(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
09 May 2019 (09.05.2019)

WIPO | PCT

(10) International Publication Number
WO 2019/087001 A1

(51) International Patent Classification:
A61M 5/20 (2006.01)

(21) International Application Number:
PCT/IB2018/058200

(22) International Filing Date:
22 October 2018 (22.10.2018)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
17199307.4 31 October 2017 (31.10.2017) EP

(71) Applicant: **TECPHARMA LICENSING AG** [CH/CH]; Brunnmattstrasse 6, 3401 Burgdorf (CH).

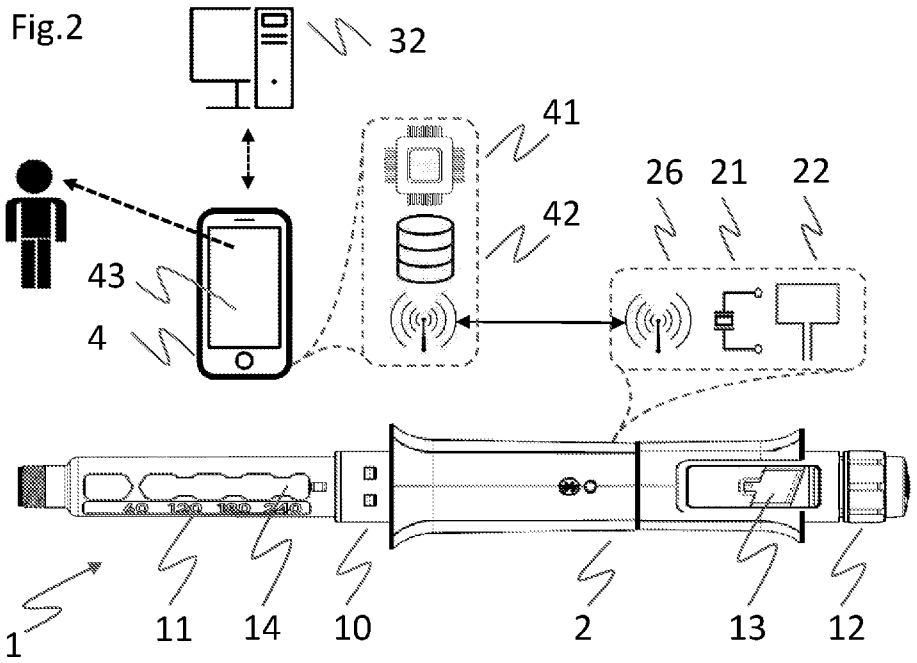
(72) Inventors: **KÜHNI, Florian**; Sandrainstrasse 60, 3007 Bern (CH). **LABUDDE, Marc**; Bergstrasse 9, 3095 Spiegel (CH). **URBANEK, Leos**; Vereinsweg 5, 3012 Bern (CH).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ,

(54) Title: MONITORING OF DISPOSABLE INJECTION DEVICES

Fig.2



(57) Abstract: The present invention is concerned a medical monitoring system with increased patient safety and confidence. The system comprise a disposable injection device with a container holder for holding a container or reservoir such as a cartridge or a syringe comprising a liquid drug for subcutaneous injection. The system further includes a passive machine-readable tag mounted to a device housing of the injection device and coding or storing drug information about the drug comprised in the container. The system also includes an electronic module or supplemental device adapted to be releasably attached to the injection device. The electronic module comprises injection status sensing means for monitoring a status of an injection or for tracking a progress of a medication event, as well as a tag reader different from the sensing means for reading the drug information from the machine-readable tag. The system ultimately includes a drug status signaling or interfacing unit for signaling to a user a drug status that is based on, or derived

WO 2019/087001 A1

[Continued on next page]

UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*
— *in black and white; the international application as filed contained color or greyscale and is available for download from PATENTSCOPE*

DESCRIPTION

MONITORING OF DISPOSABLE INJECTION DEVICES

FIELD OF THE INVENTION

The present invention relates to drug delivery systems for delivering, administering, injecting, infusing and/or dispensing liquids including a drug, medicament, or active ingredient. It departs from a medical monitoring system with an injection device and an electronic module attachable to the injection device.

BACKGROUND OF THE INVENTION

A variety of diseases exist that require regular treatment by subcutaneous administration of a medicament, and a number of drug delivery devices have been developed to support a patient in accurately and controllably delivering an amount of drug in a self-administration process. Delivery devices include injection devices that are removed from the injection site after each medication event or drug delivery process. Disposable injection devices include auto-injectors, patch injectors, variable dose injection pens, and any other injection device for delivering a fixed or variable dose of drug from a container that is not intended to be replaced by the patient. Fix dose disposable injection devices include single-dose injection devices such as auto-injectors or patch injectors as well as multi-dose injection devices such as fix dose injectors. Auto-injectors automatically deliver a fixed dose of liquid drug from a pre-filled syringe by means of a pre-strained injection spring provided for biasing a piston rod and shifting a piston comprised in the syringe. Patch injectors or ready-to-use pre-filled wearable bolus injectors are patched to the skin of the patient in view of a single dose injection taking between thirty seconds and several minutes. Fix-dose injectors have a single, non-variable dosage volume, or provide a limited number of fixed, non-variable injection dosage volumes for the user to choose from.

Diabetes may be treated by administration of insulin with the help of delivery devices that are handled by the patients themselves. Suitable delivery devices include pre-filled multi-dose disposable insulin pens as well as re-usable insulin pens that allow replacement of an empty insulin cartridge by a new one. Such variable-dose injection devices may benefit from an electronic unit or control unit integrated in the injection device, or being part of an

auxiliary or supplemental module detachably attached to the injection device. The electronic unit in turn serves to monitor the injection of insulin, in order to proactively prevent false handling of the device and/or to keep track of the doses already applied. In addition to generating data related to an instantaneous condition and/or use of the injection device, information on the insulin type, cartridge batch, and/or expiration date may be evaluated by the electronic unit.

EP 17163755.6 discloses an electronic unit comprising a mechanical feedback sensor and a processing unit adapted to cooperate with an injection device generating a mechanical feedback during an injection process. The electronic unit is part of a reusable electronic module that attaches to a mechanical injection device for monitoring of an injection process executed by a user by means of the injection device. The electronic module has a dedicated module housing adapted to be attached, by means of a releasable locking mechanism, to a component or part of the injection device such as a device housing or a discharge button, and is designed to avoid obstruction of other interface elements of the injection device, specifically of a dosing knob. The electronic module is adapted to detect and exploit mechanical, tactile, and/or acoustic feedback signals emanating from the injection device. The electronic unit comprises a visual, audible and/or tactile status indicator indicating to a user a status of the system as derived from the feedback sensor output. The status of the system may include any of a device status of the injection device, a module status of the electronic module, or a process status of an overall injection process or injection device handling process. The status information may include a positive confirmation of a dose having been set or corrected, or an indication about a lapse of a minimum holding, delay, or dwell time following completion of a substance expel or piston forwarding activity to inform the user that it is now safe to remove the injection device.

