Injection Device

Field of the Invention

The present invention relates to an injection device for delivering an injection, as well as an injection kit and a method of operating the injection device.

Background of the Invention

Some conventional injection devices incorporate some form of impediment so as to selectively impede, or prevent, the delivery of an injection from the injection device. In such devices the injection can only be carried out when the user has moved the impediment out of its impeding position. This reduces the possibility of inadvertently delivering an injection from the injection device since any attempt to deliver the injection when the impediment is in its impeding position will not be successful. In other words, the injection device can be placed in a locked state. In order to successfully deliver an injection, the user must carry out the action to move the impediment, and so take the injection device out of its locked state, and then subsequently perform the action required for injection delivery.

Such an injection device is described in WO2006/106294. This injection device has an impediment in the form of a protrusion that, when in its impeding position, restricts the motion of the trigger that is required to commence the injection delivery. The impediment can be moved to a position where it does not restrict the motion of the trigger by moving a sliding sleeve into the housing of the injection device.

It has been found that users of injection devices, such as those described in WO2006/106294, struggle to discern when the impediment has been sufficiently moved in order to allow activation of the device. This can be very frustrating for users, since they may make numerous unsuccessful attempts at activating the injection as they are unaware that the impediment remains in its impeding position. Further, the frustrated user may attempt to force the injection device, i.e. by applying excessive pressure to the trigger, and so damage the injection mechanism.

There is therefore a need to provide an injection device that provides an intuitive feedback to the user to indicate the progress of the injection device from a locked state to a state in which the injection may be carried out. The present invention addresses such a problem.

Summary of the Invention

A first aspect of the present invention provides an injection device for delivering an injection comprising a housing having a longitudinal axis, a proximal end and a distal end, the housing being arranged such that the injection is delivered from its distal end; and a release mechanism comprising an impediment, the release mechanism being movable between a first position, in which the impediment is in an impeding position so as to impede the delivery of the injection, and a second position, in which the impediment is in a non-impeding position so as to not impede the delivery of the injection, wherein the force required to move the release mechanism from the first position to the second position varies with the distance moved by the release mechanism, the variation in the force required with distance being represented by a force profile, which is non-linear.

In a second aspect, the present invention provides an injection device for delivering an injection comprising a housing having a longitudinal axis, a proximal end and a distal end, the housing being arranged such that the injection is delivered from its distal end; and a release mechanism comprising an impediment, the release mechanism being moveable between a first position, in which the impediment is in an impeding position so as to impede the delivery of the injection, and a second position, in which the impediment is in a non-impeding position so as to not impede the delivery of the injection, wherein the injection device produces an audible signal when the release mechanism is moved from the first position to the second position.

Hence, the injection device can be selectively placed in a locked state, where an impediment impedes, or prevents, the delivery of the injection from the injection device, which reduces the risk of inadvertently delivering an injection. The injection device can also be selectively placed in an unlocked state, where the impediment no longer impedes, or prevents, the delivery of the injection from the injection device, allowing the injection to be administered.

The injection device is preferably an auto-injector. Auto-injectors increase the ease with which the user can carry out the injection, since many of the injection steps are automated.

The injection device of the present invention may use a needle to administer the injection. In such a case, it is preferred that the needle remains covered within the injection device prior to administration of the injection, and when the injection device is in its locked state. This reduces the possibility of accidental needle pricks. When the injection device is put into its unlocked state, by moving the release mechanism from its first position to its second position, it is then possible for the needle to be moved to an uncovered position as part of the injection process.

The housing can contain the fluid to be injected along with mechanisms of the injection device. The housing has a longitudinal axis that runs along the length of the housing. Further, the housing has a proximal end and a distal end.

The terms “proximal” and “distal” are used herein in relation to the person administering the injection. For example, when the injection is being administered by a user to a patient, the proximal end is the end closest to the user, while the distal end is the end furthest away from the user but closest to the patient who will receive the injection. Correspondingly, the housing is arranged such that the injection is delivered from its distal end. It should be noted that the use of the terms “proximal” and “distal” does not imply that the injection device cannot be used for self-administering an injection. In such a case, the distal end would still be defined as the end of the injection device that is closest to the target injection site immediately prior to the delivery of the injection.

The impediment may stop the action required to effect the injection from the injection device. For example, where the injection device is an auto-injector, the impediment may restrict the movement of the trigger which activates the injection cycle. Alternatively, the impediment may represent a barrier to the deliverance of the injection from the distal end of the housing of the injection device, i.e. the impediment may restrict the movement of an injection needle out of the housing and so prevent the injection cycle from being carried out.

The impediment may be in the form of a protrusion that impedes the delivery of the injection by blocking one of the motions required to administer the injection from the injection device. Such motions include the movement of a trigger for activating an auto-injector, the movement of the needle out of the injection device to penetrate the recipient’s skin, the movement of the drive of an auto-injector, the movement of a syringe within the injection device, and the movement of a component, such as a syringe carrier, that moves the syringe within the injection device.

The release mechanism may be in the form of a switch, for example a rocker switch or a slide switch, where movement of the switch moves the impediment from its impeding position to its non-impeding position and, preferably, *vice versa*.

