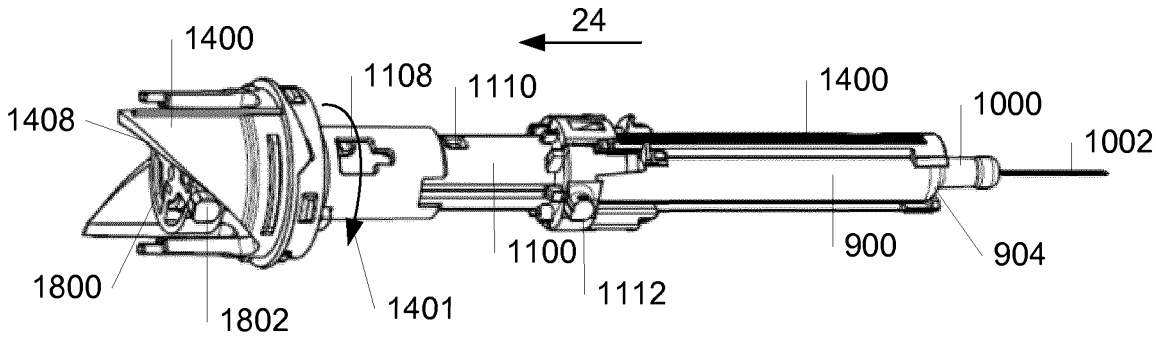


Fig. 9B

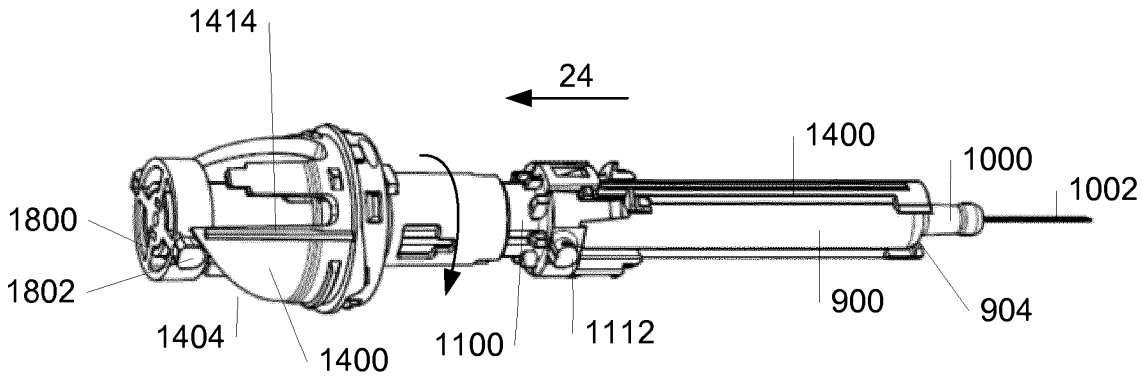


Fig. 9C

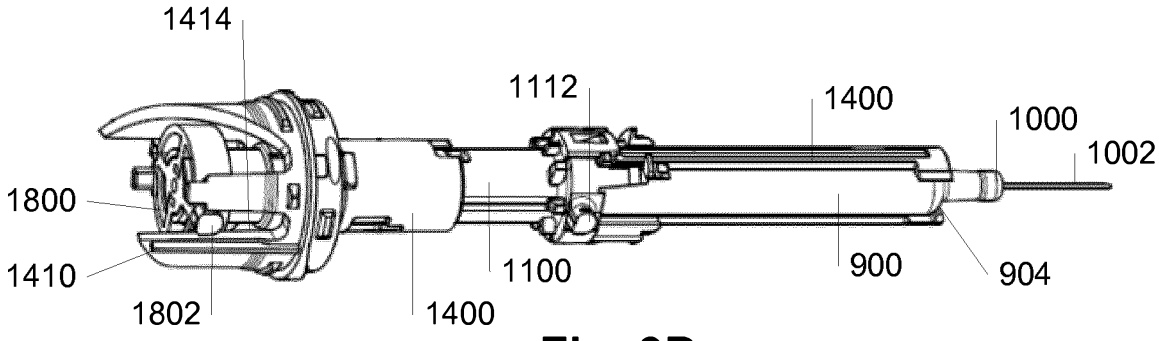
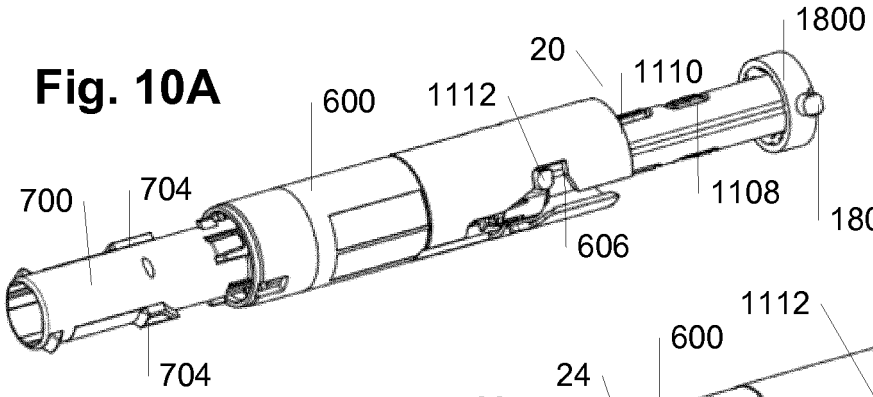


