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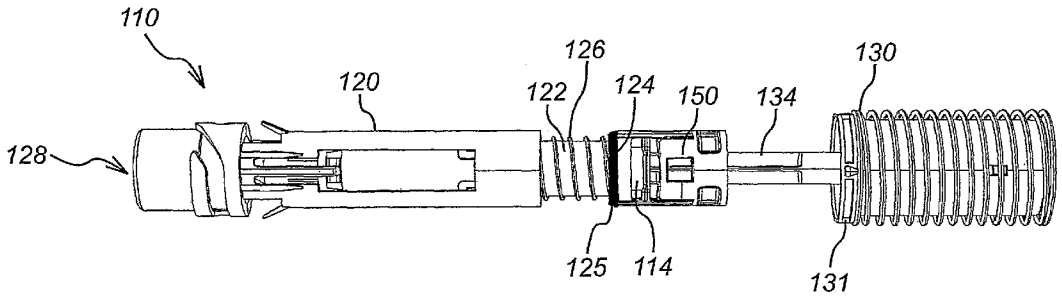
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) **Title:** INJECTION DEVICE



(57) **Abstract:** An injection device (210; 1 10) is provided that includes a damping element (225; 125) which acts between a syringe carrier (222; 122) and a sleeve (219; 1 19) to cushion the impact as they come into contact, thereby reducing the transmission of energy from the impact to the components of a drive (230, 231, 232, 234; 130, 131, 132, 134) and preventing their fracture. The damping element (225; 125) also reduces the noise, which may be distressing to a user of the device (210; 110), produced when the syringe carrier (222; 122) and the sleeve (219; 1 19) come into contact and reduces the pain suffered by a user upon operation of the device (210; 110).

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INJECTION DEVICE

(Buffer ring)

FIELD OF THE INVENTION

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.

BACKGROUND OF THE INVENTION

Previously known injection devices 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.

The high impact forces associated with the spring-operated mechanisms of such devices can lead to mechanical failure of various components. This causes improper operation of the device and the user may not receive the correct dose of the drug to be administered. The syringe itself is often manufactured from glass and is therefore brittle and liable to fracture. The problem of syringe breakage during operation of the device is discussed in a co-pending UK patent application, published as GB 2414401, which is incorporated herein in its entirety by reference.

Such devices also incorporate a delay mechanism as part of the multi-component drive system that advances the syringe from the housing of the device and pushes its needle into a user's body by application of force to the rear of the syringe stopper. This may fail during a firing cycle by brittle fracture caused by transmission of an impact force due to sudden deceleration of the syringe carrier relative to the case nose as the two components contact.

SUMMARY OF THE INVENTION

The injection device of the present invention is designed to overcome this and other problems.

In view of the foregoing and in accordance with a first aspect of the invention, there is provided an injection device comprising:

a housing adapted to receive a syringe having a discharge nozzle, so that the syringe is movable between a retracted position in which the discharge nozzle is contained within the housing and an extended position in which the discharge nozzle extends from the housing through an exit aperture;

a drive that acts upon the syringe to advance it from its retracted position to its extended position and discharge its contents through the discharge nozzle;

a first component that advances with the syringe;

a second component that restrains the advancement of the first component as the syringe reaches its extended position; and

a damping element that acts between the first component and the second component.

The damping element acts as a cushion to reduce the transmission of an impact force to the components of the drive, due to sudden deceleration of the first component relative to the second component as the two components come into contact when the syringe reaches its extended position. The peak loading in these components is thereby reduced and their fracture can be prevented. The damping element also reduces the noise, which may be distressing to a user of the device, produced when the first and second components come into contact and reduces the pain suffered by a user upon operation of the device.

In an embodiment of the present invention, the position of the second component may be fixed relative to the housing. Alternatively, the second component is integrally formed with the housing.

