pre-filled or fill at time-of-use injectable drug syringes. As such, the adaptable retraction mechanisms of the present invention may be flexibly attached, affixed, mounted, or otherwise mated to standard barrels, such as straight-glass barrels. These embodiments, accordingly, provide novel and cost-efficient components and devices which are readily integrated into drug filling processes.

[0009] In an aspect of embodiments of the invention, there is provided a barrel adapter for a safety syringe having a barrel and a plunger assembly adapted to move within the barrel. The barrel adapter includes a barrel tip adapted to be sealingly engaged with a distal end of the barrel and a needle retraction mechanism having a needle subassembly and an actuator subassembly. The needle subassembly includes a needle and a needle-over-mold (NOM) through which the needle extends. The needle subassembly is disposed at least partially within the barrel tip, and adapted to move from an injection position in which the needle extends from a distal end of the barrel tip to a retracted position in which the needle is disposed within at least one of the barrel tip or the barrel. The actuator subassembly includes a needle seal, a push-bar including at least one force transfer element extending through the needle seal and is axially translatable through the needle seal and an actuating surface, axial translation of the at least one force transfer element through the needle seal axially translating the at least one actuating surface. The push bar is disposed at least partially proximal the needle seal. The needle retraction mechanism includes a biasing member and an actuable locking arrangement. The locking arrangement is disposed to maintain the biasing member in an energized position when the locking arrangement is locked and release the biasing member when actuated. The locking arrangement is actuable by depression of the plunger assembly, and contact of the plunger assembly with the push bar. The biasing member is disposed to move the needle from the injection position to the retracted position when the biasing member is released from the energized position.

[0010] In a further aspect of embodiments of the invention, there is provided an automatically retractable safety syringe including a barrel having a distal end and a proximal end, a plunger assembly adapted to move within the barrel, and a barrel adapter sealingly engaged with the distal end of the barrel. The safety syringe further includes a plunger assembly adapted to move within the barrel, the plunger assembly including a plunger rod and a plunger seal. The barrel adapter includes a barrel tip adapted to be sealingly engaged with a distal end of the barrel and a needle retraction mechanism having a needle subassembly and an actuator subassembly. The needle subassembly includes a needle, a

needle-over-mold (NOM) through which the needle extends, and a retention mechanism. The needle subassembly is disposed at least partially within the barrel tip, and adapted to move from an injection position in which the needle extends from a distal end of the barrel tip to a retracted position in which the needle is disposed within at least one of the barrel tip or the barrel. The actuator subassembly includes a needle seal, a push-bar, and an actuating surface. The needle retraction mechanism includes a biasing member and an actuable locking arrangement. The locking arrangement is disposed to maintain the biasing member in an energized position when the locking arrangement is locked and release the biasing member when actuated. The locking arrangement is actuable by depression of the plunger assembly, continued movement of the plunger seal of which moves the actuating surface in an axial direction to actuate the actuable locking mechanism to retract the needle. The biasing member is disposed to move the needle from the injection position to the retracted position when the biasing member is released from the energized position. A flange may be included in at least one embodiment of the syringe to, for example to close off the proximal end of the syringe and barrel from the outside environment and/or to provide a tangible aspect for ergonomic gripping of the syringe.

[0011] In another aspect of embodiments of the invention, there is provided a method of assembling a barrel adapter for a safety syringe. The method includes the steps of assembling a push bar to a needle seal with at least a proximal contact surface of the push bar disposed proximal to the needle seal and with at least one force transfer element extending through the needle seal, the at least one force transfer element being disposed for axial translation through the needle seal, coupling a needle subassembly including a needle to the needle seal with a proximal end of the needle providing a fluid pathway through the needle seal, disposing the needle assembly at least partially within a barrel tip with axial translation of the at least one force transfer element being disposed to move an actuating surface in an axial direction, energizing at least one biasing member between a needle-over-mold of the needle subassembly and a spring guide of the barrel tip, and coupling the needle subassembly to the barrel tip with an actuable locking arrangement to maintain the at least one biasing member in an energized state, the actuable locking arrangement being disposed to maintain the biasing member in an energized position when the locking arrangement is locked and release the biasing member when actuated, the biasing member being disposed to move the needle from the injection position to the retracted position when the biasing member is released from the energized position, the locking arrangement being actuable by axial movement of the

actuating surface relative to the actuable locking arrangement, the actuable locking arrangement being actuable by axial movement of the push bar, force transfer element, and actuating surface as a result of contact and depression of a plunger assembly to actuate the actuable locking arrangement to at least partially release the at least one biasing member from the energized state and retract the needle at least partially inside of at least one of the barrel tip and the barrel..

[0012] Accordingly, the barrel adapters include the components necessary for needle retention and retraction, and are configured to mate with standard barrels. The barrel adapter is configured to mate and be affixed, through a number of known methods, to the distal end of a barrel. In at least one embodiment, the barrel adapters are configured to mate with barrels that are substantially straight in cross-sectional profile (e.g., substantially parallel along at least a distal portion of the barrel), such as glass straight-barrels. The barrel adapters may be