

**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] ~~One aspect of the present disclosure provides a system for injecting a drug. The system may include an outer housing defining an interior space and configured, in some embodiments, to be held by a patient or user during an injection. A container may be disposed or disposable in the interior space of the outer housing, and may be filled or fillable with the drug. A stopper may be movably disposed in the container for expelling the drug from the container. The system may include a drive assembly including a plunger for acting on the stopper, an energy source outputting or operable to output a force, and 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 may selectively engage the mechanical linkage to control actuation of the mechanical linkage. In a pre-injection state, the trigger member may inhibit actuation of the mechanical linkage; whereas, in an injection state, the trigger member may permit actuation of the mechanical linkage. The system may also have a post-injection state wherein the plunger is stationarily positioned in an end-of-dose position. The outer housing may be configured so that it is substantially free of or 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. 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] ~~Another aspect of the present disclosure provides a system for injecting a drug. The system may include a container filled or fillable with the drug, and a stopper movably disposed in the container for expelling the drug from the container. The system may include a drive assembly including a plunger for acting on the stopper, an energy source outputting or operable to~~

output a force, and 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 may selectively engage the mechanical linkage to control actuation of the mechanical linkage. In a pre-injection state, the trigger member may inhibit actuation of the mechanical linkage; whereas, in an injection state, the trigger member may permit actuation of the mechanical linkage. The system may also have a post-injection state wherein the plunger is stationarily positioned in an end-of-dose position. In the pre-injection state, at least the energy source, the plunger, the mechanical linkage, and the trigger member may be operably connected in series to define a first force transmission loop, and wherein the first force transmission loop directly or indirectly receives the force output by the energy source. 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 disposed or disposable in the interior space, and filled or fillable with the drug;
 - 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;
 - 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 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 any one of claims 1 or 2, 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 3, comprising:
 - 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.
5. The system of claim 4, wherein the energy source guide and the energy source housing are disposed within the interior space of the outer housing.
6. The system of any one of claims 4 or 5, wherein, in the pre-injection state, the energy source directly contacts the plunger sleeve, the plunger sleeve directly contacts the trigger member, the trigger member directly contacts the nut, the nut directly contacts the energy source housing, the energy source housing directly contacts the energy source guide, and the energy source guide directly contacts the energy source.
7. The system of any one of claims 4 to 6, wherein, in the pre-injection state, the first force transmission loop is restricted to the operable connection among the energy source, the plunger sleeve, the trigger member, the nut, the energy source housing, and the energy source guide.
8. The system of any one of claims 1 or 2, 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.

9. The system of claim 8, wherein, in the pre-injection state, the energy source directly contacts the plunger sleeve, the plunger sleeve directly contacts the trigger member, the trigger member directly contacts the energy source guide, and the energy source guide directly contacts the energy source.

10. The system of any one of claims 8 or 9, wherein, in the pre-injection state, the first force transmission loop is restricted to the operable connection among the energy source, the plunger sleeve, the trigger member, and the energy source guide.

11. The system of claim 1, the plunger having a threaded interior surface threadably engaging a threaded exterior surface of the container.

12. The system of claim 11, wherein, in the injection state, at least the plunger, the stopper, and the container are operably connected in series to define a third force transmission loop, and wherein the third force transmission loop directly or indirectly receives the force output by the energy source.

13. The system of claim 12, wherein, in the injection state, the plunger directly contacts the stopper or a washer arranged between the plunger and the stopper, the stopper directly contacts the container, and the container directly contacts the plunger.

14. The system of any one of claims 12 or 13, the third force transmission loop being restricted to the operable connection among the plunger, the stopper, and the container.

15. The system of any one of claims 1 to 7, 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.

16. The system of claim 15, wherein, in the injection state, at least the energy source, the plunger sleeve, the damper, the damper housing, the energy source housing, and the energy source guide are operably connected in series to define a second force transmission loop, and wherein the second force transmission loop directly or indirectly receives the force output by the energy source.

17. The system of claim 16, wherein, in the injection state, the energy source directly contacts the plunger sleeve, the plunger sleeve directly contacts the damper, the damper directly contacts the damper housing, the energy source housing directly contacts the energy source guide, and the energy source guide directly contacts the energy source.

