A handle assembly (100) for a hand-actuated fluid delivery device (10) is disclosed. The handle assembly (100) includes a first handle member (110) that is mounted on a pivot (126) fixed to a second handle member (120). A locking spring (130) is mounted on this pivot (126). This locking spring (130), together with a corresponding actuator (140), cooperate to selectively provide resistance to movement of a plunger (30) in an aspiration direction in at least certain conditions. Disposing the actuator (140) in a locking position disposes the locking spring (130) in a locking configuration. Sliding friction or sliding friction forces between the locking spring (130) and the pivot (126), with the locking spring (130) being in its locking configuration, provides resistance to movement of the first handle member (110) relative to the second handle member (120) in a manner that would move the plunger (30) in an aspiration direction.
HAND-ACTUATED FLUID DELIVERY DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This patent application is a non-provisional patent application of, and claims priority to, pending U.S. Provisional Patent Application Ser. No. 61/562,538, that is entitled “HAND-ACTUATED FLUID DELIVERY DEVICE,” that was filed on 22 Nov. 2011, and the entire disclosure of which is hereby incorporated by reference in its entirety herein.

FIELD OF THE INVENTION

[0002] The present invention generally relates to the field of fluid delivery devices that accommodate both injection and aspiration operations.

BACKGROUND

[0003] “Powered” syringes of various types (e.g., syringes that are driven by an appropriate power source) are used to inject various types of medical fluid into a patient. In at least certain situations, it remains desirable to manually inject medical fluid into a patient. Some of these hand-actuated fluid delivery devices are manually operable to not only inject medical fluid into a patient, but to draw fluid into the device as well (e.g., to aspirate bodily fluid into a barrel of a hand-actuated fluid delivery device; to draw a medical fluid into a barrel of a hand-actuated fluid delivery device for subsequent injection). A first type of relative movement between a pair of handle members of such a representative fluid delivery device may be used for a discharge operation (e.g., to move a plunger of the fluid delivery device in a discharge direction), and a second type of relative movement between this same pair of handle members may be used for an aspiration operation (e.g., to move a plunger of the fluid delivery device in an aspiration direction). At least certain hand-actuated fluid delivery devices actually bias a pair of handle members in a direction to move the corresponding plunger in an aspiration direction. Such an “automated” movement of a pair of handle members, to in turn move a plunger of the fluid delivery device in an aspiration direction, may not be desirable in all circumstances.

SUMMARY

[0004] First, second, and third aspects of the present invention are each generally directed to a hand-actuated fluid delivery device (e.g., a hand-powered injector or syringe). This hand-actuated fluid delivery device includes a barrel, a plunger, and a handle assembly. The plunger is movable relative to the barrel through operation of the handle assembly. That is, the handle assembly is interconnected with and operable to move the plunger relative to the barrel in both a discharge direction (e.g., where fluid may be discharged from the fluid delivery device, for instance for injection into a patient) and an aspiration direction (e.g., where fluid may be loaded into the interior of the barrel, including by a suction action or by drawing fluid into the barrel).

[0005] In the case of the first aspect, the hand-actuated fluid delivery device includes a plunger lock and an actuator. An entirety of a locking force that is provided by this plunger lock is in the form of sliding friction or sliding friction forces. The actuator is movable between locking and unlocking positions (e.g., to control the configuration or state of the plunger lock). The sliding friction or sliding friction forces for the plunger lock is in an active state with the actuator being in its locking position. In this locking configuration for the plunger lock, the plunger lock restrains movement of the plunger in the aspiration direction for at least certain conditions.

[0006] In the case of the second aspect, the hand-actuated fluid delivery device includes a locking spring. Moreover, the handle assembly includes a pivot, a first handle member, and a second handle member. This pivot is fixed to either the first or second handle member; and the other handle member is pivotable about this pivot to accommodate relative motion between the two handle members. The locking spring is wrapped around the pivot and is selectively disposable in a locking configuration to restrain movement of the plunger in the aspiration direction for at least certain conditions.

[0007] In the case of the third aspect, the hand-actuated fluid delivery device includes a locking spring and an actuator. Moreover, the handle assembly includes a pivot, a first handle member, and a second handle member. This pivot is fixed to the second handle member and the first handle member is pivotable relative to the second handle member about this pivot. The locking spring is wrapped around the pivot and includes first and second end portions. The first end portion of the locking spring is anchored relative to the first handle member. The second end portion of the locking spring is engaged with the actuator at least when the actuator is in its locking position. The actuator is mounted on the first handle member and is movable between its locking position and an unlocking position.

[0008] A number of feature refinements and additional features are separately applicable to each of the first, second, and third aspects of the present invention. These feature refinements and additional features may be used individually or in any combination in relation to each of the first, second, and third aspects of the present invention. As such, each of the following features that will be discussed may be, but are not required to be, used with any other feature or combination of features of each of the first, second, and third aspects of the present invention. The following discussion is separately applicable to each of the first, second, and third aspects of the present invention, up to the start of the discussion of a fourth aspect of the present invention.

[0009] The hand-actuated fluid delivery device may include what may be characterized as a plunger lock. The plunger lock may be of a configuration such that the entirety of the locking forces provided by the plunger lock, where these locking forces resist movement of the plunger in the aspiration direction, are in the form of sliding friction or sliding friction forces. The plunger lock may be in the form of a locking spring, such as a torsion spring. In one embodiment, tightening the locking spring disposes the same in a locking configuration, while unwinding or loosening the locking spring disposes the same in an unlocked configuration.

[0010] The hand-actuated fluid delivery device may include an actuator that is associated with a plunger lock or locking spring, where the plunger lock/locking spring is disposible into a locking configuration that resists movement of the plunger in the aspiration direction for at least certain conditions. The actuator may be movable between locking and unlocking positions in relation to the plunger lock/locking spring. Moving the actuator to its locking position may dispose the plunger lock/locking spring in its locking configuration. Moving the actuator to its unlocking position may allow the plunger lock/locking spring to change to an
unlocked configuration. In one embodiment, the actuator is movably mounted on one of the handle members of the handle assembly, for instance by a pivot pin or the like.

