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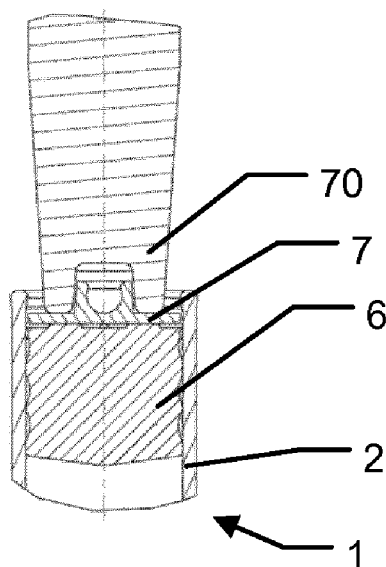


Fig. 6

(57) Abstract: A method of forming a medicament cartridge (1) for a medical injection device, comprises the steps of: a) providing a cartridge barrel (2), b) providing a piston (6) being at least partly made of an elastomeric material, the piston (6) comprising a distal end configured for fluid contact with medicament in the cartridge (1) and a proximal end having a proximal contact surface, c) positioning the piston (6) in the cartridge barrel (2), d) providing a piston bearing (7), wherein the piston bearing comprises a distal contact surface for engaging the piston (6) and a proximal surface (7c) configured for attachment to a piston rod (8), e) applying a surface heat treatment of the proximal contact surface of the piston (6) and/or the distal contact surface of the piston bearing (7) causing a melting a surface area of at least one of said contact surfaces for softening material disposed at the surface treated area, and f) positioning the distal surface of the piston bearing (7) in abutting contact with the proximal surface of the piston (6) to cause a bond to be established between the piston bearing (7) and the piston (6).

## **METHOD OF FORMING A MEDICAMENT CARTRIDGE, AND MEDICAMENT CARTRIDGE FORMED BY THE METHOD**

The present invention relates to an assembly of components for a drug delivery device that allows a user to select a single or multiple doses of an injectable liquid drug and to dispense the selected dose of the product and to apply said product to a patient, preferably by injection. In particular, the present invention relates to a method of forming a piston assembly for use in such drug delivery devices.

### **10 BACKGROUND**

In the disclosure of the present invention reference is mostly made to drug delivery devices used e.g. in the treatment of diabetes by delivery of insulin, however, this is only an exemplary use of the present invention.

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Drug delivery devices allowing for multiple dosing of a required dosage of a liquid medicinal product, such as liquid drugs, and further providing administration of the liquid to a patient, are as such well-known in the art. Generally, such devices have substantially the same purpose as that of an ordinary syringe.

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Drug delivery devices of this kind have to meet a number of user specific requirements. For instance in case of those with diabetes, many users will be physically infirm and may also have impaired vision. Therefore, these devices need to be robust in construction, yet easy to use, both in terms of the manipulation of the parts and understanding by a user of its operation. Further, the dose setting must be easy and unambiguous and where the device is to be disposable rather than reusable, the device should be inexpensive to manufacture and easy to dispose. In order to meet these requirements, the number of parts and steps required to assemble the device and an overall number of material types the device is made from have to be kept to a minimum.

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Typically, the liquid drug to be administered is provided in a medicament cartridge that has a moveable piston or bung mechanically interacting with a piston rod driven by an expelling mechanism of the drug delivery device. By applying thrust to the piston in distal direction, a predefined amount of the liquid drug is expelled from an outlet of the cartridge. To distribute forces evenly on the piston surface a piston bearing is typically located between the piston rod and the piston.

Typically, prior to a primary use of the device, an end-user has to conduct a so-called priming of the expelling mechanism in order to ensure that already with an initial dose setting and a first subsequent dose dispensing step, an accurate amount of the liquid drug is dispensed in a predefined way. An initial dose setting and expelling of a minor dose may in certain situations also be required for removing any air present in the medicament cartridge and/or a connected needle and for performing a flow check.

Some end-users prefer to keep an already mounted needle attached to the device between dose administrations. WO 2014/060369 A1 refers to the particular problem of uncontrolled movement of the piston of a held cartridge between dose administrations and proposes to establish a connection between a piston rod foot and the piston of a held cartridge for example by use of a spike that inserts into the piston or by using glue. This is to mitigate the potential issue of an air gap being formed between a piston rod and a piston of a held cartridge which may be caused by accidental dislodgment between the piston and the piston rod.

Document WO 98/11927 A1 specifically deals with infusion apparatuses and syringe ampoules therefor wherein an expulsion member is attached to a stopper of a syringe ampoule in order to prevent free flow when a catheter is attached to the ampoule. The stopper has no orifice for coupling to a drawing rod but a connection between the end of the expulsion member and the stopper may be provided by means of a spike, an adhesive, a magnet, a suction cup, etc.