Alternatively, the release mechanism may comprise a movable sleeve, the sleeve being at least partially within the housing and protruding from the distal end of the housing. The moveable sleeve moving proximally along the longitudinal axis of the housing when moving the release mechanism from the first position to the second position. The sleeve may be in the form of a

cylindrical element. Further, the cylindrical sleeve may have its longitudinal axis aligned parallel with the longitudinal axis of the housing, or additionally may have its longitudinal axis coincident with the longitudinal axis of the housing. Such a form for the moveable sleeve ensures the force required to move the sleeve is distributed over a large area, i.e. the circumference of the protruding end of the moveable sleeve, while not interrupting the deliverance of the injection through the hollow centre and along the longitudinal axis of the cylinder.

A release mechanism in the form of a movable sleeve protruding from the distal end of the housing can be moved by pushing the protruding sleeve against the skin of the intended recipient of the injection. This can cause the required movement of the movable sleeve to place the injection device in its unlocked state. This is a straight-forward approach for moving the release mechanism from its first position to its second position as part of the injection procedure.

It is further preferred that the movable sleeve protrudes from the distal end when in the first position and is flush with the distal end of the housing when in the second position. This maximises the range of movement of the movable sleeve for a given protrusion distance and offers a further visual indication as to whether the release mechanism has been fully moved into the second position prior to attempting to deliver the injection.

A force needs to be applied to the release mechanism in order to move it from its first position to its second position. This force can vary as the release mechanism is moved from its first position to its second position. This variation in the force required to move the release mechanism can be represented by a force profile, which is the variation in force with distance moved by the release mechanism. The direction of movement of the release mechanism is usually into the injection device (i.e. proximally). In the present invention, this force profile may be non-linear. In other words, the force required to move the release mechanism is not proportional to the distance moved by a release mechanism. This is in contrast to prior art injection devices, which are based on linear-elastic behaviour.

The use of a non-linear variation produces tactile feedback that can allow the user to intuitively assess the progress of the release mechanism from its first position to its second position. Therefore, the user can learn the feeling of the force profile associated with moving the release mechanism from its first position to its second position. The user can then use their knowledge of this feedback to assess whether the release mechanism has been successfully moved from its first position to its second position, and thus assess whether the injection device is ready for administering an injection. This reduces the likelihood that the user will attempt to perform an injection when the injection device is still in its locked state.

Alternatively or in addition, the injection device may produce audible feedback, in the form of an audible signal, when the release mechanism moves from the first position to the second position. The user will then be able to use this audible feedback to assess when the injection device is ready for administering an injection. In particular, an audible signal may sound when the release mechanism reaches the second position and the impediment is in a non-impeding position. The use of a non-linear variation in the force profile may produce the audible feedback that aids the user in assessing the progress of the release mechanism from its first position to its second position. This is further described below. Alternatively, or in addition, the audible signal may be effected by other means, for example the audible signal could be effected by certain components of the injection device contacting, leading to production of the audible signal. The contact of these components may complete an electrical circuit leading to the electronic production of an audible signal such as an electronic tone or beep. The contact of these components may initiate a mechanical mechanism that produces an audible signal, such as the impact of a hammer on a bell.

The non-linear force profile may be provided by the release mechanism having a resilient member that runs along a camming surface, wherein the combination of the resilient member and the camming surface is configured to produce the desired force profile. For example, the camming surface could be configured with one or more undulations, in the form of bumps or indents, which cause a specific variation in the force profile as the resilient member runs along this feature of the camming surface. The bumps and indents on the camming surface can also provide an audible signal, indicating the resilient member's progress along the camming surface. The camming surface may have one bump/indent, or two bumps/indents, or three bumps/indents or four or more bumps/indents. The camming surface may have a combination of bumps and indents. The camming surface may be curved, which can provide the non-linear force profile.

Alternatively or in addition, the non-linear force profile can be provided by the resilient member encountering a varying amount of frictional force as it progresses along the camming surface. For example, the resilient member may encounter an increasing amount of frictional force and/or a decreasing amount of frictional force, contributing an increasing force and/or decreasing force to the force profile as the release mechanism moves from the first position to the second position. The variation in frictional force can be achieved by varying the roughness of the camming surface portion along which the resilient member runs and/or varying the material of the camming surface portion along which the resilient member runs.

The variation in frictional force may cause the non-linear force profile on its own, or it can be used in combination with other methods of varying the force profile, such as the presence of undulations described above.

The injection device may have more than one set of resilient member and camming surface, i.e. there could be two resilient members with respective camming surfaces, or three or four resilient members with respective camming surfaces. When there is more than one set of resilient member and camming surface, each set may independently have any of the features described herein.

Further details of the possible forms of the force profile are given below. Other approaches for varying the force profile are within the scope of this invention.

The release mechanism may be resiliently biased towards the first position. In this way, the impediment that is coupled to the release mechanism is biased towards its impeding position. This ensures that a positive action has to occur in order to enable an injection to be administered from the injection device of the present invention, further reducing the possibility of accidentally delivering the injection.