[0011] The handle assembly used by the hand-actuated fluid delivery device may include a pivot, a first handle member, and a second handle member. This pivot may be fixed to the second handle member and the first handle member may be pivotable relative to the second handle member about this pivot (e.g., the first handle member may be movably mounted on this pivot so as to be able to move/pivot relative to the second handle member). The locking spring may be wrapped around the pivot and may include first and second end portions. The first end portion of the locking spring may be appropriately anchored in some fashion relative to the first handle member, while the second end portion of the locking spring may be engaged with the above-noted actuator at least when the actuator is in its locking position. The locking spring could utilize its spring forces to bias the first end portion against a stop or fulcrum that is fixed relative to the first handle member. In this case, the first end portion of the locking spring may be maintained in a fixed position relative to the first handle member in at least certain instances (e.g., the first end portion could be moved away from such a stop or fulcrum against the biasing forces provided by the locking spring). The first end portion of the locking spring could be attached or fixed to the first handle member (e.g., so that at least part of this first end portion remains stationary relative to the first handle member at all times).

[0012] Disposing the actuator in its locking position may tighten the locking spring about the pivot (that may be fixed to the second handle member and on which the first handle member may be pivotally mounted). Disposing the actuator in its unlocking position may be characterized as loosening or unwinding the locking spring about this pivot. As the first handle member is movable relative to the second handle member, as the locking spring may move with the first handle member, and as the pivot may move with the second handle member, movement of the first handle member relative to the second handle member may cause the locking spring to at least attempt to slide about the pivot. Moving the actuator between its locking and unlocking positions may be characterized as changing the magnitude of the sliding friction or sliding friction forces between the locking spring and the pivot. Disposing the actuator in its locking position may be characterized as increasing the magnitude of the sliding friction or sliding friction forces between the locking spring and the pivot (e.g., by compressing the locking spring against the pivot; by tightening the locking spring about the pivot). Disposing the actuator in its unlocking position may be characterized as decreasing the magnitude of the sliding friction or sliding friction forces between the locking spring and the pivot (e.g., by loosening or unwinding the locking spring about the pivot).

[0013] A fourth aspect of the present invention is directed to a method of operating a hand-actuated fluid delivery device. A handle assembly is operated in a first operational mode to move a plunger in a discharge direction (e.g., where fluid may be discharged from the fluid delivery device, for instance for injection into a patient) and with a plunger lock being in a locking configuration. Operation of the handle assembly in this first operational mode causes a reduction in a magnitude of sliding friction or sliding friction forces (e.g., this decrease in sliding friction is responsive to or is realized based upon operation of the first handle assembly in the first operational mode) being provided by the plunger lock in its locking configuration. Operation of the handle assembly in the first operational mode is at some point in time terminated, which causes the magnitude of sliding friction or sliding friction forces being provided by the plunger lock to increase (e.g., this increase in sliding friction is responsive to or is realized based upon termination of operation of the first handle assembly in the first operational mode) so as to resist movement of the plunger in an aspiration direction (e.g., where fluid may be loaded into the fluid delivery device, including by a suction action or by drawing fluid into the fluid delivery device) for at least certain conditions.

[0014] A number of feature refinements and additional features are applicable to the fourth aspect of the present invention. These feature refinements and additional features may be used individually or in any combination. The following discussion is applicable to the fourth aspect, up to the start of the discussion of a fifth aspect of the present invention. Initially, the hand-actuated fluid delivery device discussed above in relation to the first aspect, the second aspect, and the third aspect each may be used in the method for the fourth aspect.

[0015] The plunger lock may be in the form of a torsion spring. The reduction of the magnitude of the sliding friction provided by the plunger lock may include unwinding or loosening this torsion spring. The operation of the handle assembly in the first operational mode may generate a force that is transmitted to the torsion spring in a manner that unwinds or loosens the torsion spring. Upon termination of the first operational mode, the sliding friction or sliding friction forces may be increased by contracting or tightening the torsion spring.

[0016] An actuator may be moved from an unlocking position to a locking position in the case of the fourth aspect, with the actuator possibly being biased to the locking position (e.g., so as to not require user input or the application of a user-generated force to move the same to the locking position). When the actuator is in its locking position, the plunger lock may be in its locking configuration. The actuator may be in its locking position when the handle assembly is operated in the first operational mode to move the plunger in the discharge direction. However, operation of the handle assembly in its first operational mode may cause a reduction of the magnitude of the sliding friction or sliding friction forces used by the plunger lock to resist movement of the plunger in the aspiration direction.

[0017] The noted actuator may be moved (e.g., manually by a user; by a user exerting a manual force on the actuator) from its locking position to its unlocking position. This movement of the actuator may be opposed by biasing forces being exerted on the actuator. In any case, this movement of the actuator to its unlocking position may cause a reduction in the magnitude of the sliding friction or sliding friction forces being provided by the plunger lock that tends to resist movement of the plunger in the aspiration direction (e.g., this reduction in sliding friction may be caused by, responsive to, or realized based upon movement of the actuator to its unlocking position). Thereafter, the handle assembly may be operated in a second operational mode to move the plunger in the aspiration direction.

[0018] A fifth aspect of the present invention is directed to a method of operating a hand-actuated fluid delivery device. This hand-actuated fluid delivery device includes a plunger, a locking spring, first and second handle members that are pivotally connected by a pivot that is fixed to the second
handle member, and an actuator, where the locking spring is mounted on the pivot. A first handle operation entails moving the first and second handle members relative to one another about the pivot in a manner so as to move the plunger in a discharge direction (e.g., to where fluid may be discharged from the fluid delivery device, for instance for injection into a patient). The first handle operation is terminated. A resistance is provided to movement of the first and second handles relative to one another in a manner that would move the plunger in an aspiration direction (e.g., where fluid may be loaded into the fluid delivery device, including by a suction action or by drawing fluid into the fluid delivery device). This resistance is provided by having the locking spring being in a locking configuration. The actuator may be moved to an unlocking position, which causes the locking spring to loosen or unwind about the pivot and which disposes the locking spring in an unlocked configuration. Thereafter, a second handle operation may be undertaken to move the plunger in the aspiration direction.

