

DRUG DELIVERY DEVICE HAVING A REAR CAP FOR INCREASED DROP ROBUSTNESS**CROSS-REFERENCE TO RELATED APPLICATION**

[0001] The present application claims priority to U.S. Provisional Patent Application No. 63/584,978, filed September 25, 2023, the entire contents of which are hereby incorporated by reference herein.

FIELD OF DISCLOSURE

[0002] The present disclosure generally relates to drug delivery devices and, more particularly, devices for automatically injecting a drug into a patient that have rear caps configured to increase drop robustness.

BACKGROUND

[0003] A general aversion to exposed needles, as well as health and safety issues, have led to the development of drug delivery devices, such as injectors and autoinjectors, which conceal a needle or other insertion member prior to use and which automate or semi-automate various aspects of an injection process. Such devices offer a variety of benefits as compared with traditional forms of drug delivery including, for example, delivery via a conventional syringe.

[0004] A drug delivery device may incorporate various mechanisms to implement various automated or semi-automated features. Such features may include automatically covering a needle in a pre-delivery and/or post-delivery state, automatically activating a drive mechanism, automatically indicating to the user that drug delivery is complete, among other features. Certain such features are activated by the application of an external force, for example, by a user. Such features may be prone to premature or inadvertent activation in cases where the drug delivery device subjected to a sudden unintended force or motion during manufacture, transport, storage, and/or other handling of the device.

[0005] For example, a drug delivery device may experience a substantial impact force if it is dropped from a height and strikes a stationary surface such as the ground. The impact force has the potential to prematurely activate the automated or semi-automated features, cause displacement of one or more components of the drug delivery device, and/or cause structural damage to the drug delivery device. The likelihood of such problems is increased if the drug delivery device has recently been removed from cold storage, which is required for drug delivery devices containing certain drugs. In a cold state, various components of the drug delivery device may be relatively brittle and thus vulnerable to fracture or damage as the result of a sudden impact. Accordingly, there is a need for an improved drug delivery device that increases drop robustness and reduces the likelihood of inadvertent activation, displacement of components, and structural damage when the drug delivery device experiences an impact force from a drop.

[0006] The present disclosure sets forth drug delivery devices embodying advantageous alternatives to existing drug delivery devices, and device housing features, and that may address one or more of the challenges or needs mentioned herein.

SUMMARY

[0007] One aspect of the present disclosure provides a drug delivery device comprising a housing, a drug storage container, a plunger, a releaser member, and a rear cap. The housing may define a longitudinal axis and have an opening at a distal end thereof. The drug storage container may include a barrel, a stopper, and a delivery member. The stopper may be movably positioned within the barrel, and the delivery member may be positioned at a distal end of the barrel and may have an insertion end configured to extend at least partially through the opening during a delivery state. The plunger may be movable toward the distal end of the drug storage container to engage the stopper and expel a drug from the drug storage container through the delivery member. The releaser member may have a first position wherein the releaser member prevents the plunger from moving into the delivery state and a second position wherein the releaser member does not prevent the plunger from moving into the delivery state. The rear cap is coupled to the housing at a proximal end thereof, and the rear cap is asymmetric relative to the longitudinal axis of the housing to translate a portion of an impact force on the rear cap to a rotational acceleration of the drug delivery device.

[0008] In some embodiments, the housing may include a tubular housing, and the rear cap may be at least partially defined by an annular side wall and a top surface. In some embodiment, at least the portion of the top surface of the rear cap may be generally slanted at a predefined angle from a lateral axis perpendicular to the longitudinal axis. In some embodiments, the predefined angle may be between about 5° and about 30° from the lateral axis. In other embodiments, the predefined angle may be between about 10° and about 25° from the lateral axis. In some embodiments, at least the portion of the top surface may be a linear surface. In other embodiments, at least the portion of the top surface may be a concave surface. In yet another embodiment, at least the portion of the top surface may be a convex surface. In some embodiments, the rear cap may include a chamfer connecting the annular side wall and the top surface. In some embodiments, the portion of the top surface that is generally slanted at the predefined angle may define a first portion of the top surface, and the top surface may further include a second portion defined by a flat surface that is parallel to the lateral axis.

[0009] In some embodiments, the top surface of the rear cap may be a linear surface. In other embodiments, the top surface of the rear cap may be a convex surface. In some embodiments, the rear cap may include a protrusion on the top surface, and the protrusion may be offset from the longitudinal axis. The protrusion may project generally away from the top surface of the rear cap along the longitudinal axis.

[0010] In some embodiments, the drug delivery device may further comprise a plunger guide configured to operatively couple the housing and the rear cap. In some embodiments, the

plunger may be configured to rotate while translating toward the distal end of the drug storage container.

[0011] In some embodiments, the tubular housing may define a generally cylindrical shape. In other embodiments, the tubular housing may define a non-cylindrical shape, and an outer diameter of the tubular housing may vary along the longitudinal axis. In some embodiments, the housing and the rear cap may be defined by a single, monolithic structure. In some embodiments, the drug delivery device may be an autoinjector.

[0012] Another aspect of the present disclosure provides a drug delivery device comprising a housing, a drug storage container, a plunger, a releaser member, and a rear cap. The housing may define a longitudinal axis and have an opening at a distal end thereof. The drug storage container may include a barrel, a stopper, and a delivery member. The stopper may be movably positioned within the barrel, and the delivery member may be positioned at a distal end of the barrel and may have an insertion end configured to extend at least partially through the opening during a delivery state. The plunger may be movable toward the distal end of the drug storage container to engage the stopper and expel a drug from the drug storage container through the delivery member. The releaser member may have a first position wherein the releaser member prevents the plunger from moving into the delivery state and a second position wherein the releaser member does not prevent the plunger from moving into the delivery state. The rear cap is coupled to the housing at a proximal end thereof, and the rear cap is asymmetric relative to the longitudinal axis of the housing to promote or cause rotation of the drug delivery device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] It is believed that the disclosure will be more fully understood from the following description taken in conjunction with the accompanying drawings. Some of the drawings may have been simplified by the omission of selected elements for the purpose of more clearly showing other elements. Such omissions of elements in some drawings are not necessarily indicative of the presence or absence of particular elements in any of the exemplary embodiments, except as may be explicitly delineated in the corresponding written description. Also, none of the drawings is necessarily to scale.

[0014] Fig. 1A illustrates a perspective view of a drug delivery device.

[0015] Fig. 1B illustrates a perspective view of the drug delivery device of Fig. 1A, with a needle cap removed therefrom.

[0016] Fig. 2 illustrates cross-sectional view of the drug delivery device of Figs. 1A and 1B.

[0017] Fig. 3 illustrates contact points and centers of gravity of a drug delivery device with a dome-shaped rear cap and an exemplary drug delivery device with an asymmetric rear cap, in accordance with various embodiments of the present disclosure.

[0018] Fig. 4A illustrates a perspective view of an exemplary drug delivery device with an exemplary rear cap, in accordance with various embodiments of the present disclosure.

[0019] Fig. 4B illustrates a right side view of the exemplary drug delivery device of Fig. 4A, in accordance with various embodiments of the present disclosure.

[0020] Fig. 4C illustrates a perspective view of the exemplary rear cap of Figs. 4A and 4B, in accordance with various embodiments of the present disclosure.

[0021] Fig. 5A illustrates a perspective view of an exemplary drug delivery device with another exemplary rear cap, in accordance with various embodiments of the present disclosure.

[0022] Fig. 5B illustrates a right side view of the exemplary drug delivery device of Fig. 5A, in accordance with various embodiments of the present disclosure.

[0023] Fig. 5C illustrates a perspective view of the exemplary rear cap of Figs. 5A and 5B, in accordance with various embodiments of the present disclosure.

[0024] Fig. 6A illustrates a perspective view of an exemplary drug delivery device with another exemplary rear cap, in accordance with various embodiments of the present disclosure.

[0025] Fig. 6B illustrates a right side view of the exemplary drug delivery device of Fig. 6A, in accordance with various embodiments of the present disclosure.

[0026] Fig. 6C illustrates a perspective view of the exemplary rear cap of Figs. 6A and 6B, in accordance with various embodiments of the present disclosure.

[0027] Fig. 7A illustrates a perspective view of an exemplary drug delivery device with another exemplary rear cap, in accordance with various embodiments of the present disclosure.

[0028] Fig. 7B illustrates a right side view of the exemplary drug delivery device of Fig. 7A, in accordance with various embodiments of the present disclosure.

[0029] Fig. 7C illustrates a perspective view of the exemplary rear cap of Figs. 7A and 7B, in accordance with various embodiments of the present disclosure.

[0030] Fig. 8A illustrates a perspective view of an exemplary drug delivery device with another exemplary rear cap, in accordance with various embodiments of the present disclosure.

[0031] Fig. 8B illustrates a right side view of the exemplary drug delivery device of Fig. 8A, in accordance with various embodiments of the present disclosure.

[0032] Fig. 8C illustrates a perspective view of the exemplary rear cap of Figs. 8A and 8B, in accordance with various embodiments of the present disclosure.

[0033] Fig. 9A illustrates a perspective view of an exemplary drug delivery device with another exemplary rear cap, in accordance with various embodiments of the present disclosure.

[0034] Fig. 9B illustrates a right side view of the exemplary drug delivery device of Fig. 9A, in accordance with various embodiments of the present disclosure.

[0035] Fig. 9C illustrates a perspective view of the exemplary rear cap of Figs. 9A and 9B, in accordance with various embodiments of the present disclosure.

[0036] Fig. 10 illustrates a graph of changes in relative displacement between a releaser member and a guard extension over time after vertical drop impact, in accordance with various embodiments of the present disclosure.

[0037] Fig. 11 illustrates a front view of an exemplary drug delivery device with another exemplary rear cap, in accordance with various embodiments of the present disclosure.

[0038] Fig. 12 illustrates a front view of an exemplary drug delivery device with another exemplary rear cap, in accordance with various embodiments of the present disclosure.

DETAILED DESCRIPTION

[0039] The present disclosure generally relates to drug delivery devices operable by a user for administering a drug, or in the case where a patient is the user, self-administering a drug. Various features are disclosed such as an asymmetric rear cap for transforming linear velocity of the drug delivery device after a vertical drop into rotation of the device. The asymmetric rear cap is configured to create a distance between a contact point of the rear cap as a result of a drop and a center of gravity (also referred to as “center of axis”) of the device so as to translate some of the linear velocity to rotational acceleration of the device. These features and others work together and/or interact with one another to reduce any displacement of one or more components in the drug delivery device after a drop impact and, thus, increase robustness of the drug delivery device. These and other advantages will be apparent to one of ordinary skill in the art reviewing the present disclosure. As used herein, the term “rear cap” is used interchangeably with a “rear end cap.”

[0040] The presently disclosed rear cap may translate linear momentum and impact force from a drop of the drug delivery device into rotation acceleration, thereby causing the device to rotate. In addition, the presently disclosed rear cap creates a distance between a point of contact on the rear cap when the device is dropped and a center of gravity of the device. Accordingly, these features of the presently disclosed rear cap may prevent or inhibit the activation of one or more automated or semi-automated features included in the drug delivery device including, for example, a drive mechanism for expelling a drug, a releaser, among others. In addition, these features of the presently disclosed rear cap may prevent or inhibit damage to the drug delivery device that may otherwise result from the externally applied force as a result of the drop. For example, the rear cap may diminish the likelihood of fractures or cracks forming in the cap and/or other portions of the drug delivery device if a user accidentally drops the drug delivery device. Additionally, these features of the presently disclosed rear cap may reduce displacement of one or more components of the drug delivery device as a result of the externally applied force. These and other advantages will be apparent to one of ordinary skill in the art reviewing the present disclosure.

[0041] Figs. 1A-1B and 2 illustrate several views of a drug delivery device 10 for delivering a drug, which may also be referred to herein as a medicament or drug product. The drug may be, but is not limited to, various biologicals such as peptides, peptibodies, or antibodies. The drug may be in a fluid or liquid form, although the disclosure is not limited to a particular state.

