# INJECTION DEVICE WITH LOCKING MECHANISM FOR SYRINGE CARRIER

## Field of the Invention

The present invention relates to an injection device of the type which has a syringe and which extends the syringe, discharges its contents and then retracts it automatically.

## Background of the Invention

Injection devices are shown in WO 95/35126 and EP-A-0 516 473. These devices employ a drive spring and some form of release mechanism that releases the syringe from the influence of the drive spring once its contents are supposed to have been discharged, to allow it to be retracted by a return spring.

Generally, the return spring is relatively weak, since its restoring force must be overcome by the drive spring, even while the drive spring is doing work on the various components of the injection device and the syringe during an injection cycle. This may give rise to a problem when the injection device is used with sealed hypodermic syringes, which typically have a hermetically sealed cover, needle shield or "boot" that covers the hypodermic needle and maintains the sterility of the syringe contents. Naturally, it is necessary to maintain the sterility of the syringe contents up to the point of administration, which devices that are designed to be disposable, as many will be, means that the boot must be removed with the syringe inside the injection device.

Typically, the action required to remove the boot from the syringe is simply to pull the boot away from the syringe, which requires a force in excess of 20N. This is significantly greater than the restoring force of the return spring, so the syringe will be pulled out of the injection device as the boot is removed and, when the boot comes away, it will snap back into place. This is not the best way to handle the syringe. The shock could damage it, the needle could be damaged and there may be problems re-engaging the syringe with those components of the injection device designed to act upon it. Even

in cases where there is no return spring, for example where the syringe is held in place by friction with components of the injection device, the problem will still arise of relocating the syringe onto those components of the injection device designed to act upon it.

Moreover, there is a problem with having the syringe generally moveable in a direction out of the injection device. Accidental activation of the drive spring by mechanical failure of the drive spring's release mechanism (e.g. a trigger) can occur, for example by dropping the device on a hard surface. This accidental activation could cause the syringe to be extended unintentionally out of the device and its contents to be ejected. This could expose the needle of the syringe and increase the risk of inadvertent ski puncturing and/or infection.

## Summary of the Invention

The injection device of the present invention is designed to deal with the aforementioned problems.

In a first aspect of the present invention, there is provided an injection device comprising:

a housing adapted to receive a syringe having a discharge nozzle, the syringe being moveable in the housing along a longitudinal axis between a retracted position in which the discharge nozzle is contained within the housing and an extended position in which the discharge nozzle of the syringe extends from the housing through an exit aperture;

an actuator;

a drive adapted to be acted upon by the actuator and in turn act upon the syringe to advance it from its retracted position to its extended position and discharge its contents through the discharge nozzle;

a release mechanism adapted, in an engaged position, to prevent the actuator acting on the drive and, in a disengaged position, to permit the actuator to act on the drive;

a syringe carrier adapted to support the syringe as it is advanced; and

a locking mechanism between the syringe carrier and the release mechanism to inhibit movement of the syringe carrier and syringe towards the exit aperture when the release mechanism is in its engaged position.

Thus, the syringe carrier and syringe are locked in place within the injection device until such time that the device is actuated by activation of the release mechanism. This prevents damage to the syringe and its contents. Moreover, this assists in preventing accidental activation of the injection device, for example by dropping the injection device on a hard surface.

Preferably, the locking mechanism is adapted to prevent movement of the syringe carrier towards the exit aperture when the release mechanism is in its engaged position.

Preferably, the release mechanism is located at an external side surface of the housing. The external side surface may be distanced from the longitudinal axis in a perpendicular direction with respect to the longitudinal axis.

Moreover, the release mechanism may comprise an activation surface adapted for application of pressure by a user of the injection device in a direction into the housing to move the release mechanism from its engaged position to its disengaged position.

In one embodiment of the present invention, the release mechanism comprises a protrusion extending into the housing, wherein the protrusion engages the syringe carrier in the engaged position of the release mechanism and is disengaged from the syringe carrier in the disengaged position of the release mechanism.

Preferably, the protrusion comprises an aperture through which the syringe carrier extends.

Furthermore, the aperture may comprise:

a first portion which is dimensioned to engage with the syringe carrier when the release mechanism is in its engaged position; and

a second portion which is dimensioned not to engage with the syringe carrier when the release mechanism is in its disengaged position.