A number of feature refinements and additional features are applicable to the fifth aspect of the present invention. These feature refinements and additional features may be used individually or in any combination. The following discussion is applicable to at least the fifth aspect. Initially, the hand-actuated fluid delivery device discussed above in relation to the first aspect, the second aspect, and the third aspect each may be used in the method for the fifth aspect.

The actuator may be moved to a locking position, which may cause the locking spring to be disposed in its locking configuration. In one embodiment, the actuator is biased to its locking position to alleviate the need for an operator to exert a force on the actuator to move the same to its locking position. Disposing the locking spring in its locking configuration (e.g., caused by, responsive to, based upon, or as a result of moving the actuator to its locking position) may include tightening the locking spring about the pivot. This tightening of the locking spring about the pivot may increase a magnitude of the sliding friction or the sliding friction forces between the locking spring and the pivot.

The first handle operation may be executed with the locking spring being in its locking configuration. Execution of the first handle operation may generate and exert a force on the locking spring in a manner that tends to loosen or unwind the locking spring from about the pivot. This loosening or unwinding the locking spring may be used to reduce the magnitude of the sliding friction or sliding friction forces between the locking spring and the pivot.

Movement of the actuator to its unlocking position may be done manually by a user, for instance by a user exerting a manual force on the actuator (e.g., to pivot the same relative to the first handle member). A user may need to overcome a biasing force being exerted on the actuator to move the same from its locking position to its unlocking position. One user hand may be used to execute the second handle operation, and another user hand may be used to move the actuator to its unlocking position.

A number of feature refinements and additional features are separately applicable to each of above-noted first, second, third, fourth, and fifth aspects of the present invention. These feature refinements and additional features may be used individually or in any combination in relation to each of the above-noted first, second, third, fourth, and fifth aspects of the present invention. Any feature of any other various aspects of the present invention that is intended to be limited to a "singular" context or the like will be clearly set forth herein by terms such as "only," "single," "limited to," or the like. Merely introducing a feature in accordance with commonly accepted antecedent basis practice does not limit the corresponding feature to the singular (e.g., indicating that a handle assembly includes "a locking spring" alone does not mean that handle assembly includes only a single locking spring). Moreover, any failure to use phrases such as "at least one" also does not limit the corresponding feature to the singular (e.g., indicating that a handle assembly includes "a locking spring" alone does not mean that the handle assembly includes only a single locking spring). Use of the phrase "at least generally" or the like in relation to a particular feature encompasses the corresponding characteristic and insubstantial variations thereof (e.g., indicating that a barrel is at least generally cylindrical encompasses the barrel being cylindrical). Finally, a reference of a feature in conjunction with the phrase "in one embodiment" does not limit the use of the feature to a single embodiment.

**BRIEF DESCRIPTION OF THE FIGURES**

**FIG. 1** is a side view of a prior art hand-actuated fluid delivery device.

**FIGS. 2A-C** are schematic representations of use of the prior art hand-actuated fluid delivery device of FIG. 1.

**FIG. 3** is a cutaway, side view of a handle assembly with an aspiration lock, and that may be used by a hand-actuated fluid delivery device.

**FIG. 4** is a perspective view of a locking spring disposed on a pivot of the handle assembly of FIG. 3.

**DETAILED DESCRIPTION**

**FIGS. 1 and 2A-C** present a prior art hand-actuated fluid delivery device **10**. Hand-actuated fluid delivery device **10** includes a barrel **20**, a plunger **30** associated with barrel **20**, and a scissor-grip handle assembly **40** which causes plunger **30** to move longitudinally relative to barrel **20**. One or both of barrel **20** and plunger **30** may be removable from handle assembly **40** to facilitate the replacement of these components and the reuse of handle assembly **40**. Generally, the handle assembly **40** is sized so as to be engaged and operated by a single hand of a user.

**Barrel** **20** of hand-actuated fluid delivery device **10** is an elongate member with a hollow interior extending through the length thereof. Along the majority of its length, barrel **20** may be substantially uniform in both cross-sectional shape and cross-sectional dimensions. The region of barrel **20** having such substantial cross-sectional uniformity is referred to herein as body **22**. As depicted, body **22** extends from a proximal end **21p** of barrel **20** to a tapered section or region **24** thereof. A discharge tip **25** is located on the opposite side of tapered section **24**, at a distal end **21d** of barrel **20**.

**Within body** **22** and tapered region **24** of barrel **20**, the hollow interior thereof forms a receptacle **23**. The volume of receptacle **23** is preferably suitable for the desired use of the hand-actuated fluid delivery device **10**. For example, in applications where only small volumes of fluids will be injected or aspirated with hand-actuated fluid delivery device **10**, barrel **20** may include a receptacle **23** with a relative small volume (e.g., 5 cubic centimeters ("cc"), 10 cc, etc.). When hand-actuated fluid delivery device **10** is to be used to inject or aspirate larger volumes of fluids, the volume of receptacle **23** may also be larger (e.g., 20 cc, 30 cc, 60 cc, etc.). Alterna-
tively, receptacle 23 of barrel 20 may have other standard syringe volumes or a volume that is tailored to a specific use for hand-actuated fluid delivery device 10.

[0031] The hollow interior of syringe tip 25 may be referred to herein as a lumen 26. Lumen 26 may have a diameter of as small as about 1 mm (0.04 inch) or smaller. Of course, discharge tips 25 with different sizes of lumens 26 may be utilized, as the size of a lumen 26 may depend at least partially upon the gauge of a needle or the lumen size of a catheter to be coupled with discharge tip 25. In order to facilitate the coupling of a needle or catheter with discharge tip 25, discharge tip 25 may include a coupling member at or near the distal end 21d of barrel 20.

