injections. As an alternative to using spring power, certain needle-free injectors use compressed gas, battery power or a pyrotechnic charge to drive fluid through the nozzle and into or through the skin or tissue of the subject.

[0009] For example, Boyd et al. in patent US 8,734,384 B2 discloses a compressed gas injector which operates by pushing the piston into a fluid filled chamber, which pressurizes the fluid and creates a fluid jet as it empties through a jet orifice. Actuation of the injector in this device is preferably triggered from pressing the device against the patient's skin. Triggering the device however is not handy and the gas pressure pistons can be misused or mishandled and require resupply with limited shelf life.

[0010] Some needle-free injectors are intended for disposal after a single use, while others are reloadable. Certain other needle-free injectors inject powdered substances as micro projectiles.

[0011] Improvement on the state of art is obviously needed. More specifically, safer and handier mechanisms are in demand which can excerpt precision metered doses at precision selected pressures for self-administering safety. Hand power reloading is preferred over prepackaged consumable power cartridges.

[0012] The object of the invention is to improve on the state of the art by overcoming the listed and other shortcomings in needle-free liquid medicine delivery into human or animal bodies.

Summary of the Invention

[0013] The above problems and others are at least partially solved and the above objects and others realized in a process, which, in some examples, according to the teachings of this invention, uses a medical fluid injection device, comprising: a housing having an inner surface and an outer surface which extend from a proximal trigger end to a distal dispensing end

along an injection axis; a housing top retainer comprising a lower stop socket, an upper pop-in socket, a venting slot, and an external actuation surface disposed transverse to the injection axis at the trigger end, the external actuation surface comprising a surface that tapers downward towards the dispensing end; wherein said venting slot is positioned at a distal portion of said housing top retainer near said lower stop socket; a syringe adapter at the dispensing end of the housing, the syringe adapter configured to retain a needle- free syringe such that a plunger of the needle-free syringe is movable within the housing along the injection axis; wherein said syringe adapter comprises an outer surface that extends away from the injection axis beyond the outer surface of the housing; a piston retained within the housing by the syringe adapter and movable along the injection axis between a loaded position near the trigger end and an unloaded position near the dispensing end, the piston comprising a piston head near the dispensing end and a trigger catch near the trigger end of the housing, the piston head being movably positioned to bias the plunger of the needle-free syringe via the piston head along the injection axis; a compression spring associated with the piston, the piston and compression spring sized relative to the housing such that the compression spring is compressible along the injection axis within the housing; a trigger mounted within the housing near the trigger end and movable between a non-actuated position and an actuated position by depression of a push-button disposed at the external actuation surface of the housing, the trigger comprising a trigger latch configured to engage the trigger catch when the trigger is in the non-actuated position and the piston is in the loaded position, and to release the trigger catch when the trigger is in the actuated position, wherein the trigger catch is configured to urge the trigger latch in a direction transverse to the injection axis when the piston moves from the unloaded position to the loaded position; and wherein the housing, syringe adapter, and needle-free syringe are configured such that a gas within and a sound created within the housing are directed out the venting slot upon actuation of said fluid injection device.

[0014] The trigger catch of some examples of the fluid injection device comprises an annular engagement surface extending radially outward from the injection axis and facing towards the dispensing end of the housing. The trigger latch of some examples comprises an engagement surface extending inwardly towards the

injection axis and facing towards the trigger end of the housing, and which engages the annular engagement surface of the trigger catch when the trigger is in the non-actuated position and clears the trigger catch when the trigger is in the actuated position. The trigger catch of the fluid injection device of some examples further comprises an annular beveled surface which faces away from the injection axis towards the trigger end of the housing. The trigger latch of some examples further comprises a beveled surface which faces towards the injection axis and towards the dispensing end of the housing.

[0015] The trigger of some examples further comprises a lever biased towards the push-button by a return spring disposed within the housing. The return spring in some embodiments is a clip spring biased against the lever of the trigger.

[0016] The fluid injection device of some examples further comprises a movable safety cap for blocking depression of the push-button, said safety cap comprising a pivot hinge and a snap-in recess lock. The safety cap of some such examples is pivotally mounted to the external actuation surface of the housing and may be additionally popped up by the fingernail of the thumb of a self-injecting patient.