A wireless communication unit is connected to the processing unit, and adapted to wirelessly communicate, specifically upload, injection information to a nearby mobile device or dedicated medical gateway. The injection information includes at least a time stamp and the expelled dose, indicative of a time of a medication event and of a quantity of injected medicament, and optionally a dialed and/or corrected dose. The injection information may be transmitted instantaneously, or stored in a memory unit connected to the processing unit, for later upload or batch transfer. The injection information may, in addition or alternatively, include a quality measure of an injection process, such as a binary flag indicating that a determined dialed dose corresponds to a determined expelled dose.

WO 2001/062322 discloses a medicament dispenser such as an inhalator comprising a medicament (aerosol) container which is removably mountable in the housing of the dispenser. A Radio Frequency Identification (RFID) tag moulded into the housing of the dispenser includes an antenna and an integrated circuit chip connecting with said antenna. The RFID tag is arranged for reading of data therefrom by a reader remote from the medicament dispenser, such as a hand-held/portable electronic device, by transmitting radiofrequency energy to the antenna and receiving radiofrequency energy therefrom. The reader is arranged to communicate with a local electronic data management system or a networked computer system, and to write information to the RFID tag once a specific step in the process has been completed.

In the context of a medical self-administration process, reading and writing of an RFID tag, specifically of a Near-Field Communication (NFC) tag, by a mobile device may be problematic because of the limited provision and/or accessibility of RFID interfaces in current mobile devices and because of the inherent limitation of the communication range. After an initial pairing and exchange of power and information between the target delivery device with the RFID tag and the mobile device with the initiator RFID transceiver, the two devices are likely to separate for the rest of the injection process. Accordingly, for control or documentation purposes, specifically for writing of changed information to the RFID tag at the end of the injection, the two devices have to be brought into contact again at the end of the medication event. This may be forgotten by a patient.

WO 2009/024562 discloses a medical device with a Radio Frequency Identification (RFID) unit comprising a pressure sensor integrated with a liquid medicament container to enable wireless pressure monitoring. The liquid medicament container is coupled with a first housing part of the medical device, which first housing part may for instance constitute a pre-filled disposable injection device. The RFID unit communicates wirelessly with a control circuit that is contained in a second housing part of the medical device, or in an associated auxiliary module that is releasably attached to the first housing part. The control circuit is adapted to process the values measured by the RFID unit, to compare it with pre-defined values and to provide an alert to the user if the measured values fall out of normal operating conditions, and to communicate data relating to the measured values to an external computing device for further data processing.

Alternatively, the auxiliary module of WO 2009/024562 holds a control circuit which includes a power supply, a radiofrequency transmitter and receiver and antenna means for

sending and receiving electromagnetic radiation to power a passive RFID sensor system of the injection device so that the sensor system is able to pick up sensed data regarding various conditions of the injection device such as movements of the actuator mechanism. The sensor system is integrated with the drug cartridge or arranged in the vicinity of the actuator mechanism, and may additionally be utilized for encoding the type of drug or cartridge, and/or information about production date. Accordingly, the medical delivery device may receive the coded information and derive for instance whether the drug is the one programmed in the medical device for the user to use, or whether the recommended last usage date has expired.

Attaching an RFID tag to a container that is subsequently inserted into a delivery device may be problematic as the space or radial distance between the container and the inner surface of a container holder may become very small due to unavoidable manufacturing tolerances. This may lead to damage such as partial detachment of a tag including an antenna and sensors during insertion of the container into the container holder. Either the diameter of the container or of the container holder may have to be, at least locally, adapted to accommodate for a tag that is less two-dimensional than a mere paper label. Likewise, arranging a tag in the vicinity of an actuator mechanism for sensing movements of the latter requires a device design specifically adapted. However, changes to the internal design of the injection device generally have vast consequences and definitively are not feasible in retrofit configurations with an existing and proven injector design.

In the present context, the terms “substance”, “drug”, “medicament” and “medication” are to be understood to include any flowable medical formulation suitable for controlled administration through a means such as, for example, a cannula or a hollow needle, and comprises a liquid, a solution, a gel or a fine suspension containing one or more medical active ingredients. A medicament can be a composition comprising a single active ingredient or a pre-mixed or co-formulated composition with more than one active ingredient present in a single container. Medication includes drugs such as peptides (e.g., insulin, insulin-containing drugs, GLP-1 containing drugs or derived or analogous preparations), proteins and hormones, active ingredients derived from, or harvested by, biological sources, active ingredients based on hormones or genes, nutritional formulations, enzymes and other substances in both solid (suspended) or liquid form but also polysaccharides, vaccines, DNA, RNA, oligonucleotides, antibodies or parts of antibodies but also appropriate basic, auxiliary and carrier substances.

DESCRIPTION OF THE INVENTION

It is an objective of the invention to increase patient safety and confidence in a medical monitoring system with an electronic module attachable to an injection device for monitoring purposes. This objective is achieved by a medical monitoring system and by an electronic module according to the independent claims. Preferred embodiments are evident from the dependent patent claims.

According to the invention, a medical monitoring system includes a disposable injection device with a container holder for holding a container or reservoir such as a cartridge or a syringe comprising a liquid drug for subcutaneous or intramuscular injection. The system further includes a passive machine-readable tag mounted to, for instance embedded in or attached to a surface of, a device housing of the injection device and coding or storing drug information about the drug comprised in the container. The system also includes an electronic module or supplemental device adapted to be releasably, or reversibly, attached to the injection device. The electronic module comprises injection status sensing means for monitoring a status of an injection or for tracking a progress of a medication event, as well as a tag reader different from the sensing means for reading the drug information from the machine-readable tag. The system ultimately includes a drug status signaling or interfacing unit for signaling to a user a drug status that is based on, or derived from, the drug information.