The first component provides an interface between the syringe and the second

component and, preferably, the syringe acts upon the first component to advance it. Advantageously, the interaction of the first component and the second component restrains the advancement of the syringe beyond its extended position.

The first component may comprise a cylindrical section having an external diameter and the second component may comprise a cylindrical section having an internal diameter, wherein the external diameter of the cylindrical section of the first component is less than the internal diameter of the cylindrical section of the second component. Preferably, the first component further comprises a flange with an external diameter that is larger than the internal diameter of the second component. The second component may act upon the flange of the first component to restrain its advancement as the syringe reaches its extended position.

The damping element may be positioned between the second component and the flange of the first component. Alternatively, the damping element may be located at the end of the first component through which the discharge nozzle of the syringe passes.

The damping element may be integrally formed with either the first component or the second component. Preferably, the damping element integrally formed with the first component. This may be achieved by moulding the damping element into the first component.

The damping element may be annular in shape and is preferably a thermoplastic elastomer that may be selected from Santoprene®, Evoprene® or polyurethane. Most preferably, the damping element is made of Santoprene®.

The injection device may further comprise means for biasing the syringe from its extended position to its retracted position and a support for carrying the means for biasing the syringe. Preferably, the means for biasing the syringe acts between the second component and the flange of the first component. The second component may have a region of reduced internal diameter that is acted upon by the biasing means.

Preferably, the first component is a syringe carrier and the second component is a sleeve

that substantially surrounds the syringe carrier.

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 shows a perspective view of an injection device according to the present invention;

Figure 2 shows a side view of the injection device of figure 1 with the housing of the injection device removed;

Figure 3 shows a side view of the injection device of figure 1 with further components removed;

Figure 4 shows a side view of the sleeve, the return spring, the syringe carrier and the damping element of the injection device of figure 1; and

Figure 5 shows a side view of the sleeve, the return spring, the syringe carrier and the damping element of an alternative injection device of the present invention.

DETAILED DESCRIPTION OF THE DRAWINGS

Figures 1 to 4 show an injection device 110 according to a first embodiment of the present invention. The injection device 110 has a syringe 114 contained within a housing 112. The syringe 114 comprises a needle 118 and is housed within a syringe carrier 122, which in turn sits partially inside a sleeve 120.

The syringe carrier 122 has a first end 123 that supports the discharge end of the syringe 114. At the other end of the syringe carrier 122 is a flange 124 against which a return

spring 126 is biased. The return spring 126 acts between the flange 124 and a region of reduced internal diameter (not shown) of the sleeve 120 to bias the syringe 114 from an extended position, in which the needle 118 extends from the aperture 128, to a retracted position, in which the needle 118 is contained within the housing 112. A damping element 125 is integrally formed with the syringe carrier 122 in front of flange 124. The damping element 125 is annular in shape and is fabricated from Santoprene®, a thermoplastic elastomer.

The drive takes the form of a compression drive spring 130. Drive from the drive spring 130 is transmitted via a multi-component drive to the piston of the syringe 114 to advance the syringe 114 from its retracted position to its extended position and discharge its contents through the needle 118. The drive accomplishes this task by acting directly upon the syringe 114 and its contents. Static friction between the drive element 134 and the syringe body 116 initially ensures that they advance together, until the return spring 126 bottoms out or the syringe body 116 meets some other obstruction (not shown) that retards its motion.

The multi-component drive 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 first drive element 132. This in turn transmits drive to the second drive element 134 already mentioned.

The drive element 132 includes a hollow stem (not shown), the inner cavity of which forms a collection chamber in communication with a vent that extends from the collection chamber through the end of the stem. The second drive element 134 includes a blind bore (not shown) that is open at one end to receive the stem and closed at the other. The bore and the stem define a fluid reservoir, within which a damping fluid is contained.