This arrangement provides a secure and effective locking mechanism for preventing movement of the syringe carrier via the release mechanism, in addition to the release mechanism's function of retaining the drive in an unactuated position until such time that the release mechanism is activated.

Advantageously, an edge of the first portion of the aperture may engage with the syringe carrier when the release mechanism is in its engaged position and will not be so engaged when the release mechanism is moved to its disengaged position.

Preferably, the syringe carrier comprises an opening for engagement by the protrusion when the locking mechanism is in its engaged position.

In one embodiment of the present invention, the opening is a channel extending about a section of the circumference of the outer surface of the syringe carrier.

In another embodiment of the present invention, the opening is a slot about a section of the circumference of the outer surface of the syringe carrier, wherein the slot extends through the outer surface of the syringe carrier.

In one embodiment of the present invention, a section of the housing comprises an opening through which the protrusion extends, at least when the locking mechanism is in its engaged position.

Preferably, the drive comprises a shaft extending parallel to the longitudinal axis, or, indeed, along the longitudinal axis.

Preferably, the actuator comprises biasing means adapted to bias the syringe carrier from a retracted position to an extended position.

The injection device may comprise a removable cap for locating on the housing and for covering at least a portion of the exit aperture,

Advantageously, the removable cap may be connected to a removable shield on the discharge nozzle, such that the shield is removed from the discharge nozzle when the cap is removed from the housing.

In one embodiment of the present invention, the drive includes first and second drive elements, of which the first is acted upon by the actuator and in turn acts upon the second, and the second acts upon the syringe or the syringe carrier to advance it from its retracted position to its extended position and discharge its contents through the discharge nozzle, the first drive element being capable of movement relative to the second when the first is acted upon by the actuator and the second is restrained by the syringe or the syringe carrier.

In another embodiment of the present invention, the injection device comprises a coupling that prevents the first drive element from moving relative to the second until they have been advanced to a nominal decoupling position that is less advanced than the said nominal release position.

Preferably, the coupling comprises a decoupling mechanism, activated when the drive elements have been advanced to the said nominal decoupling position and adapted to decouple the first drive element from the second, thus allowing the first drive element to move relative to the second.

## Brief Description of the Drawings

The invention will now be described by way of example with reference to the accompanying drawings, in which:

Fig. 1a is a right-side view of the injection device according to the present invention;

Fig. 1b is a perspective view of the injection device of Fig. 1 with its cap removed;

Fig. 1c is a perspective view of the cap of the injection device of Fig. 1;

Fig. 2a is an exploded right-side view of the injection device of Fig. 1;

Fig. 2b is a right-side view of the assembled components of the injection device of Fig. 1;

Fig. 2c is a perspective view of a multi-component drive used in the injection device of Fig. 1

Fig. 3a is a perspective view of a proximal portion of a trigger button used in the injection device of Fig. 1; and

Fig. 3b is a cross-sectional view of the injection device of Fig. 1.

**Detailed Description of the Drawings**

Fig. 1a is a right-side view of an injection device 110 according to the present invention. The injection device 110 has a housing 112, a cap 111 which is removable from a proximal end 167 the housing 112 and a trigger button 102. Other parts of the device will be described in greater detail below.

Fig. 1b is a perspective view of the injection device 110 according to the present invention with the cap (not shown) removed from its end. The end of the housing 112 has an exit aperture 128, from which the end of a sleeve 119 can be seen to emerge.

Fig. 1c is a perspective view of the cap 111 of the injection device 110 according to the present invention. The cap 111 has a central boss 121 that fits within the sleeve 119 when the cap 111 is installed on the housing 112.

Fig. 2a is an exploded right-side view of the components of the injection device 110 according to the present invention and Fig. 2b is a right-side view of the assembled components of the injection device 110 according to the present invention without the housing 112 or cap 111.

As illustrated, the injection device 110 comprises a hypodermic syringe 114 of conventional type, including a syringe body 116 terminating at one end in a discharge nozzle, specifically a hypodermic needle 118, and at the other in a flange 120. The conventional plunger that would normally be used to discharge the contents of the syringe 114 manually has been removed and replaced with a drive element (referred to below as the second drive element 134) that contacts a bung 122 in the syringe 114. The bung 122 constrains a drug (not shown) to be administered within the syringe body 116. Whilst the syringe illustrated is of hypodermic type, this need not necessarily be so. Transcutaneous or ballistic dermal and subcutaneous syringes may also be used with the injection device of the present invention.