The disposable injection device preferably is an auto-injector, a patch injector, a variable dose injection pen, or any other injection device for delivering a fixed or variable dose of drug from a container that is not intended to be replaced by the patient. The injection device may be automated and comprise a preloaded mechanical or even electrical source of energy for expelling the drug, or be exclusively powered by the self-administrating patient. Even in the presence of a source of electrical power in the injection device the use of a separate electronic module may be advantageous, not least in retrofit configurations with an existing injection device design that is not available for the inclusion of sensors and electronics.

The injection status sensing means of the electronic module capture signals indicative of an injection status that depends on a position or a movement of a component of the injection device. The injection status may include a device status of the injection device or a process status of an overall medication event or injection device handling process. The machine readable tag preferably is devoid of any sensing capability or other dynamic interaction with the interior of the injection device. The injection device does not have to, and preferably

does not, include sensing and signaling electronics on behalf of a device-external receiver, in perfect agreement with a requirement for reverting to existing and proven injection device designs. Mounting the tag to the injection device housing specifically excludes attaching the tag to the container. Accordingly, both the machine-readable tag and the tag reader of the electronic module are preferably arranged proximal of a proximal end of the container and/or of a container viewing window of an elongate pen-shaped injection device, with the term "proximal" referring to the end of the injection device that is opposite a distal end, wherein the distal end comprises a needle or cannula.

The drug information includes any or all of a drug identifier, an expiry date, or a batch number of the drug, medicament, or active ingredient contained in the container. The drug information traditionally may have been included in a barcode or plain text Unique Device Identifier. The status may be derived from the drug information as previously obtained from the machine-readable tag by an evaluating or processing unit, preferably in relation to or in connection with further evaluation information. For instance, coded drug information about the drug type may be compared with a therapy plan of the patient and/or with stored information about previous administrations, to confirm that drug type, or placebo in case of a clinical trial phase, and drug dose identified and ready to be injected are indeed the correct medication to be administered imminently. This may constitute particularly valuable information in case of multiple drug types or medication variants being scheduled for alternating administration by the patient, specifically if such multiple drugs are administered by way of identical or similar injection devices. Further, coded drug information may include a number or identifier of the batch or lot to which the instant container pertains, which may be evaluated against information indicative of a possible recall of the batch in question. Ultimately, drug information about the expiry date of the drug comprised in the container may be evaluated against the actual date. In the event of wrong medication, batch recall, or drug expiration a corresponding alarm is signalled to the user by the signalling unit, whereas in the absence of such event, either no signal or a safe-to-use signal is emitted. The invention thus contributes, by way of a confirmatory or warning feedback in due time prior to injection, to an increased confidence of the patient in what he or she is expected to be doing, to fewer handling errors, and ultimately to an increased adherence to a therapy plan. Furthermore, the medical monitoring system according to the invention allows to easily and unambiguously complement, or correlate, the monitoring results obtained by the electronic module with drug information read from the tag.

In an exemplary application of the invention, the injection device is an auto-injector, and the medical monitoring system is used in the context of a clinical trial, with all advanced remote adherence tracking being accomplished by the electronic module. In line with the invention, the electronic module may alert users at the point-of-use in case a batch of investigational drug distributed earlier has to be corrected or removed from the clinical trial. In this context, automated handling of drug information read from the tag reduces the number of system interaction steps that the trial patient is expected to perform, including monitoring of drug supply, and minimizes the administrative burden of conducting and documenting clinical research. With all monitoring, documenting and supporting functionality being executed by the electronic module, the auto-injector itself does not require any physical modification, and the same auto-injector can be used for the clinical trials as well as for the commercial drug product.

In a preferred embodiment the electronic module includes the evaluating unit to evaluate the drug information read from the tag, as well as the signaling unit. In this case the further evaluation information has to be available at the electronic module locally, which may imply a local clock and/or a memory unit storing a copy of the therapy plan or drug batch information in the form of a blacklist or a whitelist. The latter obviously has to be preloaded to the memory unit beforehand. The memory unit may also store information about previous medication events of the injection device.

Any signaling unit of the electronic module, whether for signaling a drug status evaluated locally or received by a communication unit of the electronic module, comprises a visual, audible and/or tactile status indicator as the human interfacing means. The status indicator may be simple and limited to a multicolor LED or to no more than three distinct LEDs in traffic-light colors and/or an audible signal generator for generating language-independent beep sounds or simple melodies. The status indicator may explicitly exclude any advanced human-machine interfacing capability, and be limited to a few, specifically less than ten, messages conveyable to the user. In particular, the electronic module may be devoid of a display, screen, or projector for visually transmitting readable instructions, and likewise exclude an artificial speech assistant for reading out loud the instructions. Such advanced HMI functionality including elaborate graphic display and speech output capabilities are preferably being provided by a mobile device communicatively connected to the electronic module.

In an advantageous embodiment of the preferred variant, the system comprises a gateway device, specifically a stationary internet or medical gateway device, communicatively connected to a remote server, and adapted to retrieve most updated evaluation information there from. The electronic module comprises a communication unit to transmit the drug information to the gateway device, and to receive the evaluation information from the gateway device. Specifically, an updated batch recall or safe-to-use condition of a batch may be provided by the server upon receipt of the batch number read from the tag, and transmitted via the gateway device to the evaluating unit of the electronic module. In this case, less or no evaluation information has to be stored at the electronic module. With the attention of the user being tied to the electronic module, the gateway device does not need to, and preferably does not, include an elaborate HMI.

In an alternative preferred embodiment, the electronic module comprises a communication unit to transmit the drug information to a mobile device such as a smartphone or tablet device running a dedicated application program, or a laptop computer configured accordingly. The mobile device in turn comprises the evaluation unit to derive the drug status based on the drug information. The drug status may be signaled to the user by an elaborate HMI of the mobile device, or returned to the electronic module for signaling by a signaling unit of the electronic module as described above. The latter may be beneficial as the focus of the patient may be on the injection device and hence on the signaling unit of the electronic module rather than on the mobile device.

In an advantageous variant of the alternative preferred embodiment, the mobile device is in turn communicatively connected to a remote server, and adapted to retrieve most updated evaluation information there from, to be evaluated by the evaluating unit of the mobile device. Specifically, an update about a batch recall or safe-to-use condition of a batch may be obtained upon receipt of the batch number and transmitted to the mobile device.

Communication between the electronic module and the gateway device or the mobile device may preferably take place via Bluetooth Low Energy (BTLE) or equivalent short or near range wireless communication technology. In this context it is understood that a potential tag reading unit of the gateway or mobile device is not used to access the drug information of the tag, and that any restriction as to a relative arrangement of the gateway or mobile device and the injection device is determined by the communication technology employed by the communication unit of the electronic module.

