

INJECTION SYSTEMS FOR DRUG DELIVERY
WITH INTERNAL FORCE TRANSMISSION

CROSS-REFERENCE TO RELATED APPLICATION

[0001] Priority is claimed to United States Provisional Patent Application No. 62/740,232, filed October 2, 2018, the entire contents of which are hereby incorporated by reference.

FIELD OF DISCLOSURE

[0002] The present disclosure generally relates to injection systems for drug delivery and, more particularly, managing internal forces generated within such systems.

BACKGROUND

[0003] Injectable drugs are conventionally administered through the use of a needle attached to a syringe. The needle is manually inserted into a patient's tissue, and a plunger is then manually displaced to eject a drug from a reservoir into the patient. Use of a syringe to self-administer a drug can be cumbersome and/or uncomfortable for certain patients, particularly those having little or no experience with operating syringes. As such, patients often resort to automated injection systems to assist with the injection. Such systems generally provide the actuation energy necessary to insert the needle or cannula and/or expel the drug from the reservoir.

[0004] Storing and/or releasing actuation energy creates mechanical stress in various components of the injection system. The stress can be significant, particularly in applications involving the injection of a high viscosity drug. Further, the stress may be present before, during, and even after the injection takes place. To ensure that such stress does not compromise the integrity of the injection system, it may be necessary to construct various components within certain design parameters, including, for example, having no less than a certain thickness and/or material strength. Typically the outer casing or housing of the injection system is required to bear at least some of the stress. This can place limitations on the shape and/or material used for the outer casing, which in turn can affect the patient/user experience.

[0005] As set forth in more detail below, the present disclosure sets forth injection systems embodying advantageous alternatives to the existing injection systems, and that may address one or more of the challenges or needs mentioned herein, as well as provide other benefits and advantages.

SUMMARY

[0006] According to a first aspect of the present invention, there is provided a system for injecting a drug, comprising: an outer housing defining an interior space and configured to be held by a patient or user during an injection; a container filled or fillable with the drug, at least a portion of the container being disposed in the interior space of the outer housing; a stopper

movably disposed in the container for expelling the drug from the container; a plunger for acting on the stopper; an energy source outputting or operable to output a force, at least a portion of the energy source being disposed in the interior space of the outer housing; a mechanical linkage operable to transmit the force output by the energy source to the plunger to cause the plunger to act on the stopper to expel the drug; a trigger member selectively engageable with the mechanical linkage to control actuation of the mechanical linkage; the system having a pre-injection state, wherein the trigger member inhibits actuation of the mechanical linkage, and an injection state, wherein the trigger member permits actuation of the mechanical linkage; and wherein the outer housing is substantially free of any load directly or indirectly caused by the force output by the energy source in the pre-injection state and/or the injection state.

[0007]

According to a second aspect of the present invention, there is provided a system for injecting a drug, comprising: a housing defining at least a portion of an exterior surface of the system; a container filled or fillable with the drug, at least a portion of the container being disposed in the housing; a stopper movably disposed in the container for expelling the drug from the container; a plunger for acting on the stopper; an energy source outputting or operable to output a force, at least a portion of the energy source being disposed in the housing; a mechanical linkage operable to transmit the force output by the energy source to the plunger to cause the plunger to act on the stopper to expel the drug; a trigger member selectively engageable with the mechanical linkage to control actuation of the mechanical linkage; the system having a pre-injection state, wherein the trigger member inhibits actuation of the mechanical linkage, and an injection state, wherein the trigger member permits actuation of the mechanical linkage; and wherein, in the pre-injection state, at least the energy source, the plunger, the mechanical linkage, and the trigger member are operably connected in series to define a first force transmission loop, wherein the first force transmission loop directly or indirectly receives the force output by the energy source, and wherein the housing is excluded from the first force transmission loop in the pre-injection state such that the housing is substantially free of any load directly or indirectly caused by the force output by the energy source in the pre-injection state.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] 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.

[0009] Fig. 1 is a cross-sectional view of an injection system for drug delivery in a pre-injection state according to an embodiment of the present disclosure, and illustrating a first force transmission loop within the system.