As illustrated, the injection device 110 includes a return spring 126 that biases the syringe 114 from an extended position in which the needle 118 extends from the aperture 128 in a case nose 112a of the housing 112 to a retracted position in which the needle 118 is contained within the housing 112. The return spring 126 acts on the syringe 114 via a syringe carrier 127. The syringe 114 is moveable along a longitudinal axis 105 of the injection device 110 which extends centrally along the length of the injection device 110 from the exit aperture 128 at its proximal end 167 to a distal end 168.

Contained within the housing at its distal end 168 is an actuator, which here takes the form of a compression drive spring 130. Drive from the drive spring 130 is transmitted via a multi-component drive 129 to the syringe 114 to advance it from its retracted position to its extended position and discharge its contents through the needle 118. The drive 129 accomplishes this task by acting directly on the drug and the syringe 114. Hydrostatic forces acting through the drug and, to a lesser extent, static friction between the bung 122 and the syringe body 116 initially ensure that they advance together, until the return spring 126 bottoms out on the syringe carrier 127 or meets some other obstruction (not shown) that retards its motion.

Fig. 2c is an exploded perspective view of the multi-component drive 129. The multi-component drive 129 between the drive spring 130 and the syringe 114 consists of three principal components. A drive sleeve 131 takes drive from the drive spring 130 and transmits it to a delay piston 133 on a first drive element 132. This in turn transmits drive to the second drive element 134.

As will be seen from Fig. 2c, the first drive element 132 includes a hollow stem 140, the inner cavity of which forms a collection chamber 141 in communication with a vent 144 that extends from the collection chamber 141 through the end of the stem 140. The second drive element 134 includes a blind bore 146 that is open at one end to receive the stem 140 and closed at the other. As will be appreciated, the bore 146 and the stem 140 define a fluid reservoir within which a damping fluid is contained.

The trigger button 102 is provided on the side of the housing 112 which, when in an engaged position with a proximal end 145 of the drive sleeve 131, serves to retain the drive spring 130 in a compressed state by contact between locking surface 102b and the drive sleeve 131 when the button 102 is in an unactuated position. The trigger button 102 can pivot on the housing 112 via pivot 102a. When downwards pressure is applied to the trigger button 102 at an activation surface 102c (i.e. pressure directed into the housing 112), the locking surface 102b moves upwards in a direction away from the longitudinal axis 105. In this actuated position of the button 102, the locking surface 102b is decoupled from the drive sleeve 131, thereby allowing the drive sleeve 131 to move relative to the housing 112 towards the exit aperture 128 under the influence of the drive spring 130.

The sliding sleeve 119 is moveable from its extended position (as shown in Fig. 1b) where it protrudes out of the exit aperture 128 into a retracted position in the case nose 112a of the housing 112. The sliding sleeve 119 is connected to a button lock element 150 which has resilient arms 151 which bias the sliding sleeve 119 into its extended position in which its end protrudes from the end of the case nose 112a. Thus, application of pressure to the end of the sliding sleeve 119, for example by pressing the end of the sliding sleeve 119 against tissue, causes it to move into its retracted position into the

housing 112; release of the pressure causes the sliding sleeve 119 to move into its extended position under bias from the resilient arms 151 acting against a side wall of the housing 112. The button lock element 150 has a button lock protrusion 152 which contacts with the end of a trigger button protrusion 102d on the trigger button 102 when the sliding sleeve is in its extended position. The trigger button protrusion 102 extends in a direction which is generally parallel to the longitudinal axis 105 of the injection device 110. The button lock protrusion 152 extends in a direction which is generally perpendicular to the longitudinal axis 105 towards the trigger button protrusion 102d. The trigger button protrusion 102d has an aperture 102e which can move over the top of the button lock protrusion 152 when the button lock element 150 has been moved away from the exit aperture 128 (i.e. when the sliding sleeve 119 has been moved into the exit aperture 128 into its retracted position). In this position, the trigger button 102 can be moved into its deactivated position by rotating the trigger button 102 about the pivot 102a in the direction of the pressure applied to the pressure surface 102c. Thus, the button lock element 150 and the sliding sleeve 119 act together to lock the trigger button 102 in its activated position (i.e. the locking surface 102b contacts the end of the drive sleeve 131 preventing it from moving towards the exit aperture 128 under the bias of the compressed drive spring 130).

