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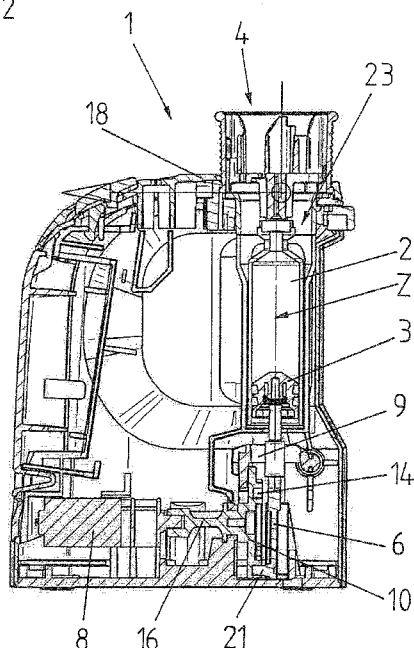
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(54) Title: DEVICE FOR MOVING A PISTON INSIDE A CARTRIDGE

Fig.2



(57) Abstract: An advantageous device (1) for moving the piston inside a cartridge has a cartridge body (2) and a piston (3) arranged therein displaceable along a longitudinal axis (Z) of the cartridge body (2), and comprises: a first portion (4) having first coupling means (5) for releasably coupling the cartridge body (2) of the cartridge to the first portion (4) in such a manner that in both directions of said longitudinal axis (Z) of the cartridge body (2) there exists a positive connection and/or a frictional connection between the cartridge body (2) and the first portion (4); and a second portion (6) having second coupling means (7, 11a, 11b, 12; 7, 12, 17a, 17b) for releasably coupling the piston (3) of the cartridge to the second portion (6) in such a manner that in both directions of said longitudinal axis (Z) of the cartridge body (2) there exists a positive connection and/or a frictional connection between the piston (3) and the second portion (6). Said first (4) and second portions (6) are moveable relative to each other in order to effect, in the intended use of the device (1), at least a forward displacement of the piston (3) coupled to the second portion (6) inside the cartridge body (2) coupled to the first portion (4) along said longitudinal axis (Z) of the cartridge body (2). The second coupling means (7, 11 a, 11 b, 12; 7, 12, 17a, 17b) are designed in such a manner that for establishing and releasing the positive connection and/or frictional connection with the piston (3), their shape can reversibly be changed.



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DEVICE FOR MOVING A PISTON INSIDE A CARTRIDGE

Field of technology

The present invention relates to a device for moving the piston inside a cartridge, to a system comprising the device as well as to a method using the device according to the preambles of
5 the independent claims.

Background

A typical problem when dispensing or dosing a liquid from a cartridge, e.g. when dosing insulin from an insulin cartridge with an automated insulin pump, is not only to make sure that, for dispensing the liquid, the piston can be pushed forward inside the cartridge body in a
10 controlled manner, but also that the piston cannot be sucked into the cartridge body by a pressure differential between the front and back side of the piston.

Furthermore, when filling the cartridge with a liquid from a liquid reservoir by retracting the piston inside the cartridge body, a further problem is to make sure that, even though a maximum stroke of the piston can be utilized, there is no risk that the piston is drawn out of
15 the cylinder body.

From the prior art, different approaches to solve these problems are known:

For dispensing or dosing liquid from a cartridge or for filling a cartridge with a liquid by means of an automated device it is known to fix the cartridge body inside the device and to connect the piston with a threaded connection to a piston rod of the device by which it can be pushed
20 forward and/or be retracted in a controlled manner inside the cartridge body within the limits of its design stroke.

For manually filling cartridges or syringe assemblies it is furthermore known from the prior art to provide a physical stop for the piston at the end of the cartridge body or of the cylinder of the syringe assembly which prevents the piston from being drawn out of the cartridge body or
25 syringe cylinder.

Furthermore, cartridges or syringe assemblies are known having a piston which provides, at its backside, moveable coupling means which, in a positive manner, engage an especially adapted piston rod once this piston rod is pushed towards the backside of the piston and,

once coupled to the piston rod, release the piston rod only in case they are retracted by the piston rod past a defined position within the cartridge body or syringe cylinder.

Furthermore, from EP 0337252 A1, a cartridge is known having a piston which provides, at its backside, a threaded pin for coupling it to a piston rod, wherein this threaded pin is formed by an element which is disconnected from the piston once the piston is retracted into a defined position within the cartridge body by a piston rod threaded onto the threaded pin.

However, the known solutions using a threaded connection for coupling the piston to a piston rod suffer from the disadvantage that they require a complex relative motion between the piston and the piston rod for establishing and releasing the connection, which is undesirable since it requires certain skills of the user or, in case of an automated device, a complex mechanical arrangement for controlling the motion of the piston rod. Also, there is the disadvantage that the quality of the connection to be established and the possibility to release it later on is influenced by the friction between the piston and the cartridge body or the syringe cylinder, since this friction defines the torque which can be applied to the threaded connection.

The solutions providing a physical stop for the piston at the end of the cartridge body or of the cylinder of the syringe assembly have the disadvantage that in the manufacturing of the cartridge or syringe assembly, additional operating steps are required, which increases the manufacturing costs.

The solutions providing moveable coupling means at the backside of the piston which release the piston rod once the piston is retracted into a defined position or providing an element for connection with the piston rod which element is disconnected from the piston once the piston is retracted into a defined position have the disadvantage that the piston is of complex design and as a result is difficult to manufacture and expensive.

All of the known solutions suffer from the disadvantage, that they require relatively expensive cartridge or syringe assembly designs that reduce the attractiveness to use them in fields where the cartridge or syringe assembly should be an inexpensive single use article, like e.g. a self filled insulin cartridge for the therapy of diabetes.

Therefore there is a general need for improvements in this area.

Summary of the Invention

It is an object of the disclosure to provide technical solutions which at least partially avoid the disadvantages of the prior art.

These and other objects are substantially achieved by a device for moving a piston inside a cartridge, by a system, and by a method according to the independent claims. Further advantageous embodiments follow from the dependent claims and the description.

A first aspect of the disclosure concerns a device for moving the piston inside a cartridge having a cartridge body and a piston arranged therein that is displaceable along a longitudinal axis of the cartridge body. Such cartridges generally can be described as liquid tight containers comprising a container body with a cylindrical interior space defining a longitudinal axis and with a piston arranged in said interior space, which in a liquid tight manner abuts to the boundary walls of the interior space and is moveable within said interior space along said longitudinal axis in order to increase or reduce the volume of the fluid tight space defined by the boundary walls of the interior space and by the front face of the piston.

Such a device according to the first aspect of the disclosure for moving the piston inside a cartridge having a cartridge body and a piston arranged therein displaceable along a longitudinal axis of the cartridge body comprises a first portion having first coupling means for releasably coupling the cartridge body of the cartridge to the first portion in such a manner that in both directions of said longitudinal axis of the cartridge body there exists a positive connection and/or a frictional connection between the cartridge body and the first portion; and a second portion having second coupling means for releasably coupling the piston of the cartridge to the second portion in such a manner that in both directions of said longitudinal axis of the cartridge body there exists a positive connection and/or a frictional connection between the piston and the second portion. Said first and second portions are moveable relative to each other in order to effect, in the intended use of the device, at least a forward displacement of the piston coupled to the second portion inside the cartridge body coupled to the first portion along said longitudinal axis of the cartridge body. The second coupling means are designed in such a manner that for establishing and releasing the positive connection and/or frictional connection with the piston, their shape can reversibly be changed.

The connections which can be established with the first and second coupling means between the first portion and the cartridge body and between the piston and the second portion in each case have to be greater than the frictional forces between the piston and the boundary

walls of the cartridge body when moving the piston inside the cartridge, and additionally the forces generated in the filling and/or dispensing operation of the cartridge by pressure differentials established between the front and back side of the piston. The first portion and the second portion are moveable relative to each other in such a manner that when, in the intended use of the device, e.g. filling of a cartridge with a liquid or dispensing liquid from a cartridge containing a liquid, the cartridge body of a cartridge is coupled via the first coupling means in the above described manner to the first portion and the piston of said cartridge is coupled via the second coupling means in the above described manner to the second portion, at least a forward displacement of the piston along said longitudinal axis of the cartridge body can be effected by their relative movement. The second coupling means are designed in such a manner that for establishing and releasing the positive connection and/or frictional connection with the piston, their shape can reversibly be changed.

By this design of the device it becomes possible to generate a system according to a second aspect of the disclosure comprising the device according to the first aspect of the disclosure and a cartridge especially adapted to be releasably coupled to the first and second coupling means of the device in the described manner, wherein the cartridge can be of a simple, inexpensive design, thus making the system attractive for use in fields where the cartridge should be an inexpensive single use article, like e.g. for use as a system for filling self filled insulin cartridges for the therapy of diabetes or as a system for dosing or dispensing, respectively, insulin from a single use cartridge.

In an advantageous embodiment of such a device according to the first aspect of the disclosure, being particularly suitable for use in filling the cartridge with a liquid, for example with a liquid drug such as insulin, the first and second portions of the device are moveable relative to each other in such a manner that, in the intended use of the device, e.g. for filling the cartridge with a liquid, they can effect a forward and a backward displacement of the piston coupled to the second portion along the longitudinal axis of the cartridge body inside the cartridge body coupled to the first portion.

Such an advantageous device comprises a first portion having first coupling means for releasably coupling the cartridge body of the cartridge to be filled to the first portion in such a manner that in both directions of said longitudinal axis of the cartridge body there exists a positive connection and/or a frictional connection between the cartridge body and the first portion; and a second portion having second coupling means for releasably coupling the piston of the cartridge to be filled to the second portion in such a manner that in both

directions of said longitudinal axis of the cartridge body there exists a positive connection and/or a frictional connection between the piston and the second portion. Said first and second portions are moveable relative to each other in order to effect, in the intended use of the device, a forward and backward displacement of the piston coupled to the second portion
5 inside the cartridge body coupled to the first portion along the longitudinal axis of the cartridge body. The second coupling are designed in such a manner that for establishing and releasing the positive connection and/or frictional connection with the piston, their shape can reversibly be changed.

Advantageously, the device has drive means for moving the first and second portions relative
10 to each other, like e.g. a battery powered electric motor with a dedicated gear and linkage. Such devices can be automated and thus allow convenient use without specialized skills.

In a further advantageous embodiment of the device the second coupling means are designed in such a manner that their change in shape can partially or solely be effected through a contact with the piston and/or with the cartridge body of the cartridge, e.g. through a contact
15 force which acts on a linkage mechanism of the second coupling means which, as a result, changes the shape of the second coupling means or e.g. through an electrical contact switch which initiates a change in shape of the second coupling means through an electrically driven mechanism. This coupling concept has the advantage, that the connection between the piston and the second coupling means is established when they are brought into a specific position
20 relative to each other and thus there is no need to separately identify the position of the piston and the second portion for establishing said connection.