In a preferred embodiment, the machine-readable tag is attached externally to the device housing, which is compatible with non-transparent device housings, and which specifically excludes embedding the tag into the device housing in a manufacturing or molding step of the device housing preceding an assembly of the injection device. Attaching the tag to the device housing surface allows delaying of a programming or printing of the tag to a very late stage, specifically to finalize the tag during or even after assembly of the drug container and the injection device, but still before attachment of the tag to the device housing.

The passive machine-readable tag may include an optical bar code or a data-matrix / QR code, or even a portion of plain text printed on an adhesive label, that may be scanned by the electronic module by means of a corresponding bar code or QR code reading unit, or by an OCR unit, preferably during a relative displacement or approach of the tag and the reader. However, optical tags may become unreadable through scratches or depositions and are not designed to be rewritten or otherwise modified, and corresponding reading units tend to be complex and/or expensive. Therefore a non-optical Radio Frequency Identification (RFID) tag or transponder is preferably employed, specifically a NFC tag operating according to one of the Near-Field Communication (NFC) standards. Accordingly, the electronic module is equipped with an RFID / NFC reading or readout unit. Such a drug-information RFID reading unit may be used concurrently for reading of sensor signals provided from an appropriate RFID transponder, either separate from or identical with the aforementioned drug-information carrying tag. For instance, a temperature sensor for determining that a target temperature for injection has been reached may be implemented as a single-chip RFID field powered temperature sensor mounted to the injection device. This temperature feedback further contributes to an increased ease and confidence of the patient.

At least the standardized Near-Field Communication (NFC) tags contain data including unique tag identifiers such as serial numbers encoded in the tag at the time of manufacture in read-only format such that this information cannot be altered once set, as well as rewriteable information. A user memory in a tiny chip of a up to a few hundred bytes provides for sufficient space to store the drug information even in the presence of adequate cyber security measures. They can be custom-encoded by their manufacturers. Near-field communication uses magnetic induction between two loop antennas connected to respective RFID chips or control units, and located within a near field of each other, thus effectively forming an air-core transformer operating at an exemplary frequency of 13.56 MHz well below an UHF band of 300 MHz or higher. There are two communication modes, passive

and active mode. In the passive communication mode, the initiator device provides a carrier field and the target device responds by modulating the existing field. In this mode, the target device may draw its operating power from the initiator-provided electromagnetic field. In the context of the present invention, the initiator is an electronic unit as part of the electronic module, and the target is the passive tag or transponder attached to the medicament delivery device housing. In the active communication mode, both initiator and target device communicate by alternately generating their own fields. A device deactivates its RF field while it is waiting for data. In this mode, both devices typically have power supplies.

The RFID tag may be an inlay embedded in a smart label between a layer of adhesive and an outmost layer carrying printed text. Alternatively, the RFID tag may itself include some adhesive to be attached to the device housing, specifically to a part of the external surface of the device housing forming a recess or shallow depression of a depth corresponding to the thickness of the RFID tag, in order to be covered subsequently by an ordinary text label or sticker. Instead of a recess, a wall extending from the device housing surface and essentially surrounding the tag may be provided to prevent mechanical contact between the tag and the electronic module housing.

In further embodiments of the invention, the RFID tag comprises a re-writable memory section, and the electronic module comprises an RFID writer to write changed drug information to the re-writable memory section of the RFID tag. Changed drug information may relate to a medication event having been completed recently, and include binary information indicative of the completion, timing information indicative of the date and time of the completion, quantitative information indicative of the expelled dose, qualitative information indicative of an expelled dose matching a dialed dose, or of an observed holding time being sufficient. Changed information may include any other kind of information that may be of value at a later stage, such as when reading the RFID memory section of disposed injection devices for post injection studies. Specifically, in case the injection device is a multi-dose device, the evaluating unit may be configured to determine, from a dose of drug ejected and measured by the sensing means, an amount of drug remaining in the container. This amount is written to the RFID tag, and may serve as drug information for subsequent medication events. Storing certain re-writable information on the device itself lowers complexity of data management, at least until the injection device is disposed of, and specifically in case of multiple electronic modules or mobile devices being used with one and the same injection device.

According to the invention, an electronic module or supplemental device adapted to be detachably attached to a device housing of a disposable injection device comprises injection status sensing means for monitoring a status of an injection or for tracking a progress of a medication event performed by means of the injection device. The electronic module comprises a tag reader for reading or capturing drug information that is stored on a machine-readable tag mounted to the device housing. The electronic module further comprises a wireless communication unit for communicating drug information read from the tag to a nearby mobile device or medical gateway. The drug information stored in the tag preferably includes a batch number of a drug comprised in a container having been inserted into the injection device to which the module is attached.

The injection status sensing means may include a mechanical feedback sensor and a processing unit adapted to cooperate with an injection device generating a tactile or acoustic feedback during a medication event. The injection status sensing means may include an electrical sensor such as a contact-free inductive or capacitive sensor. An exemplary inductive sensor may detect initial, intermediate, and final values of, and/or corresponding changes or differences in, a static or alternating magnetic field or flux depending on a position or displacement of a magnetic device component. The injection status may include a device status of the injection device or a process status of an overall medication event or injection device handling process, and may also be communicated or uploaded by the communication unit.

In a preferred embodiment, the electronic unit comprises drug status signaling means for signaling a drug status evaluated from the drug information. An evaluation unit, either being part of the electronic module and receiving additional evaluation information in response to the drug information having been communicated, or being part of a mobile device receiving the drug information, prepares, and eventually returns, the evaluated drug status in the form of a safe-to-use feedback to be signalled by the signalling unit.

Still preferably, the tag is a Radio-Frequency Identification (RFID) tag, and the tag reader is adapted to read a passive RFID tag containing electronically stored drug information and being mounted to a device housing of the injection device. The RFID reader is different from or additional to the injection status sensing means. Correspondingly, the RFID tag is devoid of any sensing capability or other dynamic interaction with the interior of the injection device, and the injection device is devoid of sensing and signaling electronics.

BRIEF DESCRIPTION OF THE DRAWINGS

The subject matter of the invention will be explained in more detail in the following text with reference to preferred exemplary embodiments which are illustrated in the attached drawings, in which:

Fig.1 depicts a variant of a medical monitoring system with an auto-injector;

Fig.2 depicts a variant with a variable dose injection device and a mobile device;

Fig.3 depicts an axially aligned arrangement of an RFID tag and an RFID tag reader; and

Fig.4 depicts three transversally distinct arrangements of the tag and the tag reader.