Fig. 9D

Fig. 10A



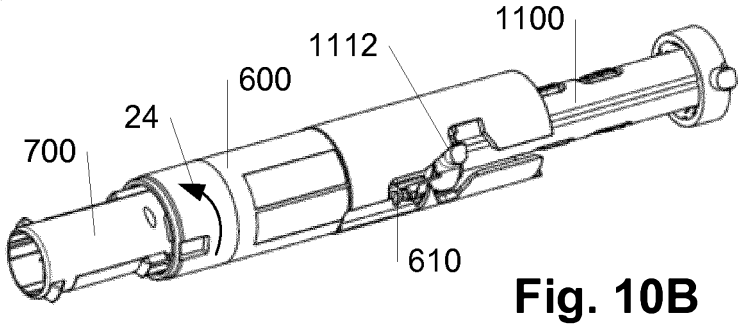
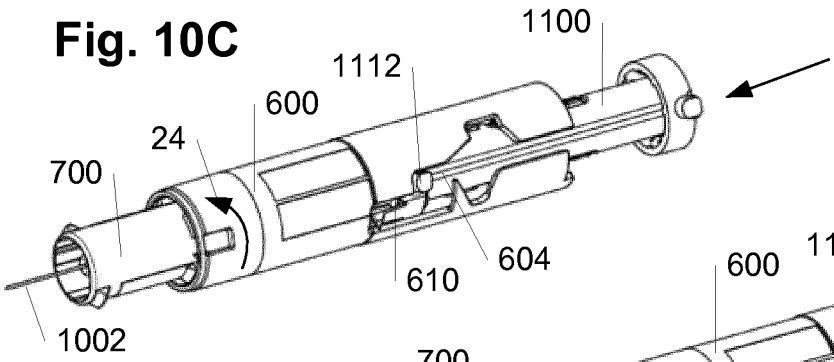


Fig. 10B

Fig. 10C



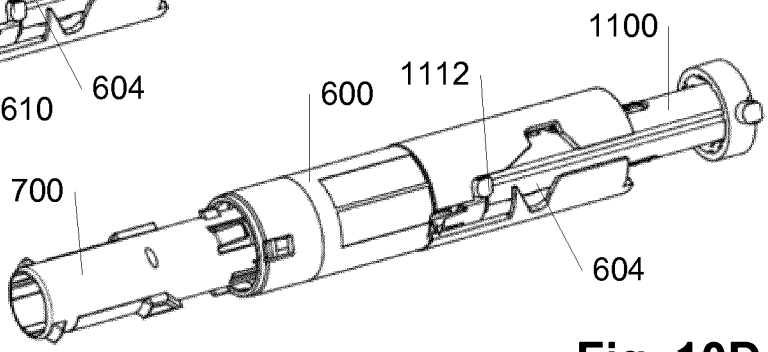
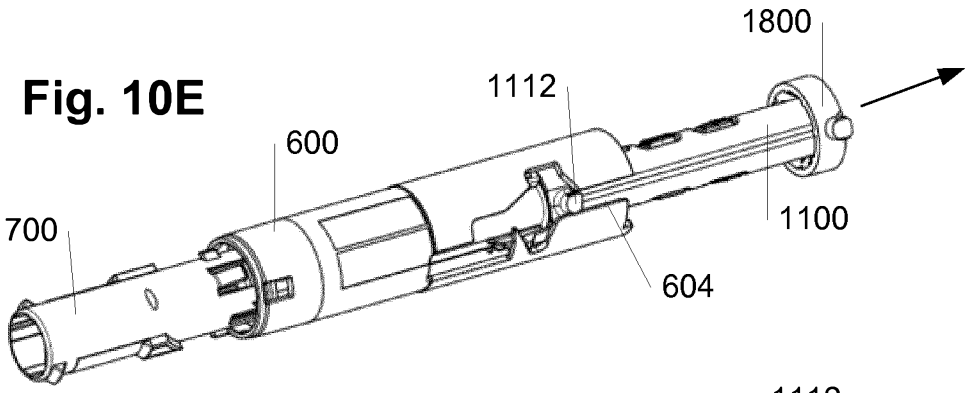


