DRUG DELIVERY DEVICE HAVING DAMPING MECHANISM

CROSS-REFERENCE TO RELATED APPLICATION

[0001] Priority is claimed to United States Provisional Patent Application No. 62/745,813, filed October 15, 2018, the entirety of which is hereby incorporated herein by reference.

FIELD OF DISCLOSURE

[0002] The present disclosure generally relates to injectors and, more particularly, to a torque driven injector having a damping mechanism.

BACKGROUND

[0003] Autoinjectors and on-body injectors offer several benefits in delivery of medicaments and/or therapeutics. One of the benefits can include simplicity of use, as compared with traditional methods of delivery using, for example, conventional syringes.

[0004] Many injector systems use coil spring structures to provide actuation energy for functions such as needle insertion and medicament delivery. The use of springs can offer benefits of simplicity for the user and device automation, but can have certain limitations. For example, there is a linear relationship between force and displacement in linear spring actuators. To provide sufficient energy for drug delivery at the end of plunger stroke, an excessive amount of energy may be input to the system as drug delivery commences.

[0005] Further, as higher viscosity drugs are delivered via autoinjectors, requisite spring forces will likely increase. Springs with higher spring constants transmit more force per travel distance to the drug product and primary container at the beginning of travel. In many autoinjectors, an air gap is present between a plunger face and a storage portion that contains the medicament prior to its injection into a user. When the drug is to be administered, the spring urges the plunger face through the air gap towards the medicament. Because the plunger face exhibits little resistance when traversing the air gap and due to large forces urging the plunger, the plunger face may make abrupt contact with the storage portion containing the medicament. A patient may feel this excessive energy as a “slap” or similar physical “bump”, as the spring driven plunger impacts the stopper of the primary container storing the drug. Further, the user may also experience a jerk, recoil, and/or a reaction force when rotational movement begins due to the abrupt change in acceleration. Such mechanical bumps can be distracting and/or disturbing to users of the injectors and can therefore impact proper dose administration. Further, the “slap” and “bump” generated by the excessive energy can potentially cause catastrophic effects, such as breakage of the primary container and drug product damage cause by shear load. Furthermore, high force springs can produce undesirably high shear rates on the drug product.

[0006] Further still, patients may experience a large variation in injection times due to variations in characteristics of the medicament. These variations can be disturbing to users, who may think something is wrong with administration of the drug, and thus they may end the injection before they receive the full dosage. Variations in injection time may be caused by large drug viscosity variation due to changes to the temperature of the drug, large variations in friction between components in the device (e.g., between a syringe barrel and a stopper), and so on.

SUMMARY

[0006a] According to a first aspect of the present invention, there is provided a drug delivery device comprising:

a housing defining a shell having a proximal end, a distal end, and a longitudinal axis extending between the proximal end and the distal end thereof;

a needle assembly at least partially disposed within the housing at the proximal end thereof, the needle assembly comprising a syringe barrel containing a medicament and a needle or a cannula;

a drive assembly at least partially disposed within the housing and operably coupled to the needle assembly to urge the medicament through the needle or cannula; and

a damper mechanism at least partially disposed within the housing adjacent to the distal end thereof, the damper mechanism being operably coupled to the drive assembly and the housing, wherein upon activating the drive assembly, the damper mechanism exerts a torque on the drive assembly to dampen an effect of the drive assembly.

[0006b] According to a second aspect of the present invention, there is provided a damper mechanism for a drug delivery device comprising:

a frame member;

a damper member operably coupled to a drive assembly of the drug delivery device;

a chamber formed between a portion of the frame member and the damper member; and

a damper fluid disposed within the chamber formed between the frame member and the damper member;

wherein upon activating the drug delivery device to administer a medicament to a user, the frame member and the damper member rotate relative to each other and the damper fluid exerts an opposing force on at least one of the frame member and the damper member.

[0007] ~~In accordance with a first aspect,~~ There is provided a drug delivery device includes a housing defining a shell having a proximal and a distal end, a needle assembly at least partially disposed within the housing at the proximal end, a drive assembly at least partially disposed within the housing, and a damper mechanism at least partially disposed within the housing at the distal end. The housing further defines a longitudinal axis extending between the proximal end and the distal end. The needle assembly includes a syringe barrel containing a medicament and a needle or a cannula. The drive assembly is operably coupled to the needle assembly to urge the medicament through the needle or cannula. The damper mechanism is operably coupled to the drive assembly and the housing. Upon activating the drive assembly, the damper mechanism dampens an effect thereof. In some examples, the syringe barrel may be constructed from a polymeric material. The medicament may have a viscosity of less than approximately 10cP at approximately 21 degrees Celsius.