[0010] Fig. 2A is a cross-sectional view of the embodiment of the injection system of Fig. 1 in an injection state, and depicting a second force transmission loop within the system.

[0011] Fig. 2B is a cross-sectional view of the embodiment of the injection system of Fig. 1 in the injection state, and illustrating a third force transmission loop within the system.

[0012] Fig. 2C is a cross-sectional view of the embodiment of the injection system of Fig. 1 in the injection state, and depicting a fourth force transmission loop within the system.

[0013] Fig. 3A is a cross-sectional view of the embodiment of the injection system of Fig. 1 in a post-injection state, and depicting a fifth force transmission loop within the system.

[0014] Fig. 3B is a cross-sectional view of the embodiment of the injection system of Fig. 1 in the post-injection state, and illustrating a sixth force transmission loop within the system.

[0015] Fig. 4 is a cross-sectional view of an injection system for drug delivery in a pre-injection state according to an alternative embodiment of the present disclosure, and illustrating an alternate version of the first force transmission loop within the system.

[0016] Fig. 5 is a cross-sectional view of an injection system for drug delivery in an injection state according to an alternative embodiment of the present disclosure, and illustrating an alternate version of the third force transmission loop within the system.

[0017] Fig. 6 is a cross-sectional view of an injection system for drug delivery in a post-injection state according to an alternative embodiment of the present disclosure, and depicting an alternate version of the fifth force transmission loop within the system.

[0018] Fig. 7 is a cross-sectional view of an injection system for drug delivery in a post-injection state according to an alternative embodiment of the present disclosure, and illustrating an alternate version of the sixth force transmission loop within the system.

DETAILED DESCRIPTION

[0019] The present disclosure generally relates to the configuration and operation of an injection system for drug delivery. While most embodiments are described in the context of a hand-held injector such as autoinjector, the scope of the present disclosure is not limited to such injectors. Other injection systems for which the present disclosure is applicable include, without

What is claimed is:

1. A system for injecting a drug, comprising:
 - an outer housing defining an interior space and configured to be held by a patient or user during an injection;
 - a container filled or fillable with the drug, at least a portion of the container being disposed in the interior space of the outer housing;
 - a stopper movably disposed in the container for expelling the drug from the container;
 - a plunger for acting on the stopper;
 - an energy source outputting or operable to output a force, at least a portion of the energy source being disposed in the interior space of the outer housing;
 - a mechanical linkage operable to transmit the force output by the energy source to the plunger to cause the plunger to act on the stopper to expel the drug;
 - a trigger member selectively engageable with the mechanical linkage to control actuation of the mechanical linkage;
 - the system having a pre-injection state, wherein the trigger member inhibits actuation of the mechanical linkage, and an injection state, wherein the trigger member permits actuation of the mechanical linkage; and
 - wherein the outer housing is substantially free of any load directly or indirectly caused by the force output by the energy source in the pre-injection state and/or the injection state.
2. The system of claim 1, wherein, in the pre-injection state, at least the energy source, the plunger, the mechanical linkage, and the trigger member are operably connected in series to define a first force transmission loop, the first force transmission loop directly or indirectly receiving the force output by the energy source.
3. The system of claim 1, the mechanical linkage including a nut and a plunger sleeve, the nut threadably engaging the plunger and being operably connected to the energy source via the plunger sleeve, the plunger sleeve receiving at least a portion of the plunger in the pre-injection state.
4. The system of claim 1, comprising an energy source guide receiving at least a portion of the energy source, and the mechanical linkage including a plunger sleeve receiving at least a portion of the plunger.
5. The system of claim 1, the plunger having a threaded interior surface threadably engaging a threaded exterior surface of the container.
6. The system of claim 1, comprising:
 - the mechanical linkage including a plunger sleeve receiving at least a portion of the plunger;
 - a damper operable to reduce a velocity of the plunger prior to acting on the stopper;

a damper housing receiving at least a portion of the damper;
an energy source guide receiving at least a portion of the energy source; and
an energy source housing receiving at least a portion of the energy source guide.

7. The system of claim 6, comprising:

the mechanical linkage including a nut threadably engaging the plunger; and
a container holder receiving at least a portion of the container.