Fig. 10D

Fig. 10E



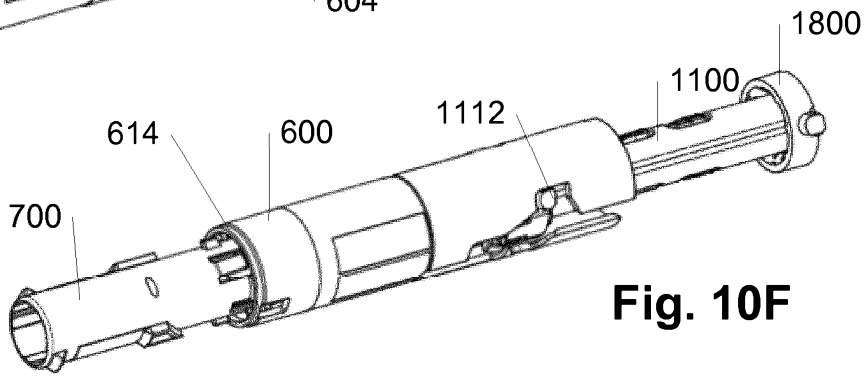


Fig. 10F

Fig. 11A

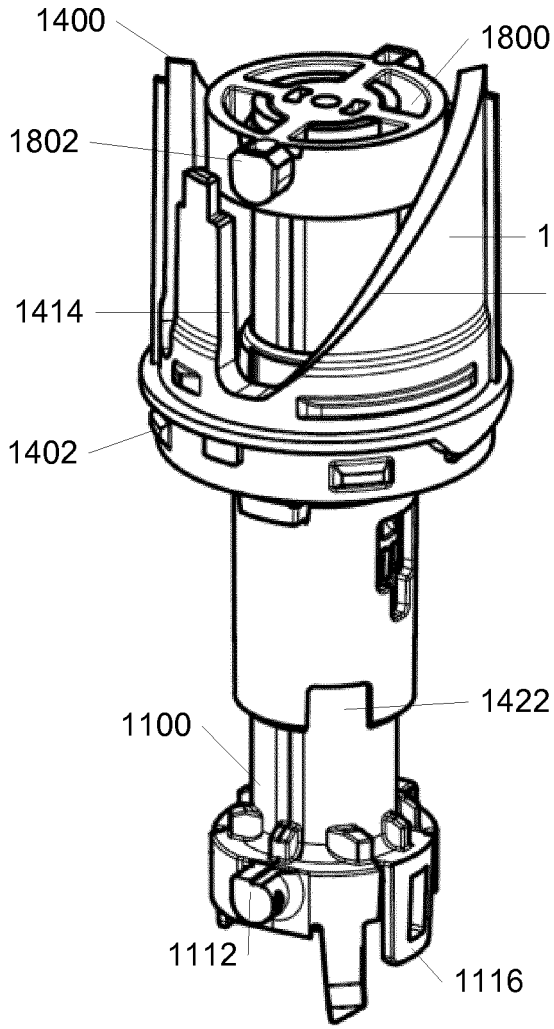
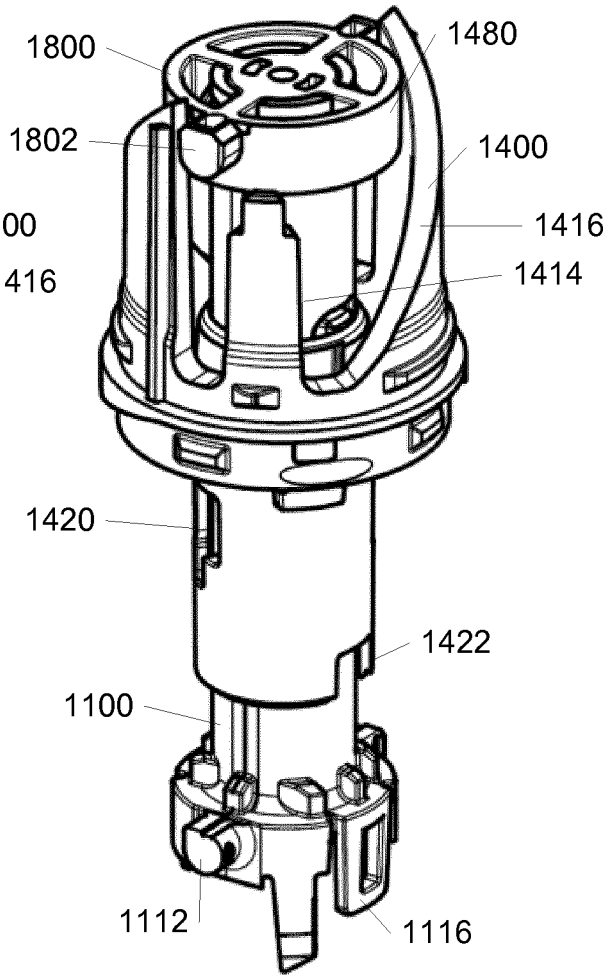