When the sliding sleeve 119 has been moved into a position in which it is retracted into the housing 112 (i.e. into its unlocked position) and the trigger button 102 has been rotated into its deactivated position, the operation of the device 110 is then as follows.

Initially, the drive spring 130 moves the drive sleeve 131, the drive sleeve 131 moves the first drive element 132 and the first drive element 132 moves the second drive element 134, in each case by acting through flexible latch arms 132a, 134a, 134b. The second drive element 134 moves and, by virtue of static friction and hydrostatic forces acting through the drug (not shown), moves the syringe body 116 and syringe carrier 127 against the action of the return spring 126. The return spring 126 compresses and the hypodermic needle 118 emerges from the exit aperture 128 of the housing 112. This continues until the return spring 126 bottoms out or the syringe body 116 meets some other obstruction (not shown) that retards its motion. Because the static friction between the second drive element 134 and the syringe body 116 and the hydrostatic forces acting

through the drug (not shown) to be administered are not sufficient to resist the full drive force developed by the drive spring 130, at this point the second drive element 134 begins to move within the syringe body 116 and the drug (not shown) begins to be discharged. Dynamic friction between the second drive element 134 and the syringe body 116 and hydrostatic forces acting through the drug (not shown) to be administered are, however, sufficient to retain the return spring 126 in its compressed state, so the hypodermic needle 118 remains extended.

Before the second drive element 134 reaches the end of its travel within the syringe body 116, so before the contents of the syringe have fully discharged, the flexible latch arms 134a, 134b linking the first and second drive elements 132, 134 reach a constriction 137 provided on a latch actuator element 137a which is fixed to the end of the syringe carrier 127. The constriction 137 moves the flexible latch arms 134a, 134b inwards from the position shown in Fig. 2c to a position at which the flexible latch arms 134a, 134b no longer couple the first drive element 132 to the second drive element 134, aided by the bevelled surfaces on the constriction 137. Once this happens, the first drive element 132 acts no longer on the second drive element 134, allowing the first drive element 132 to move relative to the second drive element 134.

Because the damping fluid is contained within a reservoir (not shown) defined between the end of the first drive element 132 and the blind bore 146 in the second drive element 134, the volume of the reservoir will tend to decrease as the first drive element 132 moves relative to the second drive element 134 when the former is acted upon by the drive spring 130. As the reservoir collapses, damping fluid is forced through the vent 144 into the collection chamber 141. Thus, once the flexible latch arms 134a, 134b have been released, the force exerted by the drive spring 130 does work on the damping fluid, causing it to flow though the constriction formed by the vent 144, and also acts hydrostatically through the fluid and through friction between the first and second drive elements 132, 134, thence via the second drive element 134. Losses associated with the flow of the damping fluid do not attenuate the force acting on the body of the syringe to a great extent. Thus, the return spring 126 remains compressed and the hypodermic needle remains extended.

After a time, the second drive element 134 completes its travel within the syringe body 116 and can go no further. At this point, the contents of the syringe 114 are completely discharged and the force exerted by the drive spring 130 acts to retain the second drive element 134 in its terminal position and to continue to cause the damping fluid to flow though the vent 144, allowing the first drive element 132 to continue its movement.

Before the reservoir of fluid is exhausted, the flexible latch arms 132a linking the drive sleeve 131 with the first drive element 132 reach another constriction (not shown) within the housing 112. This constriction moves the flexible latch arms 132a inwards from the position shown to a position at which they no longer couple the drive sleeve 131 to the first drive element 132, aided by bevelled surfaces on the constriction. Once this happens, the drive sleeve 131 acts no longer on the first drive element 132, allowing them to move relative each other. At this point, of course, the syringe 114 is released, because the forces developed by the drive spring 130 are no longer being transmitted to the syringe 114, and the only force acting on the syringe will be the return force from the return spring 126. Thus, the syringe 114 is now returned to its retracted position and the injection cycle is complete.