[0042] Various implementations and configurations of the drug delivery device 10 are possible. The drug delivery device 10 may be configured as a single-use, disposable injector.

In other embodiments, the drug delivery device 10 may be configured as multiple-use reusable injector. The drug delivery device 10 may be operable for self-administration by a patient or for administration by caregiver or a formally trained healthcare provider (e.g., a doctor or nurse). The drug delivery device 10 may take the form of an autoinjector or pen-type injector, and, as such, may be held in the hand of the user over the duration of drug delivery.

[0043] The configuration of various components included in the drug delivery device 10 may depend on the operational state of the drug delivery device 10. The drug delivery device 10 may have a pre-injection or storage state, an injection or dosing state, and a post-injection state, although fewer or more states are also possible. The pre-injection state may correspond to the configuration of the drug delivery device 10 subsequent to assembly and prior to activation by the user. In some embodiments, the pre-injection state may exist in the time between when the drug delivery device 10 leaves a manufacturing facility and when a patient or user activates a drive mechanism 30 of the drug delivery device 10. This includes the moments in time after the user has removed the drug delivery device 10 from any secondary packaging and prior to positioning the drug delivery device 10 against the injection site. The injection state may correspond to the configuration of the drug delivery device 10 while drug delivery, also referred to herein as dosing, is in progress. The post-injection state may correspond to the configuration of the drug delivery device 10 after drug delivery is complete and/or when a stopper is arranged in an end-of-dose position in a drug storage container.

[0044] As shown in Figs. 1A and 1B, the drug delivery device 10 includes an outer casing or housing 12. In some embodiments, the housing 12 may be sized and dimensioned to enable a person to grasp the injector 10 in a single hand. The housing 12 may have a generally elongate, tubular shape, such as a cylindrical shape, and extend along a longitudinal axis A between a proximal end and a distal end of the housing 12. In some embodiments, the housing 12 may have a generally elongate, non-tubular shape, such as a rectangular shape, triangular shape, or other non-cylindrical geometrical shapes. An opening 14 (Fig. 2) may be formed in the distal end to permit an insertion end 28 of a delivery member 16 (Fig. 2) to extend outside of the housing 12. A transparent or semi-transparent inspection window 17 (Figs. 1A and 1B) may be positioned in a wall of the housing 12 to permit a user to view component(s) inside the drug delivery device 10, including a drug storage container 20. Viewing the drug storage container 20 through the window 17 may allow a user to confirm that drug delivery is in progress and/or complete. A removable cap 19 may cover the opening 14 prior to use of the drug delivery device 10, and, in some embodiments, may include a gripper 13 (Fig. 2) configured to assist with removing a sterile barrier 21 (e.g., a rigid needle shield (RNS), a non-rigid needle shield (nRNS), etc.) mounted on the insertion end 28 of the delivery member 16. The gripper 13 may include one or more inwardly protruding barbs or arms that frictionally or otherwise mechanically engage the sterile barrier 21 to pull the sterile barrier 21 with the removable cap 19 when the

user separates the removable cap 19 from the housing 12. Thus, removing the removable cap 19 has the effect of removing the sterile barrier 21 from the delivery member 16.

[0045] As shown in Fig. 2, the drive mechanism 30 may be disposed partially or entirely within the housing 12. Generally, the drive mechanism 30 may be configured to store energy and, upon or in response to activation of the drive mechanism 30 by the user, release or output that energy to drive the plunger 26 to expel the drug 22 from the drug storage container 20 through the delivery member 16 into the patient. In the present embodiment, the drive mechanism 30 is configured to store mechanical potential energy; however, alternative embodiments of the drive mechanism 30 may be configured differently, for example, with the drive mechanism 30 storing electrical or chemical potential energy. Generally, upon activation of the drive mechanism 30, the drive mechanism 30 may convert the potential energy into kinetic energy for moving the plunger 26. The drive mechanism 30 may include a plunger biasing member 50, a hollow rod 46 for supporting the plunger biasing member 50, a plunger biasing member seat 38, the releaser member 52, a plunger guide 60, an extender biasing member 35, and a guard extension 37. The plunger biasing member 50 may include a spring, such as a compression spring (e.g., a helical compression spring) which is initially retained in an energized state. In the energized state, the plunger biasing member 50 may be compressed such that its axial length is shorter than it would be in a natural or de-energized state. When released, the plunger biasing member 50 may try to expand to its natural axial length, and as a consequence, exert a biasing force pushing the plunger 26 in the distal direction. In other embodiments, the plunger biasing member 50 may include a torsion spring, which is initially retained in an energized state. When released, the plunger biasing member 50 may rotate, and as a consequence, cause the plunger 26 to rotate while translating in the distal direction.

[0046] As shown in Fig. 2, the drug delivery device 10 may include a housing 12, which may include two separate and interconnected structures: a rear end cap 23 (e.g., a rear cap) at the proximal end of the drug delivery device 10 and a tubular housing 25 extending substantially completely along the length of the drug delivery device 10 and defining the opening 14. Additionally or alternatively, the housing 12 may include fewer or more components. The tubular housing 25 may have a hollow and generally cylindrical or tubular shape, and the rear end cap 23 may have a generally hemispherical shape or a hollow cylindrical shape with an open end and a closed off end. In some embodiments, the housing 25 and/or the rear end cap 23 may have a non-cylindrical shape, such as a rectangular shape, triangular shape, or other non-cylindrical geometrical shapes. In some embodiments, the rear end cap 23 and the tubular housing 25, and any components to be positioned therein, may be assembled together to define different sub-assemblies, such as the drive mechanism 30. In some embodiments, the different sub-assemblies are assembled independently of each other and then later combined with one another, as well as with the drug storage container 20, to form the fully-assembled drug delivery device 10. In certain such embodiments, some or all of the foregoing phases of assembly may

occur in different manufacturing facilities or environments. In alternative embodiments, the housing 12 may be constructed in one piece, such that the housing 12 is defined by a single, monolithic structure that integrates a rear cap 23 and tubular housing 25 in a single component.

[0047] The drug storage container 20 is disposed within an interior space of the housing 12 and is configured to contain a drug 22. The drug storage container 20 may be pre-filled and shipped, e.g., by a manufacturer, to a location where the drug storage container 20 is combined with a remainder of the drug delivery device 10. For example, the drug 22 may be distributed and/or provided to patients in more than one use case, such as a as a pre-filled syringe or as an autoinjector including a pre-filled syringe. By utilizing the same or similar syringe components in either case, at least some of above steps such as filling, labeling, packaging, shipping, and distribution may be streamlined or simplified for two different use cases. As another example, in the event that multiple use cases utilize some or all of the same syringe components, some regulatory pathways to marketing and/or distributing the drug may be streamlined and/or simplified for at least one of the multiple use cases.

[0048] The housing 12 may be pre-loaded with the drug storage container 20, e.g., by a manufacturer, or alternatively, loaded with the drug storage container 20 by a user prior to use of the drug delivery device 10. The drug storage container 20 may include a rigid wall defining an internal bore or reservoir. The wall may be made of glass or plastic. A stopper 24 may be moveably disposed in the drug storage container 20 such that it can move in a distal direction along the longitudinal axis A between proximal end and a distal end of the drug storage container 20. The stopper 24 may be constructed of rubber or any other suitable material. The stopper 24 may slidably and sealingly contact an interior surface 15 of the wall of the drug storage container 20 such that the drug 22 is prevented or inhibited from leaking past the stopper 24 when the stopper 24 is in motion. Distal movement of the stopper 24 expels the drug 22 from the reservoir of the drug storage container 20 into the delivery member 16. The proximal end of the drug storage container 20 may be open to allow a plunger 26 to extend into the drug storage container 20 and push the stopper 24 in the distal direction. In the present embodiment, the plunger 26 and the stopper 24 are initially spaced from each other by a gap 18 (Fig. 2). Upon activation of a drive mechanism 30, the plunger 26 moves in the distal direction to close the gap and comes into contact with the stopper 24. Subsequent distal movement of the plunger 26 drives the stopper 24 in the distal direction to expel the drug 22 from the drug storage container 20. In alternative embodiments, the stopper 24 and the plunger 26 may initially be in contact with one another or coupled to one another, e.g., via a threaded coupling, such that they move together jointly from the start of movement of the plunger 26. Once the stopper 24 is in motion, it may continue to move in the distal direction until it contacts a proximally-facing portion of the interior surface 15 of the wall of the drug storage container 20. This position of the stopper 24 may be referred to as the end-of-dose or end-of-delivery position,

and may correspond to when delivery of the drug 22 to the patient is complete or substantially complete.

[0049] In some embodiments, a volume of the drug 22 included in the reservoir of the drug storage container 20 may be equal to 1 mL, or equal to approximately (e.g., $\pm 10\%$) 1 mL, or equal to 2.5 mL, or equal to approximately (e.g., $\pm 10\%$) 2.5 mL, or equal to 3 mL, or equal to approximately (e.g., $\pm 10\%$) 3 mL, or less than or equal to approximately (e.g., $\pm 10\%$) 1 mL, or less than or equal to approximately (e.g., $\pm 10\%$) 2 mL, or less than or equal to approximately (e.g., $\pm 10\%$) 3 mL, or less than or equal to approximately (e.g., $\pm 10\%$) 4 mL, or less than approximately (e.g., $\pm 10\%$) 5 mL, or less than or equal to approximately (e.g., $\pm 10\%$) 10 mL, or within a range between approximately (e.g., $\pm 10\%$) 1 – 10 mL, or within a range between approximately (e.g., $\pm 10\%$) 1 – 5 mL, or within a range between approximately (e.g., $\pm 10\%$) 1 – 4 mL, or within a range between approximately (e.g., $\pm 10\%$) 1 – 3 mL, or within a range between approximately (e.g., $\pm 10\%$) 1 - 2.5 mL.

[0050] The delivery member 16 is connected or operable to be connected in fluid communication with the reservoir of the drug storage container 20. A distal end of the delivery member 16 may define the insertion end 28 of the delivery member 16. The insertion end 28 may include a sharpened tip of other pointed geometry allowing the insertion end 28 to pierce the patient's skin and subcutaneous tissue during insertion of the delivery member 16. The delivery member 16 may be hollow and have an interior passageway. One or more openings may be formed in the insertion end 28 to allow drug to flow out of the delivery member 16 into the patient.

[0051] In one embodiment, the drug storage container 20 may be a pre-filled syringe and has a staked, hollow metal needle for the delivery member 16. Here, the needle is fixed relative to the wall of the drug storage container 20 and may be in permanent fluid communication with the reservoir of the drug storage container 20. In other embodiments, the needle may be coupled to the drug storage container 20 via a Luer Lock or other suitable connection. In yet other embodiments, the drug storage container 20 may be a needle-less cartridge, and, as such, initially may not be in fluid communication with the delivery member 16. In such embodiments, the drug storage container 20 may move toward a proximal end of the delivery member 16, or vice versa, during operation of the drug delivery device 10 such that the proximal end of the delivery member 16 penetrates through a septum covering an opening in the drug storage container 20 thereby establishing fluid communication between the reservoir of the drug storage container 20 and the delivery member 16.

[0052] The drug storage container 20 may include a body portion 20g with a distal end 20e and a proximal end 20f. The drug storage container 20 may be fixed relative to the housing 12 such that the drug storage container 20 does not move relative to the housing 12 once installed in the housing 12. As such, the insertion end 28 of the delivery member 16 extends permanently through the opening 14 in the housing 12 in the pre-injection, injection, and post-

injection states. For example, as shown in Fig. 2, the delivery member 16 extends beyond a distal end of the housing 12 that defines the opening 14. However, in some configurations, such as the storage configuration shown in Fig. 2, the delivery member 16 is covered / protected by the sterile barrier 21 and a guard member 32 that surrounds the delivery member 16 and protects against or reduces the likelihood of unintended or premature needle stick, as will be discussed in more detail below. The term "body portion" of the drug storage container 20 as used herein is the generally cylindrical portion of the drug storage container 20.