Although different attachment methods for attaching a piston bearing with a piston have been suggested in the art, alternative methods for solving this problem in a simple yet effective way is still required.

## SUMMARY

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It is an object of the present invention to provide, for an injection device, a medicament cartridge comprising a piston and piston bearing assembly having improved but simple attachment between a piston of a held medicament cartridge and a piston bearing of the injection device. It is a further object of the invention to provide a simplified and robust method of attaching a piston bearing relative to a piston of a medicament cartridge.

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In the disclosure of the present invention, embodiments and aspects will be described which will address one or more of the above objects or which will address objects apparent from the below disclosure as well as from the description of exemplary embodiments.

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In a first aspect, the present invention relates to a method of forming a piston assembly for a medicament cartridge for cooperation with a medical injection device wherein the medicament cartridge comprises a tubular cartridge barrel extending along an axis, the piston assembly configured for being received in the tubular barrel of the medicament cartridge and for being slideably displaceable towards a distal end thereof to expel medicament through an outlet. The method comprises the steps of:

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a) providing a piston at least partly made of an elastomeric material, the piston comprising a distal end configured for fluid contact with medicament in the cartridge, a proximal end having a proximal contact surface, and a sealing periphery disposed between the distal and proximal end,

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b) providing a piston bearing, wherein the piston bearing defines a distal contact surface for engaging the piston and a proximal surface configured for attachment to a piston rod,

c) applying a surface treatment of the proximal contact surface of the piston and/or the distal contact surface of the piston bearing causing a melting of a surface area of at least one of said contact surfaces for softening material disposed at the surface treated area, and

5 d) positioning the distal surface of the piston bearing in abutting contact with the proximal surface of the piston to cause a bond to be established between the piston bearing and the piston.

10 In some embodiments, in method step c) of applying a surface treatment, heat is applied to melt said surface area.

In a second aspect, the present invention relates to a method of forming a medicament cartridge for a medical injection device wherein the medicament cartridge comprises a tubular cartridge barrel extending along an axis and a piston assembly at least partly received in the cartridge barrel, the piston assembly being slideably displaceable towards a distal end of the cartridge barrel to expel medicament through an outlet. The method comprising the steps of:

a) providing the cartridge barrel,

20 b) providing a piston at least partly made of an elastomeric material, the piston comprising a distal end configured for fluid contact with medicament in the cartridge, a proximal end having a proximal contact surface, and a sealing periphery disposed between the distal and proximal end,

c) positioning the piston in the cartridge barrel,

25 d) providing a piston bearing, wherein the piston bearing defines a distal contact surface for engaging the piston and a proximal surface configured for attachment to a piston rod,

30 e) applying a surface heat treatment of the proximal contact surface of the piston and/or the distal contact surface of the piston bearing causing a melting of a surface area of at least one of said contact surfaces for softening material disposed at the surface treated area, and

f) positioning the distal surface of the piston bearing in abutting contact with the proximal surface of the piston to cause a bond to be established between the piston bearing and the piston.

5 In accordance with the second aspect of the invention, the step e) of applying a surface heat treatment of the proximal contact surface of the piston is performed subsequent to step c) of positioning the piston in the cartridge barrel, whereby full flexibility of the manufacturing process is enabled. Large-scale manufacturing may involve manufacturing of a standardized cartridge to be used in many  
10 different types of applications, e.g. wherein the same type of cartridge may be used both in configurations wherein the piston bearing is bonded to the piston of the cartridge as well as in configurations wherein a piston bearing is not bonded to the piston. Hence, a cost effective manufacturing of medicament cartridges may be obtained.

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In certain embodiments, the medicament cartridge forms a pre-filled cartridge accommodating a medicament. In certain embodiments, the step of filling the medicament cartridge is performed prior to the step of applying a surface heat treatment.

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By positioning the distal surface of the piston bearing in abutting contact with the proximal surface of the piston, the softened material will create a bond between the distal surface of the piston and the distal surface of the piston bearing when allowed to harden.

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A portion of the piston forming the proximal end of the piston, or alternatively the entire piston, may in some embodiments be made from an elastomeric composition such as bromobutyl or chlorobutyl rubber. Suitable materials for the piston bearing may include thermoplastic polymers such as polypropylene.

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In certain embodiments, the proximal contact surface of the piston may define a substantially planar surface. Also the distal contact surface of the piston bearing may form a substantially planar surface.

In certain embodiments, in step e) of applying a surface heat treatment, said surface heat treatment is performed exclusively on the piston causing a melting of a surface area of the proximal contact surface of the piston.