[0017] The inner surface of some examples of the housing of the fluid injection device comprises a portion extending towards the injection axis and which blocks the compression spring from contacting the trigger.

[0018] The syringe adapter of some examples is removable. The syringe adapter of some examples is removably affixed to the dispensing end of the housing. The syringe adapter of some examples is irremovably affixed to the dispensing end of the housing.

[0019] The housing of some examples is capable of being configured to removably accept alternatively configured syringe adaptors.

[0020] The piston and the compression spring of some examples is capable of being removable from the housing when the syringe adapter is removed from the housing. The housing of some examples is capable of being configured to removably accept one or both of alternatively sized pistons and springs. The compression spring of some examples is capable of being retained around the piston by the piston head.

[0021] Various examples of this disclosure relate to a kit comprising: a fluid injection device of the type defined above; and a loader configured to receive the fluid injection device on an interior retaining surface comprising a lip adapted to engage the outer surface of the syringe adapter of the fluid injection device, wherein the loader is movable about a hinge between an open state and a closed state to extend a plunger into an open end of the syringe adapter to contact the piston head so as to push the piston from the unloaded position into the loaded position.

[0022] In some examples, the syringe adapter of the fluid injection device is capable of being removable and the kit of some embodiments further comprises one or more additional compression springs, each of which is distinctly configured to provide a different spring force. In some examples, the syringe adapter contains features that allow the syringe adapter to work smoothly with springs designed for the appropriate size of the syringe adapter. In some examples, the syringe adapter of the fluid injection device is capable of being removable and the kit of some examples further comprises one or more additional syringe adapters, each of which is configured to retain a different needle-free syringe.

[0022a] In another aspect, a fluid injection device, comprises: a housing comprising an inner surface and an outer surface which extend from a proximal trigger end to a distal dispensing end along an injection axis; a housing top retainer at said trigger end comprising a venting slot and an external actuation surface disposed transverse to the injection axis at the trigger end, the external actuation surface comprising a surface that tapers downward towards

the dispensing end; wherein said venting slot is positioned at a distal portion of said housing top retainer; a syringe adapter at the dispensing end of the housing, the syringe adapter configured to retain a needle-free syringe and thereby create a seal of the dispensing end; said syringe adapter comprising an outer surface that extends away from the injection axis beyond the outer surface of the housing; a piston retained within the housing and movable between a loaded position and an unloaded position to bias a plunger of the needle-free syringe; a trigger mounted near the trigger end on the injection axis and movable between a non-actuated position and an actuated position to initiate movement of the piston from the loaded position to the unloaded position upon actuation of the trigger, said trigger comprising a push-button with a front sliding guide, a rear sliding guide, a restrainer protrusion, and a lever contact; a loader comprising an interior retaining surface configured to receive the housing and the syringe adapter; wherein the loader is movable about a hinge between an open state and a closed state; wherein movement of the loader from said open state to said closed state is configured to extend a loader plunger through an open end of the syringe adapter to make contact with said piston within the housing and to push the piston from said unloaded position into said loaded position; wherein said interior retaining surface comprises a lip configured to engage the syringe adapter outer surface; wherein engagement of the syringe adapter outer surface with said lip is configured to retain the syringe adapter and the housing within said interior retaining surface without stress on the housing trigger end when the piston is pushed from said unloaded position into said loaded position; and wherein the housing, syringe adapter, and needle-free syringe are configured such that a gas within and a sound created within the housing are directed towards the trigger end and out the venting slot upon actuation of said fluid injection device.

[0022b] In some examples, the housing inner surface comprises a narrowed inner surface section narrower than the compression spring but wider than the piston; said narrowed inner surface forms a shelf for compressing said compression spring; said piston comprises a tapered neck near a proximal end of the piston distal of the trigger catch; and said tapered neck extends into said narrowed inner surface with said piston in loaded position.

