Injection Device

Background Technology

The present invention relates to an injection device of the type that receives a syringe, extends it, discharges its contents and then retracts it automatically. Devices of this general description are shown in WO 95/35126 and EP-A-0 516 473 and tend to 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.

In devices of this nature, it is desirable for the return spring to be sufficiently strong that it can retract the syringe quickly. However, it is then possible for the syringe to be retracted so forcefully that it escapes from those elements of the device that are supposed to hold it during the extension and retraction phases. The syringe may then be free to move around within the body of the device. This gives rise to a number of undesirable effect. Firstly, the syringe will rattle around in the body of the device, giving an impression of poor quality. Secondly, shaking the device, which may be encouraged in those patients of a certain disposition by the rattling noise made by the syringe, might break the syringe, allowing broken glass to escape. Moreover, if the device has a viewing window, through which the discharged syringe may be inspected, the syringe will no longer be correctly positioned relative to it.

Summary of the Invention

It is an objective of the present invention to provide an improved injection device that does not suffer from these shortcomings.

Accordingly, the present invention provides an injection device comprising:

a housing adapted to receive a syringe having a discharge nozzle and including means for biasing the syringe from an extended position in which the discharge nozzle of the syringe extends from the housing to a retracted position in which the discharge nozzle is contained within the housing;

an actuator;

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

a release mechanism, activated when the drive has been advanced to a nominal release position, to release the syringe from the action of the actuator, whereupon the biasing means restores the syringe to its retracted position; and

a locking mechanism that confines the returned syringe in its retracted position.

By confining the syringe in its retracted position, rather than permitting it to break free, the present invention overcomes the disadvantages discussed above. Preferably, the locking mechanism is activated when the drive has been advanced to a locking position that is no more advanced than the said nominal release position.

In a preferred implementation of the present invention, the housing includes a syringe carrier adapted to receive the syringe and the biasing means is adapted to bias the syringe carrier from an extended position to a retracted position. In that case, the locking mechanism can prevent the drive from retracting relative to the syringe carrier, thus confining the syringe between the drive and the syringe carrier in preparation for the activation of the release mechanism.

Con convenience of manufacture and simplicity of operation, the drive may include a flexible latch that rides over a detent as the drive is advanced and thereafter engages beyond it. For example, the syringe carrier may include a detent and the flexible latch may ride over the detent as the drive is advanced and thereafter engage beyond it. The flexible latch may comprises a flexible barb, for increased security of latching.

A plurality of such flexible latches may be present, and they can be substantially equidistantly spaced around the circumference of the drive.

Brief Description of the Drawings

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

Figure 1 is an illustration of a comparative injection device as discussed above; and

Figures 2-4 show an embodiment of the present invention.

Detailed Description

Figure 1 shows an injection device 210 in which a housing 212 contains a hypodermic syringe 214. The syringe 214 is again of conventional type, including a syringe body 216 terminating at one end in a hypodermic needle 218 and at the other in a flange 220, and a rubber bung 222 that constraints a drug 224 to be administered within the syringe body 216. The conventional plunger that would normally be connected to the bung 222 and used to discharge the contents of the syringe 214 manually, has been removed and replaced with a multi-component drive element as will be described below. Whilst the syringe illustrated is again of hypodermic type, this need not necessarily be so. As illustrated, the housing includes a return spring 226 that biases the syringe 214 from an extended position in which the needle 218 extends from aperture 228 in the housing 212, to a retracted position in which the hypodermic needle 218 is contained within the housing 212. The return spring 226 acts on the syringe 214 via a sleeve 227.

At the other end of the housing is a compression drive spring 230. Drive from the drive spring 230 this transmitted via the multi-component drive to the syringe 214 to advance it from its retracted position to its extended position and discharge its contents through the needle 218. The drive accomplishes this task by acting directly on the drug 224 and the syringe 214. Hydrostatic forces acting through the drug 224 and, to a lesser extent, static friction between the bung 222 and the syringe body 216 initially ensures that they advance together, until the return spring 226 bottoms out or the syringe body 216 meets some other obstruction that retards its motion.

The multi component drive between the drive spring 230 and the syringe 214 again consists of three principal components. The drive sleeve 231 takes drive from the drive spring 230 and transmits it to flexible latch arms 233 on a first drive element 232. These elements are shown in detail "A". The first drive element 232 in turn transmits drive via flexible latch arms 235 to a second drive element 234. These elements are shown in detail "B". As before, the first drive element 232 includes a hollow stem 240, the inner cavity of which forms a collection chamber 242. The second drive element 234 includes a blind for 246 that is open at one end to receive the stem 240 and closed at the other. As can be seen, the bore 246 and the stem 240 define a fluid reservoir 248, within which a damping fluid is contained.