The resilient bias towards the first position may be provided by a resilient member of the release mechanism experiencing increased deformation as it is moved from the first position to the second position. In other words, the deformation of the resilient member of the release mechanism may increase when the sleeve moves from the first position to the second position. The resilient bias is then driven by the relief of this deformation. It is preferable that this resilient member is the same used for providing the non-linear force profile detailed herein.

The force profile associated with the injection device of the present invention may exhibit an increasing force when the release mechanism is moved from the first position to the second position. Examples of two such force profiles are given in figure 1. Alternatively, or in addition, the force profile may exhibit a decreasing force when the release mechanism is moved from the first position to the second position. The force may continuously increase, or continuously decrease, as the release mechanism is moved from the first position to the second position. The force may continuously vary as the release mechanism is moved from the first position to the second position. In particular, the force may continuously vary as the release mechanism is moved through its full range of movement, i.e. from being fully in its first position to being fully in its second position. An example of a force profile that exhibits both an increasing force and a decreasing force as the release mechanism moves from the first position to the second position is given in figure 2.

Utilising a force profile with a combination of increasing and decreasing forces, such as depicted in figure 2, can provide a particularly distinct tactile and audible feedback to the user since the force required to move the release mechanism varies periodically. The user will be able to readily discern the various increases and decreases in required force and so will, with experience, be able to use the tactile and audible clues to know when the release mechanism has been sufficiently moved so as to be in its second position.

In its simplest form, such a force profile would have a force that first increases and then decreases as the release mechanism is moved from the first position to the second position. Therefore, the skilled person would be able to feel completion of the required movement and so know that the injection device had been placed in the unlocked state.

Regarding the force profile depicted in figure 2, the user of an injection device with such a force profile can learn that after experiencing three of these periods, the injection device will be in its unlocked state and the injection can be delivered.

A similar effect can be achieved by using a force profile that is always increasing (or decreasing) but exhibits a variation in the rate of increase in the force with distance (i.e. a variation in the gradient of the force profile). Such a profile is depicted in figure 3, where there is a periodic variation in the rate of increase of the force with distance. First it increases and then it decreases before increasing and decreasing three more times. This variation can provide the tactile and audible feedback that informs the user of the progress of the release mechanism towards its second position and the unlocked state.

In its simplest form, such a force profile would have a force profile gradient that first increases and then decreases as the release mechanism is moved from its first position to its second position. After sensing the one increase and decrease, the user will know that the release mechanism has been moved a sufficient distance into its second position and the injection can be administered.

Regarding the force profile depicted in figure 3, the user can learn that after experiencing four of these periods, the injection device will be in its unlocked state and the injection can be delivered.

A force that changes from increasing with distance moved by the release mechanism to decreasing with distance moved by the release mechanism (or *vice versa*), and a force gradient that changes from increasing with distance moved by the release mechanism to decreasing with distance moved by the release mechanism (or *vice versa*) are both forms of periodic variation of the force profile that can be used with the present invention.

The force profile may have any number of periodic variations. As stated above, in its simplest form there will be just one increase and one decrease. Alternatively, there can be two increases and decreases, or three increases and decreases (as depicted in figure 2), or four or more increases and decreases (as depicted in figure 3).

The use of a plurality of periodic variations results in a ratchet-type effect as the force varies with distance giving a repetitive nature to the tactile and/or audible feedback. This assists the user in assessing the progress of the release mechanism from the first position to the second position.

All of the force profiles described herein allow the user to feel the progress of the release mechanism from the first position to the second position. Therefore the user is able to learn this feeling and subsequently ensure that the release mechanism is moved from the first position to the second position before administration of the injection is attempted.

The injection device may further comprise an activation means for effecting commencement of the injection, wherein the impediment interacts with a component of the activation means when it is in the impeding position so as to impede the activation means and so impede the delivery of the injection.

The activation means may comprise a trigger, the trigger being configured to be movable into an active position in order to effect the delivery of an injection from the injection device. The trigger could be in the form of a rocker switch or a slide switch or any equivalent form.

The activation means may comprise a drive which can provide the force required to deliver the injection. The drive may be in the form of a spring. The spring may be held in a state of compression prior to the delivery of the injection. During the delivery of the injection the spring is allowed to expand exerting the force which effects the delivery of the injection from the injection device.

As described above, in order to impede the delivery of the injection, the impediment of the injection device of the present invention may interact with a component of the activation means. For example, the impediment may interact with the trigger. Hence, the impediment when in the impeding position may stop the trigger from being moved into its active position. When the impediment is moved into its non-impeding position the trigger can then move to the active position and effect the commencement of the injection.

Alternatively, the impediment could interact with the drive which provides the force required to deliver the injection. For example, the impediment could stop the drive, in the form of a spring, from expanding and so stop the injection from being delivered.

As noted above, the release mechanism may comprise a resilient member and a camming surface upon which the resilient member is configured to ride along as the release mechanism is moved from the first position to the second position. In this way, the riding of the resilient member on the camming surface results in the force profile, and so the camming surface and the resilient member can be configured to provide any desired force profile. For example, the camming surface can be adjusted so that the resilient member experiences a varying amount of deformation as it rides along the camming surface and therefore results in a varying amount of force resisting its motion resulting in the force profile. Possible features on the camming surface are at least one bump and/or at least one indent.