[0008] In this ~~aspect~~example, the damper mechanism includes a frame member, a damper member operably coupled to the drive assembly, a chamber formed between a portion of the frame member and the damper member, and a damper fluid disposed within the chamber. In some forms the frame member may be formed integrally with the housing. Upon activating the drive assembly of the drug delivery device, the frame member and the damper member rotate relative to each other, and the damper fluid exerts an opposing force on at least one of the frame member and the damper member.

[0009] In some approaches, the drug delivery device may also include an excess chamber fluidly coupled to the chamber. This excess chamber is adapted to receive excess damper fluid. Further, in some forms, the device may include a seal disposed near the chamber to retain the damper fluid within the chamber. In some ~~aspects~~examples, the chamber is axially aligned with the longitudinal axis. In other approaches, the chamber may be partially axially aligned with the longitudinal axis and may be partially transversely aligned therewith. In yet other approaches, the chamber may be transversely aligned with the longitudinal axis.

[0010] In any of these examples, the drive assembly may include a plunger assembly including a threaded plunger rod and a plunger face, a plunger rod guide coupled to the plunger assembly, and a torque spring coupled to the plunger rod guide. The plunger face is disposed near the needle assembly and is movable along the longitudinal axis of the housing. The plunger rod guide guides rotational movement of the plunger assembly and is operably coupled to one of the frame member or the damper member. The torque spring exerts a force on the plunger rod guide that causes the plunger rod guide to rotate. Rotation of the plunger rod guide causes the plunger assembly to advance towards the proximal end of the housing to urge the medicament through the needle assembly. The plunger assembly may additionally include a clearance of greater than approximately 10mm between the threaded plunger rod and the plunger face. Further, the syringe barrel may contain at least approximately 1mL of medicament that has a viscosity of at least approximately 4cP. Other examples are possible.

[0011] Further, in any of the foregoing examples, the damper mechanism can exert an opposing force on the drive assembly, or on at least one component operably coupled with the drive assembly.

[0012] ~~In accordance with another aspect,~~There is provided a damper mechanism for a drug delivery device includes a frame member, a damper member operably coupled to a drive assembly of the drug delivery device, a chamber formed between a portion of the frame member and the damper member, and a damper fluid disposed within the chamber. Upon activating the drug delivery device to administer a medicament to a user, the frame member and the damper member rotate relative to each other and the damper fluid exerts an opposing force on at least one of the frame member and the damper member.

[0013] ~~In accordance with yet another aspect,~~There is provided an autoinjector includes a housing defining a shell having a proximal end, a distal end, and a longitudinal axis extending therebetween, a needle assembly at least partially disposed within the housing at the proximal end thereof, and a drive assembly at least partially disposed within the housing. The needle assembly includes a syringe barrel containing a medicament and a needle or a cannula. The drive assembly is operably coupled to the needle assembly to urge the medicament through the needle or cannula. The drive assembly includes a plunger assembly having a plunger rod and a plunger face being disposed near the needle assembly and being moveable along the longitudinal axis of the housing. The syringe barrel is adapted to contain at least approximately 1mL of medicament having a viscosity of at least approximately 4cP. The plunger rod and the plunger face have an initial clearance of greater than approximately 10mm.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] The above needs are at least partially met through provision of the torque driven drug delivery device described in the following detailed description, particularly when studied in conjunction with the drawings, wherein:

[0015] Fig. 1 illustrates a cross-sectional view of an example torque driven drug delivery device having a damper mechanism in accordance with various embodiments;

[0016] Fig. 2 illustrates a close-up cross-sectional view of the damper mechanism of the example drug delivery device of Fig. 1 in accordance with various embodiments;

What is claimed is:

1. A drug delivery device comprising:

a housing defining a shell having a proximal end, a distal end, and a longitudinal axis extending between the proximal end and the distal end thereof;

a needle assembly at least partially disposed within the housing at the proximal end thereof, the needle assembly comprising a syringe barrel containing a medicament and a needle or a cannula;

a drive assembly at least partially disposed within the housing and operably coupled to the needle assembly to urge the medicament through the needle or cannula; and

a damper mechanism at least partially disposed within the housing adjacent to the distal end thereof, the damper mechanism being operably coupled to the drive assembly and the housing, wherein upon activating the drive assembly, the damper mechanism dampens an effect thereof.

2. The drug delivery device of claim 1, wherein the damper mechanism comprises:

a frame member;

a damper member operably coupled to the drive assembly;

a chamber formed between a portion of the frame member and the damper member; and

a damper fluid disposed within the chamber formed between the frame member and the damper member;

wherein upon activating the drive assembly of the drug delivery device, the frame member and the damper member rotate relative to each other and the damper fluid exerts an opposing force on at least one of the frame member and the damper member.