In still a further advantageous embodiment of the device, the second coupling means are designed in such a manner that their change in shape can partially or solely be effected through control means of the device, like e.g. through an electrically driven linkage
25 mechanism which in dependency of the position of the second portion relative to the first portion changes the shape of the second coupling means. This concept has the advantage, that the connection between the piston and the second coupling means can be established independently of a prior contact between the piston or the cartridge body and the second coupling means and thus without loading the piston or the cartridge body with any forces
30 through the second coupling means before establishing the connection.

Advantageously, the device is designed in such a manner that the shape of the second coupling means can or can only be changed when the first and the second portions assume a

specific position relative to each other. This functionality makes sure that the connection between the second portion of the device and the piston of the cartridge can or can only be established and be released in specific relative positions of the first and second portions relative to each other, e.g. can or can only be established and released in relative positions which correspond to a fully retracted position of the piston of the cartridge received in the device for filling, which would be useful in devices which are intended for filling cartridges, or e.g. can or can only be established in a relative position which corresponds to a fully retracted position of the piston of the cartridge received in the device for dispensing liquid from it and can or can only be released in a relative position which corresponds to a fully forwards pushed position of the piston of said cartridge, which would be useful in devices for dispensing a liquid from a cartridge.

In another advantageous embodiment, the device is designed in such a manner that the shape of the second coupling means is automatically changed when the first and the second portions are moved into a specific position relative to each other and/or are moved out of a specific position relative to each other. This offers the advantage that the device has an uncomplicated control concept and is easy to understand and operate even for unskilled person.

In order to make sure that a release of the first coupling means and a subsequent removal of the cartridge body from the first portion cannot result in the piston being pulled out of the cartridge body, it is furthermore advantageous that the device is designed in such a manner that the shape of the second coupling means can or can only be changed into a coupled or engaging status when the cartridge body of a cartridge has been coupled to the first portion by means of the first coupling means and/or that the shape of the second coupling means is automatically changed into a released status when, after the cartridge body of a cartridge has been coupled to the first portion by means of the first coupling means, said first coupling means are released.

In still a further advantageous embodiment, the device is designed in such a manner that said second portion is moveable relative to the first portion forwards and backwards between a fully retracted position and a fully extended position along a longitudinal axis in order to effect, in the intended use of the device, a forward and backward displacement of the piston inside the cartridge body. In this embodiment, the shape of the second coupling means advantageously is automatically changed when the second portion is moved into the fully retracted position and/or is moved out of the fully retracted position.

For example, the device can be designed in such a manner that the shape of the second coupling means automatically changes from a releasing status into a coupling or engaging status when, starting from the fully retracted position, a forward movement of the second portion is initiated. More advantageously the shape of the second coupling means is also automatically changed back to the releasing status when the second portion, after the forward movement, again reaches the fully retracted position. Such devices are especially suitable as filling devices for self filled cartridges.

In still a further advantageous embodiment of the device, the second coupling means comprise a pincer mechanism having at least two pincer arms, the shape of which can be changed through a closing and opening movement of the pincer arms. The pincer arms comprise protrusions extending away from them for engagement into radial undercuts formed in a piston of a cartridge to be filled. By means of such a pincer mechanism, second coupling means that can change their shape in order to establish and release a connection with a piston of a cartridge can in a reliable and cost effective manner be made available.

Advantageously, the device is designed in such a manner that said pincer mechanism can be opened and closed by control means of the device which, for doing so, are brought into contact with contact surfaces of the pincer arms and are moved relative to these contact surfaces in direction of the longitudinal axis of the cartridge body to open or to close the pincer mechanism. In this manner, the pincer mechanism can be actuated in a simple way and with a minimum of additional moveable parts.

In the before described embodiment it is furthermore advantageous that device is designed in such a manner that the pincer mechanism is guided in guides for linear movement and can be moved forwards and backwards by means of a cam wheel which can be rotated by drive means.

The linkage between the cam wheel and the pincer mechanism advantageously is realized in that the pincer mechanism comprises a pin or key which travels in a groove formed in the cam wheel. Thus in such an embodiment of a device, the pincer mechanism is coupled with the cam wheel via a pin or key formed at the pincer mechanism which travels in a groove formed in the cam wheel. Such a linkage for generating a movement of the second portion relative to the first portion is simple in design, inexpensive in manufacturing and reliable in operation.

In a particularly advantageous variant of such a device, the pincer mechanism can be opened and closed by control means of the device which are as well operated by the cam wheel. As a

result, a forced mechanical coupling between the movement of the first and second portions relative to each other and the change in shape of the second coupling means results.

In an even more advantageous variant of such an embodiment, these control means for opening and closing the pincer mechanism comprise a pusher which can be pushed up by a notch formed at the cam wheel, thereby pushing together the arms of the pincer mechanism. By this design, a simple and reliable mechanism for controlling the change in shape of the second coupling means and the relative movement between the first and second portions of the device results.

Furthermore, in the before mentioned embodiments in which both, the relative movement between the first and second portions as well as the opening and closing of the pincer mechanism is controlled by a common cam wheel, it is advantageous that the cam wheel is designed in such a manner that, while the pincer mechanism is opened and closed by control means operated by the cam wheel, the pincer mechanism which is part of the second portion of the device is held by the cam wheel in a fully retracted position. By means of this control concept it is possible to ensure that the pincer mechanism is coupled to the piston of the cartridge in a defined position.

By advantage, the cam wheel is coupled to a drive unit, e.g. an electrical motor with associated gear and control, via a rotationally flexible coupling. By means of this, if the cam wheel is rotated forwards and backwards between two physical stops, control of the drive unit can be realized without the risk of overloading components due to recent torque peaks by monitoring the energy consumption of the drive unit and by stopping the drive unit or reverse its rotation direction once a specific energy consumption, e.g. in the case of an electric motor a certain electric current, is detected. However, also other control concepts are envisaged, e.g. comprising sensors which are detecting certain relative positions of the first and second portions or certain angles of rotation of the cam wheel.

In a further advantageous embodiment, the device according to the first aspect of the disclosure is a device for filling a cartridge with a liquid from a liquid reservoir or for dispensing or dosing a liquid from a cartridge containing a liquid, in particular a liquid drug, in particular insulin. In these applications, the advantages of the disclosure become especially clearly apparent.

A second aspect of the disclosure concerns a system comprising a device according to the first aspect of the disclosure and a cartridge having a cartridge body and a piston arranged therein

displaceable along a longitudinal axis of the cartridge body. The cartridge body of the cartridge is especially adapted to be releasably coupled to the first coupling means of the first portion of the device in such a manner that in both directions of said longitudinal axis of the cartridge body there exists a positive connection and/or a frictional connection between the
5 cartridge body and the first portion. The piston of the cartridge is especially adapted to be releasably coupled to the second coupling means of the second portion in such a manner that in both directions of said longitudinal axis of the cartridge body there exists a positive connection and/or a frictional connection between the piston and the second portion.

The connections which can be established between the first portion and the cartridge body
10 and between the piston and the piston rod in each case are greater than the frictional forces between the piston and the boundary walls of the cartridge body when moving the piston inside the cartridge and the forces generated in the intended use of the system, e.g. filling of the cartridge with a liquid and/or dispensing liquid from the cartridge, by pressure differentials between the front and back side of the piston.

15 Since in the system according to the second aspect of the disclosure the cartridge can be of a simple, inexpensive design, the system is attractive for use in fields where the cartridge should be an inexpensive single use article, like e.g. for use as a system for filling self filled insulin cartridges for the therapy of diabetes or as a system for dosing or dispensing, respectively, insulin from a single use cartridge.

20 In an advantageous embodiment of such a system according to the second aspect of the disclosure, the piston of the cartridge at its back side comprises at least one radial undercut. The second coupling means of the second portion of the device comprise moveable parts, and are designed in such a manner that, when the cartridge body is coupled by the first coupling means to the first portion and the second portion is moved towards the piston and displaces
25 the piston forwards inside the cartridge body, the moveable parts are moved, in particular against spring forces, at least partially through a contact with the piston and/or with the cartridge body, from a position, in which there is no engagement with the at least one radial undercut into a position in which they engage said at least one radial undercut in such a manner that in both directions of said longitudinal axis of the cartridge body there exists a
30 positive connection between the piston and the second portion. When, during a subsequent backward displacement of the piston inside the cartridge body effected by the second portion the piston reaches a specific retracted position within the cartridge body, the moveable parts are moved, in particular by spring forces, from the position, in which they engage said at least

one radial undercut into the position in which there is no engagement with the at least one radial undercut.

In an advantageous variant of such a system, the piston of the cartridge at its back side comprises at least one radial undercut, The second coupling means of the second portion
5 comprise moveable parts, and are designed in such a manner that, when the cartridge body is coupled by the first coupling means to the first portion, when the second portion is arranged in the fully retracted position or in a specific almost fully retracted position and when a forward movement of the second portion is initiated, the moveable parts, in particular by spring forces, at least partially controlled by control means of the device, are moved from a
10 position, in which there is no engagement with the at least one radial undercut, into a position in which they engage said at least one radial undercut in such a manner that in both directions of said longitudinal axis of the cartridge body there exists a positive connection between the piston and the second portion.

More advantageously, this embodiment of a system comprises a device according to the first
15 aspect of the disclosure, wherein the second coupling means are designed in such a manner that, when, after the forward movement of the second portion has been initiated, during a subsequent backward displacement of the piston inside the cartridge body effected by the second portion, the second portion again reaches the fully retracted position or the specific almost fully retracted position, the moveable parts are moved, in particular against spring
20 forces, at least partially controlled by control means of the device, from the position, in which they engage said at least one radial undercut into the position in which there is no engagement with the at least one radial undercut.

In another advantageous embodiment of the system, the piston of the cartridge at its back side comprises at least one radial undercut, for engagement of the second coupling means of
25 the second portion of the device. The second coupling means of the device comprise moveable parts and are designed in such a manner that, when the cartridge body is coupled by the first coupling means to the first portion of the device and the second portion is moved towards the piston and starts to displace the piston forwards inside the cartridge body, the moveable parts of the second coupling means are moved, advantageously against spring
30 forces, partially or solely through a contact with the piston and/or with the cartridge body, from a position, in which there is no engagement with the at least one radial undercut in the piston into a position in which they engage said at least one radial undercut in such a manner that in both directions of said longitudinal axis of the cartridge body there exists a positive

connection between the piston and the second portion enabling a forward and backward displacement of the piston through a movement of the second portion. Furthermore the second coupling means of the device are designed in such a manner that when, during a subsequent backward displacement of the piston inside the cartridge body effected by the second portion the piston reaches a specific retracted position within the cartridge body, the moveable parts are moved, advantageously by spring forces, from the position, in which they engage said at least one radial undercut back into the position in which there is no engagement with the at least one radial undercut.

As mentioned earlier, this coupling concept has the advantage that the connection between the piston and the second coupling means can be established when the piston and the second coupling means are brought into a specific position relative to each other and thus there is no need to separately identify the exact positions of the piston and the second portion for establishing said connection.