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In accordance with the different aspects of the invention, the piston has been subjected to a vulcanization process prior to the step of applying a surface heat treatment of the proximal contact surface of the piston.

10 The proximal surface of the piston bearing is configured for attachment to a piston rod so that when the piston bearing is attached to the piston rod, the piston bearing is prevented from moving in the distal direction relative to the piston rod. Said attachment may further be formed so that the piston bearing is prevented from moving in the proximal direction relative to the piston rod.

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In some embodiments, the proximal surface of the piston bearing is formed so as to cooperate and attach relative to the piston rod so that the piston rod and the piston bearing are axially fixed relative to each other while allowing the piston rod to rotate freely relative to the piston bearing.

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In some embodiments, the piston bearing is an integral part of a piston rod of an injection device, such as forming part of a unitary piston rod.

The proximal end of the piston may define a rim portion engaging or adapted to  
25 engage the tubular barrel of the medicament cartridge. In method step e), said surface heat treatment may involve melting a surface area of the proximal surface of the piston at locations radially spaced apart from said rim portion, such as 1-2 mm from the outermost portions of the piston.

30 In some embodiments, prior to step e), the piston is arranged fully inside the tubular barrel of the medicament cartridge, and in step e) the surface heat treatment is performed while the piston is disposed inside the tubular cartridge barrel. This enables the attachment process to be performed on a prefilled

medicament cartridge during assembly operations of an injection device introducing flexibility in the production process.

5 In some embodiments the method comprises a step, prior to step e), of arranging the piston in an axial position inside the tubular barrel where the proximal contact surface of the piston is located distally to a proximal end face of the tubular barrel, such as wherein the proximal contact surface of the piston is located more than 2 mm from the proximal face of the tubular cartridge barrel.

10 In other embodiments, the attachment between the piston and the piston bearing is carried out before the piston is introduced into the tubular barrel of the medicament cartridge.

15 In method step e) of applying a surface heat treatment, heat may be applied by local energy deposition to melt said surface area. In some embodiments, heat is applied by non-contact energy deposition. In other embodiments heat is applied by establishing surface contact between a heated heating member and said surface area.

20 Energy deposition may be performed by radiating said surface area or illuminating said surface area by means of an illumination source, such as by a laser. In other embodiments heat is applied by depositing ultrasonic energy at said surface area.

25 In some embodiments of methods of forming the medicament cartridge, step f) may be performed prior to step e) of applying a surface heat treatment. The step of depositing ultrasonic energy by generating ultrasonic energy at said surface area may involve coupling an ultrasonic emitter to a proximal surface portion of the piston bearing.

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In further embodiments at least one of the piston and the piston bearing comprises a material or compound that is inductively heatable and wherein heat is applied by inductively heating said surface area. Such method may involve

performing step f) prior to step e). In other embodiments step e) is performed prior to step f).

5 In further embodiments, in step f) axial pressure is applied between the piston and the piston bearing. Said axial pressure may be applied while the deposited energy dissipates ensuring an effective bond between the piston and the piston bearing. In certain embodiments, axial pressure is maintained for a pre-defined period subsequent to finalization of step e) of surface heat treatment, such pre-defined period being selected between 0.2 and 4 seconds, such as between 0.4  
10 and 1 second, such as between 0.5 and 2 seconds.

In a third aspect, the present invention relates to a piston assembly formed in by the method according to the first aspect described above.

15 In a fourth aspect, the present invention relates to a medicament cartridge comprising a piston assembly, where the medicament cartridge is formed in accordance with one of the methods according to the second aspect described above.

20 The medicament cartridge may comprise a tubular barrel made from glass. Said glass barrel may comprise siliconized wall areas at the inner surface of the cartridge barrel. The medicament cartridge may be prefilled with a medicament. A distal end of the tubular barrel connects to an outlet which may be provided with a seal in the form of a pierceable septum configured for being pierced and  
25 penetrated by an injection needle.

In a fifth aspect, the present invention relates to an injection device for receiving a medicament cartridge in accordance with the fourth aspect. The injection device may be configured for expelling a multitude of individual doses performed  
30 as separate dose administrations, wherein the individual doses may be provided by a fixed dose amount or a variable dose amount. In other forms the injection device may be configured for expelling only a single dose from a held medicament cartridge. The injection device may be configured for attachment to

an injection needle that couples to the medicament cartridge of the device. The injection device may be provided as a disposable device wherein a pre-filled medicament cartridge is irremovably received in the injection device, or alternatively, as a durable device intended for replacement of an empty  
5 medicament cartridge.

In some forms the injection device comprises an expelling mechanism that couples to a piston rod wherein the piston rod is adapted to rotate as it is forced distally during dose expelling. In some embodiments, the attachment between  
10 the piston bearing and the piston rod allows free rotation of the piston rod, as the piston rod rotates during dose expelling.