The resilient member may not continuously ride along the camming surface as the release mechanism is moved from its first position to its second position. For example, the resilient member may not ride along the camming surface when the release mechanism is initially moved from being fully in its first position but will engage and ride along the camming surface as it moves fully into its second position, engaging the camming surface for the first time somewhere between the first position and the second position. This non-continuous riding of the resilient member on the camming surface will contribute to the non-linear nature of the force profile. Alternatively, the resilient member may be initially engaged with the camming surface but become disengaged as the release mechanism moves from its first position to its second position.

The resilient member may be in the form of a resilient arm, which acts as a cantilever with its free end running along the camming surface. Therefore, the various features on the camming surface result in varying degrees of bending of the cantilever and so varying degrees of deformation resulting in a particular force profile. The resilient member/arm is part of the release mechanism and so will move when the release mechanism moves. The resilient member/arm may be integrally formed with the release mechanism. This simplifies the manufacturing process of the injection device.

The camming surface and resilient arm may be configured such that the resilient arm is deformed within a two-dimensional plane. In particular, the resilient arm may be configured to run along the camming surface in the proximal direction and distal direction of the injection device when the release mechanism is moved in the proximal direction and distal direction of the injection device respectively. An example of such an arrangement has the camming surface on the inside of the

housing and generally inclined towards the longitudinal axis of the housing, the inclination increasing along the longitudinal direction of the housing. As the resilient arm runs along the camming surface, the general incline causes the resilient member to be deformed towards the central longitudinal axis, in the radial direction.

Alternatively, the camming surface can be arranged on the internal surface of the housing in a generally circumferentially inclined manner, preferably around the longitudinal axis of the housing. The resilient arms then run along the generally circumferentially inclined camming surface in a generally circumferential direction when the release mechanism is moved in the proximal and distal directions of the injection device. If the rotational movement of the release mechanism is constrained, the deformation of the resilient arms in the generally circumferential direction is maximised. This generally circumferential arrangement reduces the diametrical space requirement of the camming surface/resilient arm mechanism, since the resilient arms do not need to bend towards the centre of the housing but instead run around the internal surface of the housing.

The form of camming surfaces described above may have undulations or exhibit a varying amount of friction influencing the force profile observed when moving the resilient arms along the camming surface.

Even if the camming surfaces described above have undulations or exhibit varying amounts of friction along the camming surface, the general incline of the surface means that the resilient member is more deformed when the release mechanism is in its second position compared to when it is in its first position. In other words, as the release mechanism moves from its first position to its second position, there is a general trend of increased deformation in the resilient member.

The injection device may be configured to receive a syringe. In particular, the injection device may be configured to receive a hypodermic syringe. To this end, the injection device may further comprise a syringe carrier, which can hold a syringe within the injection device and carry the syringe during the delivery of the injection.

Where the injection device is configured to receive a syringe, the impediment may act on the syringe in order to impede the delivery of the injection when the impediment is in its impeding position. When the injection device comprises a syringe carrier, the impediment may act on the syringe carrier in order to impede the injection when the impediment is in its impeding position.

A third aspect of this invention provides an injection kit comprising an injection device of the present invention and a syringe. In particular, the syringe may be a hypodermic syringe. The injection device in the injection kit is configured to receive the syringe that is present in the injection kit. The injection device that forms part of the injection kit may have any of the features described above.

A fourth aspect of the present invention provides a method of operating an injection device of the present invention, comprising the steps of moving the release mechanism from the first position towards the second position; and delivering the injection after detecting the audible signal. The injection device utilised with this method may have any of the features described above.

A fifth aspect of the present invention provides a method of operating an injection device of the present invention, comprising the steps of moving the release mechanism from the first position towards the second position and delivering the injection after detecting the non-linear nature of the force profile. The injection device utilised with this method may have any of the features described above.

The methods of the present invention allows the user to learn from experience the tactile and/or audible feedback caused by the non-linear nature of the force profile, which indicates that the release mechanism has moved fully from its first position to its second position indicating that the injection can be successfully delivered. Therefore, the user is able to ensure that the release mechanism has been fully moved into its second position avoiding the problems associated with prior art devices.

The injection device or injection kit of any of the above embodiments may contain a substance selected from the group consisting of: golimumab, hormones, antitoxins, substances for the control of pain, substances for the control of thrombosis, substances for the control or elimination of infection, peptides, proteins, human insulin or a human insulin analogue or derivative, polysaccharide, DNA, RNA, enzymes, antibodies, oligonucleotide, antiallergics, antihistamines, anti-inflammatories, corticosteroids, disease modifying anti-rheumatic drugs, erythropoietin, or vaccines, for use in the treatment or prevention of rheumatoid arthritis, psoriatic arthritis, ankylosing spondylitis, ulcerative colitis, hormone deficiency, toxicity, pain, thrombosis, infection, diabetes mellitus, diabetic retinopathy, acute coronary syndrome, angina, myocardial infarction, atherosclerosis, cancer, macular degeneration, allergy, hay fever, inflammation, anaemia, or myelodysplasia, or in the expression of protective immunity.