In still a further advantageous embodiment of the system, again the piston of the cartridge at its back side comprises at least one radial undercut, for engagement of the second coupling means of the second portion of the device. The second coupling means of the device comprise moveable parts and are designed in such a manner that, when the cartridge body is coupled by the first coupling means to the first portion of the device and when the second portion of the device is arranged in the fully retracted position or in a specific almost fully retracted position and when a forward movement of the second portion is initiated, the moveable parts of the second coupling means, advantageously by spring forces, partially or solely controlled by control means of the device, are moved from a position, in which there is no engagement with the at least one radial undercut in the piston, into a position in which they engage said at least one radial undercut in such a manner that in both directions of said longitudinal axis of the cartridge body there exists a positive connection between the piston and the second portion enabling a forward and backward displacement of the piston through a movement of the second portion.

As mentioned earlier, this coupling concept has the advantage that the connection between the piston and the second coupling means can be established independently of a prior contact between the piston and the second coupling means and thus without any forces acting from the second portion onto the piston or the cartridge body before establishing the connection.

Advantageously, in this embodiment the second coupling means are designed in such a manner that, when, after the forward movement of the second portion has been initiated, during a subsequent backward displacement of the piston inside the cartridge body effected through a movement of the second portion relative to the first portion, the second portion again reaches the fully retracted position or the specific almost fully retracted position, the moveable parts of the second coupling means are moved, by advantage against spring forces, partially or solely controlled by control means of the device, from the position, in which they engage said at least one radial undercut in the piston back into the position in which there is no engagement with the at least one radial undercut. Such systems are especially suitable as automated filling systems for self filled cartridges.

Advantageously, in the systems discussed so far the moveable parts of the device of the system comprise or are formed by the resilient arms of a pincer mechanism. Such a pincer mechanism is reliable and inexpensive.

A third aspect of the disclosure concerns a method of moving the piston in a cartridge having a cartridge body and a piston arranged therein displaceable along a longitudinal axis of the cartridge body, comprising: a) providing a system according to the second aspect of the disclosure as discussed above; b) releasably coupling the cartridge body of the cartridge by means of the first coupling means to the first portion of the device in such a manner that in both directions of said longitudinal axis of the cartridge body there exists a positive connection and/or a frictional connection between the cartridge body and the first portion; c) releasably coupling the piston of the cartridge by means of the second coupling means to the second portion in such a manner that in both directions of said longitudinal axis of the cartridge body there exists a positive connection and/or a frictional connection between the piston and the second portion, wherein said connection is established through a change in shape of the second coupling means; and d) moving the piston inside the cartridge body along said longitudinal axis through a relative movement between the first and second portions of the device.

In an advantageous embodiment of the method according to the third aspect of the disclosure, the method is a method of filling a cartridge with a liquid, in particular with a liquid drug, in particular with insulin, from a liquid reservoir.

Since in the method according to the third aspect of the disclosure the cartridge can be of a simple, inexpensive design, the method is attractive for use in fields where the cartridge

should be an inexpensive single use article, like e.g. as method of filling self filled insulin cartridges for the therapy of diabetes or as method of dosing or dispensing, respectively, insulin from a single use cartridge.

In an advantageous variant of such a method according to the third aspect of the disclosure, for filling a cartridge with a liquid from a liquid reservoir, the method comprises: a) providing a system according to the second aspect of the disclosure and a liquid reservoir; b) releasably coupling the cartridge body of the cartridge by means of the first coupling means to the first portion of the device in such a manner that in both directions of said longitudinal axis of the cartridge body there exists a positive connection and/or a frictional connection between the cartridge body and the first portion; c) releasably coupling the piston of the cartridge by means of the second coupling means to the second portion in such a manner that in both directions of said longitudinal axis of the cartridge body there exists a positive connection and/or a frictional connection between the piston and the second portion, wherein said connection is established through a change in shape of the second coupling means; d) connecting the cartridge and the liquid reservoir in such a manner that the inside of the liquid reservoir and the inside of the cartridge communicate with each other while they are hermetically sealed against the outside; and e) increasing the volume of the inside of the cartridge by moving the piston through a relative movement between the first and second portions of the device backwards inside the cartridge body, thereby displacing liquid from the inside of the liquid reservoir into the inside of the cartridge.

In an even more advantageous variant of such a method, before the volume of the inside of the cartridge is increased by moving the piston through a relative movement between the first and second portions of the device backwards inside the cartridge body for displacing liquid from the inside of the liquid reservoir into the inside of the cartridge, the volume of the inside of the cartridge is reduced by moving the piston through a relative movement between the first and second portions of the device forwards inside the cartridge body.

In a further advantageous variant of a method according to the third aspect of the disclosure, for dispensing or dosing a liquid from a cartridge containing the liquid, the method comprises: a) providing a system according to the second aspect of the disclosure with a cartridge containing the liquid to be dispensed or dosed; b) releasably coupling the cartridge body of the cartridge by means of the first coupling means to the first portion of the device in such a manner that in both directions of said longitudinal axis of the cartridge body there exists a positive connection and/or a frictional connection between the cartridge body and the first

portion; c) releasably coupling the piston of the cartridge by means of the second coupling means to the second portion in such a manner that in both directions of said longitudinal axis of the cartridge body there exists a positive connection and/or a frictional connection between the piston and the second portion, wherein said connection is established through a
5 change in shape of the second coupling means; and d) moving the piston forwards inside the cartridge body along said longitudinal axis through a relative movement between the first and second portions of the device, thereby dispensing liquid from the cartridge.

In another particular variant of such a method, in a first step of the method, a system according to the second aspect of the disclosure is provided, comprising a device according to
10 the first aspect of the disclosure and a dedicated cartridge. Thereafter, the cartridge body of the cartridge and the piston of the cartridge are releasably coupled by the first and the second coupling means of the device to the first and second portions of the device in each case in such a manner that in both directions of the longitudinal axis of the cartridge body there exists a positive connection and/or a frictional connection between the cartridge body and the first
15 portion and between the piston and the second portion. For establishing the connection between the piston and the second portion, the shape of the second coupling means is changed. After the cartridge body and the piston of the cartridge have been coupled to the first and second portions of the device by the first and second coupling means, the piston is moved inside the cartridge body along the longitudinal axis of same through a relative
20 movement between the first and second portions of the device.

In another advantageous embodiment, the cartridge, which is coupled with its cartridge body and its piston to the first and second portions of the device by the first and second coupling means as described before, is connected with a liquid reservoir containing a liquid in such a manner that the inside of the liquid reservoir and the inside of the cartridge communicate with
25 each other while they are hermetically sealed against the outside. After the cartridge has been connected to the liquid reservoir, the piston is moved inside the cartridge body along the longitudinal axis of same through a relative movement between the first and second portions of the device in such a manner that the volume of the inside of the cartridge is increased, thereby displacing liquid from the inside of the liquid reservoir into the inside of the cartridge.

Advantageously, before increasing the volume of the inside of the cartridge as described above for displacing liquid from the inside of the liquid reservoir into the inside of the cartridge, the piston is moved inside the cartridge body along the longitudinal axis of same through a relative movement between the first and second portions of the device in such a manner that

the volume of the inside of the cartridge is reduced. This can take place according to alternative embodiments of the method before or after the cartridge has been connected to the liquid reservoir.

In another advantageous embodiment of the method according to the third aspect of the disclosure, the method is a method of dispensing or dosing a liquid, advantageously a liquid drug, more advantageously insulin, from a cartridge containing the liquid. In this advantageous embodiment of the method according to the third aspect of the disclosure, the cartridge of the system according to the second aspect of the disclosure which is provided contains the liquid to be dosed or dispensed. After the cartridge body and the piston of the cartridge have been coupled to the first and second portions of the device by the first and second coupling means in the manner described earlier, the piston is moved inside the cartridge body along the longitudinal axis of same through a relative movement between the first and second portions of the device in such a manner that the volume of the inside of the cartridge is reduced, thereby dispensing liquid from the cartridge.

Brief description of the drawings

In order to facilitate a fuller understanding of the present disclosure, reference is now made to the appended drawings. These references should not be construed as limiting the present disclosure, but are intended to be exemplary only.

Figure 1 shows a side view of an embodiment of a device according to the disclosure.

Figure 2 shows sectional view of the device of Figure 1 along line B–B in Figure 3.

Figure 3 shows a sectional view of the device of Figure 1 along line A–A in Figure 1.

Figure 4 shows the detail X of Figure 3.

Figure 5 shows the detail Y of Figure 3.

Figure 6 shows a perspective view from a first direction onto the base plate of the device according to Figure 1 with the pincer mechanism and the associated drive and control mechanism.

Figure 7 shows a perspective view from a second direction onto the pincer mechanism and the associated control mechanism shown in Figure 6.

Figure 8 shows a schematic illustration of different steps a) to g) of an alternative coupling concept according to the disclosure.

Description of embodiments of the invention

Figure 1 shows a side view of a device 1 according to the disclosure for filling self filled insulin cartridges with insulin from an insulin reservoir. The Figures 2 and 3 show sectional views of the device 1, once in section along the line A-A in Figure 1 (Figure 3) and once in section along the line B-B in Figure 3 (Figure 2), with a suitable cartridge 2, 3 received within the device 1. Thus the figures 2 and 3 also show sectional views of a system according to the disclosure with the device 1 of Figure 1 and a suitable cartridge installed therein.

As can be seen when in addition to the Figures 1 to 3 considering Figure 4, which shows the detail X of Figure 3, the cartridge body 2 of the cartridge is releasably held inside the device 1 and connected to the housing 18 of the device 1 by a connector assembly 4 (first portion of the device according to the claims). The connection with the connector assembly 4 is established by arms 5 (first coupling means according to the claims) of the connector assembly 4 which engage with protrusions 12 arranged at their free ends the radial undercut formed by the neck portion of the cartridge body 2 in such a manner that, in both directions of the longitudinal axis Z of the cartridge body 2, there exists a positive connection between the cartridge body 2 and the connector assembly 4 and thus between the cartridge body 2 and the housing 18 of the device 1.

As can be seen when in addition considering Figure 5, which shows the detail Y of Figure 3, the piston 3 of the cartridge is releasably coupled at its backside to a pincer mechanism 7 (second coupling means according to the claims) having two resilient pincer arms 11a, 11b which are spread by a spring 19. The pincer arms 11a, 11b engage with protrusions 12 formed at their free ends a radial undercut formed by a ring 20 fixedly mounted in a central opening in the backside of the piston 3 in such a manner that in both directions of the longitudinal axis Z of the cartridge body 2 there exists a positive connection between the piston 3 and the pincer mechanism 7.

As can be seen when furthermore considering the Figures 6 and 7, which show perspective views from different directions onto the pincer mechanism 7 and the associated drive mechanism, the pincer mechanism 7 is part of a slider assembly 6 (second portion according to the claims), which is guided in guides 13 for linear movement and can be moved forwards and backwards in direction of the longitudinal axis Z of the cartridge body 2 by means of a

cam wheel 10 which can be rotated by an electric motor 8 coupled to it via an rotationally flexible coupling 16.

The linkage between the slider assembly 6 and the cam wheel 10 is established by a pin 21 formed at the slider 6, which pin 21 is received in a groove 14 formed in the cam wheel 10.

- 5 When rotating the cam wheel 10 with the motor 8 clockwise and anti-clockwise, the pin 21 travels in the groove 14 between the two ends of the groove 14, thereby lifting and lowering the slider assembly 6 with its pincer mechanism 7 and, as a result, moving the piston 3 forwards and backwards in direction of the axis Z inside the cartridge body 2.