[0032] Barrel 20 also includes a handle connection element 28. As depicted, handle connection element 28 extends from body 22 at proximal end 21p of barrel 20 and includes an aperture formed therethrough. The aperture is sized and configured to receive a hinge element 70 and, thus, to facilitate the connection of a member of handle assembly 40 to barrel 20. While FIG. 1 depicts barrel 20, receptacle 23, and lumen 26 as having substantially cylindrical shapes with circular cross-sections taken transverse to a longitudinal axis Ap of barrel 20, syringe barrels with any other suitable cross-sectional shapes (e.g., ovals, ellipses, polygons, etc.) may also be utilized as appropriate.

[0033] Plunger 30 is an elongate member with dimensions that permit plunger 30 to be inserted into receptacle 23 of barrel 20 through proximal end 21p thereof. Plunger 30 includes a body 32 and a head 34 at a distal end 31d of body 32. The proximal end 31p of body 32, and thus of plunger 30, is configured to have force applied thereto to facilitate movement of plunger 30 in both directions along a longitudinal axis Ap of plunger 30. A “discharge direction” is a movement of the head 34 toward the discharge tip 25. An “aspiration direction” is a movement of the head 34 away from the discharge tip 25.

[0034] Head 34 of plunger 30 may comprise a somewhat deformable, resilient member. By way of example, head 34 may be formed from silicone or any other resilient polymer (e.g., rubber) that is suitable for use in medical applications. The shape of head 34 may be substantially complementary to a shape of the portion of receptacle 23 of barrel 20 that is located within tapered region 24 and a portion of body 22 adjacent thereto. The size of head 34 is may be substantially the same as or somewhat larger than the correspondingly shaped portion of receptacle 23 so as to facilitate the substantial displacement of fluid from receptacle 23 as plunger 30 is fully inserted therein (e.g., to provide a sliding seal between the head 34 and barrel 20 during relative movement therebetween).

[0035] In order to facilitate movement of head 34 of plunger 30 along the full length of receptacle 23, the length of plunger 30 may be greater than the combined lengths of body 22 and tapered region 24 of barrel 20. Of course, in order to apply the amount of force necessary to move plunger 30 through the length of receptacle 23, body 32 of plunger 30 may be formed from a more rigid material than that of head 34. Accordingly, head 34 may include a receptacle (not shown) that is configured to receive a corresponding head connection protrusion (not shown) at the distal end of body 32.

[0036] Proximal end 31p of plunger 30 includes a handle connection element 38. Handle connection element 38 includes an aperture formed through body 32 of plunger 30 at a location that facilitates the pivotal connection of a member of handle assembly 40 thereto by way of a hinge element 70. In addition, proximal end 31p of plunger 30 may include a secondary movement element 36, such as a loop or another member by which an individual may cause plunger 30 to move in one or both directions along longitudinal axis Ap thereof.

[0037] Handle assembly 40 includes two elongate members, a first handle member 50 and a second handle member 60. The handle assembly 40 is sized such that the first handle member 50 and the second handle member 60 may be engaged by a common, single hand of a user. That is and for the condition shown in FIG. 1, one portion of a users hand may engage the first handle member 50, and another portion of this same users hand may engage the second handle member 60 to manually actuate the hand-actuated fluid delivery device 10 to discharge fluid therefrom. First handle member 50 and second handle member 60 may also be pivotally connected with one another in a manner such that, along with the shapes of first and second handle members 50 and 60, it provides an increased leverage so as to decrease the amount of force that must be exerted by an individual’s hand to move plunger 30 relative to barrel 20 on a fluid discharge stroke.

[0038] First handle member 50, which may be configured to be held primarily with an individual’s fingers, includes a gripping end 52 and a plunger attachment end 58. In addition, first handle member 50 includes pivotal connection element 56 positioned at a central region 55 thereof, which may be located substantially centrally along the length thereof, to facilitate connection of first handle member 50 to second handle member 60 of handle assembly 40. Pivotal connection element 56 includes an aperture that may have a circular shape and that receives a hinge element 70, or pivot pin, which, in turn, connects first handle member 50 and second handle member 60 to one another. As shown, first handle member 50 includes an elongated loop 53 along gripping end 52, through which an individual’s fingers may be inserted. Alternatively, or in addition to loop 53, gripping end 52 may include a finger grip 54 that is contoured so as to comfortably receive the fingers of an individual.

[0039] Plunger attachment end 58 of first handle member 50 includes (e.g., terminates at) a plunger connection element 59 that facilitates the pivotal connection of first handle member 50 to the corresponding handle connection element 38 of plunger 30. Plunger connection element 59 may comprise an aperture that is configured to receive hinge element 70. First handle member 50 and plunger 30 are pivotally connected to one another by positioning plunger attachment end 58 against the appropriate location of plunger 30 with plunger connection element 59 and an aperture (not shown) of handle connection element 38 in alignment. A single hinge element 70 is then inserted through both plunger connection element 59 and the noted aperture of handle connection element 38. Hinge element 70 may include an enlarged head 71 at each end thereof to maintain the assembled, pivotal relationship of plunger 30 and first handle member 50. Of course, other known types of pivotal connection arrangements between plunger 30 and first handle member 50 and their corresponding elements may also be utilized.

[0040] First handle member 50 is bent, or angled, at some point along the length thereof, between gripping end 52 and plunger attachment end 58, to at least partially provide the desired amount of leverage for forcing plunger 30 to move longitudinally through receptacle 23 of barrel 20. As shown in
FIG. 1, first handle member 50 is angled at two locations, a first of which is located between gripping end 52 and central region 55, and a second of which is located between central region 55 and plunger attachment end 58. Although FIG. 1 depicts gripping end 52 and central region 55 as being oriented at an angle of about 140° relative to one another, and central region 55 and plunger attachment end 58 as being oriented at an angle of about 90° relative to one another, other angles and bend locations may be utilized, as appropriate.

[0041] Second handle member 60 of handle assembly 40 is an elongate member that is configured to be held by an individual’s palm or thumb. Second handle member 60 includes a gripping end 62 and a barrel attachment end 68, as well as a central region 65 located between gripping end 62 and barrel attachment end 68. Gripping end 62 of second handle member 60 may include a thumb loop 63 through which the thumb of an individual using hand-actuated fluid delivery device 10 may be inserted.