3. The drug delivery device of claim 2, wherein the frame member is integrally formed with the housing.

4. The drug delivery device of claim 2 or 3, further comprising an excess chamber fluidly coupled to the chamber, the excess chamber adapted to receive excess damper fluid.

5. The drug delivery device of any one of claims 2-4, further comprising a seal disposed near the chamber to retain the damper fluid within the chamber.

6. The drug delivery device of any one of claims 2-5, wherein the chamber is axially aligned with the longitudinal axis.

7. The drug delivery device of any one of claims 2-6, wherein the chamber is partially axially aligned and partially transversely aligned with the longitudinal axis.

8. The drug delivery device of any one of claims 2-5, wherein the chamber is transversely aligned with the longitudinal axis.

9. The drug delivery device of any one of claims 2-8, wherein the drive assembly comprises:

a plunger assembly comprising a threaded plunger rod and a plunger face being disposed near the needle assembly and being moveable along the longitudinal axis of the housing;

a plunger rod guide coupled to the plunger assembly to guide rotational movement of the plunger assembly, the plunger rod guide further being operably coupled to one of the frame member or the damper member; and

a torque spring coupled to the plunger rod guide to exert a force on the plunger rod guide that causes the plunger rod guide to rotate, wherein rotation of the plunger rod guide causes the plunger assembly to advance towards the proximal end of the housing to urge the medicament through the needle assembly.

10. The drug delivery device of claim 9, wherein the plunger assembly includes a clearance of greater than 10mm between the threaded plunger rod and the plunger face, wherein the syringe barrel is adapted to contain at least approximately 1mL of medicament having a viscosity of at least approximately 4cP.

11. The drug delivery device of any one of the preceding claims, wherein the damper mechanism exerts an opposing force on the drive assembly.

12. The drug delivery device of any one of claims 1-10, wherein the damper mechanism exerts an opposing force on at least one component operably coupled with the drive assembly.

13. A damper mechanism for a drug delivery device comprising:

a frame member;

a damper member operably coupled to a drive assembly of the drug delivery device;

a chamber formed between a portion of the frame member and the damper member; and

a damper fluid disposed within the chamber formed between the frame member and the damper member;

wherein upon activating the drug delivery device to administer a medicament to a user, the frame member and the damper member rotate relative to each other and the damper fluid exerts an opposing force on at least one of the frame member and the damper member.

14. The damper mechanism of claim 13, wherein the frame member is formed integrally with a housing of the drug delivery device.

15. The damper mechanism of claim 13 or 14, wherein the damper member defines a channel, and the frame member defines protrusion extending inwardly into channel.

16. The damper mechanism of claim 13 or 14, wherein the frame member defines an elongated platform having an opening and the damper member defines a disk having a protrusion disposed through the platform opening, wherein the chamber is formed by the volume between the elongated platform and the disk.

17. The damper mechanism of any one of claims 13-16, further comprising an excess chamber fluidly coupled to the chamber, the excess chamber adapted to receive excess damper fluid.

18. The damper mechanism of any one of claims 13-17, further comprising a seal disposed near the chamber to retain the damper fluid within the chamber.

19. The damper mechanism of any one of claims 13-18, wherein the chamber is axially aligned with the longitudinal axis.

20. The damper mechanism of any one of claims 13-19, wherein the chamber is partially axially aligned and partially transversely aligned with the longitudinal axis.

21. The damper mechanism of any one of claims 13-18, wherein the chamber is transversely aligned with the longitudinal axis.

22. The damper mechanism of any one of claims 13-21, wherein the damper assembly is adapted to engage at least one of a housing of a drug delivery device or a drive assembly of the drug delivery device.

23. The damper mechanism of claim 22, wherein the damper mechanism is adapted to be assembled to the drug delivery device via an axial assembly.

24. An autoinjector comprising:

a housing defining a shell having a proximal end, a distal end, and a longitudinal axis extending between the proximal end and the distal end thereof;

a needle assembly at least partially disposed within the housing at the proximal end thereof, the needle assembly comprising a syringe barrel containing a medicament and a needle or a cannula; and

a drive assembly at least partially disposed within the housing and operably coupled to the needle assembly to urge the medicament through the needle or cannula, the drive assembly including a plunger assembly having a plunger rod and a plunger face being disposed near the needle assembly and being moveable along the longitudinal axis of the housing;

~~wherein the syringe barrel is adapted to contain at least approximately 1mL of medicament having a viscosity of at least approximately 4cP, and wherein the plunger rod and the plunger face have an initial clearance of greater than approximately 10mm.~~