As used herein, the term "insulin" is meant to encompass any drug-containing flowable medicine capable of being passed through a delivery means such as a  
15 cannula or hollow needle in a controlled manner, such as a liquid, solution, gel or fine suspension, and which has a blood glucose controlling effect, e.g. human insulin and analogues thereof as well as non-insulins such as GLP-1 and analogues thereof. In the description of exemplary embodiments reference will be made to the use of insulin.

## 20 **BRIEF DESCRIPTION OF DRAWINGS**

In the following the invention will be further described with reference to the drawings, wherein

fig. 1 is a schematic representation of a prior art pen device with a protective cap  
25 attached and with a needle attached to the cartridge,

fig. 2 shows a detailed view the piston drive components of a prior art pen device  
of fig. 1,

fig. 3 is a cross sectional view of a piston assembly according to the invention  
with a cartridge body and a piston rod,

30 fig. 4 schematically depicts a first embodiment of a heating process according to the invention wherein a laser source irradiates a proximal surface portion of the piston,

fig. 5 schematically depicts a second embodiment of a heating process according to the invention wherein a hot rod applies heat to a proximal surface portion of the piston, and

5 fig. 6 schematically depicts a third embodiment of a heating process according to the invention wherein an ultrasonic horn deposits heat between a piston and a piston bearing.

In the figures corresponding structures are mainly identified by corresponding reference numerals, i.e. whereby parts carrying reference no. "106" in fig. 1  
10 corresponds to reference "6" in figs. 3 through 6, etc.

## DESCRIPTION

When in the following terms such as "upper" and "lower", "right" and "left",  
15 "horizontal" and "vertical" or similar relative expressions are used, these only refer to the appended figures and not necessarily to an actual situation of use. The shown figures are schematic representations for which reason the configuration of the different structures as well as their relative dimensions are intended to serve illustrative purposes only. When the term member or element  
20 is used for a given component it generally indicates that in the described embodiment the component is a unitary component, however, the same member or element may alternatively comprise a number of sub-components just as two or more of the described components could be provided as unitary components, e.g. manufactured as a single injection moulded part. The term "assembly" does  
25 not imply that the described components necessarily can be assembled to provide a unitary or functional assembly during a given assembly procedure but is merely used to describe components grouped together as being functionally more closely related.

30 Fig. 1 is a schematical representation of a prior art drug delivery device in the form of a pen-formed injection device 100, i.e. a so-called "injection pen". The injection pen 100 includes a dose setting and expelling mechanism for repetitively performing individual dosage administrations, such as expelling

apportioned dosages of insulin. Injection pen 100 comprises a medicament filled cartridge 101 which is accommodated in a distal part of the injection pen. The injection pen 100 includes a housing that defines a central longitudinal axis. The proximal part 104 of the device holds a mechanism 110 for setting and injecting  
5 specific doses of a medicament from the cartridge 101. The mechanism includes an elongated piston rod 108 extending along the central longitudinal axis. The cartridge 101 comprises a passage in a distal neck part forming an outlet which is sealed by a septum, i.e. a pierceable sealing member 105. Cartridge 101 further comprises an axially slideably mounted piston 106 which is adapted to  
10 slide towards the distal part of the container 101 when a distally directed force is exerted on the piston 106. Typically, medication is delivered through an injection needle 103 which may be releasably secured to the distal part of the injection pen. The injection pen further comprises a dose dial 111 which may be manipulated by the hand of a user for selecting a dosage, the size of the selected  
15 dosage being visible in window 113. The injection pen 100 further comprises an injection button 112 for injecting a selected dosage. In the depicted form, a distally directed force on the button 112, exerted by the hand of the user, activates the mechanism 110 of the pen for causing a dosing movement of the piston rod 108 and with it the piston 106 of cartridge 101. Fig. 1 further shows a  
20 cap 115 which is adapted to be removably attached to the distal part of the injection pen. In the storage state, when the cap 115 is attached to the injection pen 100, the cap protects the cartridge 101 and the needle 103.

Fig. 2 further shows a detailed view of typical piston drive parts of an injection  
25 pen. As shown the piston rod 108 of the device transfers a drive force of the piston rod to the piston 106 by means of a piston bearing 107 hence distributing the driving load onto the proximal surface of the piston 106. The injection pens shown in figs. 1 and 2 serve as example injection devices which may be utilized in connection with the different aspects of the present invention.