As can further be seen, the two pincer arms 11a, 11b of the pincer mechanism 7 extend
10 through the opening of a rocker frame 9 which, by rotating the cam wheel 10 with the motor 8 clockwise and anti-clockwise within a certain angle of rotation, can at one end thereof be lifted and lowered by a notch 15 formed at the cam wheel 10, thereby tilting the rocker frame 9 around a bearing pin 22 located at its other end. Since the pincer arms 11a, 11b at there
15 outside comprise notches 24 which under resilient pre-stress contact sliding surfaces formed at the inside of the opening of the rocker frame 9, the tilting of the rocker frame 9 around its bearing pin 22 results in an opening and closing movement of the arms 11a, 11b of pincer mechanism 7 relative to each other. Through this opening and closing of the pincer mechanism 7 the connection between the piston 3 and the slider assembly 6 can be established (opening of the pincer mechanism) and be released (closing of the pincer
20 mechanism).

The cam wheel 10 with its groove 14 and the notch 15 is designed in such a manner that in the range of rotation in which its notch 15 is lifting and lowering the end of the rocker frame 9 and thus the pincer mechanism 7 is opened and closed, the slider assembly 6 with its pincer mechanism 7 is held by its pin 21 which is travelling in the groove 14 of the cam wheel 10 in a
25 fully retracted position.

For loading a cartridge to be filled with insulin from an insulin reservoir into the device 1 and thus arrive at the situation shown in the Figures 2 and 3, in which the cartridge body 2 is connected via the arms 5 to the connector assembly 4 and to the housing 18 and in which the cartridge piston 3 is connected via the pincer mechanism 7 to the slider assembly 6, the
30 connector assembly 4 is removed from the empty device 1 and is snapped with its arms 5 onto the neck portion of the cartridge body 2 of the cartridge to be filled. Subsequently, the connector assembly 4 together with the cartridge held between its arms 5 is inserted into the

receiving opening 23 of the device 1, where at the end of the insertion movement it is connected with the housing 18 by hooks which can be released with a release button (not shown) after the filling operation for removal of the filled cartridge. For insertion of the cartridge into the device, the slider assembly 6 with its pincer mechanism 7 is positioned in the fully retracted position and the pincer mechanism 7 is closed, i.e. the pincer arms 11a, 11b are pushed towards each other by the rocker frame 9. While the cartridge is inserted into the receiving opening 23 of the device 1, the free ends of the pincer arms 11a, 11b are introduced into the central opening at the backside of the piston 3.

After the insertion movement has been completed, the motor 8 is activated for turning the cam wheel 10 in a first rotational direction into a rotational position in which the notch 15 is no longer supporting the end of the rocker frame 9 so that the pincer mechanism 7 opens and the pincer arms 11a, 11b engage with their protrusions 12 the radial undercut formed by the ring 20 fixed in the central opening in the backside of the piston 3.

For filling the cartridge received in the before described manner within the device 1 with insulin from an insulin reservoir (not shown), the cartridge is connected, via a cannula (not shown) extending through the connector assembly 4 and a septum arranged at the head of the cartridge, to the insulin reservoir in such a manner that the inside of the insulin reservoir and the inside of the cartridge communicate with each other while they are hermetically sealed against the outside.

After the connection with the insulin reservoir has been established, the motor 8 is activated for turning the cam wheel 10 further in the first rotational direction for moving the piston 3 forwards inside the cartridge body 2, thereby reducing the volume of the inside of the cartridge and thus displacing air from the inside of the cartridge into the insulin reservoir. When the pin 21 of the slider 6, during rotation of the cam wheel in the first rotational direction, reaches the end of the groove 14 in the cam wheel 10, the rotation of the cam wheel 10 stops and the control (not shown) of the motor 8 detects an increasing electrical current consumption of the motor 8 indicating that the fully extended position of the piston 3 has been reached.

Now the control of the motor 8 reverses the rotational direction so that the cam wheel 10 is rotated in a second rotational direction which is opposite to the first rotational direction, thereby increasing the volume of the inside of the cartridge and thus displacing insulin from the inside of the insulin reservoir into the inside of the cartridge.

Alternatively, the forward movement of the piston can be performed before connecting the cartridge to the insulin reservoir so that there is no displacement of air into the insulin reservoir.

When the pin 21 of the slider 6, during rotation of the cam wheel in the second rotational direction, reaches the opposite end of the groove 14 in the cam wheel 10, the rotation of the cam wheel 10 stops and the control of the motor 8 detects an increasing electrical current consumption of the motor 8 indicating that the fully retracted position of the piston 3 has been reached. Subsequently, the control shuts of the motor 8.

Before the pin 21 reaches, when rotating the cam wheel in the second rotational direction, the end of the groove 14, the notch 15 lifts the end of the rocker frame 9, thereby automatically releasing the connection between the piston 3 and the slider assembly 6 by closing the pincer mechanism 7. To ensure that the piston 3 is released in the fully retracted position, the cam wheel is designed in such a manner that, when the notch 15 starts lifting the end of the rocker frame 9, the piston 3 has already reached the fully retracted position.

To remove the filled cartridge from the device 1, the release button for releasing the hooks which connect the connector assembly 4 with the housing 18 is pressed and the connector assembly 4 together with the cartridge is removed from the device 1. Subsequently, the arms 5 of the connector assembly 4 are unlatched and the filled cartridge is separated from the connector assembly 4. The cartridge then is ready for its intended use.

Figures 8 a) to g) schematically illustrate the coupling and decoupling procedure of an alternative coupling concept according to the disclosure, which could also be used in the device described before. In this embodiment, a piston rod 6 (the second portion according to the claims) is coupled to the piston 3 of the cartridge for moving it forwards and backwards inside the cartridge body 2. The piston rod 6 at its front end comprises an lever arrangement 7 (second coupling means according to the claims) formed of two moveable levers 17a, 17b (moveable parts according to the claims) which at their free end carry protrusion 12. For the sake of good manageability, the reference signs have not been repeated in each of the situations a) to g).

As can be seen when following the different situations illustrated in Figure 8 from situation a) to situation c), the levers 17a, 17b are held by leave springs 19 in a position that permits to introduce their free ends with the protrusions 12 into the central opening at the backside of the piston 3.

As can be seen when further considering situation d), the levers 17a, 17b are designed in such a manner that, when for coupling the piston rod 6 to the piston 3 of the cartridge the piston rod 6 is moved forward towards the piston 3 and displaces the piston 3 forwards inside the cartridge body 2, and thus the free ends of the levers 17a, 17b are introduced into the central opening at the backside of the piston 3, the levers 17a, 17b are tilted against the forces of the springs 19 through a contact with the backside of the piston 3 in such a manner that their protrusions 12 engage a radial undercut 13 in the central opening in the backside of the piston. By this, a positive connection in both directions of said longitudinal axis of the cartridge body 2 between the piston 3 and the piston rod 6 is established.

When now, as can be seen when following the different situations illustrated in Figure 8 from situation d) to situation g), during a subsequent backward displacement of the piston 3 inside the cartridge body 2 effected by a retracting movement of the piston rod 6 the piston 3 reaches a specific retracted position within the cartridge body 2, the levers 17a, 17b are tilted, driven by the forces of the springs 19, back into their initial position, thereby removing the protrusions 12 from the radial undercut 13 in the central opening in the backside of the piston 3 so that, when the piston rod 6 is further retracted, it separates from the piston 3 without pulling the piston 3 out of the cartridge body 2.

While there are shown and described certain presently advantageous embodiments of the disclosure relating to a device, system and method for filling a cartridge, it is to be distinctly understood that the invention is not limited thereto but may be otherwise variously embodied and practiced within the scope of the following claims. For example, in another embodiment, the device could be a liquid pump, such as an insulin pump and the first coupling means for holding the cartridge could be a cartridge compartment of the pump. In such an alternative embodiment, a plunger rod having the second coupling means as described herein can be utilized and provides the further advantage as mentioned above of preventing the plunger of the cartridge from being drawn into the cartridge by a pressure differential (such as due to a height or ambient pressure difference). In this way, a pump incorporating the disclosed second coupling means exhibits the further advantage of serving to prevent free-flow of a liquid (such as a liquid insulin solution) into a person using the pump.

The present invention is not to be limited in scope by the specific embodiments described herein. Indeed, various modifications of the present invention, in addition to those described herein, will be apparent to those skilled in the art from the foregoing description and accompanying drawings. Thus, such modifications are intended to fall within the scope of the
 5 appended claims.

List of Reference Numerals

	1	device
	2	cartridge body
10	3	piston
	4	first portion, connector assembly
	5	first coupling means, arm
	6	second portion, slider assembly
	7	second coupling means, pincer mechanism
15	8	drive means, motor
	9	pusher, rocker frame
	10	cam wheel
	11a, 11b	pincer arm
	12	protrusion
20	13	radial undercut, guide
	14	groove
	15	notch
	16	flexible coupling
	17a, 17b	moveable part, moveable lever
25	18	device housing
	19	spring, leave spring
	20	ring
	21	pin
	22	bearing pin
30	23	receiving opening
	24	contact surface, notch
	Z	longitudinal axis

Claims

1. A device (1) for moving a piston inside a cartridge having a cartridge body (2) and a piston (3) arranged therein displaceable along a longitudinal axis (Z) of the cartridge body (2), the device (1) comprising:
- 5 a first portion (4) having first coupling means (5) for releasably coupling the cartridge body (2) of the cartridge to the first portion (4) in such a manner that in both directions of said longitudinal axis (Z) of the cartridge body (2) there exists a positive connection and/or a frictional connection between the cartridge body (2) and the first portion (4);
- 10 a second portion (6) having second coupling means (7, 11a, 11b, 12; 7, 12, 17a, 17b) for releasably coupling the piston (3) of the cartridge to the second portion (6) in such a manner that in both directions of said longitudinal axis (Z) of the cartridge body (2) there exists a positive connection and/or a frictional connection between the piston (3) and the second portion (6);
- 15 wherein said first (4) and second portions (6) are moveable relative to each other in order to effect, in the intended use of the device (1), at least a forward displacement of the piston (3) coupled to the second portion (6) inside the cartridge body (2) coupled to the first portion (4) along said longitudinal axis (Z) of the cartridge body (2), and
- 20 wherein the second coupling means (7, 11a, 11b, 12; 7, 12, 17a, 17b) are designed in such a manner that for establishing and releasing the positive connection and/or frictional connection with the piston (3), their shape can reversibly be changed.
2. The device according to claim 1, for use in filling a cartridge having a cartridge body (2) and a piston (3) arranged therein displaceable along a longitudinal axis (Z) of the cartridge body (2) with a liquid, in particular with a liquid drug, in particular with insulin,
- 25 the device (1) comprising:
- a first portion (4) having first coupling means (5) for releasably coupling the cartridge body (2) of the cartridge to be filled to the first portion (4) in such a manner that in both directions of said longitudinal axis (Z) of the cartridge body (2) there exists a positive connection and/or a frictional connection between the cartridge body (2) and
- 30 the first portion (4);

a second portion (6) having second coupling means (7, 11a, 11b, 12; 7, 12, 17a, 17b) for releasably coupling the piston (3) of the cartridge to be filled to the second portion (6) in such a manner that in both directions of said longitudinal axis (Z) of the cartridge body (2) there exists a positive connection and/or a frictional connection between the piston (3) and the second portion (6);

wherein said first (4) and second portions (6) are moveable relative to each other in order to effect, in the intended use of the device (1), a forward and backward displacement of the piston (3) coupled to the second portion (6) inside the cartridge body (2) coupled to the first portion (4) along the longitudinal axis (Z) of the cartridge body (2), and

wherein the second coupling means (7, 11a, 11b, 12; 7, 12, 17a, 17b) are designed in such a manner that for establishing and releasing the positive connection and/or frictional connection with the piston (3), their shape can reversibly be changed.