Fig. 11B



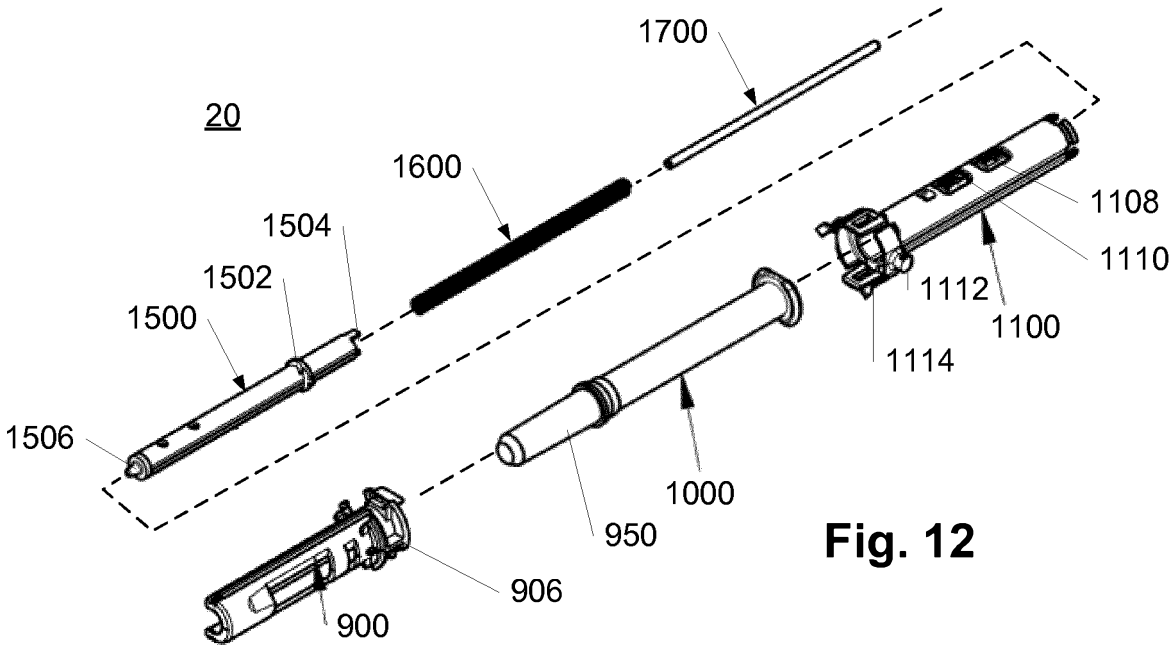


Fig. 12

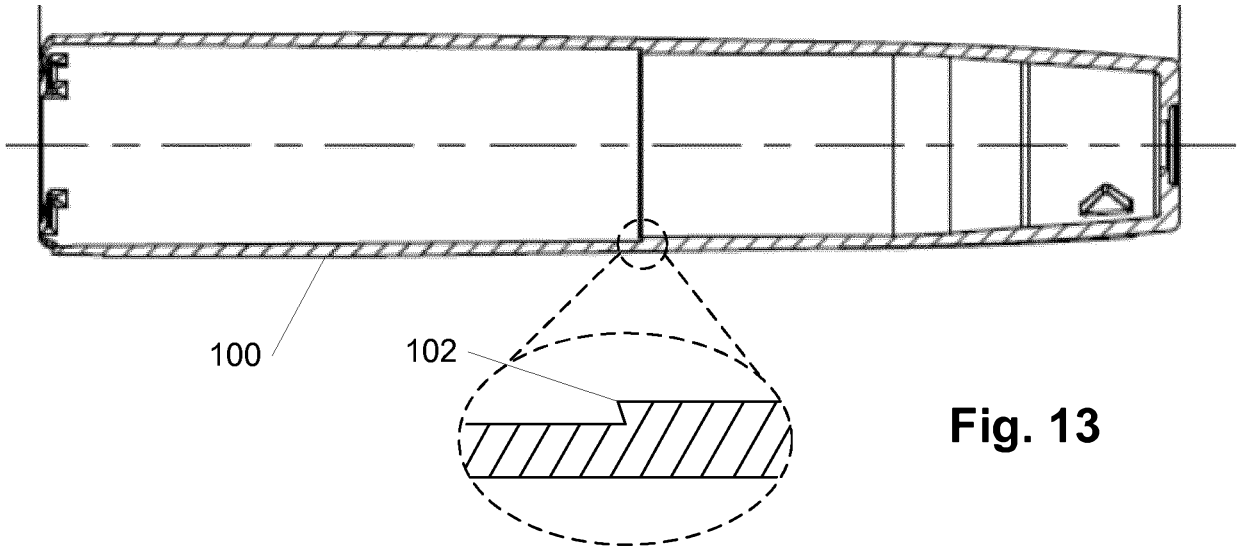


Fig. 13

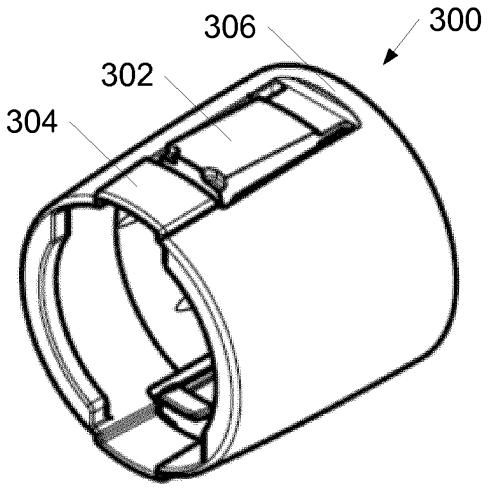