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In some prior art injection pens, the piston bearing 107 is axially attached to the distal portion of the piston rod 108 whereas in other injection pens the piston bearing is loosely withheld or sandwiched between the distal portion of the piston

rod and the piston. Some prior art pens utilize a piston rod that rotates as it moved distally for expelling a dose. In such pens engagement surfaces between the piston rod and the piston bearing are typically formed to include a bearing surface allowing free rotation of the piston rod relative to the piston bearing. In other pens the piston rod does not rotate as it moves distally during expelling of a dose. In such pens, the piston bearing need not rotate relative to the piston rod.

In accordance with the invention a piston assembly according to a first embodiment is shown in fig. 3. The piston assembly includes a piston 6 of a cartridge 1 and a piston bearing 7 where the piston 6 and the piston bearing 7 are attached to each other preventing the piston 6 from moving axially in the distal direction relative to the piston bearing 7. In accordance with one aspect of the invention, by such attachment it is ensured that the piston bearing 7 will not tend to tilt should the piston 6 be arranged with a distance relative to the piston rod of an injection device or become dislodged relative to the piston rod.

The piston 6 is formed as a generally cylindrical member made from an elastomeric rubber composition such as bromobutyl or chlorobutyl rubbers. In the shown embodiment the piston 6 is formed as a unitary molded component exhibiting a substantially flat proximal surface wherein only slight protrusions are formed. These protrusions are typically formed to prevent adherence between pistons when a multitude of pistons during manufacture are handled in bulk. The piston 6 includes a distal face adapted to be in fluid contact with medicament of the cartridge 1. Between the distal face and the proximal surface of the piston 6 a number of sealing lips protrude from a radially outwards facing surface of the piston.

In the fig. 3 embodiment the piston bearing 7 is formed as a thin circular disc made from a thermoplastic polymer such as polypropylene. The piston bearing 7 exhibits a near planar surface at the distal end and includes an attachment geometry 7c at the proximal end for attaching the piston bearing 7 to a corresponding attachment geometry 8c of piston rod 8. In the shown

embodiment, the attachment geometry 7c forms a spherical socket which is configured to receive a complementary ball formed member of the piston rod 8. By such engagement the piston rod 8 and the piston bearing 7 is axially attached relative to each other while allowing the piston rod to rotate freely relative to the piston bearing. In accordance with a further aspect of the invention, the engagement prevents the piston bearing 7 from accidentally disengaging the piston rod 8 and is sufficient to withstand forces tending to move the piston 6 relative to the piston rod 8. In the shown embodiment, the connection 7c/8c forms an axial snap connection. However, in other embodiments, other attachment geometries 7c and 8c forming the same function of preventing distal movement of the piston bearing relative to the piston rod may be used instead. Non-limiting examples may for be provided as an axial ratchet connection or a connection using magnets.

In fig. 3 the piston 6 has been attached to the piston bearing 7 by a process using a surface heat treatment of the proximal surface of the piston 6 so as to melt an area of the piston which is later to become mated with the distal surface of the piston bearing 7. Subsequent to melting, when the material is soft and sticky, the piston bearing 7 is moved into abutting contact with the piston and pressure is exerted while the softened part of the piston becomes hardened. The result is a strong bond between the piston 6 and the piston bearing 7.

Fig. 4 schematically shows a first embodiment process for melting an area of the piston 6. In fig. 4, a light source 50 emits a radiation beam 51 which impinges a portion of the proximal surface of the piston 6. Light energy is chosen having a wavelength that is absorbed by the surface of interest. Focused visible or invisible light or a laser beam is pointed towards the proximal surface of the piston 6 so that the surface is quickly elevated to above its transformation temperature whereby it becomes sticky. Exemplary radiation times with a 30w laser may be provided in the order of 0.5 to 2 seconds to ensure sufficient melting of the surface of the piston while avoiding excessive heating of deeper located regions of the piston which could otherwise influence the sealing properties of the piston. By only providing excessive heating at a shallow depth it

is ensured that the temperature at deeper regions of the piston and at the medicament portion will only increase by a non-substantive degree. Typically, radiation is not directed towards areas along the proximal rim section of the piston to avoid stickiness of the piston at locations in sliding contact with the tubular barrel 2 of the cartridge 1.

Fig. 5 schematically shows a second embodiment process for heating and melting an area of the proximal surface of the piston 6. A heated mandrel 60 in the form of a rod is brought into contact with the proximal surface of the piston 6 to elevate the temperature and thus melt shallow regions of the piston. The heated mandrel may be heated to an elevated temperature, preferably 300-400 Degrees Celsius, and maintained in contact with the piston for a short duration, e.g. in the order of 0.5 to 1 second. Elevated temperatures may offer reductions in process time but may result in increased generation of fumes. Instead of a heated rod, heating may be performed by energy deposition using an ultrasonic horn which is applied at the proximal surface of the piston 6. Subsequent to heating, the piston bearing is brought into contact with the piston and a bond is made between the two components when the melted area has been allowed to cool down.