A trigger 113 is provided on one side of the housing 112. The trigger 113, when operated, serves to decouple the drive sleeve 131 from the housing 112, allowing it to move relative to the housing 112 under the influence of the drive spring 130. 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. The second drive element 134 moves and, by virtue of static friction and hydrostatic forces acting through the contents of the syringe 114, moves the syringe body 116 against the action of the return spring 126. The syringe body 116 moves the syringe carrier 122, which compresses the return spring 126 via the flange 124. The 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.

At the point when the return spring 126 bottoms out, the damping element 125 acts between the sleeve 120, via its region of reduced internal diameter, and the syringe carrier 122, via its flange 124, to absorb some of the energy of the impact. The damping element 125 has the effect of reducing the transmission of an impact force, caused by the sudden deceleration of the syringe carrier 122 relative to the sleeve 120 as the two components contact, to the drive mechanism, specifically to the first drive element 132. This feature improves the reliability of the device 110 by reducing the peak loading in the first drive element 132 and preventing its fracture. The damping element 125 gives the additional advantage of reducing any noise, which may be disconcerting for a user, that is produced during operation of the device 110 as the flange 124 of the syringe carrier 122 strikes the sleeve 120. The damping element 125 also serves to reduce the pain suffered by a user upon operation of the device 110.

The static friction between the second drive element 134 and the syringe body 116 and the hydrostatic forces acting through the contents of the syringe 114 are not sufficient to resist the full drive force developed by the drive spring 130, so at this point the second drive element 134 begins to move within the syringe body 116 and its contents begin to be discharged. Dynamic friction between the second drive element 134 and the syringe body 116 and hydrostatic and hydrodynamic forces now acting through the contents of the syringe 114 are, however, sufficient to retain the return spring 126 in its compressed state, so the 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 114 have fully discharged, flexible latch arms linking the first and second drive elements 132, 134 reach a constriction within the housing 112 formed by an annular portion 150 at the end of the syringe carrier 122 that includes the flange 124. The constriction moves the flexible latch arms to a position so that they no longer couple the first drive element 132 to the second drive element 134. Once this happens, the first drive element 132 no longer acts 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 defined between the end of the first drive element 132 and the blind bore 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 into the collection chamber. Thus, once the flexible latch arms have been released, some of 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; the remainder acts hydrostatically through the fluid and through friction between the first and second drive elements 132, 134, thence via the second drive element 134. Consequently, the second drive element 134 continues to move within the syringe body 116 and the contents of the syringe 114 continue to be discharged. Losses associated with the flow of the damping fluid do not attenuate the force acting on the syringe body 116 to a great extent. Thus, the return spring 126 remains compressed and the needle 118 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, allowing the first drive element 132 to continue its movement.

Before the reservoir of fluid is exhausted, flexible latch arms linking the drive sleeve 131 with the first drive element 132 reach another constriction within the housing 112. The

constriction moves the flexible latch arms so that they no longer couple the drive sleeve 131 to the first drive element 132. Once this happens, the drive sleeve 131 no longer acts on the first drive element 132, allowing them to move relative to each other. At this point, the forces developed by the drive spring 130 are no longer being transmitted to the syringe 114. The only force acting on the syringe 114 will be the return force from the return spring 126 which acts on the end 123 of the syringe 114 nearest to the needle 118 via the flange 124 and the syringe carrier 122. Consequently, the syringe 114 is returned to its retracted position and the injection cycle is complete.

Figure 5 shows components of an injection device 210 according to a second embodiment of the present invention. The device 210 includes a sleeve 220 in which is substantially positioned a syringe carrier 222 having a damping element 225 co-moulded with a first end 223 of the syringe carrier which is located nearest to an exit aperture 228 of the device 210. Contact between an interface surface on the sleeve 220 and the first end 223 of the syringe carrier 222 restrains the syringe 214 as it reaches its extended position. The damping element 225 acts between the sleeve 220 and the syringe carrier 222 at this point to reduce transmission of an impact force to a first drive element 232 in a similar fashion to that previously described.