The reference symbols used in the drawings, and their primary meanings, are listed in summary form in the list of designations. In principle, identical parts are provided with the same reference symbols in the figures.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Fig.1 depicts a variant of a medical monitoring system, comprising an auto-injector as an exemplary disposable injection device 1, an electronic module 2 releasably attached to a device housing of the injection device, and an optional gateway device 31 communicatively connected via a data communication network, e.g. the Internet, to a remote server, cloud based computing facility, or expert system 32. The electronic module 2 comprises an electrical or mechanical feedback sensor as injection status sensing means 21, as well as a tag reader 22 for reading drug information from a tag or label mounted to, or supported by, the device housing. The electronic module further comprises an evaluating unit 23 for evaluating the drug information and for deriving a drug status there from. A memory or data storage unit 24 may store evaluation information on behalf of the evaluating unit. The electronic module further includes a multicolor LED as a drug status signaling means or interfacing unit 25 for providing visual feedback about the drug status, and optionally about an injection status such as a progress of an ongoing injection process, or about an availability of battery power. A communication unit 26 for wireless transmission of drug information and reception of evaluating information to and from the optional gateway device via Bluetooth Low Energy (BTLE) or equivalent short or near range wireless communication technology may further be provided.

Included in the module housing is a lock/release mechanism to secure the attachment of the electronic module to the injection device in order to protect against unintended

detachment, specifically during removal of a needle protective cap from the auto-injector. The auto-injector is intended for automatically delivering a fixed dose of liquid drug from a pre-filled syringe by means of a pre-strained injection spring provided for biasing a piston rod and shifting a piston comprised in the syringe. The auto-injector comprises a needle protective sleeve, or cover sleeve, for protecting a needle of the syringe after removal from the injection site. Upon removal of the auto-injector from the injection site the needle protective sleeve is biased to a needle protecting position by a cover sleeve spring, and locked in this position by a locking means generating a locking sound. Start and end of a substance delivery as well as injection device lift-off may be detected by the injection status sensing means and advantageously combined to obtain a characterization of the ongoing injection process or medication event, in order to track whether an injection event has occurred according to the medication schedule but also whether that injection was successfully completed or not.

The electronic module 2 of Fig.1 has a rear, or proximal, part where some or all electronic components as described are located. With the tag reader being arranged in this proximal part, the machine-readable tag is beneficially mounted to a proximal end surface of the injection device, perpendicular to a longitudinal main axis and adjacent to the tag reader. As this end surface hitherto has remained unused, introduction of an extra tagging or labeling step during device manufacture is unavoidable. In case of an RFID transponder with an antenna attached to the end surface, inductive components inside the auto-injector, such as the metallic injection or cover sleeve springs, may interfere with the RFID antenna. Still in case of an RFID reader, an antenna of the electronic module, oriented parallel and adjacent to the transponder antenna may have to be shielded from the further electronic components of the electronic module. From an electromagnetic coupling point of view, arranging the antennas at right angles, with one antenna perpendicular and the other antenna parallel to the main axis, is not excluded.

Fig.2 depicts a variant of a medical monitoring system, comprising a variable dose injection device 1 with a dose dialing facility as amply described for instance in EP 2812055, an electronic module 2 and a mobile device 4 such as a smartphone or tablet device running a dedicated application program; or a laptop computer configured accordingly. The mobile device is optionally adapted to interact with a remote server, cloud based computing facility, or expert system 32. The electronic module 2 comprises an electrical or mechanical feedback sensor as injection status sensing means 21, a tag reader 22 for reading drug information

from a tag mounted to the device housing, and a communication unit 26 for wireless transmission of drug information to the mobile device via Bluetooth Low Energy (BTLE) or equivalent short or near range wireless communication technology. The mobile device 4 includes an evaluating unit 41 for evaluating the drug information and for deriving a drug status there from. A memory or data storage unit 42 may store evaluation information on behalf of the evaluating unit. The elaborate HMI facilities of the mobile device serve as drug status signaling means 43 for providing visual, tactile, acoustical feedback about the drug status, and optionally about an injection status such as a progress of an ongoing injection process. The device housing 10 of the pen-shaped injection device is fixed to a cartridge holder 11 containing a cartridge as a transparent container filled with a liquid drug. The cartridge holder has a container viewing window 14 permitting visual access to the liquid drug. A dosing sleeve and a rotary dosing knob 12 for enabling the user to adjust a dose are arranged on the proximal end of the injection device. When the dosing sleeve is screwed out of the housing during the dosing operation, the adjusted dose is displayed in a dose display window 13. On the proximal end of the injection unit, a discharge button is snapped on the dosing sleeve.

The electronic module 2 of Fig.2 has an essentially tubular module housing that, when properly slid over the injection device housing, surrounds the injection device 1 in a position such as to neither interfere with the dial-and-dose components 12 nor obscure a dose display window 13 of the device. This requirement obviously excludes providing the tag at a proximal end surface as in the previous variant. To this purpose, the module housing has a recess or cut-out that matches with the dose display window 13. Hence the patient may continue using the injection device in a known manner, despite the presence of the electronic module, with all device interface elements remaining fully accessible throughout the handling sequence. On the other hand, the electronic module may also include a mechanical sensor to mechanically detect a rotation angle or linear shift of the dosing knob, or an optical sensor to read a dialed dose from a dosing sleeve.

Fig.3 depicts an axially aligned arrangement of an RFID tag, specifically of the corresponding transponder antenna, 15 and an RFID tag reader or corresponding reader antenna 22, applicable to both preceding variants. An injection device 1 with a device housing 10 and a container viewing window 14 is partly surrounded by an electronic module 2. The latter as well as the RFID tag antenna 15 and the RFID tag reader antenna 22 are depicted in a cross-sectional view. The antennas include a circular or rectangular conductor

loop or spiral with an area of preferably less than 20x20mm, printed on a circuit board or an a flexible support. The tag 15 is attached to a longitudinal external surface of the device housing, and axially positioned opposite of, in a transversal direction, the tag reader 22. The tag reader 22 in turn is attached to a recess of a module housing of the electronic module. In an axial direction, the tag is attached to a proximal part of the device housing proximal of the container viewing window and/or the container, such that the tag and the reader may axially overlap without the electronic module obstructing the container viewing window when attached to the injection device in an axially fixed position.