1. A drug delivery device comprising:

a housing defining a shell having a proximal end, a distal end, and a longitudinal axis extending between the proximal end and the distal end thereof;

a needle assembly at least partially disposed within the housing at the proximal end thereof, the needle assembly comprising a syringe barrel containing a medicament and a needle or a cannula;

a drive assembly at least partially disposed within the housing and operably coupled to the needle assembly to urge the medicament through the needle or cannula; and

a damper mechanism at least partially disposed within the housing adjacent to the distal end thereof, the damper mechanism being operably coupled to the drive assembly and the housing, wherein upon activating the drive assembly, the damper mechanism exerts a torque on the drive assembly to dampen an effect of the drive assembly.

2. The drug delivery device of claim 1, wherein the damper mechanism comprises:

a frame member;

a damper member operably coupled to the drive assembly;

a chamber formed between a portion of the frame member and the damper member; and

a damper fluid disposed within the chamber formed between the frame member and the damper member;

wherein upon activating the drive assembly of the drug delivery device, the frame member and the damper member rotate relative to each other and the damper fluid exerts an opposing force on at least one of the frame member and the damper member.

3. The drug delivery device of claim 2, wherein the frame member is integrally formed with the housing.

4. The drug delivery device of claim 2, further comprising an excess chamber fluidly coupled to the chamber, the excess chamber adapted to receive excess damper fluid.

5. The drug delivery device of claim 2, further comprising a seal disposed near the chamber to retain the damper fluid within the chamber.

6. The drug delivery device of claim 2, wherein the chamber is one of (a) through (c):

(a) axially aligned with the longitudinal axis,

(b) partially axially aligned and partially transversely aligned with the longitudinal axis, or

(c) transversely aligned with the longitudinal axis.

7. The drug delivery device of claim 2, wherein the drive assembly comprises:

a plunger assembly comprising a threaded plunger rod and a plunger face being disposed near the needle assembly and being moveable along the longitudinal axis of the housing;

a plunger rod guide coupled to the plunger assembly to guide rotational movement of the plunger assembly, the plunger rod guide further being operably coupled to one of the frame member or the damper member; and

a torque spring coupled to the plunger rod guide to exert a force on the plunger rod guide that causes the plunger rod guide to rotate, wherein rotation of the plunger rod guide causes the plunger assembly to advance towards the proximal end of the housing to urge the medicament through the needle assembly.

8. The drug delivery device of claim 7, wherein the plunger assembly includes a clearance of greater than 10mm between the threaded plunger rod and the plunger face, wherein the syringe barrel is adapted to contain at least approximately 1mL of medicament having a viscosity of at least approximately 4cP.

9. The drug delivery device of claim 1, wherein the damper mechanism exerts an opposing force on the drive assembly.

10. The drug delivery device of claim 1, wherein the damper mechanism exerts an opposing force on at least one component operably coupled with the drive assembly.

11. A damper mechanism for a drug delivery device comprising:

a frame member;

a damper member operably coupled to a drive assembly of the drug delivery device;

a chamber formed between a portion of the frame member and the damper member; and

a damper fluid disposed within the chamber formed between the frame member and the damper member;

wherein upon activating the drug delivery device to administer a medicament to a user, the frame member and the damper member rotate relative to each other and the damper fluid exerts an opposing force on at least one of the frame member and the damper member.

12. The damper mechanism of claim 11, wherein the frame member is formed integrally with a housing of the drug delivery device.

13. The damper mechanism of claim 11, wherein the damper member defines a channel, and the frame member defines protrusion extending inwardly into channel.

14. The damper mechanism of claim 11, wherein the frame member defines an elongated platform having an opening and the damper member defines a disk having a protrusion disposed through the platform opening, wherein the chamber is formed by the volume between the elongated platform and the disk.

15. The damper mechanism of claim 11, further comprising an excess chamber fluidly coupled to the chamber, the excess chamber adapted to receive excess damper fluid.

16. The damper mechanism of claim 11, further comprising a seal disposed near the chamber to retain the damper fluid within the chamber.

17. The damper mechanism of claim 11 wherein the chamber is one of (a) through (c):

(a) axially aligned with the longitudinal axis,

(b) partially axially aligned and partially transversely aligned with the longitudinal axis, or

(c) transversely aligned with the longitudinal axis.

18. The damper mechanism of claim 11, wherein the damper assembly is adapted to engage at least one of a housing of a drug delivery device or a drive assembly of the drug delivery device.

19. The damper mechanism of claim 18, wherein the damper mechanism is adapted to be assembled to the drug delivery device via an axial assembly.