[0053] As shown in Fig. 2, the plunger biasing member 50 may be disposed at least partially within the plunger 26, and may have a distal end abutting against a proximally facing inner surface of the plunger 26 and/or may be fixedly attached to an inner surface of the plunger 26. So that the plunger biasing member 50 may be received within the plunger 26, an outer diameter or other dimension of the plunger biasing member 50 may be equal to or less than an inner diameter of the top ring 45 and/or equal to or less than an inner diameter of the hollow rod 46. In some embodiments, the distal end of the plunger biasing member 50 may abut against a proximally facing inner surface of the base 47 of the plunger 26. Furthermore, a proximal end of the plunger biasing member 50 may abut against a distally facing surface 38a of the plunger biasing member seat 38. The plunger biasing member seat 38 may be fixedly attached to the rear housing 27 such that the plunger biasing member seat 38 provides a stationary surface for the plunger biasing member 50 to push off of. So configured, the plunger biasing member 50, when released from the energized state, may expand in length with distal end of the plunger biasing member 50 moving in the distal direction away from the stationary proximal end of the plunger biasing member 50. This motion may push the plunger 26 in the distal direction, which, in turn, may push the stopper 24 in the distal direction to expel the drug 22 from the drug storage container 20 into the delivery member 16 and thereafter into the patient.

[0054] The plunger guide 60 may be fixedly attached to the rear housing 27 such that the plunger guide 60 is immovable relative to the rear housing 27. The plunger guide 60 may have a hollow and generally cylindrical or tubular shape, and may be centered about the longitudinal axis A. An outer diameter or other outer dimension of a proximal end of the plunger guide 60 may be larger than an outer diameter or other outer dimension of a distal end of the plunger guide 60. At least a portion of the distal end of the plunger guide 60 may be positioned radially between the plunger 26 and the releaser member 52. As such, the plunger 26 may be disposed at least partially within the distal end of the plunger guide 60, and the distal end of the plunger guide 60 may be disposed at least partially within the releaser member 52, as illustrated in Fig. 2.

[0055] The releaser member 52 may have a hollow and generally cylindrical or tubular shape, and may be centered about the longitudinal axis A. As illustrated in Fig. 2, the releaser member 52 may be positioned in the radial direction between the distal end of the plunger guide 60 and a proximal end of the guard extension 37. Furthermore, the releaser member 52 may be arranged

radially inwardly of the guard biasing member 35. Generally, the releaser member 52 is configured to operably couple the guard member 32 and the plunger 26 in an activation sequence and to generate an audible signal indicating the end of drug delivery.

[0056] The releaser member 52 may be configured to rotate relative to the housing 12 and/or translate linearly relative to the housing 12, depending on the stage of operation of the drug delivery device 10. Initial rotation of the releaser member 52 associated with activation may be powered by the plunger biasing member 50 and/or the guard biasing member 35; whereas later rotation of the releaser member 52 associated with generation of the end-of-dose signal may be powered solely by the guard biasing member 35. Any linear translation of the releaser member 52 without rotation may be powered solely by the guard biasing member 35. In some embodiments, the releaser member 52 may translate linearly only in the proximal direction; however, alternative embodiments may permit linear translation of the releaser member 52 in both the proximal and distal directions.

[0057] As discussed above, the drug delivery device 10 may further include a guard mechanism for preventing contact with the insertion end 28 of the delivery member 16 when the drug delivery device 10 is not being used to administer an injection. The guard mechanism may include a guard member 32 moveably disposed at the distal end of the housing 12 adjacent to the opening 14. The guard member 32 may have a hollow and generally cylindrical or tubular shape centered about the longitudinal axis A. The guard member 32 may generally include a cylindrical portion 32a, a distal end 32c, and a proximal end 32d. The cylindrical portion 32a may be at least partially and/or selectively received within the housing 12. For example, the guard member 32 may be configured to move relative to the housing 12 such that portions of the guard member 32 are received within the housing 12 in some stages / states and are extending from the housing 12 in other stages / states.

[0058] The guard member 32 may be configured to move relative to the housing 12 between an extended position wherein at least a portion of the cylindrical portion 32a of the guard member 32 extends through the opening 14 in the housing 12 and a retracted position wherein a shorter length of the cylindrical portion 32a or no part of the cylindrical portion 32a extends through the opening 14 in the housing 12.

[0059] During operation of the device, a user may cause the guard member 32 to translate (with respect to the housing 12) in the proximal direction by pressing the guard member 32 against the injection site. In doing so, the guard member 32 will move towards the guard extension 37 and close the gap 37g therebetween (Fig. 2). Once the gap 37g is eliminated, the guard member 32 and the guard extension 37 move jointly in the proximal direction until, for example, the guard member 32 reaches the retracted position. When the injection is complete and the drug delivery device 10 is lifted off of the injection site, the extender biasing member 35 may urge the guard extension 37 so that the guard extension 37 and the guard member 32 move jointly in the distal direction. This motion (and/or a biasing force from lock ring biasing

member 51) returns the guard member 32 to the extended position, which has the effect of covering the insertion end 28 of the delivery member 16.

[0060] As shown in Fig. 2, the drug delivery device 10 may include a rear end cap 23 (e.g., a rear cap) at the proximal end of the drug delivery device 10. The rear end cap 23 may be centered about the longitudinal axis A and dome-shaped such that the rear end cap 23 is symmetrical relative to the longitudinal axis A. However, such dome-shaped rear caps, like the rear end cap 23 of the drug delivery device 10, may not be sufficiently robust and, when dropped from a vertical height, the dome-shaped rear caps may cause the force of impact to be transferred to various components within the device 10. Accordingly, when dropped, the drug delivery device 10 with the dome-shaped rear end cap 23 may be prone to component damage and/or inadvertent activation of the device 10. As an example, dropping the drug delivery device 10 with the longitudinal axis A parallel or substantially parallel to the direction of gravity and with the rear cap 23 facing generally downwards may, due to the deceleration associated with the drug delivery device 10 striking the ground, cause the releaser member 52 to move proximally (towards the rear cap 23, in the upward direction in Fig. 2) and/or cause the guard member 32 to retract into the housing 12. Either or both of these exemplary movements may potentially trigger the drive mechanism 30, thereby causing an unintended and/or premature injection. Additionally or alternatively, the deceleration may cause the lock ring 40 to rotate or otherwise move to a position where it prevents subsequent retraction of the guard member 32. This, in turn, may prematurely lockout of the guard member 32, thereby preventing a user from using the drug delivery device 10 to perform an injection.

[0061] As a more specific example of potentially undesirable consequences of dropping the drug delivery device 10, if the device 10 is dropped with the rear cap 23 facing downwards, most or all of the components of the device 10 are traveling and accelerating at roughly the same rate, but when the rear cap 23 impacts the ground or other surface then the housing 12 will decelerate before or at a faster than other internal components, such as the releaser member 52 and/or the guard member 32. In other words, upon impact, the housing will abruptly stop falling and have a relatively large deceleration while some of the other internal components are still traveling and/or accelerating towards the ground. As a result of the relatively large difference between the deceleration of the housing and the acceleration of other internal components ("acceleration delta"), upon impact or momentarily thereafter, the releaser member 52 and/or the guard member 32 may move proximally (towards the rear cap 23, in the upward direction in Fig. 2) within the housing 12, thereby potentially triggering the injection sequence. Therefore, it may be advantageous to provide a rear cap that provides increased drop robustness such that, in the event that the drug delivery device 10 is accidentally dropped from a height such that the rear cap contacts the ground with substantial velocity, the rear cap may prevent or inhibit the activation of one or more features within the device 10 and/or prevent or inhibit damage to one or more components of the device 10.

[0062] In one embodiment, it may be advantageous to provide a rear end cap that is asymmetrical relative to the longitudinal axis A. For example, Fig. 3 illustrates the difference between the drug delivery device 10 with a dome-shaped rear cap 23 and a drug delivery device 100 with a rear cap 123 that is asymmetrical relative to the longitudinal axis A, in accordance with various embodiments of the present disclosure. As discussed above with reference to Figs. 1A-1B and 2, the drug delivery device 10 includes the housing 12, the rear cap 23 disposed at a proximal end of the housing 12, and the removable cap 19 disposed at a distal end of the housing 12. The drug delivery device 100, in accordance with various embodiments of the present disclosure, includes a housing 112, a rear cap 123 disposed at a proximal end 112e of the housing 112, and a removable cap 119 disposed at a distal end 112f of the housing 112.

[0063] As shown in Fig. 3, when the drug delivery device 10 is inadvertently dropped from a height such that the rear cap 23 contacts the ground 70 at point P1 with substantial velocity, the contact point P1 is directly aligned with the center of gravity C1 of the drug delivery device 10. Accordingly, the force of the impact from hitting the ground 70 travels directly through the center of gravity C1 of the drug delivery device 10. On the other hand, when the drug delivery device 100 with an asymmetrical rear cap 123 is inadvertently dropped from a height such that the rear cap 123 contacts the ground 70 at point P2 with substantial velocity, the contact point P2 is moved out towards the outer diameter of the device 100, compared to the contact point P1 of device 10. Accordingly, the impact force travels towards the outer diameter of the drug delivery device 100 and does not travel directly through the center of gravity C2 of the device 100. Additionally, some of the impact force is translated to a rotational acceleration or torque T of the drug delivery device 100, causing the drug delivery device 100 to rotate after striking the ground 70.

[0064] A test was conducted to determine whether the asymmetrical rear cap 123 of the drug delivery device 100 would reduce the likelihood of damage and/or inadvertent activation of one or more components of the drug delivery device 100, compared to the dome-shaped rear cap 23 of the drug delivery device 10. Regarding the test set-up, a drop tester was used to evaluate the device's ability to withstand the force of impact. Five drug delivery devices 10 and five drug delivery devices 100 were each dropped on granite plane drop surface at drop heights 1.3 m, 1.45 m, 1.6 m, and 1.75 m (the drop tester's maximum height was 1.75 m). Based on the results of the drop test, dome-shaped rear caps, like rear cap 23 of drug delivery device 10, failed even at low heights of 1.3 m, whereas angled or asymmetrical rear caps, like rear cap 123, could withstand repeated drops at all heights (i.e., 1.3 m, 1.45 m, 1.6 m, and 1.75 m).

[0065] Turning now to Figs. 4A-4C, the drug delivery device 100 with the asymmetrical rear cap 123 will be described in more detail. The drug delivery device 100 may comprise the same components that make up the drug delivery device 10 that are discussed above with respect to Figs. 1A-1B and 2. By way of example, the drug delivery device 100 may comprise the drive

mechanism 30, the drug storage container 20, the delivery member 16, the releaser member 52, and other components discussed above with respect to the drug delivery device 10.

[0066] As illustrated in Figs. 4A-4C, the drug delivery device 100 includes an outer casing or housing 112. Like the housing 12, the housing 112 may have a generally elongate shape, such as a cylindrical shape, and extend along a longitudinal axis A between a proximal end 112e and a distal end 112f. In some embodiments, the housing 112 may have a generally elongate, non-tubular shape, such as a rectangular shape, triangular shape, or other non-cylindrical geometrical shapes. In other embodiments, the housing 112 may be a tubular housing and may have a generally elongate shape that extends along a longitudinal axis A between a proximal end 112e and a distal end 112f, but the tubular housing may define a non-cylindrical shape. That is, in some embodiments, an outer diameter of the tubular housing may vary along the longitudinal axis A. A transparent or semi-transparent inspection window 117 may be positioned in a wall of the housing 112 to permit a user to view component(s) inside the drug delivery device 100, including a drug storage container 120 (similar to the drug storage container 20). Although not shown, a removable cap like the removable cap 19 may cover the needle shield 132 prior to use of the drug delivery device 100. As discussed above, the drug delivery device 100 may also comprise a rear end cap 123 (also referred to as "rear cap") at the proximal end 112e of the drug delivery device 100. The rear cap 123 may have a hollow cylindrical shape with an open end and a closed off end. The rear cap 123 may be assembled together with the housing 112 to define the drug delivery device 100. In some embodiments, the rear cap 123 may be removably coupled to the housing 112 at a proximal end 112e of the housing 112. In other embodiments, the rear cap 123 and the housing 112 may be formed integrally to define a single, monolithic structure.