18. The system of any one of claims 16 or 17, the second force transmission loop being restricted to the operable connection among the energy source, the plunger sleeve, the damper, the damper housing, the energy source housing, and the energy source guide.

19. The system of any one of claims 1 to 7 or 15 to 18, comprising:
the mechanical linkage including a nut threadably engaging the plunger; and
a container holder receiving at least a portion of the container.
20. The system of claim 19, wherein, in the injection state, at least the nut, the plunger, the stopper, the container, and the container holder are operably connected in series to define a third force transmission loop, and wherein the third force transmission loop directly or indirectly receives the force output by the energy source.
21. The system of claim 20, wherein, in the injection state, the nut directly contacts the plunger, the plunger directly contacts the stopper, the stopper directly contacts the container, the container directly contacts the container holder, and the container holder directly contacts the nut.
22. The system of any one of claims 20 or 21, the third force transmission loop being restricted to the operable connection among the nut, the plunger, the stopper, the container, and the container holder.
23. The system of any one of claims 4 to 7 or 15 to 22, wherein, in the injection state, at least the energy source, the plunger sleeve, the plunger, the nut, the energy source housing, and the energy source guide are operably connected in series to define a fourth force transmission loop, and wherein the fourth force transmission loop directly or indirectly receives the force output by the energy source.
24. The system of claim 23, wherein, in the injection state, the energy source directly contacts the plunger sleeve, the plunger sleeve directly contacts the plunger, the plunger directly contacts the nut, the nut directly contacts the energy source housing, the energy source housing directly contacts the energy source guide, and the energy source guide directly contacts the energy source.
25. The system of any one of claims 23 or 24, wherein, in the injection state, the fourth force transmission loop is restricted to the operable connection among the energy source, the plunger sleeve, the plunger, the nut, the energy source housing, and the energy source guide.
26. The system of any one of claims 1 to 7 or 15 to 25, 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.
27. The system of claim 26, wherein, in the post injection state, at least the nut, the plunger, the stopper, the container, and the container holder are operably connected in series to define a fifth force transmission loop, and wherein the fifth force transmission loop directly or indirectly receives the force output by the energy source.

28. The system of claim 27, wherein, in the post-injection state, the nut directly contacts the plunger, the plunger directly contacts the stopper, the stopper directly contacts the container, the container directly contacts the container holder, and the container holder directly contacts the nut.

29. The system of any one of claims 27 or 28, wherein, in the post injection state, the fifth force transmission loop is restricted to the operable connection among the nut, the plunger, the stopper, the container, and the container holder.

30. The system of any one of claims 1 to 7 or 15 to 29, 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.

31. The system of claim 30, wherein, in the post injection state, at least the energy source, the plunger sleeve, the plunger, the nut, the energy source housing, and the energy source guide are operably connected in series to define a sixth force transmission loop, and wherein the sixth force transmission loop directly or indirectly receives the force output by the energy source.

32. The system of claim 31, wherein, in the post injection state, the energy source directly contacts the plunger sleeve, the plunger sleeve directly contacts the plunger, the plunger directly contacts the nut, the nut directly contacts the energy source housing, the energy source housing directly contacts the energy source guide, and the energy source guide directly contacts the energy source.

33. The system of any one of claims 31 or 32, wherein, in the post injection state, the sixth force transmission loop is restricted to the operable connection among the energy source, the plunger sleeve, the plunger, the nut, the energy source housing, and the energy source guide.

34. The system of any one of claims 1 to 7 or claims 15 to 25, 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;

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.

35. The system of claim 34, wherein, in the post-injection state, at least the energy source, the plunger sleeve, the plunger, the stopper, the container, the container holder, the nut, the energy source housing, and the energy source guide are operably connected in series to define a sixth force transmission loop, and wherein the sixth force transmission loop directly or indirectly receives the force output by the energy source.

36. The system of claim 35, wherein, in the post-injection state, the energy source directly contacts the plunger sleeve, the plunger sleeve directly contacts the plunger, the plunger directly contacts the stopper, the stopper directly contacts the container, the container directly contacts the container holder, the container holder directly contacts the nut, the nut directly contacts the energy source housing, and the energy source housing directly contacts the energy source guide.

37. The system of any one of claims 35 or 36, wherein, in the post-injection state, the sixth force transmission loop is restricted to the operable connection among the energy source, the plunger sleeve, the plunger, the stopper, the container, the container holder, the nut, the energy source housing, and the energy source guide.