[0042] Central region 65 of second handle member 60 includes a pivotal connection element 66 that corresponds to pivotal connection element 56 of first handle member 50. Pivotal connection element 66 may comprise an aperture formed through central region 65 and configured to receive hinge element 70. Upon properly orienting first handle member 50 and second handle member 60 relative to one another in an assembled relationship thereof and aligning the aperture of first handle member 50 with the aperture of second handle member 60, hinge element 70 may be inserted through the apertures to pivotally connect first and second members 50 and 60 to one another. Hinge element 70 again may include an enlarged head 71 at each end thereof to maintain the assembled, pivotal relationship of first handle member 50 and second handle member 60.

[0043] Handle assembly 40 may additionally include a resilient element (e.g., a spring may be associated with first and second handle members 50 and 60, for instance at or near hinge element 70) in such a way as to force first and second handle members 50 and 60 apart from one another when they are not being held together. That is, the handle members 50, 60 may be biased to move the plunger 30 in the noted aspiration direction. When first and second handle members 50 and 60 have been properly assembled with one another, it is preferred that practically any adult user be able to properly position their fingers of one hand on gripping end 52 and their thumb or palm of this same hand against gripping end 62, while gripping ends 52 and 62 are spaced a maximum distance apart from one another with head 34 of plunger located at least generally at proximal end 21p of barrel 20.

[0044] Barrel attachment end 68 of second handle member 60 includes (e.g., terminates at) a barrel connection element 69 that facilitates the pivotal connection of second handle member 60 to the corresponding handle connection element 28 of barrel 20. As depicted, barrel connection element 69 comprises an aperture that is configured to receive a hinge element 70. Second handle member 60 and barrel 20 are pivotally connected to one another by properly positioning barrel attachment end 68 and handle connection element 28 against one another, with the apertures thereof in alignment, and inserting a single hinge element 70 through both barrel connection element 69 and handle connection element 28. Hinge element 70 again may include an enlarged head 71 at each end thereof to maintain the assembled, pivotal relationship of barrel 20 and second handle member 60. Of course, other known types of pivotal connection arrangements between barrel 20 and second handle member 60 and their corresponding elements may be utilized, as appropriate.

[0045] Second handle member 60 of handle assembly 40 may be bent, or angled, to increase the leverage provided by first handle member 50 and the scissors-like arrangement of first handle member 50 and second handle member 60. As illustrated, second handle member 60 is bent at central region 65 thereof to position gripping end 62 in proximity to gripping end 52 of first handle member 50 when first handle member 50 and second handle member 60 are in an appropriate assembled relationship. With further regard to the noted scissors-like arrangement between the first handle member 50 and second handle member 60, the side view of FIG. 1 shows a reference axis Rx that extends through the hinge element 70 (that pivotally interconnects the first handle member 50 and the second handle member 60) and that is parallel to both the longitudinal axis Ay of barrel 20 and the longitudinal axis Az of plunger 30. Note that both plunger attachment end 58 (of first handle member 50) and barrel attachment end 68 (of second handle member 60) each extend relative to the hinge element 70 (between first handle member 50 and second handle member 60) onto one side of this reference axis Rx (on the side that is “above” the reference axis Rx in the side view of FIG. 1), and that both gripping end 52 (of first handle member 50) and gripping end 62 (of second handle member 60) each extend relative to the hinge element 70 (between first handle member 50 and second handle member 60) onto the opposite side of this reference axis Rx (on the side that is “below” the reference axis Rx in the side view of FIG. 1). With further regard to the noted scissors-like arrangement between the first handle member 50 and second handle member 60, the side view of FIG. 1 shows that a reference axis Ry that extends through the hinge element 70 (that pivotally interconnects the first handle member 50 and the second handle member 60) and that is perpendicular to both the longitudinal axis Ay of barrel 20 and the longitudinal axis Az of plunger 30.

[0046] One or both of first handle member 50 and second handle member 60 may include reinforcement ribs 72 or other reinforcement structures along at least a portion of the length thereof. As depicted, reinforcement ribs 72 are positioned along the edges of first handle member 50 and second handle member 60. Reinforcement ribs 72 may be positioned to prevent side-to-side bending of first handle member 50 or second handle member 60 during use of handle assembly 40 to move plunger 30 relative to barrel 20.

[0047] FIGS. 2A-C present an example of the use of the hand-actuated fluid delivery device 10. FIG. 2A illustrates the introduction of a fluid 300 into receptacle 23 of barrel 20 through either lumen 26 of discharge tip 25 by drawing plunger 30 outwardly (proximally) through receptacle 23. Plunger 30 may be drawn outwardly through receptacle 23 by a user U forcing first and second members 50 and 60 of handle assembly 40 apart from one another (their respective free ends). As plunger 30 is drawn outwardly through receptacle 23, the available volume of receptacle 23 (i.e., that located distally relative to head 34 of plunger 30) increases and a negative pressure is created within receptacle 23. This negative pressure forces fluid 300 to enter receptacle 23. As depicted, fluid 300 may be any appropriate fluid, such as contrast media, a medicine, an anesthetic, a dye, or another chemical compound.

[0048] As shown in FIG. 2B, discharge tip 25 may be coupled to a known infusion or injection apparatus 302, shown in phantom, such as a catheter or a hypodermic needle.
Infusion or injection apparatus 302 may comprise a conduit which facilitates the introduction of fluid 300 into the body of an individual. In FIG. 2C, as user U forces first handle member 50 and second handle member 60 toward one another (one part of the user’s hand engaging the first handle member 50, and another portion of this same hand engaging the second handle member 60), plunger 30 is forced inwardly (i.e., distally) through receptacle 23, decreasing the available volume within receptacle 23 and creating an increase in pressure therein. This increase in pressure within receptacle 23 forces fluid 300 out of receptacle 23 through lumen 26 of discharge tip 25, through infusion or injection apparatus 302, and into the body of the individual. The amount of fluid introduced into the individual’s body may be controlled by controlling the distance first and second members 50 and 60 are forced together.