All this takes place, of course, only once the cap 111 has been removed from the end of the housing 112. The end of the syringe is sealed with a boot 123. The central boss 121 of the cap that fits within the sleeve 119 when the cap 111 is installed on the housing 112 comprises a retainer element 125 which is fixed into the boss 121. The retainer element 125 comprises resilient protrusions 125a which are directed away from the exit aperture 128. These resilient protrusions 125a deform as the cap 111 is inserted onto the housing 112 over a needle shield or rubber boot 123. The protrusions 125a then grip the boot 123 tightly so that the ends of the protrusions are slightly embedded in the boot 123 which might be made from rubber. This means that, as the cap 111 is pulled off the housing 112, the boot 123 is pulled away from the syringe 114 with the cap 111.

Fig. 2a also shows a syringe lock protrusion 170 located on the button 102 at its distal end which is proximal to the end which is located nearest to the aperture 128. The syringe lock protrusion 170 extends in a generally perpendicular direction (with respect to the longitudinal axis 105) into the injection device 110 towards the longitudinal axis

105.

Fig. 3a illustrates a distal end of the button 102 in greater detail. As can be seen, the syringe lock protrusion 170 comprises an aperture 171 which includes a first portion 171a and a second portion 171b. The first and second portions 171a, 171b overlap with each other and have different cross-sectional areas as will be seen from Fig. 3a. The first portion 171a has an edge 171c.

Fig. 3b shows how the button 102 is integrated with the injection device 110 of the present invention.

The case nose 112a comprises a case nose slot 175 located towards the distal end of the housing 112. The case nose slot 175 extends about a substantial proportion of the circumference of the case nose 112a and extends through the case nose 112a. The case nose slot 175 does not extend round the case nose 112a on a section of its circumference which faces towards the button 102. The length of this section about the circumference of the case nose 112a corresponds to the overlap between the first and second portions 171a, 171b of the syringe lock protrusion 170. The width of the case nose slot 175 (in a direction along the longitudinal axis 105) is slightly more than the thickness of the edge 171c of the syringe lock protrusion 170.

The syringe carrier 127 comprises a syringe carrier slot 176 located towards the distal end of the syringe carrier 127. The syringe carrier slot 176 extends about a substantial proportion of the circumference of the syringe carrier 127 and extends through the syringe carrier 127 (although this is not absolutely necessary). The syringe carrier slot 176 does not extend round the syringe carrier 127 on a section of its circumference which faces towards the button 102. The length of this section about the circumference of the syringe carrier 127 corresponds to the overlap between the first and second portions 171a, 171b of the syringe lock protrusion 170. As with the case nose slot 175, the width of the syringe carrier slot 176 (in a direction along the longitudinal axis 105) is slightly more than the thickness of the edge 171c of the syringe lock protrusion 170.

In the unactuated position of the button 102 (as shown in Fig. 3b), the first portion 171a

of the syringe lock protrusion 170 surrounds the case nose slot 175 and the syringe carrier slot 176. In addition, the edge 171c of the syringe lock protrusion 170 extends through the case nose slot 175 into the syringe carrier slot 176 so that the syringe carrier 127 is locked to the button 102 and cannot move along the longitudinal axis 105. This prevents the syringe 114 and syringe carrier 127 moving towards the exit aperture 128 when the cap 111 is removed or through accidental activation of the injection device 110, for example by dropping it on a hard surface.

When the button 102 is moved to its actuated position, the edge 171c of the first portion 171a of the syringe lock protrusion 170 moves out of the syringe carrier slot 176 so that the second portion 171b of the syringe carrier protrusion 170 surrounds the syringe carrier 127, but does not engage with the syringe carrier slot 176. In this way, the syringe carrier 127 is no longer locked to the button 102 and can move along the longitudinal axis 105. Thus, the syringe 114 will extend under bias from the drive spring 130 along the longitudinal axis 105 because activation of the button 102 (by applying force to its pressure surface 102c) will have released the drive cylinder 131 from its contacting position against the locking surface 102b, thereby permitting the multi-component drive to move towards the exit aperture 128, along with the syringe 114 and syringe carrier 127.

Thus, the syringe 114 and syringe carrier 127 are prevented from moving longitudinally until the time that the button 102 is actuated. Of course, this also requires that the sliding sleeve 119 has also been moved into its retracted position, thereby releasing the button lock element 150 from its locked position against the button 102.

It will of course be understood that the present invention has been described above purely by way of example and modifications of detail can be made within the scope of the invention.