38. The system of any one of claims 1 to 37, the energy source comprising: a helical compression spring, a helical extension spring, a helical torsion spring, and/or a spiral torsion spring.

39. The system of any one of claims 2 to 39, the first force transmission loop comprising one or more reaction forces induced by the force output by the energy source.

40. The system of any one of claims 1 to 39, 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.

41. A system for injecting a drug, comprising:

a container filled or fillable with the drug;

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;

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, and wherein the first force transmission loop directly or indirectly receives the force output by the energy source.

42. The system of claim 41, 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.

43. The system of claim 41, 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.

44. The system of claim 43, wherein, in the pre-injection state, the energy source directly contacts the plunger sleeve, the plunger sleeve directly contacts the trigger member, the trigger member directly contacts the nut, the nut directly contacts the energy source housing, the energy source housing directly contacts the energy source guide, and the energy source guide directly contacts the energy source.

45. The system of any one of claims 43 or 44, wherein, in the pre-injection state, the first force transmission loop is restricted to the operable connection among the energy source, the plunger sleeve, the trigger member, the nut, the energy source housing, and the energy source guide.

46. The system of claim 41, 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.

47. The system of claim 46, wherein, in the pre-injection state, the energy source directly contacts the plunger sleeve, the plunger sleeve directly contacts the trigger member, the trigger member directly contacts the energy source guide, and the energy source guide directly contacts the energy source.

48. The system of any one of claims 46 or 47, wherein, in the pre-injection state, the first force transmission loop is restricted to the operable connection among the energy source, the plunger sleeve, the trigger member, and the energy source guide.

49. The system of any one of claims 41 or 42, the plunger threadably engaging a threaded exterior surface of the container.

50. The system of claim 49, wherein, in the injection state, at least the plunger, the stopper, and the container are operably connected in series to define a third force transmission loop, and wherein the third force transmission loop directly or indirectly receives the force output by the energy source.

51. The system of claim 50, wherein, in the injection state, the plunger directly contacts the stopper or a washer arranged between the plunger and the stopper, the stopper directly contacts the container, and the container directly contacts the plunger.

52. The system of any one of claims 50 or 51, the third force transmission loop being restricted to the operable connection among the plunger, the stopper, and the container.

53. The system of any one of claims 41 to 48, 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.

54. The system of claim 53, wherein, in the injection state, at least the energy source, the plunger sleeve, the damper, the damper housing, the energy source housing, and the energy source guide are operably connected in series to define a second force transmission loop, and wherein the second force transmission loop directly or indirectly receives the force output by the energy source.

55. The system of claim 54, wherein, in the injection state, the energy source directly contacts the plunger sleeve, the plunger sleeve directly contacts the damper, the damper housing directly contacts the energy source housing, the energy source housing directly contacts the energy source guide, and the energy source guide directly contacts the energy source.

56. The system of any one of claims 54 or 55, the second force transmission loop being restricted to the operable connection among the energy source, the plunger sleeve, the damper, the damper housing, the energy source housing, and the energy source guide.

57. The system of any one of claims 41 to 48 or 53 to 56, comprising:
the mechanical linkage including a nut threadably engaging the plunger; and
a container holder receiving at least a portion of the container.

58. The system of claim 57, wherein, in the injection state, at least the nut, the plunger, the stopper, the container, and the container holder are operably connected in series to define a third force transmission loop, and wherein the third force transmission loop directly or indirectly receives the force output by the energy source.

59. The system of claim 58, wherein, in the injection state, the nut directly contacts the plunger, the plunger directly contacts the stopper, the stopper directly contacts the container, the container directly contacts the container holder, and the container holder directly contacts the nut.

60. The system of any one of claims 44 to 48 or 53 to 59, wherein, in the injection state, at least the energy source, the plunger sleeve, the plunger, the nut, the energy source housing, and the energy source guide are operably connected in series to define a fourth force transmission loop, and wherein the fourth force transmission loop directly or indirectly receives the force output by the energy source.

61. The system of claim 60, wherein, in the injection state, the energy source directly contacts the plunger sleeve, the plunger sleeve directly contacts the plunger, the plunger directly contacts the nut, the nut directly contacts the energy source housing, the energy source housing directly contacts the energy source guide, and the energy source guide directly contacts the energy source.