[0049] The three-pivot-point configuration of handle assembly 40 provides sufficient leverage that the force applied by a single hand of a user will be translated into an adequate amount of force upon plunger 30 and within receptacle 23 to force even relatively high viscosity fluids into and out of receptacle 23. Moreover, the configurations of members 50 and 60 of handle assembly 40 facilitate gripping thereof with a single hand, the fine motor skills of which can be used in such a way as to precisely control the amount of fluid being introduced into or discharged from receptacle 23 of syringe barrel 20.

[0050] One embodiment of a handle assembly for a hand-actuated fluid delivery device is presented in FIG. 3 and is identified by reference 100. The handle assembly 100 may be used by a hand-actuated fluid delivery device that includes a barrel and plunger that is movable relative to this barrel in both a discharge direction (where fluid is dispensed from the hand-actuated fluid delivery device via manual operation by a user) and in an aspiration direction (where fluid may be loaded (e.g., drawn) into the hand-actuated fluid delivery device via manual operation by a user). For instance, the handle assembly 100 may be used in place of the handle assembly 40 in the case of the hand-actuated fluid delivery device 10 discussed above in relation to FIGS. 1-20.

[0051] The handle assembly 100 of FIG. 3 includes a first handle member 110 and a second handle member 120 that cross one another to provide for a scissors-like actuation of the handle assembly 100. The first handle member 110 includes a first free end 112 and a plunger connection element 114. The plunger connection element 114 may be of any appropriate configuration to allow the first handle member 110 to be interconnected with a plunger (e.g., plunger 30 of hand-actuated fluid delivery device 10). In one embodiment, first handle member 110 is pivotally connected to a plunger using the plunger connection element 114. For instance, the plunger could include an aperture that may be aligned with the plunger connection element 114 to accommodate receipt of a pivot pin or the like. The first handle member 110 may include a fulcrum or stop 116 that will be addressed below in relation to a locking spring 130.

[0052] The second handle member 120 includes a first free end 122 and a body connection element 124. The body connection element 124 may be of any appropriate configuration to allow the second handle member 120 to be interconnected with a body of the associated fluid delivery device (e.g., barrel 20 of fluid delivery device 10; body 22 of fluid delivery device 10). In one embodiment, the second handle member 120 is pivotally connected to another part of the fluid delivery device (e.g., barrel 20 of fluid delivery device 10; body 22 of fluid delivery device 10) using the body connection element 124. For instance, the body/barrel could include an aperture that may be aligned with the body connection element 124 of the second handle member 120 to accommodate receipt of a pivot pin or the like.

[0053] The first handle member 110 and the second handle member 120 cross one another as noted above. In this regard, a pivot 126 is fixed to the second handle member 120 in any appropriate manner (e.g., separately attached; integrally formed). That is, the pivot 126 is not intended to move relative to the second handle member 120. The first handle member 110 is movably mounted on this pivot 126. As such, the first handle member 110 is able to pivot relative to the second handle member 120 about the pivot 126. In other embodiments, the pivot 126 may not be fixed to either of the first or second handle members 110, 120 such that both the first and second handle member 110, 120 are capable of movement about the pivot 126.

[0054] With further regard to the noted scissor-like arrangement between the first handle member 110 and second handle member 120, the side view of FIG. 3 shows a reference axis R_{s}, that extends through the pivot 126 (that pivotally interconnects the first handle member 110 and the second handle member 120) and that is parallel to the axis along which the associated plunger would move when actuated by the handle assembly 100 (e.g., reference axis R_{a} may be parallel to longitudinal axis A_{l} of plunger 30 when the handle assembly 100 is used by the hand-actuated fluid delivery device 10). Note that part of the first handle member 110 and part of the second handle member 120 each extend relative to the pivot 126 onto one side of this reference axis R_{s}, (on the side that is “above” the reference axis R_{a} in the side view of FIG. 3), and that a different part of the first handle member 110 and a different part of the second handle member 120 each extend relative to the pivot 126 onto the opposite side of this reference axis R_{s}, (on the side that is “below” the reference axis R_{a} in the side view of FIG. 3).

[0055] With further regard to the noted scissor-like arrangement between the first handle member 110 and the second handle member 120, the side view of FIG. 3 shows a reference axis R_{s} that extends through pivot 126 (again, that pivotally interconnects the first handle member 110 and the second handle member 120) and that is perpendicular to the above-noted reference axis R_{a} (and that would also then be perpendicular to longitudinal axis A_{l} of plunger 30 when the handle assembly 100 is used by the hand-actuated fluid delivery device 10). The first free end 112 and the plunger connection element 114 of the first handle member 110 are disposed on opposite sides of this reference axis R_{s} in the view shown in FIG. 3 (the first free end 112 being positioned on the “left side” of this reference axis R_{s} in the view shown in FIG. 3, and the plunger connection element 114 being positioned on the “right side” of this reference axis R_{s} in the view shown in FIG. 3). Similarly, the second free end 122 and the body connection element 124 of the second handle member 120 are also disposed on opposite sides of this reference axis R_{s} in the view shown in FIG. 3 (the second free end 122 being positioned on the “right side” of this reference axis R_{s} in the view shown in FIG. 3, and the body connection element 124 being positioned on the “left side” of this reference axis R_{s} in the view shown in FIG. 3).

[0056] Moving the first free end 112 of the first handle member 110 at least generally toward the second free end 122
of the second handle member 120 causes the first handle member 110 to pivot relative to the second handle member 120 about the pivot 126, to in turn move the plunger connection element 114 of the first handle member 110 at least generally toward the body connection element 124 of the second handle member 120, to in turn move the associated plunger (e.g., plunger 30 of hand-actuated fluid delivery device 10) in a discharge direction (i.e., to the left in the view shown in FIG. 3) relative to the barrel (e.g., barrel 20) of the fluid delivery device (e.g., fluid delivery device 10). Moving the first free end 112 of the first handle member 110 at least generally away from the second free end 122 of the second handle member 120 causes the first handle member 110 to pivot relative to the second handle member 120 about the pivot 126, to in turn move the plunger connection element 114 of the first handle member 110 at least generally away from the body connection element 124 of the second handle member 120, to in turn move the associated plunger (e.g., plunger 30 of the hand-actuated fluid delivery device 10) in an aspiration direction (i.e., to the right in the view shown in FIG. 3) relative to the barrel (e.g., barrel 20) of the fluid delivery device (e.g., fluid delivery device 10).