3. The device according to claim 1 or 2, further comprising drive means (8) for moving the first (4) and second portions (6) relative to each other.
4. The device according to any of the preceding claims, wherein the second coupling means (7, 12, 17a, 17b) are designed in such a manner that their change in shape can at least partially be effected through a contact with the piston (3) and/or with the cartridge body (2).
5. The device according to any of the preceding claims, wherein the second coupling means (7, 11a, 11b, 12) are designed in such a manner that their change in shape can at least partially be effected through control means (9, 15) of the device (1).
6. The device according to any of the preceding claims, wherein the device (1) is designed in such a manner that the shape of the second coupling means (7, 11a, 11b, 12; 7, 12, 17a, 17b) can or can only be changed when the first (4) and the second portions (6) assume a specific position relative to each other.
7. The device according to any of the preceding claims, wherein the device (1) is designed in such a manner that the shape of the second coupling means (7, 11a, 11b, 12) is automatically changed when the first (4) and the second portions (6) are moved into a

specific position relative to each other and/or out of a specific position relative to each other.

8. The device according to any of the preceding claims, wherein the device (1) is designed in such a manner that the shape of the second coupling means (7, 11a, 11b, 12; 7, 12, 17a, 17b) can or can only be changed into a coupled status when the cartridge body (2) of a cartridge has been coupled to the first portion (4) by means of the first coupling means (5) and/or that the shape of the second coupling means (7, 11a, 11b, 12; 7, 12, 17a, 17b) is automatically changed when, after the cartridge body (2) of a cartridge has been coupled to the first portion (4) by means of the first coupling means (5), the first coupling means (5) are released.

9. The device according to any of the preceding claims, wherein the device (1) is designed in such a manner

that said second portion (6) is moveable relative to the first portion (4) forward and backward between a fully retracted position and a fully extended position along a longitudinal axis in order to effect, in the intended use of the device (1), a forward and backward displacement of the piston (3) inside the cartridge body (2), and

that the shape of the second coupling means (7, 11a, 11b, 12) is automatically changed when the second portion (6) is moved into the fully retracted position and/or is moved out of the fully retracted position.

10. The device according to claim 9, wherein the device (1) is designed in such a manner that the shape of the second coupling means (7, 11a, 11b, 12) is automatically changed when starting from the fully retracted position a forward movement of the second portion (6) is initiated.

11. The device according to any of the preceding claims, wherein the second coupling means (7, 11a, 11b, 12) comprise a pincer mechanism (11a, 11b, 12) having at least two pincer arms (11a, 11b), the shape of which can be changed through a closing and opening movement of the pincer arms (11a, 11b), and wherein the pincer arms (11a, 11b) comprise protrusions (12) extending from them for engagement into radial undercuts (13) formed in a piston (3) of a cartridge to be filled.

12. The device according to claim 11, wherein the device designed in such a manner that the pincer mechanism (11a, 11b, 12) can be opened and closed by control means (9, 15) of the device (1) which are contacting contact surfaces (24) of the pincer arms (11a, 11b) and are moved relative to these contact surfaces of the pincer arms (11a, 11b) in direction of the longitudinal axis (Z) of the cartridge body (2) to open or to close the pincer mechanism (11a, 11b, 12).
13. The device according to claim 11 or 12, wherein the pincer mechanism (11a, 11b, 12) is guided in guides (13) for linear movement and can be moved forwards and backwards by means of a cam wheel (10) which can be rotated by drive means (8).
14. The device according to claim 13, wherein the pincer mechanism (11a, 11b, 12) is coupled with the cam wheel (10) via a pin (21) or key formed at the pincer mechanism (11a, 11b, 12) which travels in a groove (14) formed in the cam wheel (10).
15. The device according to claim 14, wherein the pincer mechanism (11a, 11b, 12) can be opened and closed by control means (9, 15) of the device (1) which are operated by the cam wheel (10).
16. The device according to claim 15, wherein the control means (9, 15) comprise a pusher (9) which can be pushed up by a notch (15) at the cam wheel (10), thereby pushing together the arms (11a, 11b) of the pincer mechanism (11a, 11b, 12).
17. The device according to any of claims 15 to 16, wherein the cam wheel (10) is designed in such a manner that while the pincer mechanism (11a, 11b, 12) is opened and closed by control means (9, 15) operated by the cam wheel (8), the pincer mechanism (11a, 11b, 12) is held by the cam wheel (10) in a fully retracted position.
18. The device according to any of claims 13 to 17, wherein between the drive means (8) and the cam wheel (10) there is arranged a rotationally flexible coupling (16).
19. The device according any of the preceding claims, wherein the device is a device for filling a cartridge with a liquid from a liquid reservoir or for dispensing or dosing a liquid from a cartridge containing a liquid, in particular a liquid drug, in particular insulin.

- 20.** A system comprising a device (1) according any of claims 1 to 19, and a cartridge having a cartridge body (2) and a piston (3) arranged therein displaceable along a longitudinal axis (Z) of the cartridge body (2),

wherein the cartridge body (2) is especially adapted to be releasably coupled to the first coupling means (5) of the first portion (4) of the device (1) in such a manner that in both directions of said longitudinal axis (Z) of the cartridge body (2) there exists a positive connection and/or a frictional connection between the cartridge body (2) and the first portion (4); and

wherein the piston (3) is especially adapted to be releasably coupled to the second coupling means (7, 11a, 11b, 12; 7, 12, 17a, 17b) of the second portion (6) in such a manner that in both directions of said longitudinal axis (Z) of the cartridge body (2) there exists a positive connection and/or a frictional connection between the piston (3) and the second portion (6).

- 21.** The system according to claim 20, wherein the piston (3) of the cartridge at its back side comprises at least one radial undercut (13), and wherein the second coupling means (7, 12, 17a, 17b) of the second portion (6) of the device (1) comprise moveable parts (17a, 17b, 12) and are designed in such a manner that,

when the cartridge body (2) is coupled by the first coupling means (5) to the first portion (4) and the second portion (6) is moved towards the piston (3) and displaces the piston (3) forwards inside the cartridge body (2), the moveable parts (17a, 17b, 12) are moved, in particular against spring forces, at least partially through a contact with the piston (3) and/or with the cartridge body (2), from a position, in which there is no engagement with the at least one radial undercut (13) into a position in which they engage said at least one radial undercut (13) in such a manner that in both directions of said longitudinal axis (Z) of the cartridge body (2) there exists a positive connection between the piston (3) and the second portion (6),

and when, during a subsequent backward displacement of the piston (3) inside the cartridge body (2) effected by the second portion (6) the piston (3) reaches a specific retracted position within the cartridge body (2), the moveable parts (17a, 17b, 12) are moved, in particular by spring forces, from the position, in which they engage said at least one radial undercut (13) into the position in which there is no engagement with the at least one radial undercut (13).

22. The system according to claim 20 or 21, wherein the piston (3) of the cartridge at its back side comprises at least one radial undercut (13) and wherein the second coupling means (7, 11a, 11b, 12) of the second portion (6) comprise moveable parts (11a, 11b, 12) and are designed in such a manner that,

5 when the cartridge body (2) is coupled by the first coupling means (5) to the first portion (4), when the second portion (6) is arranged in the fully retracted position or in a specific almost fully retracted position and when a forward movement of the second portion (6) is initiated, the moveable parts (11a, 11b, 12), in particular by spring forces, at least partially controlled by control means (9, 15) of the device (1), are moved from
10 a position, in which there is no engagement with the at least one radial undercut (13), into a position in which they engage said at least one radial undercut (13) in such a manner that in both directions of said longitudinal axis (Z) of the cartridge body (2) there exists a positive connection between the piston (3) and the second portion (6).

23. The system according to claim 22 with a device (1) according to claim 9, wherein the
15 second coupling means (7, 11a, 11b, 12) are designed in such a manner that, when, after the forward movement of the second portion (6) has been initiated, during a subsequent backward displacement of the piston (3) inside the cartridge body (2) effected by the second portion (6), the second portion (6) again reaches the fully retracted position or the specific almost fully retracted position, the moveable parts
20 (11a, 11b, 12) are moved, in particular against spring forces, at least partially controlled by control means (9, 15) of the device (1), from the position, in which they engage said at least one radial undercut (13) into the position in which there is no engagement with the at least one radial undercut (13).

24. The system according to any of claims 20 to 23, wherein the moveable parts (11a, 11b, 12) comprise or are formed by the resilient arms (11a, 11b) of a pincer mechanism
25 (11a, 11a, 12).

25. A method of moving the piston in a cartridge having a cartridge body (2) and a piston (3) arranged therein displaceable along a longitudinal axis (Z) of the cartridge body (2), comprising:

30 a) providing a system according to any of claims 20 to 24;

b) releasably coupling the cartridge body (2) of the cartridge by means of the first coupling means (5) to the first portion (4) of the device (1) in such a manner that in both directions of said longitudinal axis (Z) of the cartridge body (2) there exists a positive connection and/or a frictional connection between the cartridge body (2) and the first portion (4);

c) releasably coupling the piston (3) of the cartridge by means of the second coupling means (7, 11a, 11b, 12; 7, 12, 17a, 17b) to the second portion (6) in such a manner that in both directions of said longitudinal axis (Z) of the cartridge body (2) there exists a positive connection and/or a frictional connection between the piston (3) and the second portion (6), wherein said connection is established through a change in shape of the second coupling means (7, 11a, 11b, 12; 7, 12, 17a, 17b); and

d) moving the piston (3) inside the cartridge body (2) along said longitudinal axis (Z) through a relative movement between the first (4) and second portions (6) of the device (1).

26. The method according to claim 25 of filling a cartridge with a liquid from a liquid reservoir, comprising:

a) providing a system according to any of claims 19 to 24 and a liquid reservoir;

b) releasably coupling the cartridge body (2) of the cartridge by means of the first coupling means (5) to the first portion (4) of the device (1) in such a manner that in both directions of said longitudinal axis (Z) of the cartridge body (2) there exists a positive connection and/or a frictional connection between the cartridge body (2) and the first portion (4);

c) releasably coupling the piston (3) of the cartridge by means of the second coupling means (7, 11a, 11b, 12; 7, 12, 17a, 17b) to the second portion (6) in such a manner that in both directions of said longitudinal axis (Z) of the cartridge body (2) there exists a positive connection and/or a frictional connection between the piston (3) and the second portion (6), wherein said connection is established through a change in shape of the second coupling means (7, 11a, 11b, 12; 7, 12, 17a, 17b);

d) connecting the cartridge and the liquid reservoir in such a manner that the inside of the liquid reservoir and the inside of the cartridge communicate with each other while they are hermetically sealed against the outside; and

e) increasing the volume of the inside of the cartridge by moving the piston (3) through a relative movement between the first (4) and second portions (6) of the device (1) backwards inside the cartridge body (2), thereby displacing liquid from the inside of the liquid reservoir into the inside of the cartridge.