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, so that the syringe is movable between a retracted position in which the discharge nozzle is contained within the housing and an extended position in which the discharge nozzle extends from the housing through an exit aperture;

a drive that acts upon the syringe to advance it from its retracted position to its extended position and discharge its contents through the discharge nozzle;

a first component that advances with the syringe;

a second component that restrains the advancement of the first component as the syringe reaches its extended position; and

a damping element that acts between the first component and the second component.

2. The injection device of claim 1 wherein the position of the second component is fixed relative to the housing.

3. The injection device of claim 2 wherein the second component is integrally formed with the housing.

4. The injection device of any preceding claim wherein the first component provides an interface between the syringe and the second component.

5. The injection device of any preceding claim wherein the syringe acts upon the first component to advance it.

6. The injection device of any preceding claim wherein the interaction of the first component and the second component restrains the advancement of the syringe beyond its extended position.

7. The injection device of any preceding claim wherein the first component comprises a cylindrical section having an external diameter and the second component

comprises a cylindrical section having an internal diameter, wherein the external diameter of the cylindrical section of the first component is less than the internal diameter of the cylindrical section of the second component.

8. The injection device of any preceding claim wherein the first component further comprises a flange with an external diameter that is larger than the internal diameter of the second component.

9. The injection device of claim 8 wherein the second component interacts with the flange of the first component to restrain its advancement as the syringe reaches its extended position.

10. The injection device of claim 9 wherein the damping element is positioned between the second component and the flange of the first component.

11. The injection device of any of claims 1-8 wherein the first component has a first end through which the discharge nozzle of the syringe passes, wherein the damping element is located at the first end.

12. The injection device of any preceding claim wherein the damping element is integrally formed with either the first component or the second component.

13. The injection device of claim 12 wherein the damping element is integrally formed with the first component.

14. The injection device of any preceding claim wherein the damping element is annular in shape.

15. The injection device of any preceding claim wherein the damping element is a thermoplastic elastomer.

16. The injection device of claim 15 wherein the damping element is selected from Santoprene®, Evoprene® or polyurethane.

17. The injection device of any preceding claim further comprising means for biasing the syringe from its extended position to its retracted position.

18. The injection device of claim 17 wherein the first component comprises a support for carrying the means for biasing the syringe.

19. The injection device of claim 18 wherein the means for biasing the syringe act between the second component and the flange of the first component.

20. The injection device of claim 19 wherein the second component has a region of reduced internal diameter that is acted upon by the biasing means.

21. The injection device of any preceding claim wherein the first component is a syringe carrier.

22. The injection device of claim 21 wherein the second component is a sleeve that substantially surrounds the syringe carrier.