A trigger (not shown) is provided at the middle of the housing 212 and, one operated, serves to decouple the drive sleeve 231 from the housing 212 allowing it to move relative to the housing 212 under the influence of the drive spring 230. The operation of the device is then as follows.

Initially, the drive spring 230 moves the drive sleeve 231, the drive sleeve 231 moves the first drive element 232 and the first drive element 232 moves the second drive element 234, in each case by acting through the flexible matching arms 233, 235. The second drive element 234 moves and, by virtue of static friction and hydrostatic forces acting through the drug 224 to be administered, moves the syringe body 216 against the action of the return spring 226. The return spring 226 compresses and the hypodermic needle 218 emerges from the exit aperture 228 of the housing 212. This continues until the return spring 226 bottoms out or the syringe body 216 meets some other obstruction that retards its motion. Because the static friction between the bung 222 and the syringe body 216 and the hydrostatic forces acting through the drug 224 to be administered are not sufficient to resist the full drive force developed by the drive spring 230, at this point the second drive element 234 begins to move within the syringe body 216 and the drug 224 begins to be discharged. Dynamic friction between the bung 222 and the syringe body 216 and hydrostatic forces acting through the drug 224 to be administered are, however, sufficient to retain the return spring 226 in its compressed state, so the hypodermic needle 218 remains extended.

Before the second drive element 234 reaches the end of its travel within the syringe body 216, so before the contents of the syringe have fully discharged, the flexible latch arms 235 linking the first and second drive elements 232, 234 reach a constriction 237. The constriction 237 is formed by a component 262 that is initially free to move relative to all other components, but that is constrained between the syringe flange 220 and additional flexible arms 247 on the second drive element 234. These additional flexible arms 247 overlie the flexible arms 235 on the first drive element 232, by means of which drive is transmitted to the second drive element 234. Figure 1 illustrates the injection device 210 at the position where the additional flexible arms 247 are just making contact with the constriction 237 in the component 262.

The constriction 237 moves the additional flexible arms 247 inwards, aided by the bevelled surfaces on both, and the additional flexible arms 247 in turn move the flexible arms 235, by means of which drive is transmitted from the first drive element 232 to the second drive element 234, inwards from the position shown to a position at which they no longer couple the first and second drive elements together. Once this happens, the first drive element 232 acts no longer on the second drive element 234, allowing the first drive element 232 to move relative to the second drive element 234.

Because the damping fluid is contained within a reservoir 248 defined between the end of the first drive element 232 and the blind bore 246 in the second drive element 234, the volume of the reservoir 248 will tend to decrease as the first drive element 232 moves relative to the second drive element 234 when the former is acted upon by the drive spring 230. As the reservoir 248 collapses, damping fluid is forced into the collection chamber 242. Thus, once the flexible latch arms 235 have been released, the force exerted by the drive spring 230 does work on the damping fluid, causing it to flow into the collection chamber 242, and also acts hydrostatically through the fluid and through friction between the first and second drive elements 232, 234, thence via the second drive element 234. 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 226 remains compressed and the hypodermic needle remains extended.

After a time, the second drive element 234 completes its travel within the syringe body 216 and can go no further. At this point, the contents of the syringe 214 are completely discharged and the force exerted by the drive spring 230 acts to retain the second drive element 234 in its terminal position and to continue to cause the damping fluid to flow into the collection chamber 242, allowing the first drive element 232 to continue its movement.

A flange 270 on the rear of the second drive element 234 normally retains the flexible arms 233 in engagement with the drive sleeve 231. However, before the reservoir 248 of fluid is exhausted, the flexible latch arms 233 linking the drive sleeve 231 with the first drive element 232 move sufficiently far forward relative to the second drive element 234 that the flange 270 is brought to register with a rebate 272 in the flexible arms 233, whereupon it ceases to be effective in retaining the flexible arms 233 in engagement with the drive sleeve 231. Now, the drive sleeve 231 moves the flexible latch arms 233 inwards from the position shown to a position at which they no longer couple the drive sleeve 231 to the first drive element 232, aided by the bevelled latching surfaces 274 on the flexible arms 233. Once this happens, the drive sleeve 231 acts no longer on the first drive element 232, allowing them to move relative to each other. At this point, of course, the syringe 214 is released, because the forces developed by the drive spring 230 are no longer being transmitted to the syringe 214, and the only force acting on the syringe will be the return force from the return spring 226. Thus, the syringe 214 now returns to its retracted position and the injection cycle is complete.