By 'the injection device or injection kit may contain a substance' it is meant that the substance may be contained within a suitable medicament container, such as a vial or syringe, within the injection device, or within the syringe of the injection kit. Such medicament container may contain other substances, such as further active or inactive ingredients.

In a further aspect of the invention, a substance is provided, the substance being selected from the group consisting of: golimumab, hormones, antitoxins, substances for the control of pain, substances for the control of thrombosis, substances for the control or elimination of infection, peptides, proteins, human insulin or a human insulin analogue or derivative, polysaccharide, DNA, RNA, enzymes, antibodies, oligonucleotide, antiallergics, antihistamines, anti-inflammatories, corticosteroids, disease modifying anti-rheumatic drugs, erythropoietin, or vaccines, for use in the treatment or prevention of rheumatoid arthritis, psoriatic arthritis, ankylosing spondylitis, ulcerative colitis, hormone deficiency, toxicity, pain, thrombosis, infection, diabetes mellitus, diabetic retinopathy, acute coronary syndrome, angina, myocardial infarction, atherosclerosis, cancer, macular degeneration, allergy, hay fever, inflammation, anaemia, or myelodysplasia, or in the expression of protective immunity, by delivery of said substance to a human subject using an injection device or injection kit according to any of the above embodiments.

In yet another aspect of the invention, an injection device is provided for use in the treatment or prevention of rheumatoid arthritis, psoriatic arthritis, ankylosing spondylitis, ulcerative colitis, hormone deficiency, toxicity, pain, thrombosis, infection, diabetes mellitus, diabetic retinopathy, acute coronary syndrome, angina, myocardial infarction, atherosclerosis, cancer, macular degeneration, allergy, hay fever, inflammation, anaemia, or myelodysplasia, or in the expression of protective immunity, by delivery of a substance selected from the group consisting of: golimumab, hormones, antitoxins, substances for the control of pain, substances for the control of thrombosis, substances for the control or elimination of infection, peptides, proteins, human insulin or a human insulin analogue or derivative, polysaccharide, DNA, RNA, enzymes, antibodies, oligonucleotide, antiallergics, antihistamines, anti-inflammatories, corticosteroids, disease modifying anti-rheumatic drugs, erythropoietin, or vaccines, to a human subject by using the injection device, where the injection device is an injection device or injection kit of any of the above embodiments.

By 'delivery of a substance' it is meant that the injection device is used to inject said substance into the human subject, for example by subcutaneous, intradermal or intramuscular injection. Said substance may be administered in combination with other substances, such as further active or inactive ingredients.

Brief Description of the Drawings

The present invention is now described by way of example with reference to the accompanying drawings, in which:-

Figure 1 depicts an example of two forms of force profiles, one with an increasing gradient and one with a decreasing gradient;

Figure 2 depicts a force profile that exhibits an increasing force followed by a decreasing force, then the force increases and decreases two more times;

Figure 3 depicts a force profile where the rate of increase in the force first increases then decreases, then increases and decreases three more times;

Figure 4 depicts an injection device of the present invention showing the mechanism within the housing;

Figure 5 depicts a plan view of an injection device of the present invention;

Figure 6 depicts the detail of the release mechanism of an injection device of the present invention;

Figure 7 depicts a detailed view of parts of the release mechanism of an injection device of the present invention;

Figure 8 depicts the detail of a bump on the camming surfaces of an injection device of the present invention;

Figure 9 depicts the force profile resulting from the combination of resilient arms and camming surfaces depicted in Figure 8;

Figure 10 depicts the detail of a plurality of bumps on the camming surface of an injection device of the present invention;

Figure 11 depicts the force profile resulting from the combination of resilient arms and camming surfaces depicted in Figure 10;

Figure 12 depicts the detail of curved camming surfaces of an injection device of the present invention;

Figure 13 depicts the force profile resulting from the combination of resilient arms and camming surfaces depicted in Figure 12;

Figure 14 depicts another possible arrangement of camming surfaces and resilient arms;

Figure 15 depicts the resulting force profile from the arrangement of figure 14;

Figure 16 depicts a possible arrangement of the camming surfaces and resilient arms where the frictional forces exerted by the camming surface change along its length;

Figure 17 depicts the resulting force profile from the arrangement of figure 16;

Figures 18a, b and c depict the movement of the resilient arm relative to a camming surface inclined towards the longitudinal axis of the injection device;

Figures 19a, b and c depict the movement of the resilient arm relative to a camming surface arranged in a circumferentially inclined manner.

Figure 20 depicts the detail of a spring arrangement of an injection device of the present invention; and

Figure 21 depicts the force profile resulting from the spring arrangement of figure 16.

Detailed Description of the Drawings

An injection device 110 according to the present invention is depicted in figures 4 and 5. The injection device 110 has an injection device housing 112 and a longitudinal axis 101. Figures 4 and 5 depict only the lower half of the housing 112. The upper part of housing 112 is absent so that the internal mechanism can be clearly seen.