23. An injection device substantially as hereinbefore described with reference to and as shown in the attached drawings.

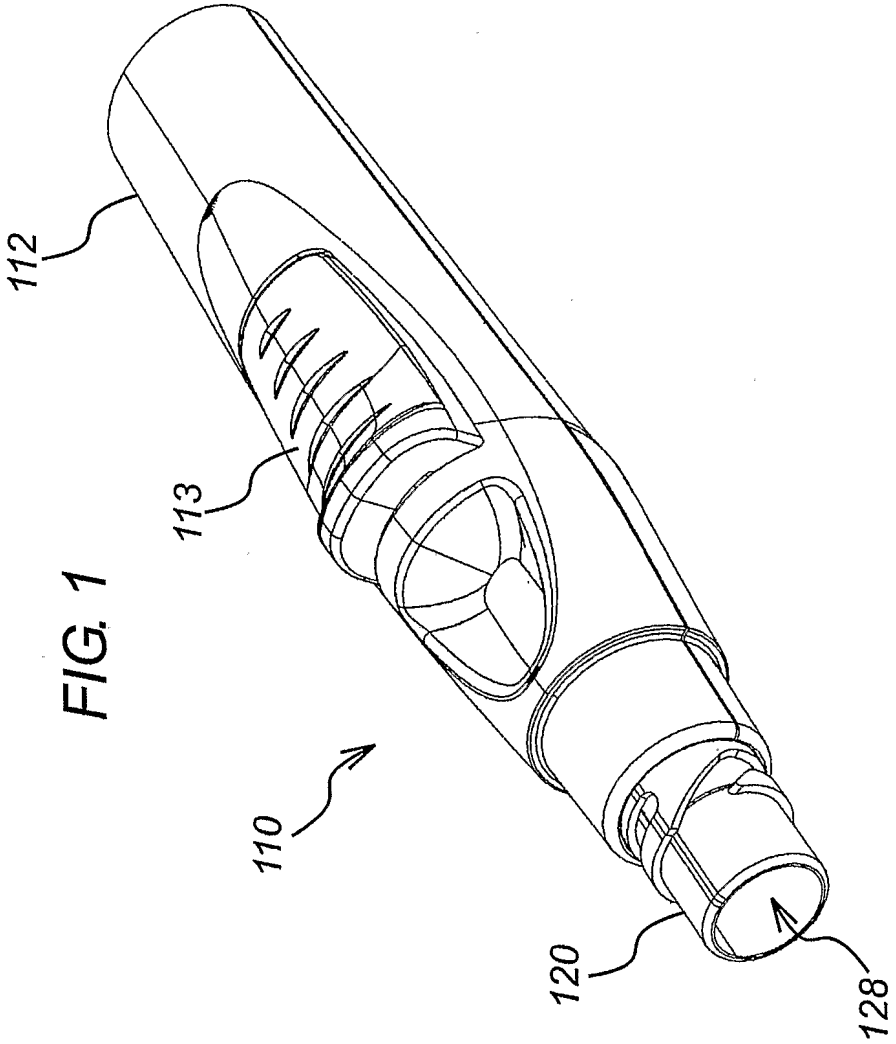
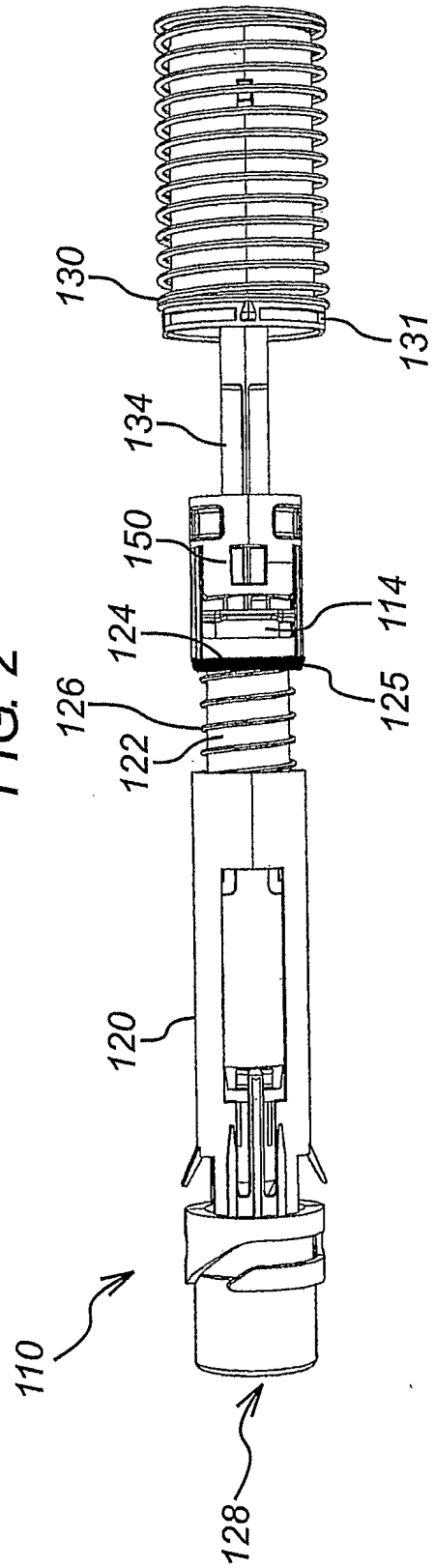