However, in this example, it may be possible for the syringe to return beyond its retracted position, or in other words to come free of the syringe carrier and then rattle around within the body of the injection device. Although there is of course no possibility of the syringe falling out of the injection device altogether, the various undesirable consequences that have already been discussed may follow.

Figures 2-4 show an injection device 310 in which this problem is neatly overcome. Again, a housing 312 contains a hypodermic syringe 314. The syringe 314 is again of conventional type, including a syringe body 316 terminating at one end in a hypodermic needle 318 and at the other in a flange 320, and a rubber bung 322 that constraints a drug 324 to be administered within the syringe body 316. Whilst the syringe illustrated is again of hypodermic type, this need not necessarily be so. As illustrated, the housing includes a return spring 326 that biases the syringe 314 from an extended position in which the needle 318 extends from an aperture 328 in the housing 312, to a retracted position in which the hypodermic needle 318 is contained within the housing 312. The return spring 326 acts on the syringe 314 via a sleeve 327. The extended position of the syringe 314 is shown in Figure 3; and the retracted position, after the injection cycle is complete is shown in Figure 4.

At the other end of the housing is a compression drive spring 330. Drive from the drive spring 330 this transmitted via the multi-component drive to the syringe 314 to advance it from its retracted position to its extended position and discharge its contents through the needle 318. The drive accomplishes this task by acting directly on the drug 324 and the syringe 314. Hydrostatic forces acting through the drug and, to a lesser extent, static friction between the bung 322 and the syringe body 316 initially ensures that they advance together, until the return spring 326 bottoms out or the syringe body 316 meets some other obstruction that retards its motion.

The multi component drive between the drive spring 330 and the syringe 314 again consists of three principal components. The drive sleeve 331 takes drive from the drive spring 330 and transmits it to flexible latch arms 333 on a first drive element 332. The first drive element 332 in turn transmits drive via flexible latch arms (not shown) to a second drive element 334. As before, the first drive element 332 includes a hollow stem 340, the inner cavity of which forms a collection chamber 342. The second drive element 334 includes a blind bore 346 that is open at one end to receive the stem 340 and closed at the other. As can be seen, the bore 346 and the stem 340 define a fluid reservoir 348, within which a damping fluid is contained.

A trigger 349 is provided in the housing 312. The trigger 349, one operated, serves to decouple the drive sleeve 331 from the housing 312 allowing it to move relative to the housing 312 under the influence of the drive spring 330. The operation of the device is then as follows.

Initially, the drive spring 330 moves the drive sleeve 331, the drive sleeve 331 moves the first drive element 332 and the first drive element 332 moves the second drive element 334, in each case by acting through the flexible matching arms (not shown). The second drive element 334 moves and, by virtue of static friction and hydrostatic forces acting through the drug 324 to be administered, moves the syringe body 316 and hence the sleeve 327 against the action of the return spring 326. The return spring 326 compresses and the hypodermic needle 318 emerges from the exit aperture 328 of the housing 312. This continues until the return spring 326 bottoms out or the sleeve 327 meets some other obstruction that retards its motion. Because the static friction between the bung 322 and the syringe body 316 and the hydrostatic forces acting through the drug 324 to be administered are not sufficient to resist the full drive force developed by the drive spring 330, at this point the second drive element 334 begins to move within the syringe body 316 and the drug 324 begins to be discharged. Dynamic friction between the bung 322 and the syringe body 316 and hydrostatic forces acting through the drug 324 to be administered are, however, sufficient to retain the return spring 326 in its compressed state, so the hypodermic needle 318 remains extended.

Before the second drive element 334 reaches the end of its travel within the syringe body 316, so before the contents of the syringe have fully discharged, the flexible latch arms (not shown) linking the first and second drive elements 332, 334 reach a constriction 337. The constriction 337 is formed by a component 362 that is formed integrally with the syringe carrier. As before, additional flexible arms (not shown) on the second drive element 334 overlie the flexible arms (not shown) on the first drive element 332, by means of which drive is transmitted to the second drive element 334.