[0067] The rear cap 123 may be defined by a generally annular or cylindrical side wall 125 and a top surface 124 (also referred to as "top wall"). In some embodiments, the rear cap 123 may further include a chamfer 126 connecting the annular side wall 125 and the top surface 124. In other embodiments, the rear cap 123 may include a rounded edge connecting the annular side wall 125 and the top surface 124. Unlike the rear cap 23, the rear cap 123 may be asymmetric relative to the longitudinal axis A (shown in Fig. 4B) of the housing 112 such that at least a portion of the top surface 124 of the rear cap 123 is generally slanted, ramped, or inclined. For example, the top surface 124 may be generally slanted at a predefined angle "a" from a lateral axis B (shown in Fig. 4B) that is perpendicular to the longitudinal axis A. The predefined angle "a" may be between about 5° and about 50° from the lateral axis B. In some embodiments, the predefined angle "a" may be between about 5° and about 30° from the lateral axis B. In other embodiments, the predefined angle "a" may be between about 10° and about 25° from the lateral axis B. In addition, at least a portion of the top surface 124 of the rear cap 123 may be a non-linear surface. For example, as shown in Figs. 4A-4C, the top surface 124 may be a convex surface.

[0068] The asymmetric, generally slanted shape and the angle of the top surface 124 of the rear cap 123 may be configured to allow the rear cap 123 to translate at least a portion of an impact force on the rear cap 123 to a rotational velocity or acceleration of the drug delivery device 100. As a more specific example, if the device 100 is dropped from a height, the generally slanted shape and angle of the top surface 124 of the rear cap 123 may be configured to translate at least a portion of the impact energy to a rotational acceleration or torque of the device 100 and cause the device 100 to rotate to its side after initially striking the ground 70. As such, at least some of the impact force may be distributed towards the outer diameter of the drug delivery device 100 such that not all of the impact force travels directly through the center of gravity C2 (shown in Fig. 3) of the device 100. Accordingly, even when the drug delivery device 100 is accidentally dropped, the asymmetric rear cap 123 may prevent or inhibit inadvertent activation of one or more components, such as the drive mechanism 30, within the device 100, reduce relative displacement between one or more components within the device 100, and prevent or inhibit structural damage to the device 100. Moreover, the generally convex shape of the top surface 124 may increase the user's comfort while the user is holding the device 100 during the injection.

[0069] Figs. 5A-5C illustrate another exemplary drug delivery device 200 with another asymmetric rear cap 223, in accordance with various embodiments of the present disclosure. The drug delivery device 200 includes an outer casing or housing 212. The housing 212 may have a generally elongate shape, such as a cylindrical shape, and extend along a longitudinal axis A between a proximal end 212e and a distal end 212f. In some embodiments, the housing 212 may have a generally elongate, non-tubular shape, such as a rectangular shape, triangular shape, or other non-cylindrical geometrical shapes. In other embodiments, the housing 212 may be a tubular housing and may have a generally elongate shape that extends along a longitudinal axis A between a proximal end 212e and a distal end 212f, but the tubular housing may define a non-cylindrical shape. That is, in some embodiments, an outer diameter of the tubular housing may vary along the longitudinal axis A. A transparent or semi-transparent inspection window 217 may be positioned in a wall of the housing 212 to permit a user to view component(s) inside the drug delivery device 200, including a drug storage container 220 (similar to the drug storage container 20). Although not shown, a removable cap like the removable cap 19 may cover the needle shield 232 prior to use of the drug delivery device 200. As discussed above, the drug delivery device 200 may also comprise a rear end cap 223 (also referred to as "rear cap") at the proximal end 212e of the drug delivery device 200. The rear cap 223 may have a hollow cylindrical shape with an open end and a closed off end. The rear cap 223 may be assembled together with the housing 212 to define the drug delivery device 200. In some embodiments, the rear cap 223 may be removably coupled to the housing 212 at a proximal end 212e of the housing 212. In other embodiments, the rear cap 223 and the housing 212 may be formed integrally to define a single, monolithic structure.

[0070] The rear cap 223 may be defined by a generally annular or cylindrical side wall 225 and a top surface 224 (also referred to as “top wall”). In some embodiments, the rear cap 223 may further include rounded edges 226 connecting the annular side wall 225 and the top surface 224. In other embodiments, the rear cap 223 may further include a chamfer, similar to chamfer 126, connecting the annular side wall 225 and the top surface 224. The rear cap 223 may be asymmetric relative to the longitudinal axis A (shown in Fig. 5B) of the housing 212 such that at least a portion of the top surface 224 of the rear cap 223 is generally slanted, ramped, or inclined. For example, the top surface 224 may be generally slanted at a predefined angle “a” from a lateral axis B (shown in Fig. 5B) that is perpendicular to the longitudinal axis A. The predefined angle “a” may be between about 5° and about 50° from the lateral axis B. In some embodiments, the predefined angle “a” may be between about 5° and about 30° from the lateral axis B. In other embodiments, the predefined angle “a” may be between about 10° and about 25° from the lateral axis B. In addition, at least a portion of the top surface 224 of the rear cap 223 may be a non-linear surface. For example, as shown in Figs. 5A-5C, the top surface 224 may be a concave surface.

[0071] The asymmetric, generally slanted shape and the angle of the top surface 224 of the rear cap 223 may be configured to allow the rear cap 223 to translate at least a portion of an impact force on the rear cap 223 to a rotational velocity or acceleration of the drug delivery device 200. As a more specific example, if the device 200 is dropped from a height, the generally slanted shape and angle of the top surface 224 of the rear cap 223 may be configured to translate at least a portion of the impact energy to a rotational acceleration or torque of the device 200 and cause the device 200 to rotate to its side after initially striking the ground. As such, at least some of the impact force may be distributed towards the outer diameter of the drug delivery device 200 such that not all of the impact force travels directly through the center of gravity of the device 200. Accordingly, even when the drug delivery device 200 is accidentally dropped, the asymmetric rear cap 223 may prevent or inhibit inadvertent activation of one or more components, such as the drive mechanism 30, within the device 200, reduce relative displacement between one or more components within the device 200, and prevent or inhibit structural damage to the device 200. Moreover, the generally concave shape of the top surface 224 may increase the user’s comfort while the user is holding the device 200 during the injection.

[0072] Figs. 6A-6C illustrate another exemplary drug delivery device 300 with another asymmetric rear cap 323, in accordance with various embodiments of the present disclosure. The drug delivery device 300 includes an outer casing or housing 312. The housing 312 may have a generally elongate shape, such as a cylindrical shape, and extend along a longitudinal axis A between a proximal end 312e and a distal end 312f. In some embodiments, the housing 312 may have a generally elongate, non-tubular shape, such as a rectangular shape, triangular shape, or other non-cylindrical geometrical shapes. In other embodiments, the housing 312 may

be a tubular housing and may have a generally elongate shape that extends along a longitudinal axis A between a proximal end 312e and a distal end 312f, but the tubular housing may define a non-cylindrical shape. That is, in some embodiments, an outer diameter of the tubular housing may vary along the longitudinal axis A. A transparent or semi-transparent inspection window 317 may be positioned in a wall of the housing 312 to permit a user to view component(s) inside the drug delivery device 300, including a drug storage container 320 (similar to the drug storage container 20). Although not shown, a removable cap like the removable cap 19 may cover the needle shield 332 prior to use of the drug delivery device 300. As discussed above, the drug delivery device 300 may also comprise a rear end cap 323 (also referred to as "rear cap") at the proximal end 312e of the drug delivery device 300. The rear cap 323 may have a hollow cylindrical shape with an open end and a closed off end. The rear cap 323 may be assembled together with the housing 312 to define the drug delivery device 300. In some embodiments, the rear cap 323 may be removably coupled to the housing 312 at a proximal end 312e of the housing 312. In other embodiments, the rear cap 323 and the housing 312 may be formed integrally to define a single, monolithic structure.

[0073] The rear cap 323 may be defined by a generally annular or cylindrical side wall 325 and a top surface 324 (also referred to as "top wall"). In some embodiments, the rear cap 323 may further include rounded edges 326 connecting the annular side wall 325 and the top surface 324. In other embodiments, the rear cap 323 may further include a chamfer, similar to chamfer 126, connecting the annular side wall 325 and the top surface 324. The rear cap 323 may be asymmetric relative to the longitudinal axis A (shown in Fig. 6B) of the housing 312 such that at least a portion of the top surface 324 of the rear cap 323 is generally slanted, ramped, or inclined. For example, the top surface 324 may be generally slanted at a predefined angle "a" from a lateral axis B (shown in Fig. 6B) that is perpendicular to the longitudinal axis A. The predefined angle "a" may be between about 5° and about 50° from the lateral axis B. In some embodiments, the predefined angle "a" may be between about 5° and about 30° from the lateral axis B. In other embodiments, the predefined angle "a" may be between about 10° and about 25° from the lateral axis B. In addition, at least a portion of the top surface 324 of the rear cap 323 may be a non-linear surface. For example, as shown in Figs. 6A-6C, the top surface 324 may be a convex surface.

[0074] The asymmetric, generally slanted shape and the angle of the top surface 324 of the rear cap 323 may be configured to allow the rear cap 323 to translate at least a portion of an impact force on the rear cap 323 to a rotational velocity or acceleration of the drug delivery device 300. As a more specific example, if the device 300 is dropped from a height, the generally slanted shape and angle of the top surface 324 of the rear cap 323 may be configured to translate at least a portion of the impact energy to a rotational acceleration or torque of the device 300 and cause the device 300 to rotate to its side after initially striking the ground. As such, at least some of the impact force may be distributed towards the outer diameter of the

drug delivery device 300 such that not all of the impact force travels directly through the center of gravity of the device 300. Accordingly, even when the drug delivery device 300 is accidentally dropped, the asymmetric rear cap 323 may prevent or inhibit inadvertent activation of one or more components, such as the drive mechanism 30, within the device 300, reduce relative displacement between one or more components within the device 300, and prevent or inhibit structural damage to the device 300. Moreover, the generally convex shape of the top surface 324 may increase the user's comfort while the user is holding the device 300 during the injection.

[0075] Figs. 7A-7C illustrate another exemplary drug delivery device 400 with another asymmetric rear cap 423, in accordance with various embodiments of the present disclosure. The drug delivery device 400 includes an outer casing or housing 412. The housing 412 may have a generally elongate shape, such as a cylindrical shape, and extend along a longitudinal axis A between a proximal end 412e and a distal end 412f. In some embodiments, the housing 412 may have a generally elongate, non-tubular shape, such as a rectangular shape, triangular shape, or other non-cylindrical geometrical shapes. In other embodiments, the housing 412 may be a tubular housing and may have a generally elongate shape that extends along a longitudinal axis A between a proximal end 412e and a distal end 412f, but the tubular housing may define a non-cylindrical shape. That is, in some embodiments, an outer diameter of the tubular housing may vary along the longitudinal axis A. A transparent or semi-transparent inspection window 417 may be positioned in a wall of the housing 412 to permit a user to view component(s) inside the drug delivery device 400, including a drug storage container 420 (similar to the drug storage container 20). Although not shown, a removable cap like the removable cap 19 may cover the needle shield 432 prior to use of the drug delivery device 400. As discussed above, the drug delivery device 400 may also comprise a rear end cap 423 (also referred to as "rear cap") at the proximal end 412e of the drug delivery device 400. The rear cap 423 may have a hollow cylindrical shape with an open end and a closed off end. The rear cap 423 may be assembled together with the housing 412 to define the drug delivery device 400. In some embodiments, the rear cap 423 may be removably coupled to the housing 412 at a proximal end 412e of the housing 412. In other embodiments, the rear cap 423 and the housing 412 may be formed integrally to define a single, monolithic structure.