[0022c] In some examples, the fluid injection device further comprises: a loader comprising an interior retaining surface configured to receive the housing and the syringe adapter; wherein the loader is movable about a hinge between an open state and a closed state; wherein movement of the loader from said open state to said closed state is configured to extend a loader plunger through an open end of the syringe adapter to make contact with said piston head within the housing and to counteract the compression spring to push the piston from said unloaded position into said loaded position; wherein said interior retaining surface comprises a lip configured to engage the syringe adapter outer surface; and wherein engagement of the syringe adapter outer surface with said lip is configured to retain the syringe adapter and the housing within said interior retaining surface without stress on the housing trigger end when the piston is pushed from said unloaded position into said loaded position.

[0023] The foregoing and other objects are intended to be illustrative of the invention and are not meant in a limiting sense. Many possible examples of the invention may be made and will be readily evident upon a study of the following specification and accompanying drawings

comprising a part thereof. Various features and subcombinations of invention may be employed without reference to other features and subcombinations. Other objects and advantages of this invention will become apparent from the following description taken in connection with the accompanying drawings, wherein is set forth by way of illustration and example, an example of this invention and various features thereof.

CLAIMS

1. A fluid injection device, comprising:

a housing comprising an inner surface and an outer surface which extend from a proximal trigger end to a distal dispensing end along an injection axis;

a housing top retainer comprising a lower stop socket, an upper pop-in socket, a venting slot, and an external actuation surface disposed transverse to the injection axis at the trigger end, the external actuation surface comprising a surface that tapers downward towards the dispensing end;

wherein said venting slot is positioned at a distal portion of said housing top retainer near said lower stop socket;

a syringe adapter at the dispensing end of the housing, the syringe adapter configured to retain a needle-free syringe such that a plunger of the needle-free syringe is movable within the housing along the injection axis;

wherein said syringe adapter comprises an outer surface that extends away from the injection axis beyond the outer surface of the housing;

a piston retained within the housing by the syringe adapter and movable along the injection axis between a loaded position near the trigger end and an unloaded position near the dispensing end, the piston comprising a piston head near the dispensing end and a trigger catch near the trigger end of the housing, the piston head being movably positioned to bias the plunger of the needle-free syringe via the piston head along the injection axis;

a compression spring associated with the piston, the piston and compression spring sized relative to the housing such that the compression spring is compressible along the injection axis within the housing;

a trigger mounted within the housing near the trigger end and movable between a non-actuated position and an actuated position by depression of a push-button disposed at the external actuation surface of the housing, the trigger comprising a trigger latch configured to engage the trigger catch when the trigger is in the non-actuated position and the piston is in the loaded position and to release the trigger catch when the trigger is in the actuated position, wherein the trigger catch is configured to urge the trigger latch in a direction transverse to the injection axis when the piston moves from the unloaded position to the loaded position; and

wherein the housing, syringe adapter, and needle-free syringe are configured such that a gas within and a sound created within the housing are directed out the venting slot upon actuation of said fluid injection device.

2. The fluid injection device of claim 1, wherein:

the trigger catch comprises an annular engagement surface extending radially outward from the injection axis and facing towards the dispensing end of the housing; and

the trigger latch comprises an engagement surface extending inwardly towards the injection axis and facing towards the trigger end of the housing, and which engages the annular engagement surface of the trigger catch when the trigger is in the non-actuated position and clears the trigger catch when the trigger is in the actuated position.

3. The fluid injection device of claim 1, wherein:

the trigger catch further comprises an annular beveled surface which faces away from the injection axis towards the trigger end of the housing; and

the trigger latch further comprises a beveled surface which faces towards the injection axis and towards the dispensing end of the housing.

4. The fluid injection device of claim 1, wherein the trigger further comprises a lever biased towards the push-button by a return spring disposed within the housing.

5. The fluid injection device of claim 4, wherein the return spring is a clip spring biased against the lever of the trigger.

6. The fluid injection device of claim 1, further comprising a movable safety cap for blocking depression of the push-button, said safety cap comprising a pivot hinge and a snap-in recess lock.

7. The fluid injection device of claim 6, wherein the safety cap is pivotally mounted to the external actuation surface of the housing.

8. The fluid injection device of claim 1, wherein the inner surface of the housing comprises a portion extending towards the injection axis and which blocks the compression spring from contacting the trigger.