Claims

1. An injection device comprising:

a housing adapted to receive a syringe having a discharge nozzle, the syringe being moveable in the housing along a longitudinal axis between a retracted position in which the discharge nozzle is contained within the housing and an extended position in which the discharge nozzle of the syringe extends from the housing through an exit aperture;

an actuator;

a drive adapted to be acted upon by the actuator and in turn act upon the syringe to advance it from its retracted position to its extended position and discharge its contents through the discharge nozzle;

a release mechanism adapted, in an engaged position, to prevent the actuator acting on the drive and, in a disengaged position, to permit the actuator to act on the drive;

a syringe carrier adapted to support the syringe as it is advanced; and

a locking mechanism between the syringe carrier and the release mechanism to inhibit movement of the syringe carrier and syringe towards the exit aperture when the release mechanism is in its engaged position.

2. The injection device according to claim 1, wherein the locking mechanism is adapted to prevent movement of the syringe carrier towards the exit aperture when the release mechanism is in its engaged position.

3. The injection device of claim 1 or claim 2, wherein the release mechanism is located at an external side surface of the housing.

4. The injection device according to claim 3, wherein the external side surface is displaced from the longitudinal axis in a perpendicular direction with respect to the longitudinal axis.

5. The injection device according to any one of the preceding claims, wherein the release mechanism comprises an activation surface adapted for application of pressure

by a user of the injection device in a direction into the housing to move the release mechanism from its engaged position to its disengaged position.

6. The injection device according to any one of the preceding claims, wherein the release mechanism comprises a protrusion extending into the housing,

wherein the protrusion engages the syringe carrier in the engaged position of the release mechanism and is disengaged from the syringe carrier in the disengaged position of the release mechanism.

7. The injection device of claim 6, wherein the protrusion comprises an aperture through which the syringe carrier extends.

8. The injection device of claim 7, wherein the aperture comprises:

a first portion which is dimensioned to engage with the syringe carrier when the release mechanism is in its engaged position; and

a second portion which is dimensioned not to engage with the syringe carrier when the release mechanism is in its disengaged position.

9. The injection device of claim 8, wherein an edge of the first portion of the aperture engages with the syringe carrier when the release mechanism is in its engaged position and is not so engaged when the release mechanism is moved to its disengaged position.

10. The injection device of any one of claims 6 to 9, wherein the syringe carrier comprises an opening for engagement by the protrusion when the locking mechanism is in its engaged position.

11. The injection device of claim 10, wherein the opening is a channel extending about a section of the circumference of the outer surface of the syringe carrier.

12. The injection device of claim 10, wherein the opening is a slot about a section of the circumference of the outer surface of the syringe carrier and wherein the slot extends through the outer surface of the syringe carrier.

13. The injection device of any one of claims 6 to 13, wherein a section of the housing comprises an opening through which the protrusion extends, at least when the locking mechanism is in its engaged position.

14. The injection device of any one of the preceding claims, wherein the drive comprises a shaft extending parallel to the longitudinal axis.

15. The injection device of any one of the preceding claims, wherein the actuator comprises biasing means adapted to bias the syringe carrier from a retracted position to an extended position.

16. The injection device of any one of the preceding claims, further comprising a removable cap for locating on the housing and for covering at least a portion of the exit aperture,

17. The injection device of claim 16, wherein the removable cap is connected to a removable shield on the discharge nozzle, such that the shield is removed from the discharge nozzle when the cap is removed from the housing.

18. The injection device according to any one of the preceding claims, wherein the drive includes first and second drive elements, of which the first is acted upon by the actuator and in turn acts upon the second, and the second acts upon the syringe or the syringe carrier to advance it from its retracted position to its extended position and discharge its contents through the discharge nozzle, the first drive element being capable of movement relative to the second when the first is acted upon by the actuator and the second is restrained by the syringe or the syringe carrier.

19. The injection device according to claim 18, further comprising a coupling that prevents the first drive element from moving relative to the second until they have been advanced to a nominal decoupling position that is less advanced than the said nominal release position.

20. The injection device according to claim 18, wherein the coupling comprises a decoupling mechanism, activated when the drive elements have been advanced to the said nominal decoupling position and adapted to decouple the first drive element from the second, thus allowing the first drive element to move relative to the second.