[0076] The rear cap 423 may be defined by a generally annular or cylindrical side wall 425 and a top surface 424 (also referred to as "top wall"). In some embodiments, the rear cap 423 may further include rounded edges 426 connecting the annular side wall 425 and the top surface 424. In other embodiments, the rear cap 423 may further include a chamfer, similar to chamfer 126, connecting the annular side wall 425 and the top surface 424. The rear cap 423 may be asymmetric relative to the longitudinal axis A (shown in Fig. 7B) of the housing 412 such that at least a portion of the top surface 424 of the rear cap 423 is generally slanted, ramped, or inclined. As shown in Figs. 7A-7C, in some embodiments, the top surface 424 of the rear cap

423 may include a first portion 424a and a second portion 424b. The first portion 424a of the top surface 424 may be generally slanted, ramped, or inclined. For example, the first portion 424a of the top surface 324 may be generally slanted at a predefined angle "a" from a lateral axis B (shown in Fig. 7B) that is perpendicular to the longitudinal axis A. The predefined angle "a" may be between about 5° and about 50° from the lateral axis B. In some embodiments, the predefined angle "a" may be between about 5° and about 30° from the lateral axis B. In other embodiments, the predefined angle "a" may be between about 10° and about 25° from the lateral axis B. The second portion 424b of the top surface 424 may be flat and parallel to the lateral axis B. While Figs. 7A-7C illustrate a top surface 424 that includes two portions 424a, 424b, in other embodiments, the top surface 424 may be divided into more than two portions, such as three, four, five, six, seven, eight, nine, or ten portions. In some embodiment, as shown in Figs. 7A-7C, the first portion 424a and the second portion 424b of the top surface 424 may be generally flat and linear. In other embodiments, at least a portion of the top surface 424 may be a non-linear surface. By way of example, at least a portion of the top surface 424, such as the first portion 424a and/or the second portion 424b, may be concave or convex.

[0077] The asymmetric, generally slanted shape and the angle of at least the first portion 424a of the top surface 424 of the rear cap 423 may be configured to allow the rear cap 423 to translate at least a portion of an impact force on the rear cap 423 to a rotational velocity or acceleration of the drug delivery device 400. As a more specific example, if the device 400 is dropped from a height, the generally slanted shape and angle of at least the first portion 424a of the top surface 424 of the rear cap 423 may be configured to translate at least a portion of the impact energy to a rotational acceleration or torque of the device 400 and cause the device 400 to rotate to its side after initially striking the ground. As such, at least some of the impact force may be distributed towards the outer diameter of the drug delivery device 400 such that not all of the impact force travels directly through the center of gravity of the device 400. Accordingly, even when the drug delivery device 400 is accidentally dropped, the asymmetric rear cap 423 may prevent or inhibit inadvertent activation of one or more components, such as the drive mechanism 30, within the device 400, reduce relative displacement between one or more components within the device 400, and prevent or inhibit structural damage to the device 400.

[0078] Figs. 8A-8C illustrate another exemplary drug delivery device 500 with another asymmetric rear cap 523, in accordance with various embodiments of the present disclosure. The drug delivery device 500 includes an outer casing or housing 512. The housing 512 may have a generally elongate shape, such as a cylindrical shape, and extend along a longitudinal axis A between a proximal end 512e and a distal end 512f. In some embodiments, the housing 512 may have a generally elongate, non-tubular shape, such as a rectangular shape, triangular shape, or other non-cylindrical geometrical shapes. In other embodiments, the housing 512 may be a tubular housing and may have a generally elongate shape that extends along a longitudinal axis A between a proximal end 512e and a distal end 512f, but the tubular housing may define a

non-cylindrical shape. That is, in some embodiments, an outer diameter of the tubular housing may vary along the longitudinal axis A. A transparent or semi-transparent inspection window 517 may be positioned in a wall of the housing 512 to permit a user to view component(s) inside the drug delivery device 500, including a drug storage container 520 (similar to the drug storage container 20). Although not shown, a removable cap like the removable cap 19 may cover the needle shield 532 prior to use of the drug delivery device 500. As discussed above, the drug delivery device 500 may also comprise a rear end cap 523 (also referred to as "rear cap") at the proximal end 512e of the drug delivery device 500. The rear cap 523 may have a hollow cylindrical shape with an open end and a closed off end. The rear cap 523 may be assembled together with the housing 512 to define the drug delivery device 500. In some embodiments, the rear cap 523 may be removably coupled to the housing 512 at a proximal end 512e of the housing 512. In other embodiments, the rear cap 523 and the housing 512 may be formed integrally to define a single, monolithic structure.

[0079] The rear cap 523 may be defined by a generally annular or cylindrical side wall 525 and a top surface 524 (also referred to as "top wall"). In some embodiments, the rear cap 523 may further include rounded edges 526 connecting the annular side wall 525 and the top surface 524. In other embodiments, the rear cap 523 may further include a chamfer, similar to chamfer 126, connecting the annular side wall 525 and the top surface 524. The rear cap 523 may be asymmetric relative to the longitudinal axis A (shown in Fig. 8B) of the housing 512 such that at least a portion of the top surface 524 of the rear cap 523 is generally slanted, ramped, or inclined. For example, the top surface 524 may be generally slanted at a predefined angle "a" from a lateral axis B (shown in Fig. 8B) that is perpendicular to the longitudinal axis A. The predefined angle "a" may be between about 5° and about 50° from the lateral axis B. In some embodiments, the predefined angle "a" may be between about 5° and about 30° from the lateral axis B. In other embodiments, the predefined angle "a" may be between about 10° and about 25° from the lateral axis B. In addition, at least a portion of the top surface 524 of the rear cap 523 may be a non-linear surface. For example, as shown in Figs. 8A-8C, the top surface 524 may be a concave surface.

[0080] The asymmetric, generally slanted shape and the angle of the top surface 524 of the rear cap 523 may be configured to allow the rear cap 523 to translate at least a portion of an impact force on the rear cap 523 to a rotational velocity or acceleration of the drug delivery device 500. As a more specific example, if the device 500 is dropped from a height, the generally slanted shape and angle of the top surface 524 of the rear cap 523 may be configured to translate at least a portion of the impact energy to a rotational acceleration or torque of the device 500 and cause the device 500 to rotate to its side after initially striking the ground. As such, at least some of the impact force may be distributed towards the outer diameter of the drug delivery device 500 such that not all of the impact force travels directly through the center of gravity of the device 500. Accordingly, even when the drug delivery device 500 is accidentally

dropped, the asymmetric rear cap 523 may prevent or inhibit inadvertent activation of one or more components, such as the drive mechanism 30, within the device 500, reduce relative displacement between one or more components within the device 500, and prevent or inhibit structural damage to the device 500. Moreover, the generally concave shape of the top surface 524 may increase the user's comfort while the user is holding the device 500 during the injection.

[0081] Figs. 9A-9C illustrate another exemplary drug delivery device 600 with another asymmetric rear cap 623, in accordance with various embodiments of the present disclosure. The drug delivery device 600 includes an outer casing or housing 612. The housing 612 may have a generally elongate shape, such as a cylindrical shape, and extend along a longitudinal axis A between a proximal end 612e and a distal end 612f. In some embodiments, the housing 612 may have a generally elongate, non-tubular shape, such as a rectangular shape, triangular shape, or other non-cylindrical geometrical shapes. In other embodiments, the housing 612 may be a tubular housing and may have a generally elongate shape that extends along a longitudinal axis A between a proximal end 612e and a distal end 612f, but the tubular housing may define a non-cylindrical shape. That is, in some embodiments, an outer diameter of the tubular housing may vary along the longitudinal axis A. A transparent or semi-transparent inspection window 617 may be positioned in a wall of the housing 612 to permit a user to view component(s) inside the drug delivery device 600, including a drug storage container 620 (similar to the drug storage container 20). Although not shown, a removable cap like the removable cap 19 may cover the needle shield 632 prior to use of the drug delivery device 600. As discussed above, the drug delivery device 600 may also comprise a rear end cap 623 (also referred to as "rear cap") at the proximal end 612e of the drug delivery device 600. The rear cap 623 may have a hollow cylindrical shape with an open end and a closed off end. The rear cap 623 may be assembled together with the housing 612 to define the drug delivery device 600. In some embodiments, the rear cap 623 may be removably coupled to the housing 612 at a proximal end 612e of the housing 612. In other embodiments, the rear cap 623 and the housing 612 may be formed integrally to define a single, monolithic structure.

[0082] The rear cap 623 may be defined by a generally annular or cylindrical side wall 625 and a top surface 624 (also referred to as "top wall"). The rear cap 623 may be asymmetric relative to the longitudinal axis A (shown in Fig. 9B) of the housing 612 such that at least a portion of the top surface 624 of the rear cap 623 is generally slanted, ramped, or inclined. For example, the top surface 624 may be generally slanted at a predefined angle "a" from a lateral axis B (shown in Fig. 9B) that is perpendicular to the longitudinal axis A. The predefined angle "a" may be between about 5° and about 50° from the lateral axis B. In some embodiments, the predefined angle "a" may be between about 5° and about 30° from the lateral axis B. In other embodiments, the predefined angle "a" may be between about 10° and about 25° from the lateral axis B. In some embodiments, at least a portion of the top surface 624 of the rear cap

623 may be a linear surface. For example, the top surface 624 may be a generally flat and linear surface.

[0083] The asymmetric, generally slanted shape and the angle of the top surface 624 of the rear cap 623 may be configured to allow the rear cap 623 to translate at least a portion of an impact force on the rear cap 623 to a rotational velocity or acceleration of the drug delivery device 600. As a more specific example, if the device 600 is dropped from a height, the generally slanted shape and angle of the top surface 624 of the rear cap 623 may be configured to translate at least a portion of the impact energy to a rotational acceleration or torque of the device 600 and cause the device 600 to rotate to its side after initially striking the ground. As such, at least some of the impact force may be distributed towards the outer diameter of the drug delivery device 600 such that not all of the impact force travels directly through the center of gravity of the device 600. Accordingly, even when the drug delivery device 600 is accidentally dropped, the asymmetric rear cap 623 may prevent or inhibit inadvertent activation of one or more components, such as the drive mechanism 30, within the device 600, reduce relative displacement between one or more components within the device 600, and prevent or inhibit structural damage to the device 600.

[0084] Turning now to Fig. 10, a graph illustrating the changes in relative displacement between a releaser member, such as releaser member 52, and a guard extension, such as guard extension 37, over time after drug delivery devices 10, 100, 200, 300, 400, 500, and 600 are vertically dropped from the same drop height is shown. As shown in the comparative analysis of Fig. 10, all of the drug delivery devices 100, 200, 300, 400, 500, and 600 with asymmetric rear caps 123, 223, 323, 423, 523, and 623, respectively, provided better performance during the drop test than the drug delivery device 10 with a dome-shaped rear cap 23. That is, each of the drug delivery devices 100, 200, 300, 400, 500, and 600 showed less relative displacement between a releaser member and a guard extension within the housing than the drug delivery device 10, when all of the devices were dropped from the same height. The comparative analysis shows that the drug delivery devices 100, 200, 300, 400, 500, and 600 require greater height (also referred to as "height to drop") than the drug delivery device 10 to cause enough relative displacement within the housing to activate the device. Accordingly, the comparative analysis of Fig. 10 shows that the drug delivery devices 100, 200, 300, 400, 500, and 600 with asymmetric rear caps 123, 223, 323, 423, 523, and 623, respectively, may reduce the likelihood of inadvertent activation as a result of relative displacement of one or more components within the housing, compared to the drug delivery device 10 with a dome-shaped, symmetrical rear cap 23, when the devices are inadvertently dropped from a vertical height.