9. The fluid injection device of claim 1, wherein the syringe adapter is removable, and the housing is configured to removably accept alternatively configured syringe adaptors.

10. The fluid injection device of claim 9, wherein:

the syringe adapter is connected to the housing via turning clockwise;

the piston and the compression spring are removable from the housing when the syringe adapter is removed from the housing; and

the housing is configured to removably accept at least one of the alternatively sized pistons and springs.

11. The fluid injection device of claim 1, wherein the syringe adapter is removably affixed to the dispensing end of the housing.

12. The fluid injection device of claim 1, wherein the syringe adapter is irremovably affixed to the dispensing end of the housing.

13. The fluid injection device of claim 1, wherein the compression spring is retained around the piston by the piston head.

14. A fluid injection device, comprising:

a housing comprising an inner surface and an outer surface which extend from a proximal trigger end to a distal dispensing end along an injection axis;

a housing top retainer at said trigger end comprising a venting slot and an external actuation surface disposed transverse to the injection axis at the trigger end, the external actuation surface comprising a surface that tapers downward towards the dispensing end;

wherein said venting slot is positioned at a distal portion of said housing top retainer;

a syringe adapter at the dispensing end of the housing, the syringe adapter configured to retain a needle-free syringe and thereby create a seal of the dispensing end;

said syringe adapter comprising an outer surface that extends away from the injection axis beyond the outer surface of the housing;

a piston retained within the housing and movable between a loaded position and an unloaded position to bias a plunger of the needle-free syringe;

a trigger mounted near the trigger end on the injection axis and movable between a non-actuated position and an actuated position to initiate movement of the piston from the loaded position to the unloaded position upon actuation of the trigger, said trigger comprising a push-button with a front sliding guide, a rear sliding guide, a restrainer protrusion, and a lever contact;

a loader comprising an interior retaining surface configured to receive the housing and the syringe adapter;

wherein the loader is movable about a hinge between an open state and a closed state;

wherein movement of the loader from said open state to said closed state is configured to extend a loader plunger through an open end of the syringe adapter to make contact with said piston within the housing and to push the piston from said unloaded position into said loaded position;

wherein said interior retaining surface comprises a lip configured to engage the syringe adapter outer surface;

wherein engagement of the syringe adapter outer surface with said lip is configured to retain the syringe adapter and the housing within said interior retaining surface without stress on the housing trigger end when the piston is pushed from said unloaded position into said loaded position; and

wherein the housing, syringe adapter, and needle-free syringe are configured such that a gas within and a sound created within the housing are directed towards the trigger end and out the venting slot upon actuation of said fluid injection device.

15. The fluid injection device of claim 14, wherein the trigger is actuated by depression of the push-button disposed at the external actuation surface of the housing.

16. The fluid injection device of claim 15, wherein the trigger comprises a trigger latch configured to engage a trigger catch when the trigger is in the non-actuated position and the piston is in the loaded position and to release the trigger catch when the trigger is in the actuated position, wherein the trigger catch is configured to urge the trigger latch in a direction transverse to the injection axis when the piston moves from the unloaded position to the loaded position.

17. The fluid injection device of claim 1, wherein:

the housing inner surface comprising a narrowed inner surface section narrower than the compression spring but wider than the piston;

said narrowed inner surface forms a shelf for compressing said compression spring;

said piston comprises a tapered neck near a proximal end of the piston distal of the trigger catch; and

said tapered neck extends into said narrowed inner surface with said piston in loaded position.

18. The fluid injection device of claim 1, further comprising:

a loader comprising an interior retaining surface configured to receive the housing and the syringe adapter;

wherein the loader is movable about a hinge between an open state and a closed state;

wherein movement of the loader from said open state to said closed state is configured to extend a loader plunger through an open end of the syringe adapter to make contact with said piston head within the housing and to counteract the compression spring to push the piston from said unloaded position into said loaded position;

wherein said interior retaining surface comprises a lip configured to engage the syringe adapter outer surface; and

wherein engagement of the syringe adapter outer surface with said lip is configured to retain the syringe adapter and the housing within said interior retaining surface without stress on the housing trigger end when the piston is pushed from said unloaded position into said loaded position.