5 **27.** The method according to claim 26, wherein, before the volume of the inside of the cartridge is increased by moving the piston (3) through a relative movement between the first (4) and second portions (6) of the device (1) backwards inside the cartridge body (2) for displacing liquid from the inside of the liquid reservoir into the inside of the cartridge, the volume of the inside of the cartridge is reduced by moving the piston (3)
10 through a relative movement between the first (4) and second portions (6) of the device (1) forwards inside the cartridge body (2).

28. The method according to claim 25 of dispensing or dosing a liquid from a cartridge containing the liquid, comprising:

15 a) providing a system according to any of claims 19 to 24 with a cartridge containing the liquid to be dispensed or dosed;

20 b) releasably coupling the cartridge body (2) of the cartridge by means of the first coupling means (5) to the first portion (4) of the device (1) in such a manner that in both directions of said longitudinal axis (Z) of the cartridge body (2) there exists a positive connection and/or a frictional connection between the cartridge body (2) and the first portion (4);

25 c) releasably coupling the piston (3) of the cartridge by means of the second coupling means (7, 11a, 11b, 12; 7, 12, 17a, 17b) to the second portion (6) in such a manner that in both directions of said longitudinal axis (Z) of the cartridge body (2) there exists a positive connection and/or a frictional connection between the piston (3) and the second portion (6), wherein said connection is established through a change in shape of the second coupling means (7, 11a, 11b, 12; 7, 12, 17a, 17b); and

d) moving the piston (3) forwards inside the cartridge body (2) along said longitudinal axis (Z) through a relative movement between the first (4) and second portions (6) of the device (1), thereby dispensing liquid from the cartridge.