FIG. 1

FIG. 2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131
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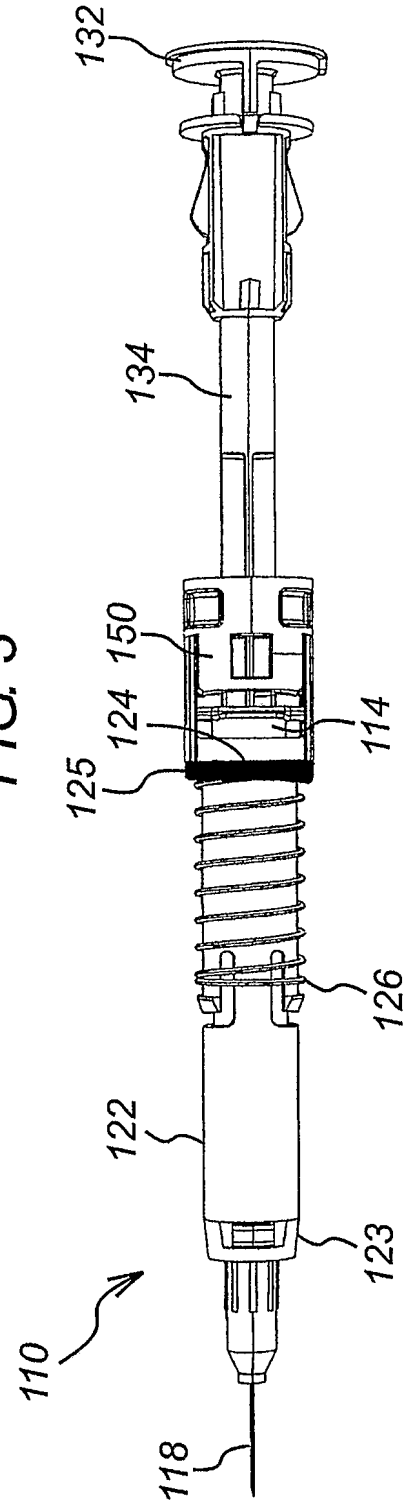
128