Fig.4 depicts three cross-sectional views of an injection device 1 and an electronic module 2 surrounding the injection device, each with a transversally distinct arrangement of an RFID tag 15 and an RFID tag reader 22. In the RFID case the antenna of the RFID transponder and the antenna of a RFID reader are generally arranged as close as possible to each other such that an optimal inductive coupling is permanently achieved in a coupled state of injection device and electronic module. Hence in a transversal direction, misalignment or even rotation of the electronic module around the injection device has to be at least partly prevented, or the antennas have to be arranged to account for such misalignment or rotation. Rotation is prevented by a non-rotational axial symmetry as exemplified by the square-shaped cross sections in Fig.4. However, misalignment may still occur as two different orientations of the electronic module with respect to the injection device are still assumed possible, i.e. the electronic module may be turned 180° around the longitudinal axis and still fit to the injection device. In this case, a single reader antenna 22 and a single transponder antenna 15 may be provided with optimized range, allowing to read a misaligned tag 15' even across the injection device at a distance of approximately 20mm that is comparable to the lateral dimensions of the antennas (leftmost drawing). Due to the increased range or sensitivity of the tag reader, an electromagnetic shield may be needed against RF signals from outside of the system. Alternatively, two reader antennas 22a, 22b may be provided at opposite sides of the electronic module, such as to optimize the coupling with a single transponder antenna 15, 15' in both orientations (center drawing). This solution may require additional space in the electronic module, but avoids the drawbacks related to alien signals. Still alternatively, both a single reader antenna 22 and a single transponder antenna 15, 15' are arranged to cover two adjacent sides of the module housing and the device housing, respectively (right-hand drawing). Here the antenna loops include a kink along a center line interconnecting two perpendicular antenna loop halves. In this case a loop halve of the reader

antenna is adjacent a loop halve of the transponder antenna whatever the orientation of the electronic module.

While the invention has been described in detail in the drawings and foregoing description, such description is to be considered illustrative or exemplary and not restrictive. Variations to the disclosed embodiments can be understood and effected by those skilled in the art and practising the claimed invention, from a study of the drawings, the disclosure, and the appended claims. In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality. The mere fact that certain elements or steps are recited in distinct claims does not indicate that a combination of these elements or steps cannot be used to advantage, specifically, in addition to the actual claim dependency, any further meaningful claim combination shall be considered disclosed.

LIST OF DESIGNATIONS

1	Injection device
10	Device housing
11	Cartridge holder
12	Dosing knob
13	Dose display window
14	Container viewing window
15	Tag
2	Electronic module
21	Sensing means
22	Tag reader
23, 41	Evaluating unit
24, 42	Memory unit
25, 43	Signalling means
26	Communication unit
31	Gateway device
32	Remote server
4	Mobile device

PATENT CLAIMS

1. A medical monitoring system comprising
   - a disposable injection device (1) with a device housing (10) holding a container with a liquid drug;
   - a machine-readable tag with drug information on the liquid drug, mounted to the device housing (10);
   - an electronic module (2) for removable attachment to the device housing (10) and including an injection status sensing means (21) for monitoring an injection status, and a tag reader (22) for reading the drug information from the tag, and
   - drug status signaling means (25, 43) for signaling a drug status based on the drug information.
2. The medical monitoring system of claim 1, wherein the electronic module (2) comprises
   - an evaluating unit (23) to derive the drug status based on the drug information, and
   - the drug status signaling means (25).
3. The medical monitoring system of claim 2, comprising a gateway device (31) to facilitate communication with a remote server (32), wherein the electronic module (2) is adapted to transmit the drug information to the gateway device, and wherein the gateway device is configured to retrieve evaluating information from the remote server and to return the evaluating information to the electronic module.
4. The medical monitoring system of claim 1, comprising a mobile device (4) with an evaluating unit (41) to derive the drug status based on the drug information, and wherein the electronic module (2) is adapted to transmit the drug information to the mobile device.
5. The medical monitoring system of claim 4, wherein the mobile device (4) is adapted to communicate with a remote server (32) and configured to retrieve evaluating information from the remote server.
6. The medical monitoring system of one of claims 1 to 5, wherein the machine-readable tag is attached to the device housing (10).
7. The medical monitoring system of one of claims 1 to 6, wherein the machine-readable tag is an RFID tag, and wherein the electronic module (2) comprises an RFID reader.

8. The medical monitoring system of claim 7, wherein the RFID tag has a rewritable section, and wherein the electronic module (2) is adapted to write information about an injection status.

9. The medical monitoring system of claim 8, wherein the injection device (1) is a multi-dose injection device, and the electronic module (2) is adapted to determine a dose delivered and to write an amount of drug remaining in the container to the rewritable section of the RFID tag.

10. An electronic module (2) for removable attachment to a device housing (10) of a disposable injection device (1) holding a container with a liquid drug, comprising
- injection status sensing means (21) for monitoring an injection status,
- a tag reader (22) for reading drug information on the liquid drug from a machine-readable tag mounted to the device housing (10), and
- a communication unit (26) for communicating the drug information.

11. The electronic module (2) of claim 10, comprising
- a drug status signaling means (25) for signaling a drug status evaluated from the drug information.