Fig.1

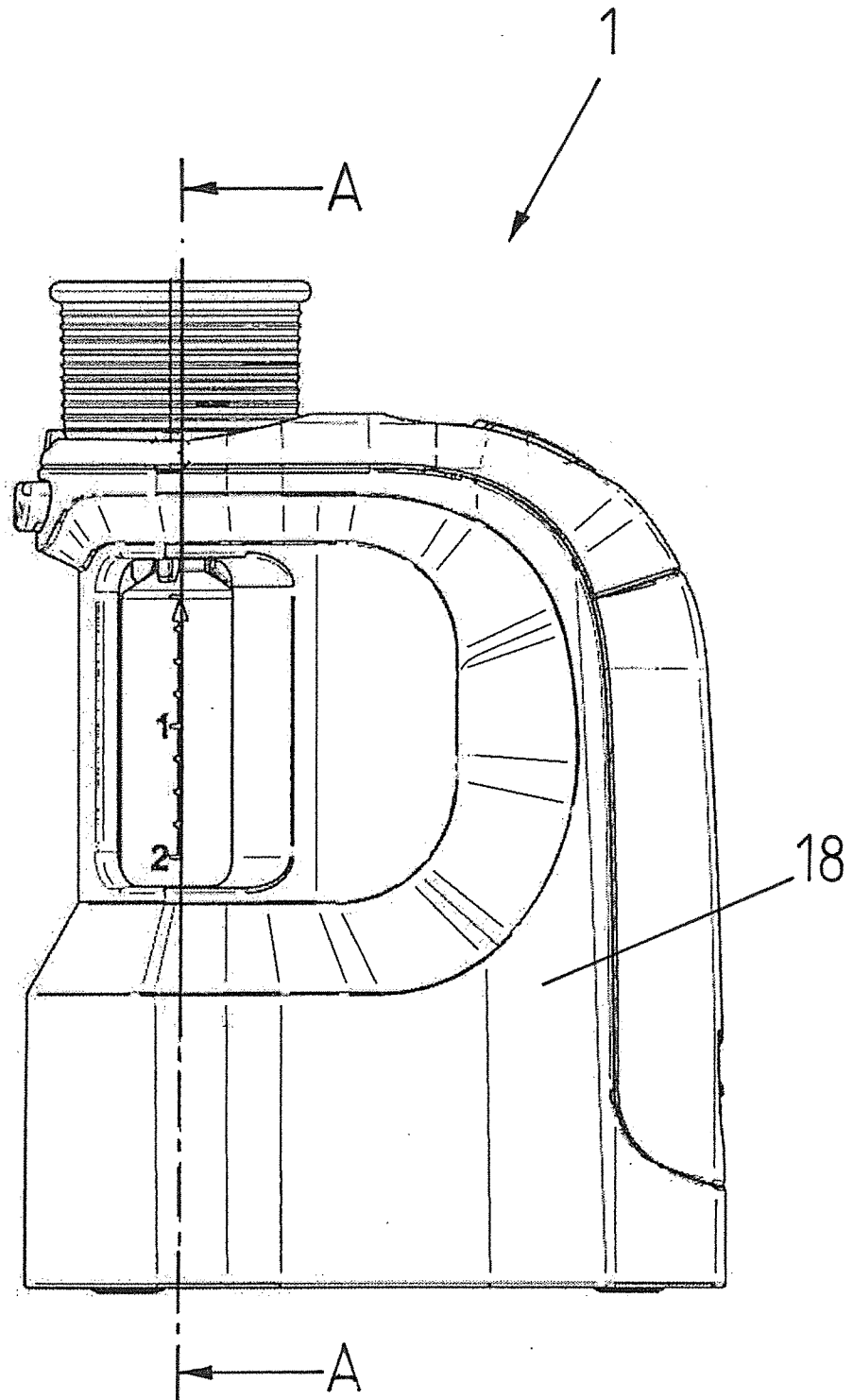


Fig.2

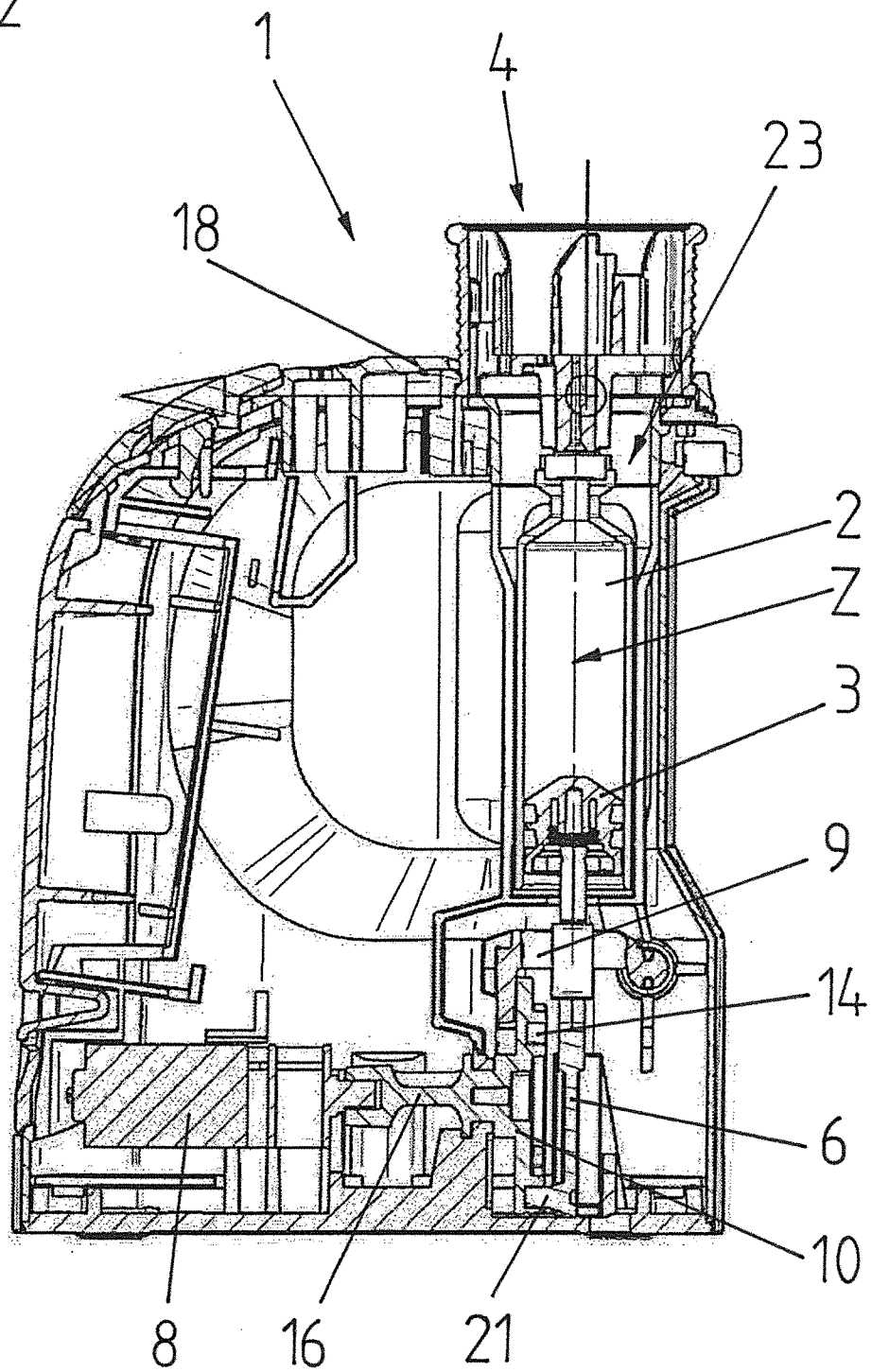


Fig.3

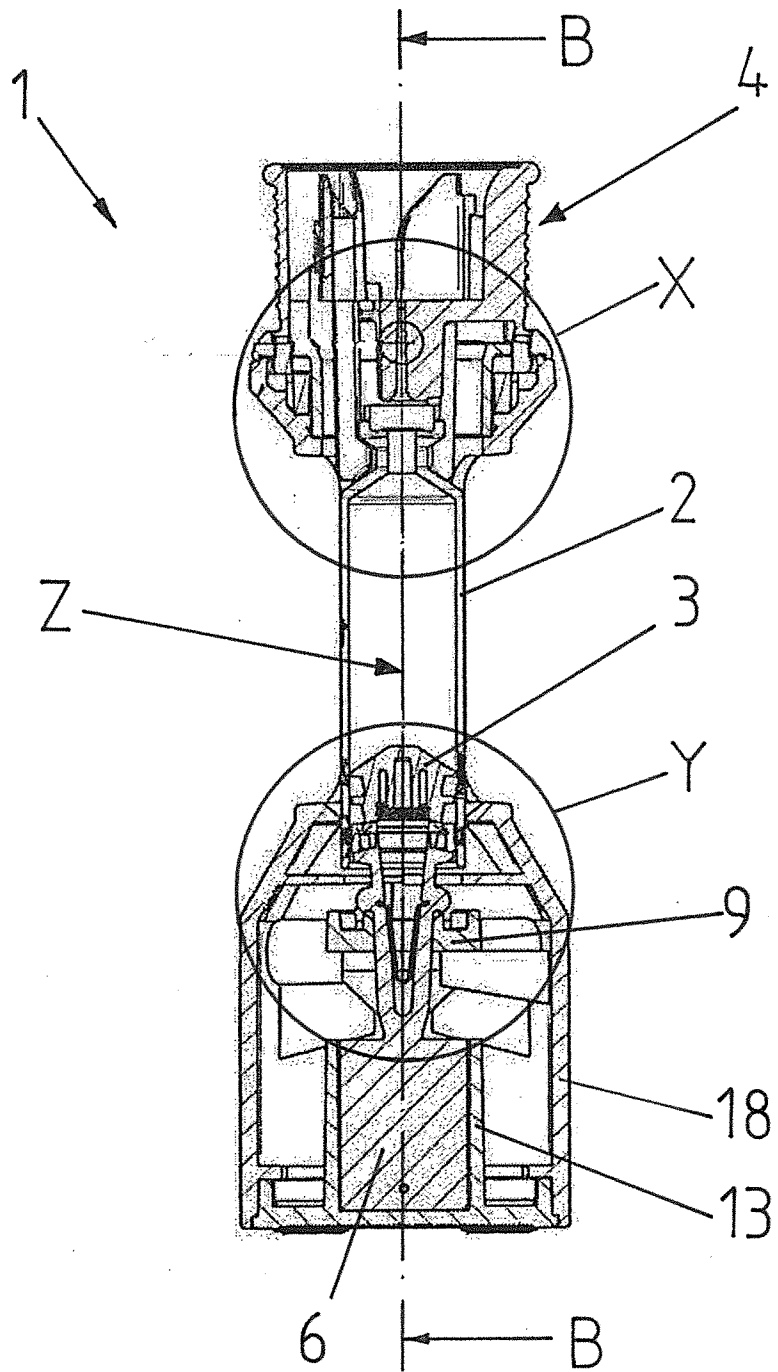


Fig.4

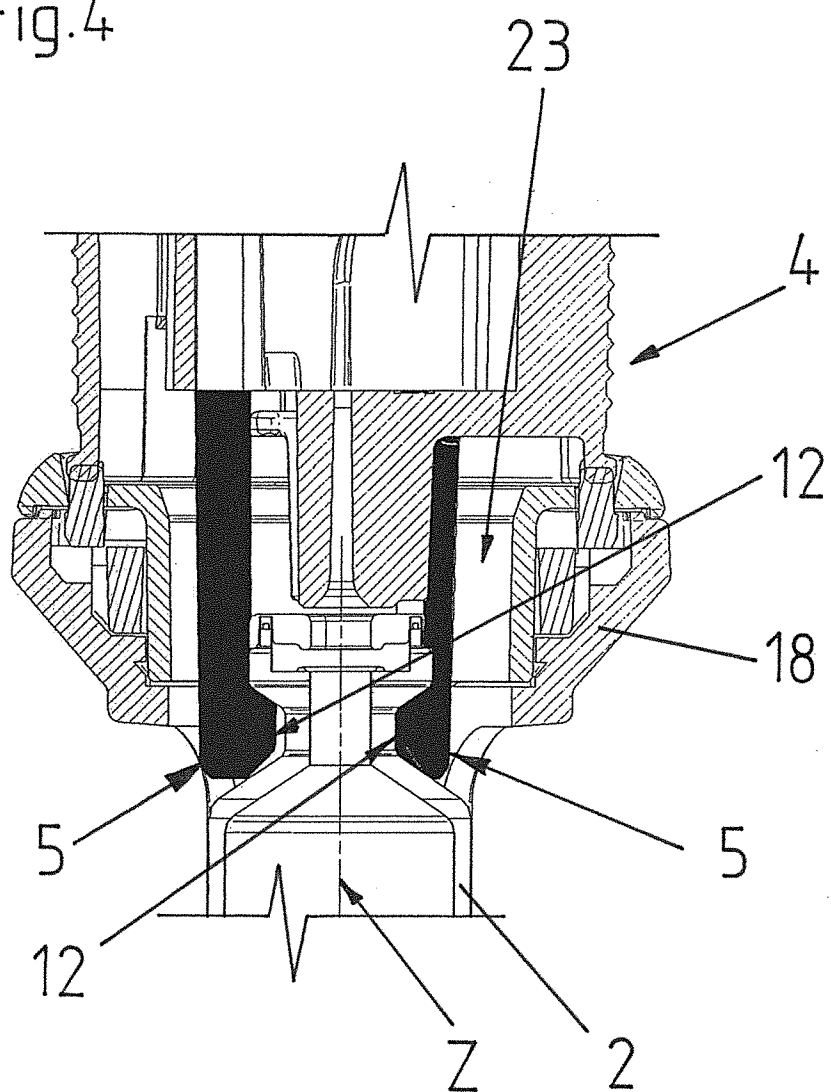
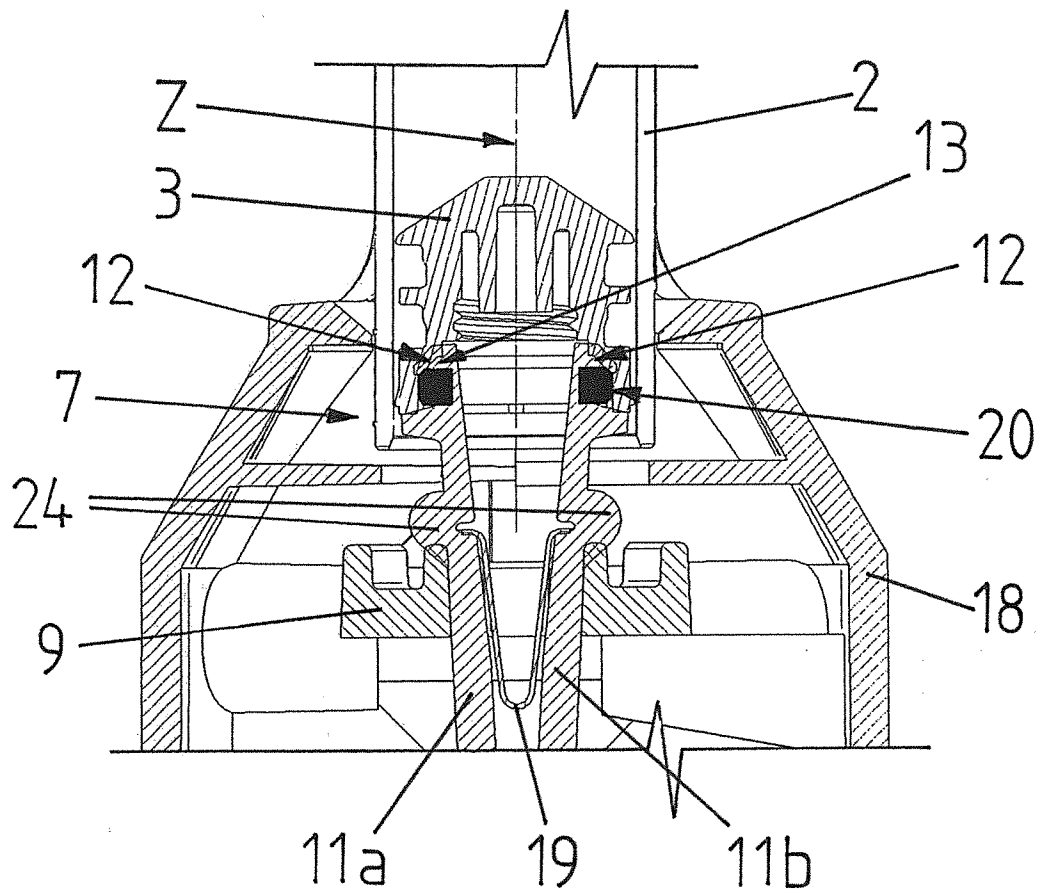