FIG. 3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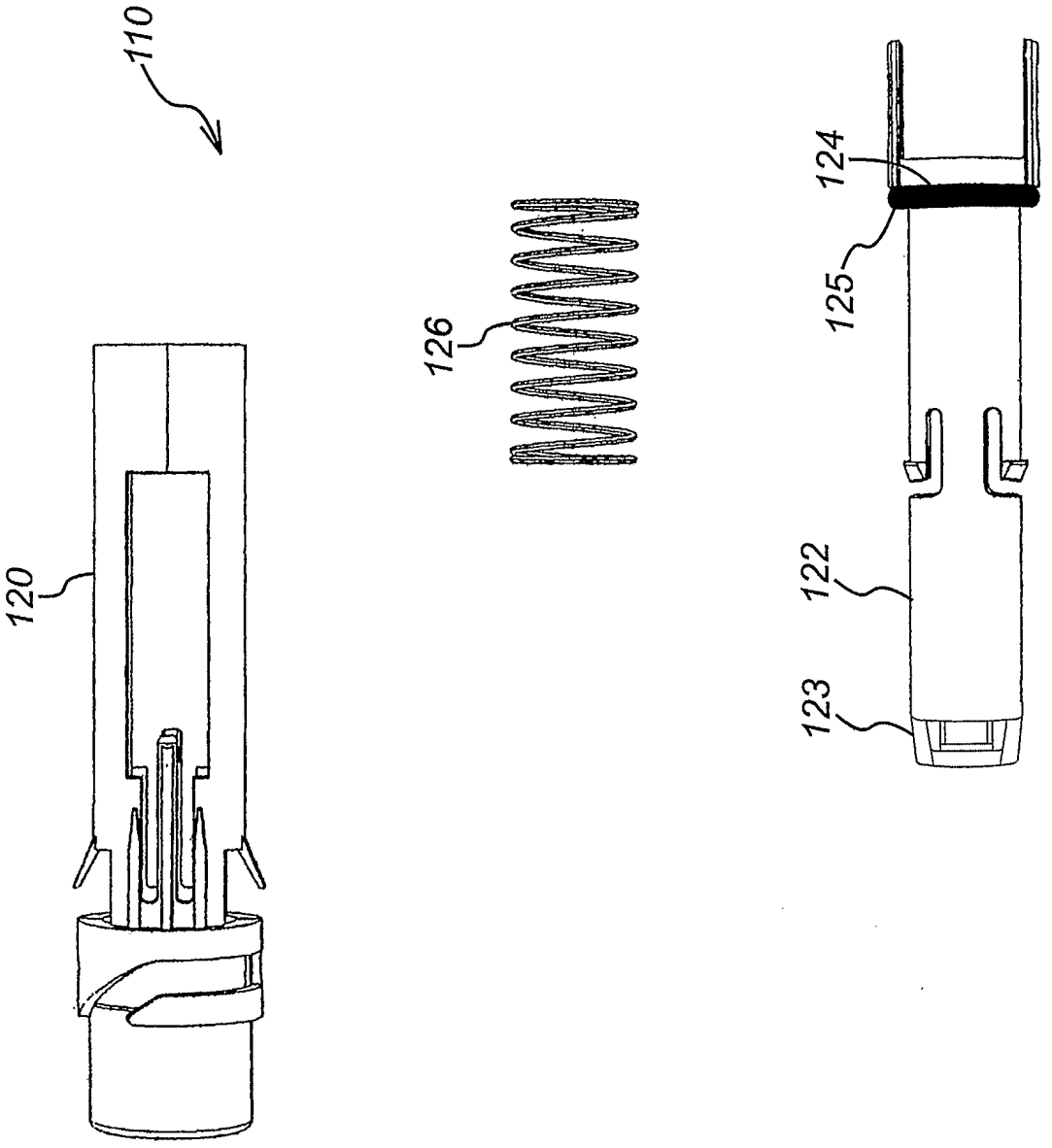