[0085] In some embodiments, the rear cap may include a protrusion, a lip, or any similar feature on a top surface of the rear cap such that the rear cap is asymmetric relative to the longitudinal axis A. By way of example, Fig. 11 illustrates a drug delivery device 700 having a dome-shaped rear end cap 723 including a protrusion 730, in accordance with various

embodiments of the present disclosure. The drug delivery device 700 includes an outer casing or housing 712. The housing 712 may have a generally elongate shape, such as a cylindrical shape, and extend along a longitudinal axis A between a proximal end 712e and a distal end 712f. In some embodiments, the housing 712 may have a generally elongate, non-tubular shape, such as a rectangular shape, triangular shape, or other non-cylindrical geometrical shapes. In other embodiments, the housing 712 may be a tubular housing and may have a generally elongate shape that extends along a longitudinal axis A between a proximal end 712e and a distal end 712f, but the tubular housing may define a non-cylindrical shape. That is, in some embodiments, an outer diameter of the tubular housing may vary along the longitudinal axis A. A transparent or semi-transparent inspection window 717 may be positioned in a wall of the housing 712 to permit a user to view component(s) inside the drug delivery device 700, including a drug storage container 720. A removable cap 719 may cover a needle shield, such as needle shield 32, prior to use of the drug delivery device 700. As discussed above, the drug delivery device 700 may also comprise a rear end cap 723 (also referred to as "rear cap") at the proximal end 712e of the drug delivery device 700. The rear cap 723 may have a hollow cylindrical shape with an open end and a closed off end. The rear cap 723 may be assembled together with the housing 712 to define the drug delivery device 700. In some embodiments, the rear cap 723 may be removably coupled to the housing 712 at a proximal end 712e of the housing 712. In other embodiments, the rear cap 723 and the housing 712 may be formed integrally to define a single, monolithic structure.

[0086] The rear cap 723 may be defined by a generally annular or cylindrical side wall 725 and a top surface 724 (also referred to as "top wall") that is dome-shaped or convex. As shown in Fig. 11, even though the rear cap 723 is dome-shaped, the rear cap 723 is asymmetric relative to the longitudinal axis A because the rear cap 723 includes the protrusion 730 on one side of the rear cap 723. The protrusion 730 may be offset from the longitudinal axis A and may project generally upwardly and away from the rear cap 723 along the longitudinal axis. When the drug delivery device 700 is inadvertently dropped from a height, the protrusion 730 on the rear cap 723 may be configured to shift the point of contact with a hard surface toward the outer edge of the drug delivery device 700 and away from the center of axis or center of gravity of the device 700 to achieve drop robustness. While Fig. 11 illustrates a single protrusion 730 on the rear cap 723, the rear cap 723 may include a plurality of protrusions 730 to define an asymmetric rear cap 723. In other embodiments, the protrusion 730 may be a lip or any similar feature that may be configured to shift the point of contact with a surface toward the outer edge of the drug delivery device 700 when the device 700 is inadvertently dropped.

[0087] The protrusion 730 on the rear cap 723 may be configured to allow the rear cap 723 to translate at least a portion of an impact force on the rear cap 723 to a rotational velocity or acceleration of the drug delivery device 700. As a more specific example, if the device 700 is dropped from a height, the protrusion 730 on the rear cap 723 may be configured to translate at

least a portion of the impact energy to a rotational acceleration or torque of the device 700 and cause the device 700 to rotate to its side after initially striking the ground. As such, at least some of the impact force may be distributed towards the outer diameter of the drug delivery device 700 such that not all of the impact force travels directly through the center of gravity of the device 700. Accordingly, even when the drug delivery device 700 is accidentally dropped, the asymmetric rear cap 723 may prevent or inhibit inadvertent activation of one or more components, such as the drive mechanism 30, within the device 700, reduce relative displacement between one or more components within the device 700, and prevent or inhibit structural damage to the device 700.

[0088] Fig. 12 illustrates a drug delivery device 800 having a flat rear end cap 823 including a protrusion 830, in accordance with various embodiments of the present disclosure. The drug delivery device 800 includes an outer casing or housing 812. The housing 812 may have a generally elongate shape, such as a cylindrical shape, and extend along a longitudinal axis A between a proximal end 812e and a distal end 812f. In some embodiments, the housing 812 may have a generally elongate, non-tubular shape, such as a rectangular shape, triangular shape, or other non-cylindrical geometrical shapes. In other embodiments, the housing 812 may be a tubular housing and may have a generally elongate shape that extends along a longitudinal axis A between a proximal end 812e and a distal end 812f, but the tubular housing may define a non-cylindrical shape. That is, in some embodiments, an outer diameter of the tubular housing may vary along the longitudinal axis A. A transparent or semi-transparent inspection window 817 may be positioned in a wall of the housing 812 to permit a user to view component(s) inside the drug delivery device 800, including a drug storage container 820. A removable cap 819 may cover a needle shield, such as needle shield 32, prior to use of the drug delivery device 800. As discussed above, the drug delivery device 800 may also comprise a rear end cap 823 (also referred to as "rear cap") at the proximal end 812e of the drug delivery device 800. The rear cap 823 may have a hollow cylindrical shape with an open end and a closed off end. The rear cap 823 may be assembled together with the housing 812 to define the drug delivery device 800. In some embodiments, the rear cap 823 may be removably coupled to the housing 812 at a proximal end 812e of the housing 812. In other embodiments, the rear cap 823 and the housing 812 may be formed integrally to define a single, monolithic structure.

[0089] The rear cap 823 may be defined by a generally annular or cylindrical side wall 825 and a top surface 824 (also referred to as "top wall") that is linearly flat. As shown in Fig. 12, even though the rear cap 823 is flat at the top, the rear cap 823 is asymmetric relative to the longitudinal axis A because the rear cap 823 includes the protrusion 830 on one side of the rear cap 823. The protrusion 830 may be offset from the longitudinal axis A and may project generally upwardly and away from the rear cap 823 along the longitudinal axis. When the drug delivery device 800 is inadvertently dropped from a height, the protrusion 830 on the rear cap 823 may be configured to shift the point of contact with a hard surface toward the outer edge of

the drug delivery device 800 and away from the center of axis or center of gravity of the device 800 to achieve drop robustness. While Fig. 12 illustrates a single protrusion 830 on the rear cap 823, the rear cap 823 may include a plurality of protrusions 830 to define an asymmetric rear cap 823. In other embodiments, the protrusion 830 may be a lip or any similar feature that may be configured to shift the point of contact with a surface toward the outer edge of the drug delivery device 800 when the device 800 is inadvertently dropped.

[0090] The protrusion 830 on the rear cap 823 may be configured to allow the rear cap 823 to translate at least a portion of an impact force on the rear cap 823 to a rotational velocity or acceleration of the drug delivery device 800. As a more specific example, if the device 800 is dropped from a height, the protrusion 830 on the rear cap 823 may be configured to translate at least a portion of the impact energy to a rotational acceleration or torque of the device 800 and cause the device 800 to rotate to its side after initially striking the ground. As such, at least some of the impact force may be distributed towards the outer diameter of the drug delivery device 800 such that not all of the impact force travels directly through the center of gravity of the device 800. Accordingly, even when the drug delivery device 800 is accidentally dropped, the asymmetric rear cap 823 may prevent or inhibit inadvertent activation of one or more components, such as the drive mechanism 30, within the device 800, reduce relative displacement between one or more components within the device 800, and prevent or inhibit structural damage to the device 800. While Figs. 11 and 12 illustrate a dome-shaped rear cap 723 and a flat rear cap 823, respectively, it should be noted that a slanted rear cap, such as rear caps 123, 223, 323, 423, 523, and 623, may also include a protrusion, a lip, or a similar feature, such as protrusions 730 and 830, to shift the point of contact with a surface upon a drop of the drug delivery device toward the outer edge of the device and away from the center of axis of the device.

[0091] From the foregoing, it can be seen that the present disclosure advantageously provides an improved design for a drug delivery device having a rear end cap configured to increase drop robustness by preventing or inhibiting inadvertent activation of one or more components, such as the drive mechanism, within the drug delivery device, preventing or inhibiting relative displacement of one or more components within the drug delivery device after striking a hard surface, and reducing the likelihood of damage to one or more components of the drug delivery device, as well as provide other benefits and advantages. All features disclosed herein with respect to any of the rear end cap embodiments may be combined in any combination, except combinations where at least some of such features are mutually exclusive.

[0092] As will be recognized, the devices and methods according to the present disclosure may have one or more advantages relative to conventional technology, any one or more of which may be present in a particular embodiment in accordance with the features of the present disclosure included in that embodiment. Other advantages not specifically listed herein may also be recognized as well.

[0093] The above description describes various devices, assemblies, components, subsystems and methods for use related to a drug delivery device. The devices, assemblies, components, subsystems, methods or drug delivery devices can further comprise or be used with a drug including but not limited to those drugs identified below as well as their generic and biosimilar counterparts. The term drug, as used herein, can be used interchangeably with other similar terms and can be used to refer to any type of medicament or therapeutic material including traditional and non-traditional pharmaceuticals, nutraceuticals, supplements, biologics, biologically active agents and compositions, large molecules, biosimilars, bioequivalents, therapeutic antibodies, polypeptides, proteins, small molecules and generics. Non-therapeutic injectable materials are also encompassed. The drug may be in liquid form, a lyophilized form, or in a reconstituted from lyophilized form. The following example list of drugs should not be considered as all-inclusive or limiting.

[0094] The drug will be contained in a reservoir. In some instances, the reservoir is a primary container that is either filled or pre-filled for treatment with the drug. The primary container can be a vial, a cartridge or a pre-filled syringe.

[0095] In some embodiments, the reservoir of the drug delivery device may be filled with or the device can be used with colony stimulating factors, such as granulocyte colony-stimulating factor (G-CSF). Such G-CSF agents include but are not limited to Neulasta® (pegfilgrastim, pegylated filgrastim, pegylated G-CSF, pegylated hu-Met-G-CSF) and Neupogen® (filgrastim, G-CSF, hu-MetG-CSF), UDENYCA® (pegfilgrastim-cbqv), Ziextenzo® (LA-EP2006; pegfilgrastim-bmez), or FULPHILA (pegfilgrastim-bmez).

[0096] In other embodiments, the drug delivery device may contain or be used with an erythropoiesis stimulating agent (ESA), which may be in liquid or lyophilized form. An ESA is any molecule that stimulates erythropoiesis. In some embodiments, an ESA is an erythropoiesis stimulating protein. As used herein, "erythropoiesis stimulating protein" means any protein that directly or indirectly causes activation of the erythropoietin receptor, for example, by binding to and causing dimerization of the receptor. Erythropoiesis stimulating proteins include erythropoietin and variants, analogs, or derivatives thereof that bind to and activate erythropoietin receptor; antibodies that bind to erythropoietin receptor and activate the receptor; or peptides that bind to and activate erythropoietin receptor. Erythropoiesis stimulating proteins include, but are not limited to, Epogen® (epoetin alfa), Aranesp® (darbepoetin alfa), Dynepo® (epoetin delta), Mircera® (methoxy polyethylene glycol-epoetin beta), Hematide®, MRK-2578, INS-22, Retacrit® (epoetin zeta), Neorecormon® (epoetin beta), Silapo® (epoetin zeta), Binocrit® (epoetin alfa), epoetin alfa Hexal, Abseamed® (epoetin alfa), Ratioepo® (epoetin theta), Eporatio® (epoetin theta), Biopoin® (epoetin theta), epoetin alfa, epoetin beta, epoetin iota, epoetin omega, epoetin delta, epoetin zeta, epoetin theta, and epoetin delta, pegylated

erythropoietin, carbamylated erythropoietin, as well as the molecules or variants or analogs thereof.