[0057] The handle assembly 100 of FIG. 3 includes what may be characterized as a plunger lock—a device to lock the plunger (e.g., fix/maintain the position of plunger 30 relative to a barrel of hand-actuated fluid delivery device 10) associated with the handle assembly 100 in a certain position or to at least restrain movement of this plunger in at least one direction (e.g., an aspiration direction). Referring now to both FIGS. 3 and 4, the handle assembly 100 includes a locking spring 130. In the illustrated embodiment, the locking spring 130 is in the form of a torsion spring. In any case, the locking spring 130 is mounted on the pivot 126. Generally, the sliding friction or sliding friction forces between the locking spring 130 and the pivot 126 provides a locking function that at least resists movement of the first free end 112 of the first handle member 110 at least generally away from the second free end 122 of the second handle member 120, which in turn provides resistance to movement of the associated plunger (e.g., plunger 30 of hand-actuated fluid delivery device 10) in an aspiration direction. The sliding friction between the locking spring 130 and the pivot 126 may be of a magnitude to preclude movement of the associated plunger (e.g., plunger 30 of hand-actuated fluid delivery device 10) in an aspiration direction in at least certain conditions—the handle assembly 100 may be biased in a manner that attempts to move the corresponding plunger in an aspiration direction relative to the barrel.

[0058] The locking spring 130 includes a first end portion 134 and a second end portion 136. The first end portion 134 may be biased/seated against the above-noted fulcrum 116 that is incorporated by the first handle member 110. The locking spring 130 then wraps at least once completely about the pivot 126 (a full 360 degrees about the pivot 126) and terminates at its second end portion 136. The locking spring 130 may be wrapped any appropriate number of times about the pivot 126. An individual wrap of the locking spring 130 is identified by reference numeral 132 in FIG. 4. Increasing the number of wraps 132 on the pivot 126 should enhance the locking function provided by the locking spring 130 (e.g., should increase the amount of sliding friction or sliding friction forces between the locking spring 130 and the pivot 126 when the locking spring 130 is in its locking configuration).
3), the locking spring 130 is allowed to “contract” against or “tighten” onto the pivot 126 (e.g., to provide a locking configuration for the locking spring 130). This increases the magnitude of the sliding friction or sliding friction forces between the locking spring 130 (which again may be viewed as being movable in conjunction with the first handle member 110) and the pivot 126 (which again is fixed to the second handle member 120). That is, as the first handle member 110 moves relative to the second handle member 120, the locking spring 130 may move (by a sliding action) relative to the pivot 126.

[0063] Operation of the locking function incorporated by the handle assembly 100 will now be summarized. The actuator 140 again may be biased to its locking position (shown by the dashed line for the actuator 140 in FIG. 3). This in turn disposes the locking spring 130 in its locked configuration (e.g., such that it is compressed against or contracts onto the pivot 126 that is fixed to the second handle member 120). Movement of the first free end 112 of the first handle member 110 at least generally toward the second free end 122 of the second handle member 120 (to produce movement of the associated plunger (e.g., plunger 30 of hand-actuated fluid delivery device 10) in a discharge direction) will exert a force on the locking spring 130 that will tend to unwind the same from the pivot 126. That is, this movement of the handle assembly 100 may be characterized as actually reducing the magnitude of the sliding friction or sliding friction forces between the locking spring 130 (which is movable along with the first handle member 110) and the pivot 126 (which moves along with the second handle member 120), which thereby allows the handle assembly 100 to be operated to discharge fluid from the corresponding hand-actuated fluid delivery device even with the actuator 140 being disposed in its locking configuration.

[0064] When movement of the first free end 112 of the first handle member 110 at least generally toward the second free end 122 of the second handle member 120 is terminated (to terminate movement of the associated plunger (e.g., plunger 30 of hand-actuated fluid delivery device 10) in a discharge direction), the spring forces of the locking spring 130 should automatically return the same to its locked configuration. That is, when movement of the first free end 112 of the first handle member 110 at least generally toward the second free end 122 of the second handle member 120 is terminated (to again terminate movement of the associated plunger in a discharge direction): 1) the locking spring 130 should compress back against or further contract onto the pivot 126; and 2) the magnitude of the sliding friction or sliding friction forces between the locking spring 130 and the pivot 126 (while pivoting the first handle member 110 relative to the second handle member 120) should be increased (“increased” being in comparison to the sliding friction forces between the locking spring 130 and the pivot 126 while the handle assembly 100 is being operated to move the associated plunger in a discharge direction).

[0065] With the locking spring 130 remaining in its locking configuration at the end of a discharge operation, the associated plunger (e.g., plunger 30 of fluid delivery device 10) should remain in a stationary position. More specifically, the magnitude of the sliding friction forces between the locking spring 130 and the pivot 126 should be sufficiently large such that any biasing force being used by the handle assembly 100 (to bias the first free end 112 of the first handle member 110 at least generally away from the second free end 122 of the second handle member 120 to move the associated plunger in an aspiration direction), should in fact be unable to move the associated plunger in an aspiration direction. If a user attempts to pull the free ends 112, 122 further apart (with the actuator 140 remaining it is locking position), this should actually further increase the magnitude of the sliding friction forces between locking spring 130 (associated with the first handle member 110) and the pivot 126 (associated with the second handle member 120), which should further increase the resistance to movement of the associated plunger in an aspiration direction.