FIG. 4

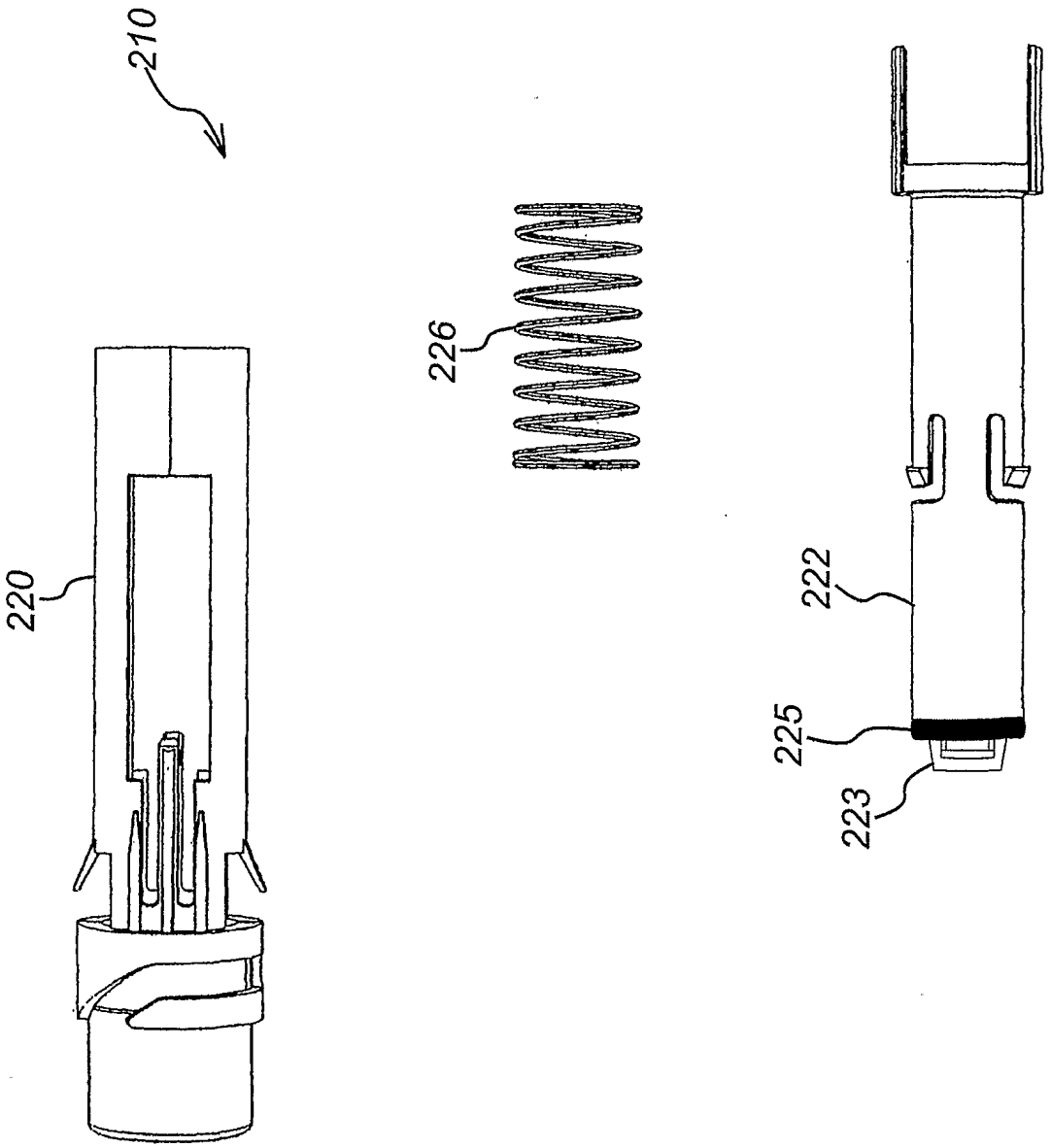

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2007/002002

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61M5/20

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A61M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 387 078 B1 (GILLESPIE III RICHARD D [US]) 14 May 2002 (2002-05-14) column 9, lines 1-20 figures 1-6	1-11,20
X	US 4 231 368 A (BECKER MICHAEL) 4 November 1980 (1980-11-04) column 5, lines 13-51 figures	1-16,21, 22

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 August 2007	04/09/2007

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Schultz, Ottmar

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2007/002002

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2005/025636 A (DALI MEDICAL DEVICES LTD [IL]; DAILY DAVID [IL]; RADAY LIOR [IL]) 24 March 2005 (2005-03-24) page 29, line 6 - page 31, line 13 page 38, line 10 - page 39, line 24 page 58, line 29 - page 61, line 5 page 67, line 8 - page 68, line 25 figures 1,29B,91,115B	1-7,12, 13, 15-17, 21,22
P,X	WO 2006/063124 A (PHARMA PEN HOLDINGS INC [US]; GILLESPIE RICHARD DAVID [US]; CROW DOUG) 15 June 2006 (2006-06-15) paragraph [0068] figures 1-10	1-18,21, 22

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box II.2

Claims Nos.: 23

Rule 6.2(a) PCT

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guideline C-VI, 8.5), should the problems which led to the Article 17(2) declaration be overcome.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/GB2007/002002

Box II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 23
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

see FURTHER INFORMATION sheet PCT/ISA/210

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/GB2007/002002

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