[0097] Among particular illustrative proteins are the specific proteins set forth below, including fusions, fragments, analogs, variants or derivatives thereof: OPGL specific antibodies, peptibodies, related proteins, and the like (also referred to as RANKL specific antibodies, peptibodies and the like), including fully humanized and human OPGL specific antibodies, particularly fully humanized monoclonal antibodies; Myostatin binding proteins, peptibodies, related proteins, and the like, including myostatin specific peptibodies; IL-4 receptor specific antibodies, peptibodies, related proteins, and the like, particularly those that inhibit activities mediated by binding of IL-4 and/or IL-13 to the receptor; Interleukin 1-receptor 1 ("IL1-R1") specific antibodies, peptibodies, related proteins, and the like; Ang2 specific antibodies, peptibodies, related proteins, and the like; NGF specific antibodies, peptibodies, related proteins, and the like; CD22 specific antibodies, peptibodies, related proteins, and the like, particularly human CD22 specific antibodies, such as but not limited to humanized and fully human antibodies, including but not limited to humanized and fully human monoclonal antibodies, particularly including but not limited to human CD22 specific IgG antibodies, such as, a dimer of a human-mouse monoclonal hLL2 gamma-chain disulfide linked to a human-mouse monoclonal hLL2 kappa-chain, for example, the human CD22 specific fully humanized antibody in Epratuzumab, CAS registry number 501423-23-0; IGF-1 receptor specific antibodies, peptibodies, and related proteins, and the like including but not limited to anti-IGF-1R antibodies; B-7 related protein 1 specific antibodies, peptibodies, related proteins and the like ("B7RP-1" and also referring to B7H2, ICOSL, B7h, and CD275), including but not limited to B7RP-specific fully human monoclonal IgG2 antibodies, including but not limited to fully human IgG2 monoclonal antibody that binds an epitope in the first immunoglobulin-like domain of B7RP-1, including but not limited to those that inhibit the interaction of B7RP-1 with its natural receptor, ICOS, on activated T cells; IL-15 specific antibodies, peptibodies, related proteins, and the like, such as, in particular, humanized monoclonal antibodies, including but not limited to HuMax IL-15 antibodies and related proteins, such as, for instance, 145c7; IFN gamma specific antibodies, peptibodies, related proteins and the like, including but not limited to human IFN gamma specific antibodies, and including but not limited to fully human anti-IFN gamma antibodies; TALL-1 specific antibodies, peptibodies, related proteins, and the like, and other TALL specific binding proteins; Parathyroid hormone ("PTH") specific antibodies, peptibodies, related proteins, and the like; Thrombopoietin receptor ("TPO-R") specific antibodies, peptibodies, related proteins, and the like; Hepatocyte growth factor ("HGF") specific antibodies, peptibodies, related proteins, and the like, including those that target the HGF/SF:cMet axis (HGF/SF:cMet), such as fully human monoclonal antibodies that neutralize hepatocyte growth factor/scatter (HGF/SF); TRAIL-R2 specific antibodies, peptibodies, related proteins and the like; Activin A specific antibodies, peptibodies, proteins, and the like; TGF-beta specific antibodies, peptibodies, related proteins,

and the like; Amyloid-beta protein specific antibodies, peptibodies, related proteins, and the like; c-Kit specific antibodies, peptibodies, related proteins, and the like, including but not limited to proteins that bind c-Kit and/or other stem cell factor receptors; OX40L specific antibodies, peptibodies, related proteins, and the like, including but not limited to proteins that bind OX40L and/or other ligands of the OX40 receptor; Activase® (alteplase, tPA); Aranesp® (darbepoetin alfa) Erythropoietin [30-asparagine, 32-threonine, 87-valine, 88-asparagine, 90-threonine], Darbepoetin alfa, novel erythropoiesis stimulating protein (NESP); Epogen® (epoetin alfa, or erythropoietin); GLP-1, Avonex® (interferon beta-1a); Bexxar® (tositumomab, anti-CD22 monoclonal antibody); Betaseron® (interferon-beta); Campath® (alemtuzumab, anti-CD52 monoclonal antibody); Dynepo® (epoetin delta); Velcade® (bortezomib); MLN0002 (anti- α 4 β 7 mAb); MLN1202 (anti-CCR2 chemokine receptor mAb); Enbrel® (etanercept, TNF-receptor /Fc fusion protein, TNF blocker); Eprex® (epoetin alfa); Erbitux® (cetuximab, anti-EGFR / HER1 / c-ErbB-1); Genotropin® (somatropin, Human Growth Hormone); Herceptin® (trastuzumab, anti-HER2/neu (erbB2) receptor mAb); Kanjinti™ (trastuzumab-anns) anti-HER2 monoclonal antibody, biosimilar to Herceptin®, or another product containing trastuzumab for the treatment of breast or gastric cancers; Humatrope® (somatropin, Human Growth Hormone); Humira® (adalimumab); Vectibix® (panitumumab), Xgeva® (denosumab), Prolia® (denosumab), Immunoglobulin G2 Human Monoclonal Antibody to RANK Ligand, Enbrel® (etanercept, TNF-receptor /Fc fusion protein, TNF blocker), Nplate® (romiplostim), rilatumumab, ganitumab, conatumumab, brodalumab, insulin in solution; Infergen® (interferon alfacon-1); Natrecor® (nesiritide; recombinant human B-type natriuretic peptide (hBNP); Kineret® (anakinra); Leukine® (sargamostim, rhuGM-CSF); LymphoCide® (epratuzumab, anti-CD22 mAb); Benlysta™ (lymphotoxin B, belimumab, anti-BlyS mAb); Metalyse® (tenecteplase, t-PA analog); Mircera® (methoxy polyethylene glycol-epoetin beta); Mylotarg® (gemtuzumab ozogamicin); Raptiva® (efalizumab); Cimzia® (certolizumab pegol, CDP 870); Soliris™ (eculizumab); pexelizumab (anti-C5 complement); Numax® (MEDI-524); Lucentis® (ranibizumab); Panorex® (17-1A, edrecolomab); Trabio® (lerdelimumab); TheraCim hR3 (nimotuzumab); Omnitarg (pertuzumab, 2C4); Osidem® (IDM-1); OvaRex® (B43.13); Nuvion® (visilizumab); cantuzumab mertansine (huC242-DM1); NeoRecormon® (epoetin beta); Neumega® (oprelvekin, human interleukin-11); Orthoclone OKT3® (muromonab-CD3, anti-CD3 monoclonal antibody); Procrit® (epoetin alfa); Remicade® (infliximab, anti-TNF α monoclonal antibody); Reopro® (abciximab, anti-GP IIb/IIIa receptor monoclonal antibody); Actemra® (anti-IL6 Receptor mAb); Avastin® (bevacizumab), HuMax-CD4 (zanolimumab); Mvasi™ (bevacizumab-awwb); Rituxan® (rituximab, anti-CD20 mAb); Tarceva® (erlotinib); Roferon-A® (interferon alfa-2a); Simulect® (basiliximab); Prexige® (lumiracoxib); Synagis® (palivizumab); 145c7-CHO (anti-IL15 antibody, see U.S. Patent No. 7,153,507); Tysabri® (natalizumab, anti- α 4integrin mAb); Valortim® (MDX-1303, anti-B. anthracis protective antigen mAb); ABthrax™; Xolair® (omalizumab); ETI211 (anti-MRSA mAb); IL-1 trap (the Fc portion of human IgG1 and the extracellular domains of both IL-1

receptor components (the Type I receptor and receptor accessory protein)); VEGF trap (Ig domains of VEGFR1 fused to IgG1 Fc); Zenapax® (daclizumab); Zenapax® (daclizumab, anti-IL-2R α mAb); Zevalin® (ibritumomab tiuxetan); Zetia® (ezetimibe); Orencia® (atacept, TACI-Ig); anti-CD80 monoclonal antibody (galiximab); anti-CD23 mAb (lumiliximab); BR2-Fc (huBR3 / huFc fusion protein, soluble BAFF antagonist); CNTO 148 (golimumab, anti-TNF α mAb); HGS-ETR1 (mapatumumab; human anti-TRAIL Receptor-1 mAb); HuMax-CD20 (ocrelizumab, anti-CD20 human mAb); HuMax-EGFR (zalutumumab); M200 (volociximab, anti- $\alpha 5\beta 1$ integrin mAb); MDX-010 (ipilimumab, anti-CTLA-4 mAb and VEGFR-1 (IMC-18F1); anti-BR3 mAb; anti-C. difficile Toxin A and Toxin B C mAbs MDX-066 (CDA-1) and MDX-1388); anti-CD22 dsFv-PE38 conjugates (CAT-3888 and CAT-8015); anti-CD25 mAb (HuMax-TAC); anti-CD3 mAb (NI-0401); adecatumumab; anti-CD30 mAb (MDX-060); MDX-1333 (anti-IFNAR); anti-CD38 mAb (HuMax CD38); anti-CD40L mAb; anti-Cripto mAb; anti-CTGF Idiopathic Pulmonary Fibrosis Phase I Fibrogen (FG-3019); anti-CTLA4 mAb; anti-eotaxin1 mAb (CAT-213); anti-FGF8 mAb; anti-ganglioside GD2 mAb; anti-ganglioside GM2 mAb; anti-GDF-8 human mAb (MYO-029); anti-GM-CSF Receptor mAb (CAM-3001); anti-HepC mAb (HuMax HepC); anti-IFN α mAb (MEDI-545, MDX-198); anti-IGF1R mAb; anti-IGF-1R mAb (HuMax-Inflam); anti-IL12 mAb (ABT-874); anti-IL12/IL23 mAb (CNTO 1275); anti-IL13 mAb (CAT-354); anti-IL2Ra mAb (HuMax-TAC); anti-IL5 Receptor mAb; anti-integrin receptors mAb (MDX-018, CNTO 95); anti-IP10 Ulcerative Colitis mAb (MDX-1100); BMS-66513; anti-Mannose Receptor/hCG β mAb (MDX-1307); anti-mesothelin dsFv-PE38 conjugate (CAT-5001); anti-PD1mAb (MDX-1106 (ONO-4538)); anti-PDGFR α antibody (IMC-3G3); anti-TGF β mAb (GC-1008); anti-TRAIL Receptor-2 human mAb (HGS-ETR2); anti-TWEAK mAb; anti-VEGFR/Flt-1 mAb; and anti-ZP3 mAb (HuMax-ZP3).

[0098] In some embodiments, the drug delivery device may contain or be used with a sclerostin antibody, such as but not limited to romosozumab, blosozumab, BPS 804 (Novartis), Evenity™ (romosozumab-aqqg), another product containing romosozumab for treatment of postmenopausal osteoporosis and/or fracture healing and in other embodiments, a monoclonal antibody (IgG) that binds human Proprotein Convertase Subtilisin/Kexin Type 9 (PCSK9). Such PCSK9 specific antibodies include, but are not limited to, Repatha® (evolocumab) and Praluent® (alirocumab). In other embodiments, the drug delivery device may contain or be used with rilotumumab, bixalomer, trebananib, ganitumab, conatumumab, motesanib diphosphate, brodalumab, vidupirant or panitumumab. In some embodiments, the reservoir of the drug delivery device may be filled with or the device can be used with IMLYGIC® (talimogene laherparepvec) or another oncolytic HSV for the treatment of melanoma or other cancers including but are not limited to OncoVEXGALV/CD; OrienX010; G207, 1716; NV1020; NV12023; NV1034; and NV1042. In some embodiments, the drug delivery device may contain or be used with endogenous tissue inhibitors of metalloproteinases (TIMPs) such as but not limited to TIMP-3. In some embodiments, the drug delivery device may contain or be used with Aimovig® (erenumab-aooe), anti-human CGRP-R (calcitonin gene-related peptide type 1 receptor) or