8. The system of claim 1, comprising:

the mechanical linkage including a nut threadably engaging the plunger;
a container holder receiving at least a portion of the container; and

wherein the system has a post-injection state wherein the plunger is stationarily positioned in an end-of-dose position, and wherein the outer housing does not bear any load caused by the force output by the energy source in the pre-injection state, the injection state, and/or the post-injection state.

9. The system of claim 1, comprising:

the mechanical linkage including a nut and a plunger sleeve, the nut threadably engaging the plunger and being operably connected to the energy source via the plunger sleeve;

an energy source guide receiving at least a portion of the energy source;

an energy source housing receiving at least a portion of the energy source guide; and

wherein the system has a post-injection state wherein the plunger is stationarily positioned in an end-of-dose position.

10. The system of claim 1, wherein the outer housing does not bear any load caused by the force output by the energy source in the pre-injection state and/or the injection state.

11. A system for injecting a drug, comprising:

a housing defining at least a portion of an exterior surface of the system;

a container filled or fillable with the drug, at least a portion of the container being disposed in the housing;

a stopper movably disposed in the container for expelling the drug from the container;

a plunger for acting on the stopper;

an energy source outputting or operable to output a force, at least a portion of the energy source being disposed in the housing;

a mechanical linkage operable to transmit the force output by the energy source to the plunger to cause the plunger to act on the stopper to expel the drug;

a trigger member selectively engageable with the mechanical linkage to control actuation of the mechanical linkage;

the system having a pre-injection state, wherein the trigger member inhibits actuation of the mechanical linkage, and an injection state, wherein the trigger member permits actuation of the mechanical linkage; and

wherein, in the pre-injection state, at least the energy source, the plunger, the mechanical linkage, and the trigger member are operably connected in series to define a first force transmission loop, wherein the first force transmission loop directly or indirectly receives the force output by the energy source, and wherein the housing is excluded from the first force transmission loop in the pre-injection state such that the housing is substantially free of any load directly or indirectly caused by the force output by the energy source in the pre-injection state.

12. The system of claim 11, wherein, in the pre-injection state, the first force transmission loop is restricted to the operable connection among the energy source, the plunger, and the mechanical linkage.

13. The system of claim 11, comprising:

the mechanical linkage including a nut and a plunger sleeve, the nut threadably engaging the plunger and being operably connected to the energy source via the plunger sleeve, the plunger sleeve receiving at least a portion of the plunger in the pre-injection state;

an energy source guide receiving at least a portion of the energy source; and

an energy source housing receiving at least a portion of the energy source guide.

14. The system of claim 11, comprising:

an energy source guide receiving at least a portion of the energy source; and

the mechanical linkage including a plunger sleeve receiving at least a portion of the plunger.

15. The system of claim 11, the plunger threadably engaging a threaded exterior surface of the container.

16. The system of claim 11, comprising:

the mechanical linkage including a plunger sleeve receiving at least a portion of the plunger;

a damper operable to reduce a velocity of the plunger prior to acting on the stopper;

a damper housing receiving at least a portion of the damper;

an energy source guide receiving at least a portion of the energy source; and

an energy source housing receiving at least a portion of the energy source guide.

17. The system of claim 11, comprising:

the mechanical linkage including a nut threadably engaging the plunger; and
a container holder receiving at least a portion of the container.

18. The system of claim 11, comprising:

the mechanical linkage including a nut threadably engaging the plunger;
a container holder receiving at least a portion of the container; and
wherein the system has a post-injection state wherein the plunger is stationarily positioned in an end-of-dose position.

19. The system of claim 11, comprising:

the mechanical linkage including a nut and a plunger sleeve, the nut threadably engaging the plunger and being operably connected to the energy source via the plunger sleeve;
an energy source guide receiving at least a portion of the energy source;
an energy source housing receiving at least a portion of the energy source guide; and
wherein the system has a post-injection state wherein the plunger is stationarily positioned in an end-of-dose position.

20. The system of claim 11, comprising:

a nut threadably engaging the plunger;
a container holder receiving at least a portion of the container;
a front housing receiving at least a portion of the container holder; and
a rear housing receiving at least a portion of the energy source; and
wherein the system has a post-injection state wherein the plunger is stationarily positioned in an end-of-dose position.