12. The electronic module (2) of claim 10 or 11, wherein the tag is an RFID tag.

Fig.1

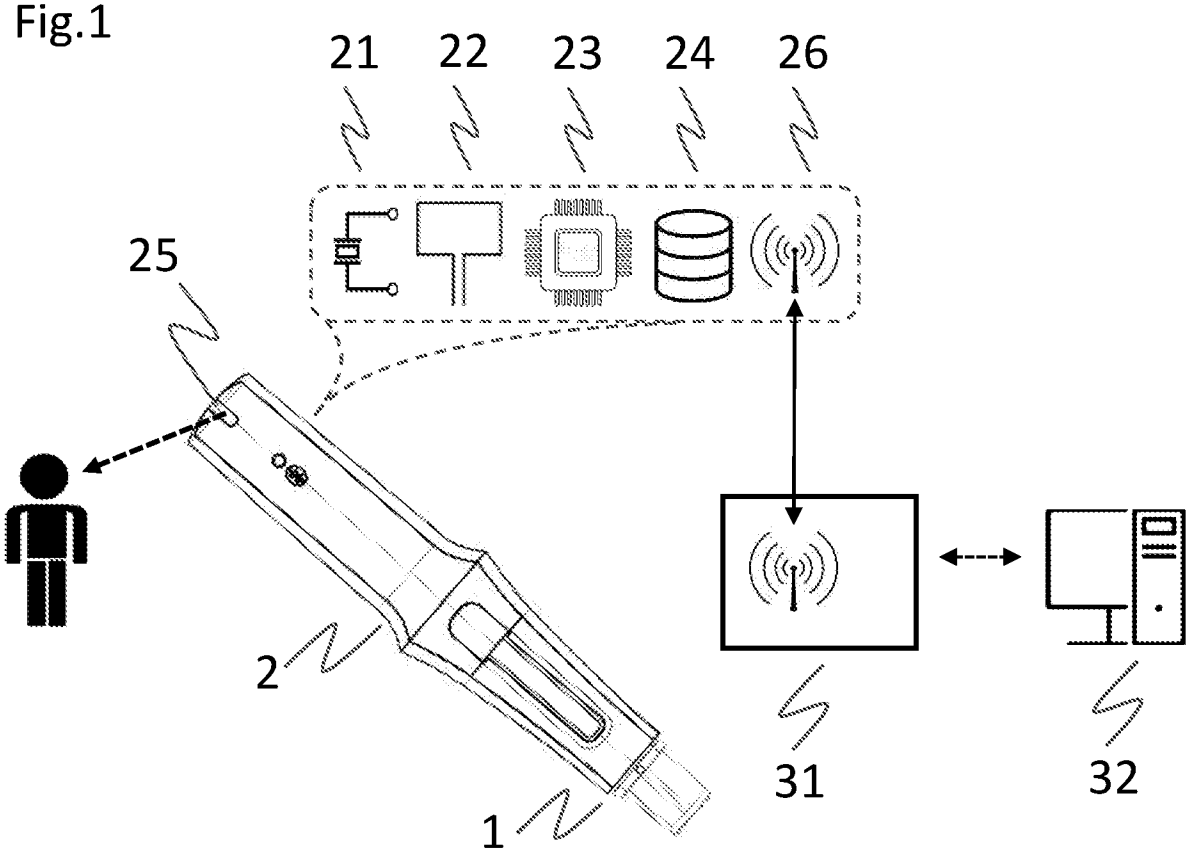


Fig.2

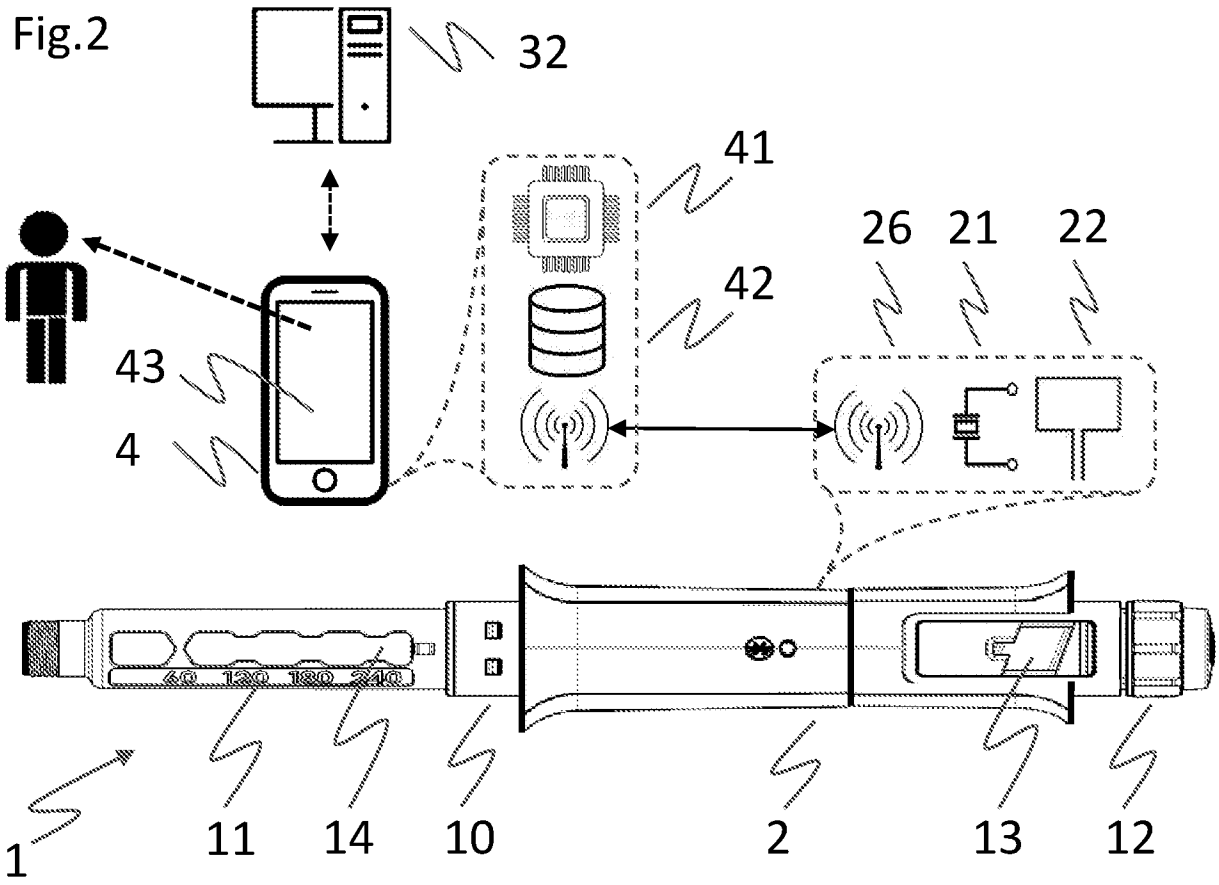
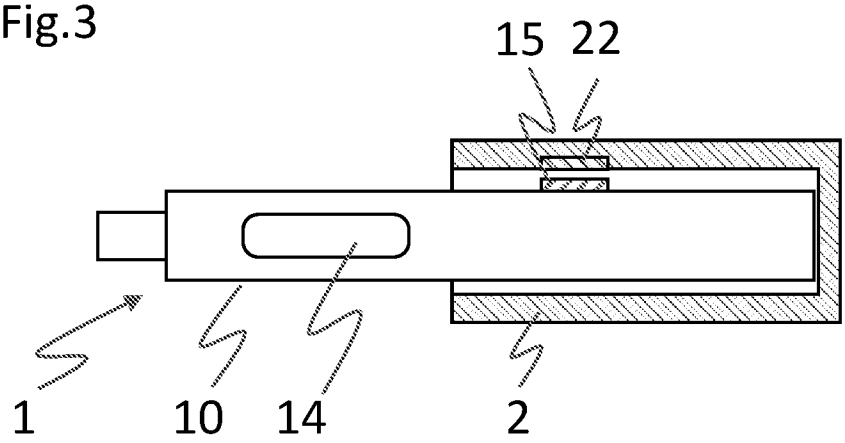
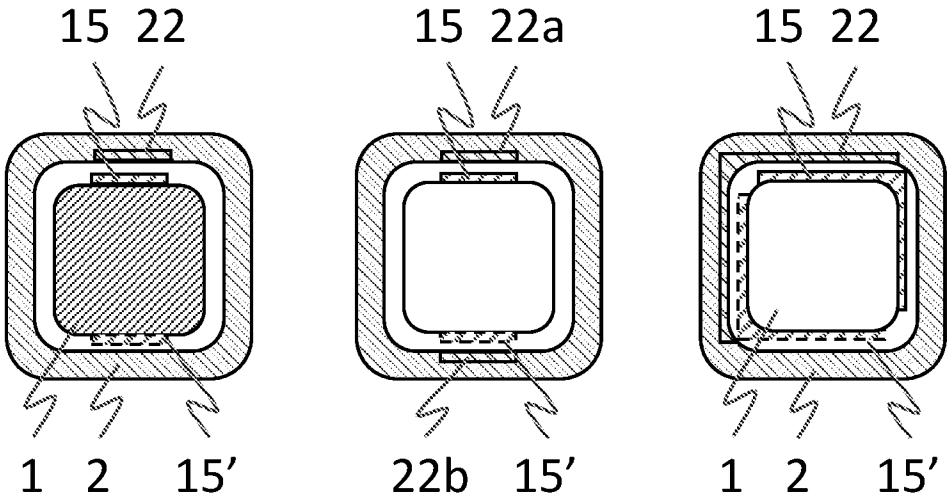