another product containing erenumab for the treatment of migraine headaches. Antagonistic antibodies for human calcitonin gene-related peptide (CGRP) receptor such as but not limited to erenumab and bispecific antibody molecules that target the CGRP receptor and other headache targets may also be delivered with a drug delivery device of the present disclosure. Additionally, bispecific T cell engager (BiTE®) antibodies such as but not limited to BLINCYTO® (blinatumomab) can be used in or with the drug delivery device of the present disclosure. In some embodiments, the drug delivery device may contain or be used with an APJ large molecule agonist such as but not limited to apelin or analogues thereof. In some embodiments, a therapeutically effective amount of an anti-thymic stromal lymphopoietin (TSLP) or TSLP receptor antibody is used in or with the drug delivery device of the present disclosure. In some embodiments, the drug delivery device may contain or be used with Avsola™ (infliximab-axxq), anti-TNF α monoclonal antibody, biosimilar to Remicade® (infliximab) (Janssen Biotech, Inc.) or another product containing infliximab for the treatment of autoimmune diseases. In some embodiments, the drug delivery device may contain or be used with Kyprolis® (carfilzomib), (2S)-N-((S)-1-((S)-4-methyl-1-((R)-2-methyloxiran-2-yl)-1-oxopentan-2-ylcarbonyl)-2-phenylethyl)-2-((S)-2-(2-morpholinoacetamido)-4-phenylbutanamido)-4-methylpentanamide, or another product containing carfilzomib for the treatment of multiple myeloma. In some embodiments, the drug delivery device may contain or be used with Otezla® (apremilast), N-[2-[(1S)-1-(3-ethoxy-4-methoxyphenyl)-2-(methylsulfonyl)ethyl]-2,3-dihydro-1,3-dioxo-1H-indol-4-yl]acetamide, or another product containing apremilast for the treatment of various inflammatory diseases. In some embodiments, the drug delivery device may contain or be used with Parsabiv™ (etelcalcetide HCl, KAI-4169) or another product containing etelcalcetide HCl for the treatment of secondary hyperparathyroidism (sHPT) such as in patients with chronic kidney disease (KD) on hemodialysis. In some embodiments, the drug delivery device may contain or be used with ABP 798 (rituximab), a biosimilar candidate to Rituxan®/MabThera™, or another product containing an anti-CD20 monoclonal antibody. In some embodiments, the drug delivery device may contain or be used with a VEGF antagonist such as a non-antibody VEGF antagonist and/or a VEGF-Trap such as aflibercept (Ig domain 2 from VEGFR1 and Ig domain 3 from VEGFR2, fused to Fc domain of IgG1). In some embodiments, the drug delivery device may contain or be used with ABP 959 (eculizumab), a biosimilar candidate to Soliris®, or another product containing a monoclonal antibody that specifically binds to the complement protein C5. In some embodiments, the drug delivery device may contain or be used with Rozibafusp alfa (formerly AMG 570) is a novel bispecific antibody-peptide conjugate that simultaneously blocks ICOSL and BAFF activity. In some embodiments, the drug delivery device may contain or be used with Omecamtiv mecarbil, a small molecule selective cardiac myosin activator, or myotrope, which directly targets the contractile mechanisms of the heart, or another product containing a small molecule selective cardiac myosin activator. In some embodiments, the drug delivery device may contain or be used with Sotorasib (formerly known

as AMG 510), a KRAS^{G12C} small molecule inhibitor, or another product containing a KRAS^{G12C} small molecule inhibitor. In some embodiments, the drug delivery device may contain or be used with Tezepelumab, a human monoclonal antibody that inhibits the action of thymic stromal lymphopoietin (TSLP), or another product containing a human monoclonal antibody that inhibits the action of TSLP. In some embodiments, the drug delivery device may contain or be used with rocatinlimab (AMG 451), a human anti-OX40 monoclonal antibody that is expressed on activated T cells and blocks OX40 to inhibit and/or reduce the number of OX40 pathogenic T cells that are responsible for driving system and local atopic dermatitis inflammatory responses. In some embodiments, the drug delivery device may contain or be used with AMG 714, a human monoclonal antibody that binds to Interleukin-15 (IL-15) or another product containing a human monoclonal antibody that binds to Interleukin-15 (IL-15). In some embodiments, the drug delivery device may contain or be used with AMG 890, a small interfering RNA (siRNA) that lowers lipoprotein(a), also known as Lp(a), or another product containing a small interfering RNA (siRNA) that lowers lipoprotein(a). In some embodiments, the drug delivery device may contain or be used with ABP 654 (human IgG1 kappa antibody), a biosimilar candidate to Stelara®, or another product that contains human IgG1 kappa antibody and/or binds to the p40 subunit of human cytokines interleukin (IL)-12 and IL-23. In some embodiments, the drug delivery device may contain or be used with Amjevita™ or Amgevita™ (formerly ABP 501) (mab anti-TNF human IgG1), a biosimilar candidate to Humira®, or another product that contains human mab anti-TNF human IgG1. In some embodiments, the drug delivery device may contain or be used with AMG 160, or another product that contains a half-life extended (HLE) anti-prostate-specific membrane antigen (PSMA) x anti-CD3 BiTE® (bispecific T cell engager) construct. In some embodiments, the drug delivery device may contain or be used with AMG 119, or another product containing a delta-like ligand 3 (DLL3) CAR T (chimeric antigen receptor T cell) cellular therapy. In some embodiments, the drug delivery device may contain or be used with AMG 119, or another product containing a delta-like ligand 3 (DLL3) CAR T (chimeric antigen receptor T cell) cellular therapy. In some embodiments, the drug delivery device may contain or be used with AMG 133, or another product containing a gastric inhibitory polypeptide receptor (GIPR) antagonist and GLP-1R agonist. In some embodiments, the drug delivery device may contain or be used with AMG 171 or another product containing a Growth Differential Factor 15 (GDF15) analog. In some embodiments, the drug delivery device may contain or be used with AMG 176 or another product containing a small molecule inhibitor of myeloid cell leukemia 1 (MCL-1). In some embodiments, the drug delivery device may contain or be used with AMG 199 or another product containing a half-life extended (HLE) bispecific T cell engager construct (BiTE®). In some embodiments, the drug delivery device may contain or be used with AMG 256 or another product containing an anti-PD-1 x IL21 mutein and/or an IL-21 receptor agonist designed to selectively turn on the Interleukin 21 (IL-21) pathway in programmed cell death-1 (PD-1) positive cells. In some embodiments, the drug delivery device may contain or be used with AMG 330 or

another product containing an anti-CD33 x anti-CD3 BiTE® (bispecific T cell engager) construct. In some embodiments, the drug delivery device may contain or be used with AMG 404 or another product containing a human anti-programmed cell death-1(PD-1) monoclonal antibody being investigated as a treatment for patients with solid tumors. In some embodiments, the drug delivery device may contain or be used with AMG 427 or another product containing a half-life extended (HLE) anti-fms-like tyrosine kinase 3 (FLT3) x anti-CD3 BiTE® (bispecific T cell engager) construct. In some embodiments, the drug delivery device may contain or be used with AMG 430 or another product containing an anti-Jagged-1 monoclonal antibody. In some embodiments, the drug delivery device may contain or be used with AMG 506 or another product containing a multi-specific FAP x 4-1BB-targeting DARPIn® biologic under investigation as a treatment for solid tumors. In some embodiments, the drug delivery device may contain or be used with AMG 509 or another product containing a bivalent T-cell engager and is designed using XmAb® 2+1 technology. In some embodiments, the drug delivery device may contain or be used with AMG 562 or another product containing a half-life extended (HLE) CD19 x CD3 BiTE® (bispecific T cell engager) construct. In some embodiments, the drug delivery device may contain or be used with Efavaleukin alfa (formerly AMG 592) or another product containing an IL-2 mutein Fc fusion protein. In some embodiments, the drug delivery device may contain or be used with AMG 596 or another product containing a CD3 x epidermal growth factor receptor vIII (EGFRvIII) BiTE® (bispecific T cell engager) molecule. In some embodiments, the drug delivery device may contain or be used with AMG 673 or another product containing a half-life extended (HLE) anti-CD33 x anti-CD3 BiTE® (bispecific T cell engager) construct. In some embodiments, the drug delivery device may contain or be used with AMG 701 or another product containing a half-life extended (HLE) anti-B-cell maturation antigen (BCMA) x anti-CD3 BiTE® (bispecific T cell engager) construct. In some embodiments, the drug delivery device may contain or be used with AMG 757 or another product containing a half-life extended (HLE) anti- delta-like ligand 3 (DLL3) x anti-CD3 BiTE® (bispecific T cell engager) construct. In some embodiments, the drug delivery device may contain or be used with AMG 910 or another product containing a half-life extended (HLE) epithelial cell tight junction protein claudin 18.2 x CD3 BiTE® (bispecific T cell engager) construct.

[0099] Although the drug delivery devices, assemblies, components, subsystems and methods have been described in terms of exemplary embodiments, they are not limited thereto. The detailed description is to be construed as exemplary only and does not describe every possible embodiment of the present disclosure. Numerous alternative embodiments could be implemented, using either current technology or technology developed after the filing date of this patent that would still fall within the scope of the claims defining the invention(s) disclosed herein.

[0100] Those skilled in the art will recognize that a wide variety of modifications, alterations, and combinations can be made with respect to the above described embodiments without

departing from the spirit and scope of the invention(s) disclosed herein, and that such modifications, alterations, and combinations are to be viewed as being within the ambit of the inventive concept(s).

What is claimed is:

1. A drug delivery device comprising:
 - a housing defining a longitudinal axis and having an opening at a distal end thereof;
 - a drug storage container including a barrel, a stopper, and a delivery member, the stopper movably positioned within the barrel, the delivery member positioned at a distal end of the barrel and having an insertion end configured to extend at least partially through the opening during a delivery state;
 - a plunger moveable toward the distal end of the drug storage container to engage the stopper and expel a drug from the drug storage container through the delivery member;
 - a releaser member having a first position wherein the releaser member prevents the plunger from moving into the delivery state and a second position wherein the releaser member does not prevent the plunger from moving into the delivery state; and
 - a rear cap coupled to the housing at a proximal end thereof, wherein the rear cap is asymmetric relative to the longitudinal axis of the housing to translate a portion of an impact force on the rear cap to a rotational acceleration of the drug delivery device.
2. The drug delivery device of claim 1, wherein the housing includes a tubular housing, and wherein the rear cap is at least partially defined by an annular side wall and a top surface.
3. The drug delivery device of claim 2, wherein at least a portion of the top surface of the rear cap is generally slanted at a predefined angle from a lateral axis perpendicular to the longitudinal axis.
4. The drug delivery device of claim 3, wherein the predefined angle is between about 5° and about 30° from the lateral axis.
5. The drug delivery device of claim 3, wherein the predefined angle is between about 10° and about 25° from the lateral axis.
6. The drug delivery device of claim 3, wherein at least the portion of the top surface is a linear surface.
7. The drug delivery device of claim 3, wherein at least the portion of the top surface is a concave surface.
8. The drug delivery device of claim 3, wherein at least the portion of the top surface is a convex surface.

9. The drug delivery device of claim 2, wherein the rear cap includes a chamfer connecting the annular side wall and the top surface.

10. The drug delivery device of claim 3, wherein the portion of the top surface that is generally slanted at the predefined angle defines a first portion of the top surface, and wherein the top surface further includes a second portion defined by a flat surface that is parallel to the lateral axis.

11. The drug delivery device of claim 2, wherein the top surface is a linear surface.

12. The drug delivery device of claim 2, wherein the top surface is a convex surface.

13. The drug delivery device of claim 2, wherein the rear cap includes a protrusion on the top surface, wherein the protrusion is offset from the longitudinal axis, and wherein the protrusion projects generally away from the top surface along the longitudinal axis.

14. The drug delivery device of claim 1, further comprising a plunger guide configured to operatively couple the housing and the rear cap.

15. The drug delivery device of claim 1, wherein the plunger is configured to rotate while translating toward the distal end of the drug storage container.

16. The drug delivery device of claim 2, wherein the tubular housing defines a generally cylindrical shape.

17. The drug delivery device of claim 2, wherein the tubular housing defines a non-cylindrical shape, and wherein an outer diameter of the tubular housing varies along the longitudinal axis.

18. The drug delivery device of claim 1, wherein the housing and the rear cap are defined by a single, monolithic structure.

19. The drug delivery device of claim 1, wherein the drug delivery device is an autoinjector.

20. A drug delivery device comprising:
a housing defining a longitudinal axis and having an opening at a distal end thereof;

a drug storage container including a barrel, a stopper, and a delivery member, the stopper movably positioned within the barrel, the delivery member positioned at a distal end of the barrel and having an insertion end configured to extend at least partially through the opening during a delivery state;

a plunger moveable toward the distal end of the drug storage container to engage the stopper and expel a drug from the drug storage container through the delivery member;

a releaser member having a first position wherein the releaser member prevents the plunger from moving into the delivery state and a second position wherein the releaser member does not prevent the plunger from moving into the delivery state; and

a rear cap coupled to the housing at a proximal end thereof, wherein the rear cap is asymmetric relative to the longitudinal axis of the housing to promote or cause rotation of the drug delivery device.