A syringe (not shown) is contained in the housing 112. The injection device 110 comprises a trigger 114 as part of the activation means. The trigger 114 is rotatable about a pivot 115 from a rest position (as shown in figure 4) to an active position. The proximal end 114b of the trigger 114 connects with a drive coupling 121 which is acted upon by a drive spring 120. The drive coupling

121 is in communication with the syringe. The drive coupling 121 and drive spring 120 all form part of the activation means which allow the delivery of the injection by acting on the syringe.

The injection device 110 comprises a release mechanism 126 in the form of a cylindrical sleeve that protrudes from the distal end of the injection device 110.

In order to effect delivery of the injection, the trigger 114 is rotated about the pivot 115 in a direction R (i.e. downwards into the housing 112 at its first end 114a). This causes the second end 114b of the trigger 114 to disengage from the drive coupling 121, thereby letting the drive spring 120 drive the syringe (via the drive coupling 121) along the longitudinal axis 101 and out of an aperture 118 in the housing 112.

However, when the release mechanism 126 is in its impeding position, which corresponds to the release mechanism protruding from the distal end of housing 112, an impediment in the form of a protrusion 154 (as depicted in figure 6) is positioned so as to abut the under-surface of portion 150 of trigger 114. In this way, the protrusion 154 impedes the rotation of the trigger and thus impedes the delivery of the injection. In order to carry out the injection, the release mechanism is moved into a second position, which corresponds to the release mechanism 126 being moved into the housing 112 along the direction of the longitudinal axis 101. When the release mechanism is in its second position the protrusion 154 aligns with cut out 152 in trigger 114. Protrusion 154 can be received in cut out 152 and so the trigger can be rotated about pivot 115 and the delivery of the injection can be effected.

As can be seen in figures 6 and 7, the release mechanism 126 is provided with a pair of intregrally formed resilient arms 201 in the form of cantilevers. The resilient arms 201 are configured to resiliently flex in a direction towards and away from the housing 112.

The housing 112 comprises a pair of camming surfaces 210 along which the resilient arms 201 will ride when the release mechanism 126 is moved from its first position in which the protrusion 154 abuts the portion 150 of the trigger 114 to its second position where the protrusion 154 can be received in the cut out portion 152 of the trigger 114. As can be seen from figure 7, the deformation in resilient arms 201 increases as the release mechanism 126 is moved from its first position to its second position, i.e. as the release mechanism 126 is moved into the housing 112 along the longitudinal axis 101 of the injection device 110. This provides a resilient bias on the release mechanism 126 towards its first position.

Detail of a possible form of the camming surface is shown in figure 8. Here it can be seen that the camming surfaces 210 comprise bumps 212. These bumps 212 introduce a non-linear variation in the force with distance moved by the release mechanism 126. In particular, the bumps 212 will result in a force profile that has a rate of increase in force that first increases and then decreases as depicted in figure 9. This non-linear force profile results in a tactile feedback to the user which indicates that the release mechanism 126 has been fully moved from its first position to its second position and activation of the injection cycle can occur.

An alternative form of the camming surface is shown in figure 10. Here it can be seen that each camming surface 210 comprises three bumps 212. These three bumps 212 result in a force profile with a periodic, ratchet-type nature where the rate of increase in force first increases and then decreases, and then increases and decreases two more times, as depicted in figure 11.

A further possible form of the camming surface is shown in figure 12. In this example, the camming surface doesn't have any bumps but instead has a continuous curved surface which increases the rate of deformation of the resilient arms 201 as the release mechanism 126 is moved from its first position to its second position. This results in the force profile depicted in figure 13, where the force continuously increases with distance and the rate of increase in the force also continuously increases with distance. As with the other force profiles, this provides tactile feedback that helps the user assess the progress of the release mechanism 126 from its first position to its second position.

Yet another possible arrangement of camming surfaces and resilient arms is depicted in figure 14. In this example, the resilient arms 201 do not contact the camming surfaces 210 when the release mechanism 126 is fully in its first position (as shown in figure 14). Therefore, the initial part of the force profile is a relatively constant force, which is caused by the frictional forces associated with moving the release mechanism 126. The force profile then demonstrates an increasing force as the release mechanism 126 is moved further towards its second position and the resilient arms 201 engage and ride along the camming surfaces 210. The resulting force profile is depicted in figure 15.

A further possible arrangement of camming surfaces and resilient arms is depicted in figure 16. Here the resilient arms (201) are always in contact with the camming surfaces (210) but there is a step-change in the frictional force between the resilient arms (201) and the camming surfaces (210) along the path which the resilient arms run. This results in a step-change in the resulting force profile, as depicted in figure 17.

The injection device can have a camming surface 201 inclined towards the longitudinal axis of the housing of the injection device, as depicted in figure 18a. The inclination increasing along the longitudinal direction of the housing. This results in the resilient arm 210 being bent towards the longitudinal axis of the housing in a two-dimensional plane when the arm is moved along the camming surface 201 in a proximal direction, as illustrated in figure 18b. A cross-sectional view of the housing, perpendicular to the longitudinal axis of the housing, shows the radial direction in which the resilient arms 210 move.