Fig. 6 schematically shows a third embodiment process for heating and melting a surface area between the piston 6 and the piston bearing 7. In this embodiment the distal surface of the piston bearing 7 is initially brought into abutting contact with the proximal surface of the piston 6. An ultrasonic horn 70 is applied to the proximal surface of the piston bearing 7 and energy is deposited and absorbed at the interface between the components in a manner contemplating a conventional ultrasonic welding process. The resulting rise in temperature makes one or both material portions of the piston 6 and the piston washer 7 sticky and a bond is made between the two components.

In further embodiments alternative means for applying heat causing a local melting of the piston and/or the piston bearing may include a hot air stream, a flame or a plasma beam which is pointed towards the surface area of interest until it gets sticky.

In still further embodiments at least one of the piston and the piston bearing of the piston assembly may include a material or compound that is inductively heatable and wherein heat is applied by inductively heating the surface area intended to provide a bond between the piston and the piston bearing. Regions of the thermoplastic polymer elements or the elastomeric rubber of the piston adjoining the inductive heatable material or compound are thus caused to heat up resulting in a localized melting of the thermoplastic polymer or rubber material making it sticky and in turn causing a bond between the piston and the piston bearing to be established. In some embodiments the piston and/or the piston bearing includes a metallic part or distributed metal particles that becomes inductively heated when an inductive field is applied to the part in question.

Still further alternatives may involve chemically melting of the surface area of interest for making the piston and the piston bearing adhere to each other for creating a bond between these components. Chemical treatment may be provided by using chlorinated aromatic carbohydrates like TCB (1,2,4-Trichlorobenzene) or ODCB (1,2-Dichlorobenzene (= Ortho Dichlorobenzene)) which can dissolve the surface layer to make it sticky. Other chemicals like Toluene (Methylbenzene), Methyl Ethyl Ketone (Butan-2-one), Acetone (2-propanone), Hexane, Winter green oil (Methyl 2-hydroxybenzoate) and Methyl isobutyl Ketone (4-Methyl-2-pentanone) are also candidates for the same purpose.

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#### Example

Measurements of different sample cartridges have been made for investigating the long-term attachment effect between the piston and the piston bearing. A series of five Penfill® 3 mL cartridges carrying a test medium and with a rubber piston made from medical use bromobutyl rubber were subjected to laser radiation at the proximal surface of the piston. A laser of type VersaLASER VLS 2.30 from Universal Laser Systems Inc., equipped with a 30W carbon dioxide (CO<sub>2</sub>) laser where used to emit laser radiation at a wavelength 10.6 microns for

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a duration of 1.0 second. Immediately thereafter, for each cartridge, a piston bearing was forced into engagement with the softened proximal surface of the piston. After being allowed to cool off for hardening, the cartridges were suspended with the piston pointing downwards and each piston was exerted to a static gravity pull of magnitude 0.4N for a period of 90 days. After the 90-day stability test, none of the test cartridges exhibited signs of separation between the piston and piston bearing. Tests with a dynamometer showed dynamic resistance up to 5N before disconnecting (end of example).

10 By using the herein described design and the assembly methods, the adherence between the piston of a held cartridge and a piston bearing can be effectively ensured enabling establishment of a connection between the piston rod of an injection device and the piston of the cartridge for preventing the piston from moving distally relative to the piston bearing and thus prevented from moving  
15 distally relative to the piston rod of a device.

The injection device shown in fig. 1 provides a non-limiting example of a pen injector which may incorporate the piston assembly and the medicament cartridge as described herein and in accordance with the assembly methods  
20 described herein. Other types of injection devices may equally well use a piston assembly in accordance with the invention, such devices including devices wherein a piston rod does not rotate as it moves distally during dose expelling, and devices wherein a bearing forms an integral part of the piston rod. While certain features of the invention have been illustrated and described herein,  
25 many modifications, substitutions, changes, and equivalents will now occur to those of ordinary skill in the art. It is, therefore, to be understood that the appended claims are intended to cover all such modifications and changes.

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**CLAIMS**

Claim 1. A method of forming a medicament cartridge (1) for a medical injection device, wherein the medicament cartridge (1) comprises a tubular cartridge barrel (2) extending along an axis and a piston assembly (6,7) being at least partly received in the tubular cartridge barrel (2), the piston assembly (6,7) being slideably displaceable towards a distal end of the cartridge barrel (2) to expel medicament through an outlet, the method comprising the steps of:

a) providing the cartridge barrel (2),

b) providing the piston (6) at least partly made of an elastomeric material, the piston (6) comprising a distal end configured for fluid contact with medicament in the medicament cartridge (1), a proximal end having a proximal contact surface, and a sealing periphery disposed between the distal and proximal end,

c) positioning the piston (6) in the cartridge barrel (2),

d) providing the piston bearing (7), wherein the piston bearing defines a distal contact surface for engaging the piston (6) and a proximal surface configured for attachment to a piston rod,

e) applying a surface heat treatment of the proximal contact surface of the piston (6) and/or the distal contact surface of the piston bearing (7) causing a melting of a surface area of at least one of said contact surfaces for softening material disposed at the surface treated area, and

f) positioning the distal surface of the piston bearing (7) in abutting contact with the proximal surface of the piston (6) to cause a bond to be established between the piston bearing (7) and the piston (6).