[0066] Based upon the foregoing, it should be appreciated that a user need not take any action at the end of a discharge operation to keep the associated plunger (e.g., plunger 30 of hand-actuated fluid delivery device 10) from moving in an aspiration direction. A user may simply release the handle assembly 100 and the associated plunger should remain in a stationary position by the locking force provided by the locking spring 130. When the user desires to retract the corresponding plunger in relation to the associated barrel (e.g., to move the corresponding plunger in an aspiration direction), the actuator 140 may be moved from its locking position (where the actuator 140 is shown by dashed lines in FIG. 3) to its unlocking position (where the actuator 140 is shown by solid lines in FIG. 3). Again, this loosens or unwinds the locking spring 130 from the pivot 126, or disposes the locking spring 130 in its unlocked configuration. Thereafter, the first free end 112 of the first handle member 110 may be moved at least generally away from the second free end 122 of the second handle member 120, to in turn increase the spacing between the plunger connection element 114 of the first handle member 110 and the body connection element 124 of the second handle member 120, to in turn move the associated plunger (e.g., plunger 30 of the hand-actuated fluid delivery device 10) in an aspiration direction.

[0067] The foregoing description of the present invention has been presented for purposes of illustration and description. Furthermore, the description is not intended to limit the invention to the form disclosed herein. Consequently, variations and modifications commensurate with the above teachings, and skill and knowledge of the relevant art, are within the scope of the present invention. The embodiments described hereinabove are further intended to explain best modes known of practicing the invention and to enable others skilled in the art to utilize the invention in such, or other embodiments and with various modifications required by the particular application(s) or use(s) of the present invention. It is intended that the appended claims be construed to include alternative embodiments to the extent permitted by the prior art.

1-10. (canceled)

11. A hand-actuated fluid delivery device comprising:
a barrel;
a plunger that is movable relative to said barrel;
a handle assembly interconnected with and operable to move said plunger relative to said barrel in both a discharge direction and an aspiration direction, wherein said handle assembly comprises a pivot, a first handle member, and a second handle member, wherein said pivot is fixed to said second handle member, and wherein said first handle member is pivotable relative to said second handle member about said pivot;
a locking spring wrapped around said pivot and comprising first and second end portions, wherein said first end portion is anchored relative to said first handle member; and
an actuator mounted on said first handle member, movable between locking and unlocking positions, and engaged with said second end portion of said locking spring at least when in said locking position.

12. The hand-actuated fluid delivery device of claim 11, wherein disposing said actuator in said locking position tightens said locking spring about said pivot, and wherein disposing said actuator in said unlocking position loosens said locking spring about said pivot.

13. The hand-actuated fluid delivery device of claim 11, wherein a locking force provided by said locking spring is entirely sliding friction between said locking spring and said pivot.

14. The hand-actuated fluid delivery device of claim 11, wherein said actuator is movable on said first handle member.

15. The hand-actuated fluid delivery device of claim 11, further comprising at least one biasing element that biases said actuator to said locking position.

16. The hand-actuated fluid delivery device of claim 11, wherein said actuator is manually movable from said locking position to said unlocking position.

17. The hand-actuated fluid delivery device of claim 11, wherein said handle assembly is operable to move said plunger in said aspiration direction with said actuator being in said unlocking position.

18-27. (canceled)

28. A method of operating a hand-actuated fluid delivery device comprising a plunger, a locking spring, a handle assembly comprising first and second handle members that are pivotally connected by a pivot that is fixed to said second handle member, and an actuator, wherein said locking spring is mounted on said pivot, said method comprising:
executing a first handle operation comprising moving said first and second handle members relative to one another about said pivot in a manner to move said plunger in a discharge direction;
terminating said first handle operation;
resisting movement of said first and second handle members relative to one another in a manner to move said plunger in an aspiration direction, wherein at least part of said resisting step is executed after said terminating step and comprises said locking spring being in a locking configuration;
moving said actuator to an unlocking position;
loosening said locking spring about said pivot in response to said actuator being moved to said unlocking position, wherein said loosening step comprises disposing said locking spring in an unlocked configuration; and
executing a second handle operation comprising moving said first and second handle members relative to one another about said pivot in a manner to move said plunger in an aspiration direction, wherein said second handle operation is executed after said loosening step.

29-39. (canceled)

40. A hand-actuated fluid delivery device comprising:
a barrel;
a plunger that is movable relative to said barrel;
a handle assembly interconnected with and operable to move said plunger relative to said barrel in both a discharge direction and an aspiration direction, wherein said handle assembly comprises a pivot, a first handle member, and a second handle member, wherein said pivot is fixed to one of said first and second handle members, and wherein the other of said first and second handle members is pivotable about said pivot; and
a locking spring wrapped around said pivot, wherein said locking spring is selectively disposable in a locking configuration to restrain movement of said plunger in said aspiration direction.

41. The hand-actuated fluid delivery device of claim 40, further comprising:
an actuator movable between locking and unlocking positions in relation to said locking spring.

42. The hand-actuated fluid delivery device of claim 41, wherein said pivot is fixed to said second handle member, and wherein said first handle member is pivotable relative to said second handle member about said pivot.

43. The hand-actuated fluid delivery device of claim 42, wherein said locking spring comprises first and second end portions, wherein said first end portion is anchored relative to said first handle member, and wherein said actuator is engaged with said second end portion of said locking spring when disposed in said locking position.

44. The hand-actuated fluid delivery device of claim 43, wherein disposing said actuator in said locking position tightens said locking spring about said pivot, and wherein disposing said actuator in said unlocking position loosens said locking spring about said pivot.

45. The hand-actuated fluid delivery device of claim 43, wherein a locking force provided by said locking spring is entirely sliding friction between said locking spring and said pivot.

46. The hand-actuated fluid delivery device of claim 43, wherein said actuator is movable on said first handle member.

47. The hand-actuated fluid delivery device of claim 41, further comprising at least one biasing element that biases said actuator to said locking position.

48. The hand-actuated fluid delivery device of claim 41, wherein said actuator is manually movable from said locking position to said unlocking position.

49. The hand-actuated fluid delivery device claim 41, wherein said handle assembly is operable to move said plunger in said aspiration direction with said actuator being in said unlocking position.

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