An alternative form of the camming surface is depicted in figure 19a. This camming surface 201a is arranged in a circumferentially inclined manner around the longitudinal axis of the housing, extending inwards from the inner surface of the housing. Hence the camming surface 201a is inclined such that the resilient arm 210 will run along the circumferential camming surface 201a as the resilient arm is moved into the housing. This results in the resilient arm 210 being deformed in a circumferential direction on moving along the camming surface, as depicted in figure 19b. A cross-sectional view of the housing (figure 19c), perpendicular to the longitudinal axis of the housing, shows the circumferential direction in which the resilient arms 210 move.

As described above, various force profiles can be realised by different configurations of resilient arms 201 and the camming surfaces 210. Further, force profiles can be realised by other means, such as arrangement of springs.

An example of such an arrangement of springs is given in figure 20. The release mechanism 126 has a first pair of springs 214 and a second pair of springs 216. When the release mechanism 126 is in its first position, only the first pair of springs 214 is constrained at both ends and so capable of exerting a force against the movement of the release mechanism 126 from its first position to its second position. However, as the release mechanism 126 is moved from its first position to its second position, the second pair of springs 216 is engaged resulting in a sudden increase in the rate of increase in the force as the release mechanism 126 continues to progress towards its second position. This results in the non-linear force profile depicted in figure 21.

In use, such an injection device as described above might be used to deliver substances such as: golimumab, hormones, antitoxins, substances for the control of pain, substances for the control of thrombosis, substances for the control or elimination of infection, peptides, proteins, human insulin or a human insulin analogue or derivative, polysaccharide, DNA, RNA, enzymes, antibodies, oligonucleotide, antiallergics, antihistamines, anti-inflammatories, corticosteroids, disease modifying anti-rheumatic drugs, erythropoietin, or vaccines, for use in the treatment or prevention of rheumatoid arthritis, psoriatic arthritis, ankylosing spondylitis, ulcerative colitis, hormone

deficiency, toxicity, pain, thrombosis, infection, diabetes mellitus, diabetic retinopathy, acute coronary syndrome, angina, myocardial infarction, atherosclerosis, cancer, macular degeneration, allergy, hay fever, inflammation, anaemia, or myelodysplasia, or in the expression of protective immunity. In addition to these substances, any medicament contained within the injection device may also include other substances, such as inactive ingredients, as a skilled person would appreciate.

It will of course be understood by the person skilled in the art that particular substances are efficacious for use in the treatment or prevention of particular conditions, as is well known in the art. For instance, it is known that antiallergics are efficacious for use in the treatment or prevention of allergies; antihistamines are efficacious for use in the treatment or prevention of hay fever; anti-inflammatories are efficacious for use in the treatment or prevention of inflammation; and so on. Accordingly, any selection of one or more substances listed herein or in the claims for use in the treatment or prevention of one or more conditions for which those substance(s) are known to be efficacious is envisaged.

In a particular example, however, golimumab is known to be efficacious for use in the treatment or prevention of one or more of rheumatoid arthritis, psoriatic arthritis, ankylosing spondylitis or ulcerative colitis, or any combination of rheumatoid arthritis, psoriatic arthritis, ankylosing spondylitis and ulcerative colitis, or all of rheumatoid arthritis, psoriatic arthritis, ankylosing spondylitis and ulcerative colitis.

Golimumab may optionally be used in combination with one or more inactive ingredients such as any or all of L-histidine, L-histidine monohydrochloride monohydrate, sorbitol, polysorbate 80, and water. Golimumab may present in a composition in which golimumab is the only active ingredient. For example, golimumab may administered as SIMPONI®.

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 for delivering an injection comprising:

a housing having a longitudinal axis, a proximal end and a distal end, the housing being arranged such that the injection is delivered from its distal end; and

a release mechanism comprising an impediment, the release mechanism being moveable between a first position, in which the impediment is in an impeding position so as to impede the delivery of the injection, and a second position, in which the impediment is in a non-impeding position so as to not impede the delivery of the injection, wherein the force required to move the release mechanism from the first position to the second position varies with the distance moved by the release mechanism, the variation in the force required with distance being represented by a force profile, which is non-linear.

2. An injection device for delivering an injection comprising:

a housing having a longitudinal axis, a proximal end and a distal end, the housing being arranged such that the injection is delivered from its distal end; and

a release mechanism comprising an impediment, the release mechanism being moveable between a first position, in which the impediment is in an impeding position so as to impede the delivery of the injection, and a second position, in which the impediment is in a non-impeding position so as to not impede the delivery of the injection, wherein the injection device produces an audible signal when the release mechanism is moved from the first position to the second position.

3. An injection device according to claim 2, wherein the force required to move the release mechanism from the first position to the second position varies with the distance moved by the release mechanism, the variation in the force required with distance being represented by a force profile, which is non-linear

4. An injection device according to any one of claims 1 or 3, wherein the release mechanism is resiliently biased towards the first position.

5. An injection device according to any one of claims 1, 3 or 4, wherein the force profile exhibits an increasing force when the release mechanism is moved from the first position to the second position.

6. An injection device according to claim 5, wherein the rate of increase in the force first increases and then decreases when the release mechanism is moved from the first position to the second position.