Fig. 14A

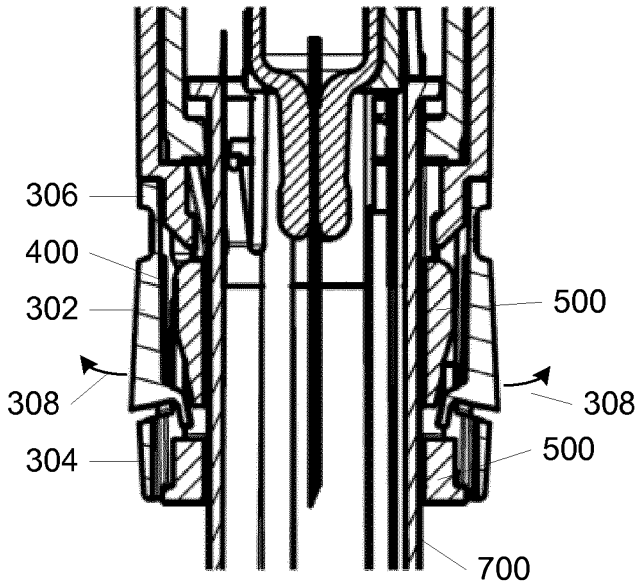


Fig. 15

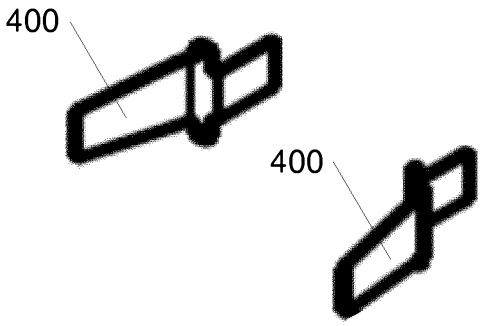


Fig. 14B

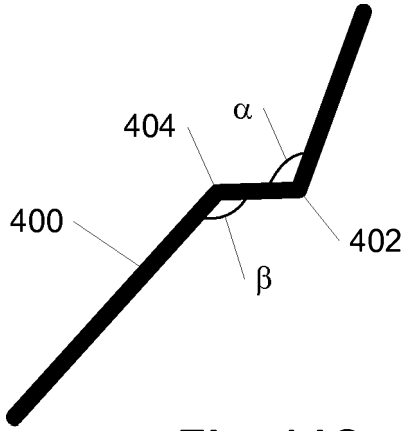


Fig. 14C