Fig.5



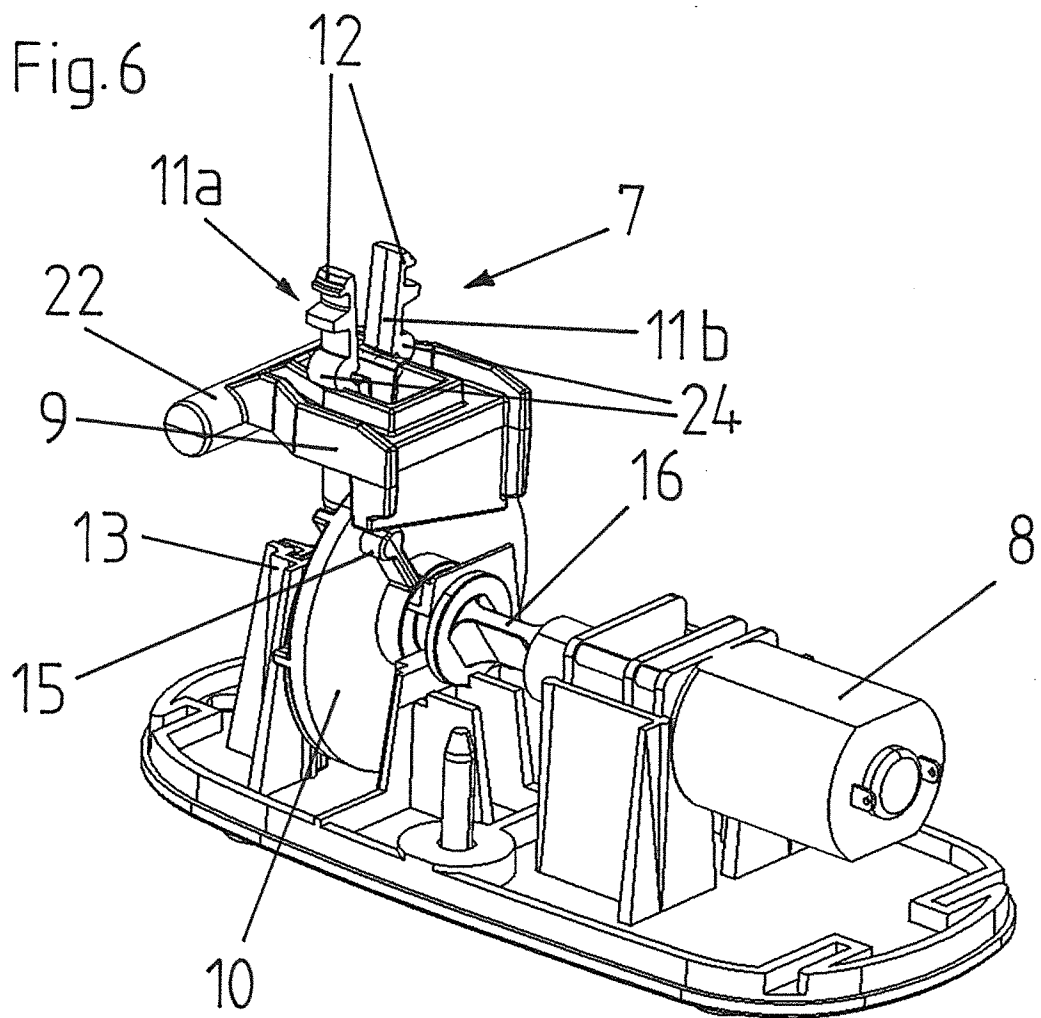


Fig.7

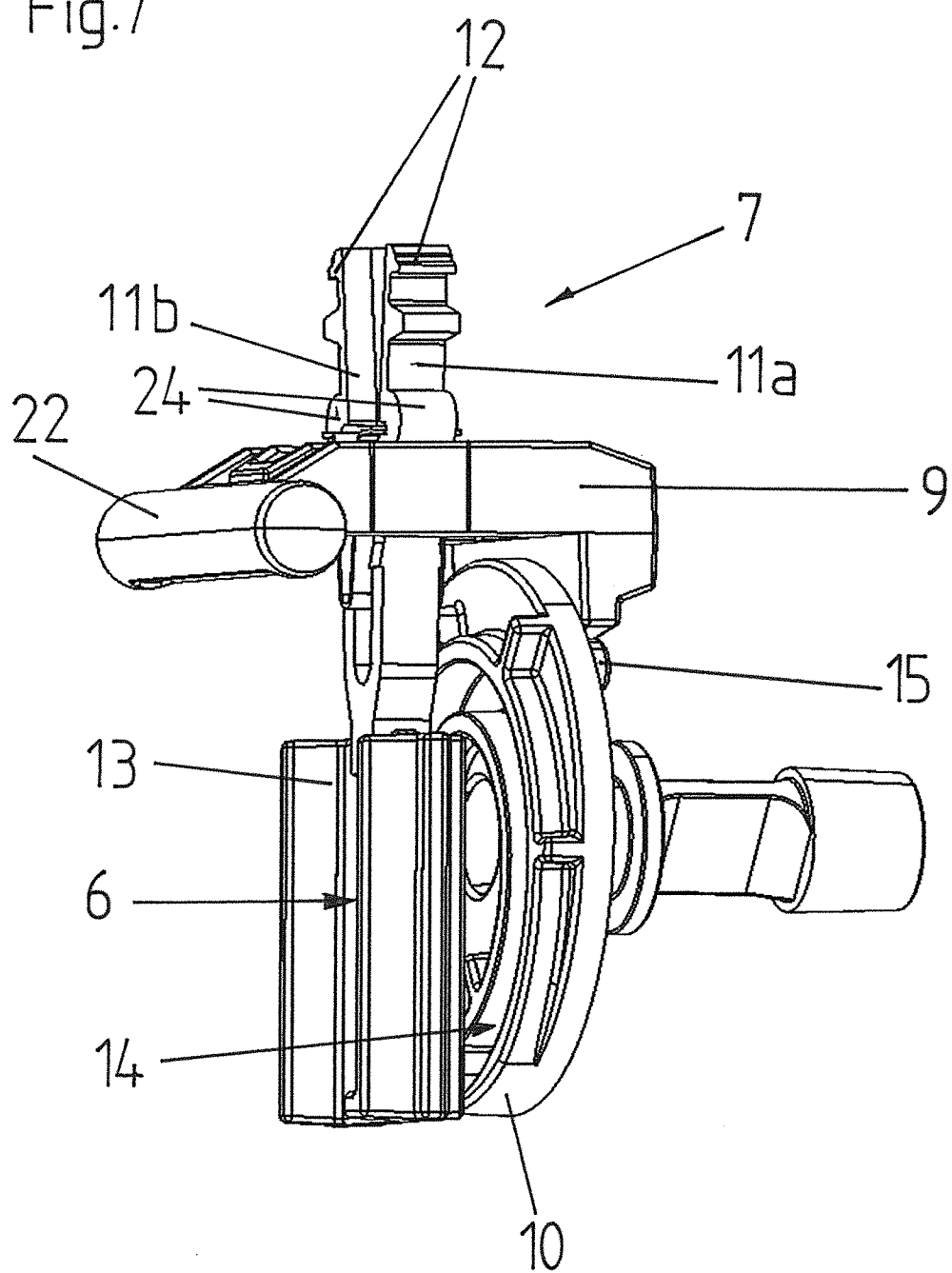
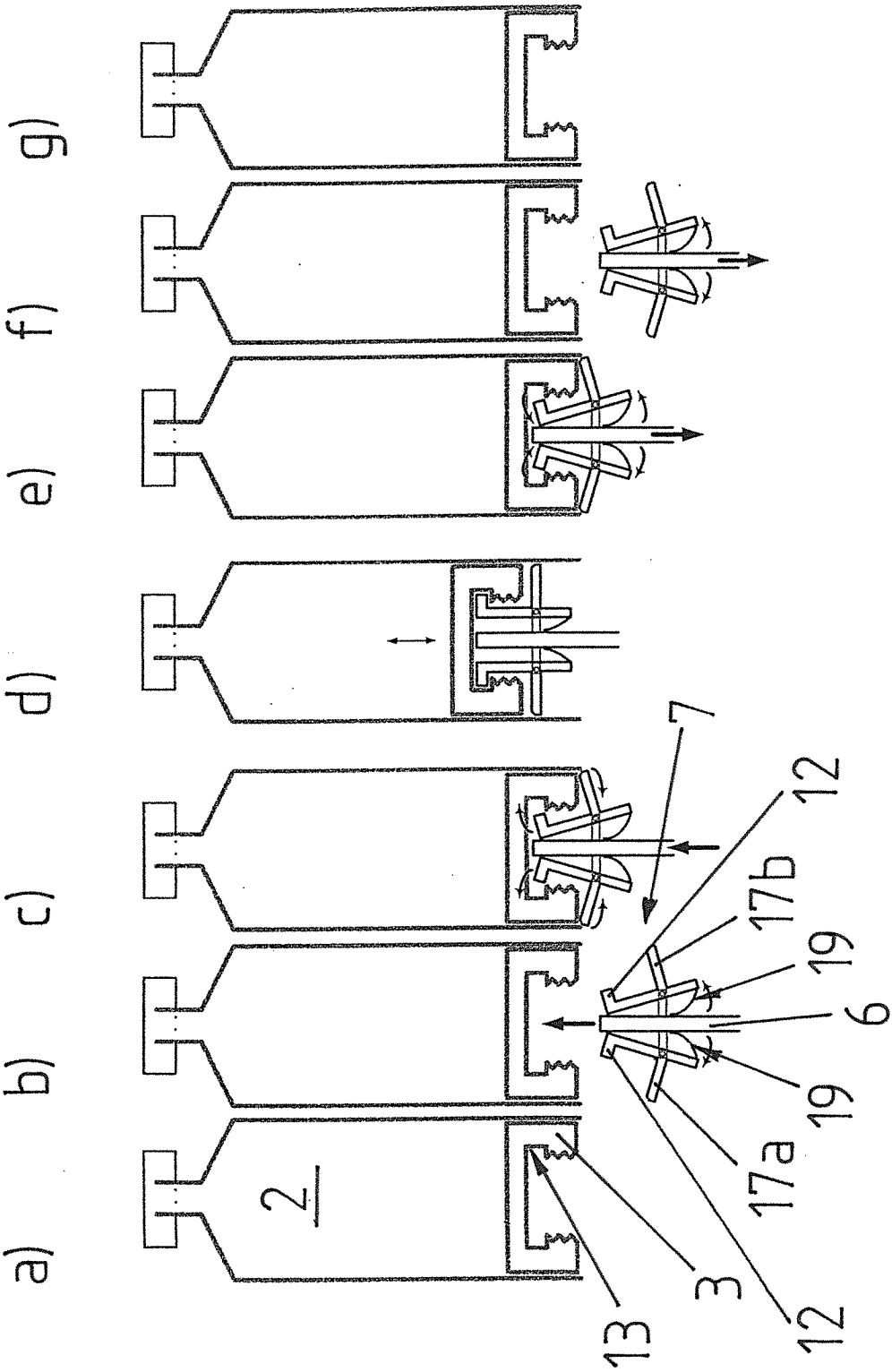


Fig.8



INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP2012/055354

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☒ Claims Nos.: 28(completely); 25(partially)
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
see FURTHER INFORMATION sheet PCT/ISA/210
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

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

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2012/055354

A. CLASSIFICATION OF SUBJECT MATTER INV. A61M5/145 A61M5/315 A61M5/178 A61J1/20 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 A61J 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	WO 2005/002652 A2 (DISETRONIC LICENSING AG [CH]; IMHOF ERICH [CH]; PETER DANIEL [CH]) 13 January 2005 (2005-01-13)	1-12, 19-24
Y	the whole document	13-18, 25-27
X	----- EP 0 170 009 A1 (MEDRAD INC [US]) 5 February 1986 (1986-02-05)	1-12, 19-24
Y	paragraph [0044] - paragraph [0047]; figure 20	13-18, 25-27
X	----- EP 1 484 071 A1 (NEMOTO KYORINDO CO LTD [JP]) 8 December 2004 (2004-12-08)	1-12, 19-24
Y	paragraph [0056] - paragraph [0065]; figures 4a-6b	13-18, 25-27
	----- -/-	
☒ Further documents are listed in the continuation of Box C. ☒ 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 3 August 2012		Date of mailing of the international search report 10/08/2012
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 Ceccarelli, David

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2012/055354

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FR 2 091 684 A5 (HAMPEL HEINZ) 14 January 1972 (1972-01-14)	1-12, 19-24
Y	the whole document	13-18, 25-27
Y	----- EP 1 779 830 A1 (INGENIUM UNIVERSAL APS [DK]) 2 May 2007 (2007-05-02) the whole document	13-18, 25-27
Y	----- US 5 336 189 A (SEALFON ANDREW I [US]) 9 August 1994 (1994-08-09) the whole document	13-18, 25-27

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2012/055354

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2005002652	A2	13-01-2005	CA 2525797 A1 13-01-2005 DE 10330094 A1 24-02-2005 EP 1642094 A2 05-04-2006 JP 2009513167 A 02-04-2009 US 2006151545 A1 13-07-2006 WO 2005002652 A2 13-01-2005
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FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box II.2

Claims Nos.: 28(completely); 25(partially)

Claim 28 defines a method for dispensing a liquid drug, which, also in the light of the description (page 23, lines 16-35), is delivered to a patient. The patient is therefore undergoing a therapy. Claim 25, from which claim 28 depends, encompasses such drug delivery methods, and therefore also seeks protection for methods for treatment of the human body by therapy. Such methods need not be searched (Rule 39.1(iv) PCT). As regards claim 28, its whole scope regards methods for treatment of the human body by therapy and is therefore not searched at all. Claim 25 has been partially searched with respect the its subject-matter not relating to methods for treatment of the human or animal body by therapy (i.e. moving the piston for filling the cartridge).

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guideline C-VI, 8.2), should the problems which led to the Article 17(2) declaration be overcome.