62. The system of any of claims 60 or 61, wherein, in the injection state, the fourth force transmission loop is restricted to the operable connection among the energy source, the plunger sleeve, the plunger, the nut, the energy source housing, and the energy source guide.

63. The system of any of claims 41 to 48 or 53 to 62, 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.

_____ 64. The system of claim 63, wherein, in the post-injection state, at least the nut, the plunger, the stopper, the container, and the container holder are operably connected in series to define a fifth force transmission loop, and wherein the fifth force transmission loop directly or indirectly receives the force output by the energy source.

_____ 65. The system of claim 64, wherein, in the post-injection state, the nut directly contacts the plunger, the plunger directly contacts the stopper, the stopper directly contacts the container, the container directly contacts the container holder, and the container holder directly contacts the nut.

_____ 66. The system of any one of claims 64 or 65, wherein, in the post-injection state, the fifth force transmission loop is restricted to the operable connection among the nut, the plunger, the stopper, the container, and the container holder.

_____ 67. The system of any one of claims 41 to 48 or 53 to 66, 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.

_____ 68. The system of claim 67, wherein, in the post-injection state, at least the energy source, the plunger sleeve, the plunger, the nut, the energy source housing, and the energy source guide are operably connected in series to define a sixth force transmission loop, and wherein the sixth force transmission loop directly or indirectly receives the force output by the energy source.

_____ 69. The system of claim 68, wherein, in the post-injection state, the energy source directly contacts the plunger sleeve, the plunger sleeve directly contacts the plunger, the plunger directly contacts the nut, the nut directly contacts the energy source housing, the energy source housing directly contacts the energy source guide, and the energy source guide directly contacts the energy source.

_____ 70. The system of any one of claims 67 or 68, wherein, in the post-injection state, the sixth force transmission loop is restricted to the operable connection among the energy source, the plunger sleeve, the plunger, the nut, the energy source housing, and the energy source guide.

_____ 71. The system of any one of claims 41 to 48 or 53 to 62, 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;
_____ a container holder receiving at least a portion the container; and
_____ wherein the system has a post-injection state wherein the plunger is stationarily positioned in an end-of-dose position.

72. The system of claim 71, wherein, in the post-injection state, at least the energy source, the plunger sleeve, the plunger, the stopper, the container, the container holder, the nut, the energy source housing, and the energy source guide are operably connected in series to define a sixth force transmission loop, and wherein the sixth force transmission loop directly or indirectly receives the force output by the energy source.

73. The system of claim 72, wherein, in the post-injection state, the energy source directly contacts the plunger sleeve, the plunger sleeve directly contacts the plunger, the plunger directly contacts the stopper, the stopper directly contacts the container, the container directly contacts the container holder, the container holder directly contacts the nut, the nut directly contacts the energy source housing, and the energy source housing directly contacts the energy source guide.

74. The system of any one of claims 72 or 73, wherein, in the post-injection state, the sixth force transmission loop is restricted to the operable connection among the energy source, the plunger sleeve, the plunger, the stopper, the container, the container holder, the nut, the energy source housing, and the energy source guide.

75. The system of any one of claims 41 to 62, 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.

76. The system of claim 75, wherein, in the post-injection state, at least the nut, the plunger, the stopper, the container, the container holder, the front housing, and the rear housing are operably connected in series to define a fifth force transmission loop, and wherein the fifth force transmission loop receives the force output by the energy source.

77. The system of claim 76, wherein, in the post-injection state, the nut directly contacts the plunger, the plunger directly contacts the stopper, the stopper directly contacts the container, the container directly contacts the container holder, the container holder directly contacts the front housing, and the front housing directly contacts the rear housing.

78. The system of any one of claims 75 or 76, wherein, in the post-injection state, the fifth force transmission loop is restricted to the nut, the plunger, the stopper, the container, the container holder, the front housing, and the rear housing.

79. The system of any one of claims 41 to 78, the energy source comprising: a helical compression spring, a helical extension spring, a helical torsion spring, and/or a spiral torsion spring.

80. The system of any one of claims 41 to 79, the first force transmission loop comprising one or more reaction forces induced by the force output by the energy source.

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.