Claim 2. A method of forming a medicament cartridge (1) as defined in claim 1, wherein in step b), the proximal contact surface of the piston (6) is provided as a substantially planar surface.

Claim 3. A method of forming a medicament cartridge (1) as defined in any of the claims 1-2, wherein in step d) the distal contact surface of the piston bearing (7) is provided as a substantially planar surface.

Claim 4. A method of forming a medicament cartridge (1) as defined in any of the claims 1-3, wherein the proximal end of the piston (6) defines a rim portion to engaging the tubular barrel (2) of the medicament cartridge (1), wherein in step e), said surface heat treatment involves exclusively melting a surface area of the proximal surface of the piston (6) at locations radially spaced apart from said rim portion.

Claim 5. A method of forming a medicament cartridge (1) as defined in any of the claims 1-4, wherein prior to step e), the piston (6) is arranged fully inside the cartridge barrel (2) of the medicament cartridge (1), and wherein in step e) the surface hat treatment is performed while the piston (6) is disposed inside the cartridge barrel (2).

Claim 6. A method of forming a medicament cartridge (1) as defined in any of the claims 1-5, wherein in step e) of applying a surface heat treatment, said surface heat treatment is performed exclusively on the piston (6) causing a melting of a surface area of the proximal contact surface of the piston.

Claim 7. A method of forming a medicament cartridge (1) as defined in any of the claims 1-5, wherein in method step e) of applying a surface heat treatment, heat is applied by energy deposition to melt said surface area.

Claim 8. A method of forming a medicament cartridge (1) as defined in claim 7, wherein energy deposition is performed by illuminating said surface area by means of an illumination source, such as by a laser.

Claim 9. A method of forming a medicament cartridge (1) as defined in any of the claims 1-10, wherein at least one of the piston (6) and the piston bearing (7) comprises a material or compound that is inductively heatable and wherein heat is applied by inductively heating said surface area.

Claim 10. A method of forming a medicament cartridge (1) as defined in claim 7, wherein heat is applied by depositing ultrasonic energy at said surface area.

5 Claim 11. A method of forming a medicament cartridge (1) as defined in claim 10, wherein step f) is performed prior to step e), and wherein the step of generating ultrasonic energy at said surface area involves coupling an ultrasonic emitter to a proximal surface portion of the piston bearing (7).

10 Claim 12. A method of forming a medicament cartridge (1) as defined in any of the claims 1-10, wherein step e) of applying surface heat treatment is finalized prior to performing step f) of positioning the distal surface of the piston bearing (7) in abutting contact with the proximal surface of the piston (6).

15 Claim 13. A medicament cartridge (1) formed in accordance with the method as defined in any of the claims 1-12.

Claim 14. A medicament cartridge as defined in claim 13, wherein the medicament cartridge (1) comprises a tubular cartridge barrel (2) made from glass.

20 Claim 15. A medicament cartridge as defined in claim 14, wherein the medicament cartridge (1) is prefilled with a medicament and wherein a distal end of the cartridge barrel (2) connects to an outlet being sealed by a pierceable septum.

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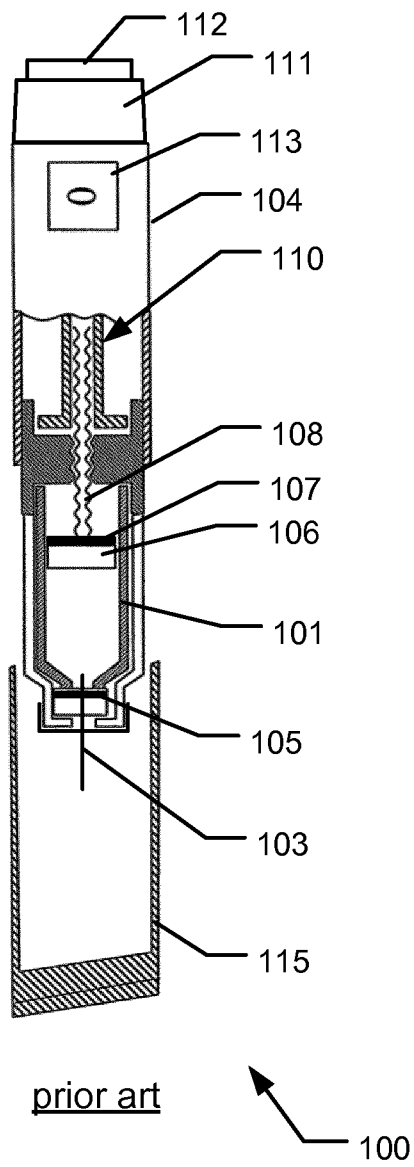