7. An injection device according to any preceding claim further comprising an activation means for effecting commencement of the injection, wherein the impediment interacts with a component of the activation means when it is in the impeding position so as to impede the activation means and so impede the delivery of the injection.

8. An injection device according to claim 7, wherein the component of the activation means is a trigger, the trigger being configured to be moveable into an active position when the impediment is in its non-impeding position so as to effect the delivery of the injection.

9. An injection device according to claim 7 or claim 8, wherein the activation means comprises a drive to provide the force required to deliver the injection.

10. An injection device according to any of claims 4 to 9, wherein the release mechanism comprises a moveable sleeve, the sleeve protruding from the distal end of the housing and moving proximally along the longitudinal axis of the housing when moving the release mechanism from the first position to the second position.

11. An injection device according to claim 10, wherein the moveable sleeve protrudes from the distal end when in the first position and is flush with the housing when in the second position.

12. An injection device according to claim 10 or claim 11, wherein the moveable sleeve comprises a resilient arm and the housing further comprises a camming surface inside the housing, the resilient arm being configured to ride along the camming surface as the moveable sleeve moves from the first position to the second position, the camming surface being configured such that the deformation of the resilient arm increases when the sleeve moves from the first position to the second position providing the resilient bias towards the first position.

13. An injection device according to claim 12, wherein the camming surface is generally inclined towards the longitudinal axis of the housing.

14. An injection device according to claim 12, wherein the camming surface is generally circumferentially inclined along the inner surface of the housing.

15. An injection device according to claim 12, 13 or 14, wherein the camming surface has an undulation to provide the non-linear force profile.

16. An injection device according to any preceding claim, wherein the injection device is configured to receive a syringe.

17. An injection device as substantially described herein with reference to the attached drawings.

18. An injection kit comprising
an injection device according to claim 16; and
a syringe.

19. A method of operating an injection device of claim 2 or 3, comprising the steps of
moving the release mechanism from the first position towards the second position; and
delivering the injection after detecting the audible signal.

20. A method of operating an injection device of any of claims 1, or 3 to 16, comprising the steps of
moving the release mechanism from the first position towards the second position; and
delivering the injection after detecting the non-linear nature of the force profile.

21. An injection device according to any one of claims 1 to 17 or an injection kit according to claim 18 containing a substance selected from the group consisting of: golimumab, hormones, antitoxins, substances for the control of pain, substances for the control of thrombosis, substances for the control or elimination of infection, peptides, proteins, human insulin or a human insulin analogue or derivative, polysaccharide, DNA, RNA, enzymes, antibodies, oligonucleotide, antiallergics, antihistamines, anti-inflammatories, corticosteroids, disease modifying anti-rheumatic drugs, erythropoietin, or vaccines, for use in the treatment or prevention of rheumatoid arthritis, psoriatic arthritis, ankylosing spondylitis, ulcerative colitis, hormone deficiency, toxicity, pain, thrombosis, infection, diabetes mellitus, diabetic retinopathy, acute coronary syndrome, angina, myocardial

infarction, atherosclerosis, cancer, macular degeneration, allergy, hay fever, inflammation, anaemia, or myelodysplasia, or in the expression of protective immunity.

22. A substance selected from the group consisting of: golimumab, hormones, antitoxins, substances for the control of pain, substances for the control of thrombosis, substances for the control or elimination of infection, peptides, proteins, human insulin or a human insulin analogue or derivative, polysaccharide, DNA, RNA, enzymes, antibodies, oligonucleotide, antiallergics, antihistamines, anti-inflammatories, corticosteroids, disease modifying anti-rheumatic drugs, erythropoietin, or vaccines,
for use in the treatment or prevention of rheumatoid arthritis, psoriatic arthritis, ankylosing spondylitis, ulcerative colitis, hormone deficiency, toxicity, pain, thrombosis, infection, diabetes mellitus, diabetic retinopathy, acute coronary syndrome, angina, myocardial infarction, atherosclerosis, cancer, macular degeneration, allergy, hay fever, inflammation, anaemia, or myelodysplasia, or in the expression of protective immunity,
by delivery of said substance to a human subject using an injection device according to any one of claims 1 to 17 or an injection kit according to claim 18.

23. An injection device for use in the treatment or prevention rheumatoid arthritis, psoriatic arthritis, ankylosing spondylitis, ulcerative colitis, hormone deficiency, toxicity, pain, thrombosis, infection, diabetes mellitus, diabetic retinopathy, acute coronary syndrome, angina, myocardial infarction, atherosclerosis, cancer, macular degeneration, allergy, hay fever, inflammation, anaemia, or myelodysplasia, or in the expression of protective immunity,
by delivery of a substance selected from the group consisting of: golimumab, hormones, antitoxins, substances for the control of pain, substances for the control of thrombosis, substances for the control or elimination of infection, peptides, proteins, human insulin or a human insulin analogue or derivative, polysaccharide, DNA, RNA, enzymes, antibodies, oligonucleotide, antiallergics, antihistamines, anti-inflammatories, corticosteroids, disease modifying anti-rheumatic drugs, erythropoietin, or vaccines,
to a human subject by using the injection device, wherein the injection device is an injection device according to any one of claims 1 to 17 or an injection kit according to claim 18.