Fig.3



1

Fig.4



INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2018/058200

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61M5/20
ADD.

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 practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2015/201880 A1 (BUREAU CHRISTOPHE [FR] ET AL) 23 July 2015 (2015-07-23) paragraphs [0009], [0056], [0065]; figures 3A, 3B	1-12
A	US 2016/213848 A1 (WHALLEY RICHARD [US] ET AL) 28 July 2016 (2016-07-28) paragraph [0052]	1-12
X	US 2015/328411 A1 (FRIEDMAN STEVEN A [US]) 19 November 2015 (2015-11-19) paragraphs [0051], [0077], [0078]; figures 1-25	1-12
A	US 2015/290396 A1 (NAGAR RON [IL] ET AL) 15 October 2015 (2015-10-15) paragraphs [0087] - [0094], [0127], [0128]; figure 3	1-12

-/--

[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 application or patent 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
20 December 2018	08/01/2019

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, Fax: (+31-70) 340-3016	Krassow, Heiko

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2018/058200

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2015/251839 A1 (DENNY JOHN W [US] ET AL) 10 September 2015 (2015-09-10) paragraph [0042]; figure 1	1-12
X	WO 2016/033507 A2 (UNITRACT SYRINGE PTY LTD [AU]; MARLIN ARTHUR [US]) 3 March 2016 (2016-03-03) paragraphs [0027], [0074] - [0077], [0218], [0219]; figure 2	1-12
X,P	EP 3 381 493 A1 (TECPHARMA LICENSING AG [CH]) 3 October 2018 (2018-10-03) the whole document	1-12
X	US 2004/051368 A1 (CAPUTO JIMMY [US] ET AL) 18 March 2004 (2004-03-18) the whole document	1-12

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2018/058200

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2015201880 A1	23-07-2015	CN 104582596 A	29-04-2015
		EP 2872056 A1	20-05-2015
		JP 6402099 B2	10-10-2018
		JP 2015527912 A	24-09-2015
		JP 2017070800 A	13-04-2017
		US 2015201880 A1	23-07-2015
		WO 2014011740 A1	16-01-2014
US 2016213848 A1	28-07-2016	CA 2874331 A1	28-11-2013
		CN 104411349 A	11-03-2015
		EP 2852813 A1	01-04-2015
		JP 2015518747 A	06-07-2015
		US 2013310756 A1	21-11-2013
		US 2015085286 A1	26-03-2015
		US 2016213848 A1	28-07-2016
		US 2018050157 A1	22-02-2018
		WO 2013177135 A1	28-11-2013
US 2015328411 A1	19-11-2015	US 8639288 B1	28-01-2014
		US 9138539 B1	22-09-2015
		US 2015328411 A1	19-11-2015
		US 2017361028 A1	21-12-2017
US 2015290396 A1	15-10-2015	EP 2911717 A2	02-09-2015
		US 2015290396 A1	15-10-2015
		WO 2014064691 A2	01-05-2014
US 2015251839 A1	10-09-2015	AU 2013355386 A1	09-07-2015
		AU 2013355389 A1	09-07-2015
		AU 2015264706 A1	01-12-2016
		AU 2018200224 A1	01-02-2018
		BR 112015012903 A2	11-07-2017
		BR 112015012905 A2	11-07-2017
		CA 2893413 A1	12-06-2014
		CA 2893420 A1	12-06-2014
		CA 2949067 A1	26-11-2015
		CN 104955435 A	30-09-2015
		CN 104956416 A	30-09-2015
		CN 106796744 A	31-05-2017
		EP 2925272 A1	07-10-2015
		EP 2926328 A1	07-10-2015
		EP 3146515 A1	29-03-2017
		HK 1215666 A1	09-09-2016
		HK 1215749 A1	09-09-2016
		JP 6430537 B2	28-11-2018
		JP 2017518808 A	13-07-2017
		NZ 726143 A	27-04-2018
		US 2014155827 A1	05-06-2014
		US 2014252927 A1	11-09-2014
		US 2015078536 A1	19-03-2015
		US 2015250956 A1	10-09-2015
		US 2015251839 A1	10-09-2015
		US 2017079734 A1	23-03-2017
		US 2017296285 A1	19-10-2017
		WO 2014089083 A1	12-06-2014
		WO 2014089086 A1	12-06-2014
		WO 2015178961 A1	26-11-2015
		WO 2015179015 A1	26-11-2015

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2018/058200

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2016033507 A2	03-03-2016	AU 2015308670 A1	09-03-2017
		BR 112017002848 A2	30-01-2018
		CA 2959162 A1	03-03-2016
		CN 107073216 A	18-08-2017
		EP 3185933 A2	05-07-2017
		JP 2017531459 A	26-10-2017
		US 2018236181 A1	23-08-2018
		WO 2016033507 A2	03-03-2016
EP 3381493 A1	03-10-2018	NONE	
US 2004051368 A1	18-03-2004	NONE	