Fig. 1

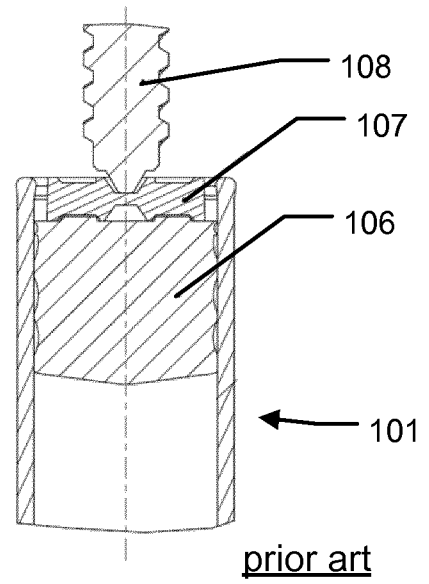


Fig. 2

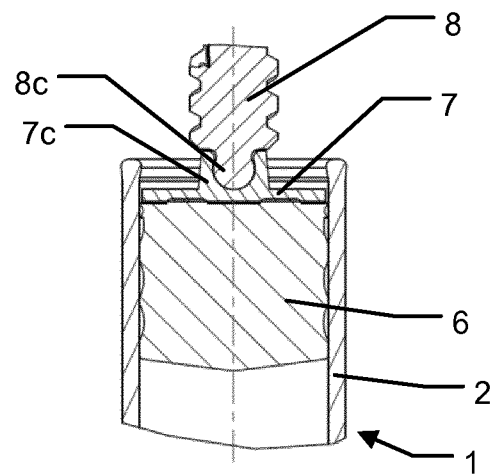


Fig. 3

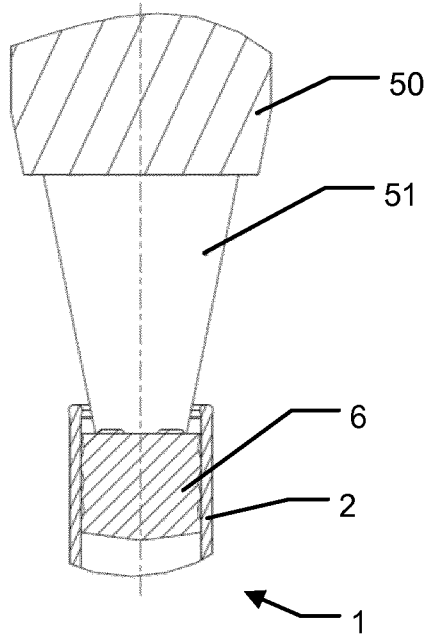


Fig. 4

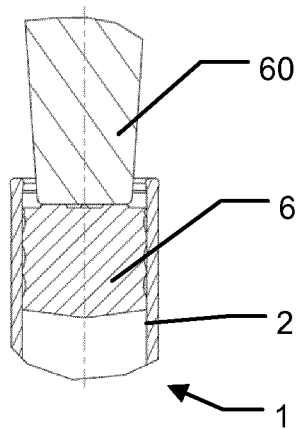


Fig. 5

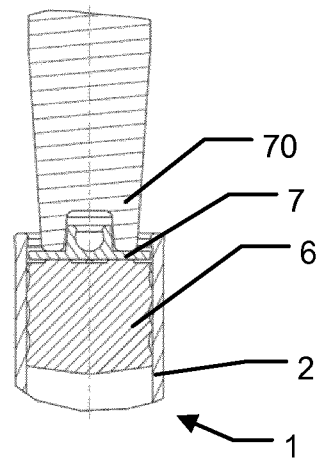


Fig. 6

INTERNATIONAL SEARCH REPORT

International application No  
PCT/EP2017/052218

A. CLASSIFICATION OF SUBJECT MATTER  
INV. A61M5/315  
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

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Further documents are listed in the continuation of Box C.

See patent family annex.

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Date of the actual completion of the international search  27 March 2017	Date of mailing of the international search report  04/04/2017
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer  Krassow, Heiko

## INTERNATIONAL SEARCH REPORT

International application No  
PCT/EP2017/052218

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International application No

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