In the same way as for Figure 1, the constriction 337 causes the first and second drive elements 332, 334 to disengage. In addition, the constriction 337 serves a second purpose. To this end, the second drive element 334 is provided with a pair of oblique flexible barbs 375. In their rest position, the barbs extend from the second drive element 334 to a diameter that is larger than the inner diameter of the constriction 337. As the second drive element advances, oblique flexible barbs 375 are pressed down against the second drive element 334, and pass thought the constriction 337. Once they have passed through it, they spring back to their rest position. Because, in that position, they extend from the second drive element 334 to a diameter that is larger than the inner diameter of the constriction 337, any attempt to move the second drive element 334 backwards through the constriction 337 will result in the flexible barbs 375 being splayed outwards, preventing the backward motion. Thus, the flexible barbs 375 and the constriction 337 together form a non-return mechanism.

Because the damping fluid is contained within a reservoir 348 defined between the end of the first drive element 332 and the blind bore 346 in the second drive element 334, the volume of the reservoir 348 will tend to decrease as the first drive element 332 moves relative to the second drive element 334 when the former is acted upon by the drive spring 330. As the reservoir 348 collapses, damping fluid is forced into the collection chamber 342. Thus, once the flexible latch arms (not shown) have been released, of the force exerted by the drive spring 330 does work on the damping fluid, causing it to flow into the collection chamber 342, and also acts hydrostatically through the fluid and through friction between the first and second drive elements 332, 334, thence via the second drive element 334. 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 326 remains compressed and the hypodermic needle remains extended.

After a time, the second drive element 334 completes its travel within the syringe body 316 and can go no further. At this point, the contents of the syringe 314 are completely discharged and the force exerted by the drive spring 330 acts to retain the second drive element 334 in its terminal position and to continue to cause the

damping fluid to flow into the collection chamber 342, allowing the first drive element 332 to continue its movement.

A flange 370 on the rear of the second drive element 334 normally retains the flexible arms 333 in engagement with the drive sleeve 331. However, before the reservoir 348 of fluid is exhausted, the flexible latch arms 333 linking the drive sleeve 331 with the first drive element 332 move sufficiently far forward relative to the second drive element 334 that the flange 370 is brought to register with a rebate 372 in the flexible arms 333, whereupon it ceases to be effective in retaining the flexible arms 333 in engagement with the drive sleeve 331. Now, the drive sleeve 331 moves the flexible latch arms 333 inwards from the position shown to a position at which they no longer couple the drive sleeve 331 to the first drive element 332, aided by the bevelled latching surfaces 374 on the flexible arms 333. Once this happens, the drive sleeve 331 acts no longer on the first drive element 332, allowing them to move relative to each other. At this point, of course, the syringe 314 is released, because the forces developed by the drive spring 330 are no longer being transmitted to the syringe 314, and the only force acting on the syringe will be the return force from the return spring 326. Thus, the syringe 314 now returns to its retracted position and the injection cycle is complete.

The non-return mechanism formed by the barbs 375 and the constriction 337 at all times constrains the syringe between the drive and the syringe carrier, thus preventing it from coming loose within the body of the injection device.

Claims

1. An injection device comprising:

a housing adapted to receive a syringe having a discharge nozzle and including means for biasing the syringe from an extended position in which the discharge nozzle of the syringe extends from the housing to a retracted position in which the discharge nozzle is contained within the housing;

an actuator;

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

a release mechanism, activated when the drive has been advanced to a nominal release position, to release the syringe from the action of the actuator, whereupon the biasing means restores the syringe to its retracted position; and

a locking mechanism that confines the returned syringe in its retracted position.

2. An injection device according to claim 1 in which the locking mechanism is activated when the drive has been advanced to a locking position that is no more advanced than the said nominal release position.

3. An injection device according to claim 1 or claim 2 in which the housing includes a syringe carrier adapted to receive the syringe and the biasing means is adapted to bias the syringe carrier from an extended position to a retracted position.

4. An injection device according to claim 3 in which the locking mechanism prevents the drive from retracting relative to the syringe carrier, thus confining the syringe between the drive and the syringe carrier in preparation for the activation of the release mechanism.

5. An injection device according to claim 2, in which the drive includes a flexible latch that rides over a detent as the drive is advanced and thereafter engages beyond it.

6. An injection device according to claim 3 or claim 4, in which:
the syringe carrier includes a detent; and
the drive includes a flexible latch that rides over the detent as the drive is advanced and thereafter engages beyond it.

7. An injection device according to claim 5 or claim 6 in which the flexible latch comprises a flexible barb.

8. An injection device according to any one of claims 5-7 including a plurality of such flexible latches.

9. An injection device according to claim 8 in which the flexible latches are substantially equidistantly spaced around the circumference of the drive.

10. An injection device according to any preceding claim in which 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.

11. An injection device according to claim 10, 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.

12. An injection device according to claim 11 in which 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.