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WO 2002/053214 (NOVO NORDISK A/S) 11 July 2002
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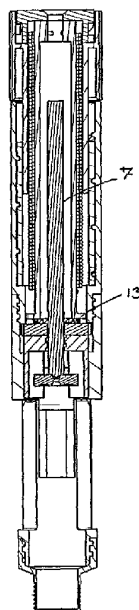
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(54) Title: INJECTION DEVICE WITH TORSION SPRING AND ROTATABLE DISPLAY



(57) Abstract: The present invention relates to an injection device comprising a torsion spring operatively connected to a dose setting member being adapted to set a dose to be ejected from the injection device. A rotatably mounted display member adapted to display the dose to be ejected in accordance with a setting of the dose setting member is also provided. The rotatably mounted display member is adapted to be rotated over an angle corresponding to at least one revolution of the display member. The display member may be implemented as a dose indicator barrel having numerals arranged along a helical path on an outer surface thereof, or alternatively, as a counting device having two or more display wheels having numerals arranged on an outer surface thereof.

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INJECTION DEVICE WITH TORSION SPRING AND ROTATABLE DISPLAY

FIELD OF THE INVENTION

5 The present invention relates to an injection device, such as a wind-up pen, wherein numerals indicating the dose to be ejected from the injection device are displayed over an angle of rotation exceeding one revolution. In particular, the numerals indicating the dose to be ejected are arranged along a helical path, or alternatively, numerals indicating the dose to be ejected are displayed on a counting device. The present invention ensures that an increased accuracy in dose setting may be obtained.

BACKGROUND OF THE INVENTION

10 Any discussion of the prior art throughout the specification should in no way be considered as an admission that such prior art is widely known or forms part of common general knowledge in the field.

15 Various types of automatic injection devices have been described in the literature. A majority of these automatic injection devices apply dose indicator barrels, dose indicator wheels or the like which, during dose setting, are only allowed to rotate less than one single revolution. The fact that the dose indicator barrel is only allowed to rotate less than one revolution during dose setting puts a limit to the obtainable angular resolution. This limited angular resolution also limits the accuracy of the dose setting procedure.

20 In prior art injection devices the dose setting scale arranged on the outer surface of the barrels or wheels contains only up to 42 scale units with an incremental of 2. Thus, the accuracy when setting a dose is limited by this rather rough incremental.

Examples of "one revolution" barrels or wheel may for example be found in US 5,725,508, EP0338806 or US 5,104,380.

25 WO 02/053214 discloses an automatic injection device having a dose indicator barrel capable of rotating more than one revolution. However, the injection device according to WO 02/053214 applies a linear spring to move a piston rod in the distal direction of the injection device. Evidently, an injection device applying a linear spring has a built-in axial displacement due to compressions and extensions of the linear spring along the axial direction of the injection device. This linear movement may easily be utilized to provide axial
30 movements of the dose indicator barrel. However, it is a disadvantage that linear springs are highly non-linear in terms of force vs. compression. In addition, a linear spring exhibits

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relative high mechanical losses. Thus, due to the problems relating to the non-linear properties and relatively high losses there is a need for injection devices having linear and more efficient injection assisting systems.

The above-mentioned problems may be solved by applying a torsion spring instead of the linear spring. An injection device applying a torsion spring is conceptually different from linear spring-based devices in that torsion-based systems do not have a built-in axial movement of the spring assisting the user in injecting a dose of medicament from the injection device. The advantages of torsion-based injection devices are many, the greatest of these probably being that torsion springs respond in a linear manner over a large working range.

Thus, there is a need for a torsion spring-based injection device providing an improved and more user friendly dose setting procedure. The present invention relates to a torsion spring-based injection device having an expanded dose scale with a high resolution.

SUMMARY OF THE INVENTION

Unless the context clearly requires otherwise, throughout the description and the claims, the words "comprise", "comprising", and the like are to be construed in an inclusive sense as opposed to an exclusive or exhaustive sense; that is to say, in the sense of "including, but not limited to".

In a first aspect there is provided, an injection device comprising:

- a housing with an inner surface provided with threads,
- a dose setting member adapted to set a dose to be ejected from the injection device,
- a torsion spring operatively connected to the dose setting member, such that energy is accumulated in the torsion spring upon rotation of the dose setting member, and released to eject the set dose automatically,
- a rotatably mounted display member threadably engaged with the threads of the housing and operatively connected with the dose setting member such that when the dose setting member is rotated in order to set a dose, the display member rotates with the dose

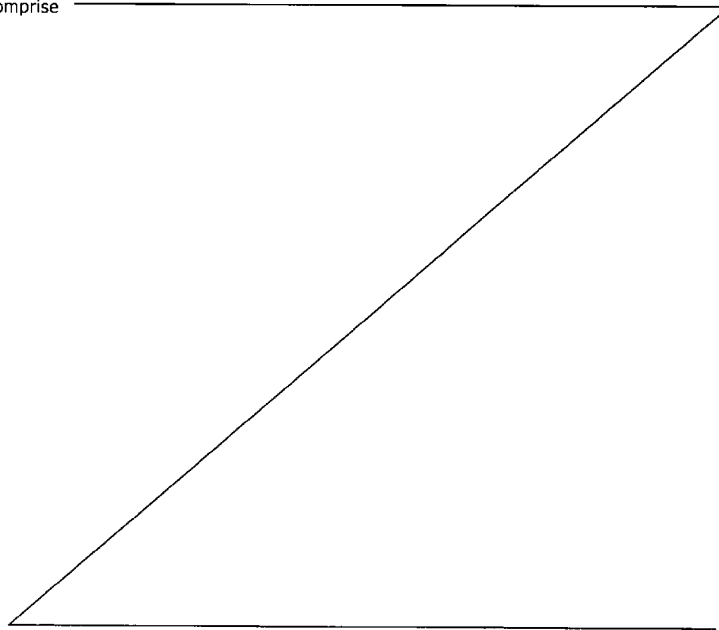
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- 5 setting member causing the display member to be axially displaced relative to the housing and adapted to display the dose to be ejected from the injection device in accordance with a setting of the dose setting member, the rotatably mounted display member being rotatable over an angle corresponding to at least one revolution of the display member.

- 10 The display member may be adapted to be moved between two end positions. These two end positions may define or set an axial operation range of the display member. The axial operation range of the display member may be associated with a substantially linear working range of the torsion spring. The working range of the torsion spring utilized to move the display member between the two end positions may constitute only a fraction of the available working range provided by the torsion spring. Thus, by applying a torsion spring only a small and linear working range of the available working range is utilized.

The display member may comprise a dose indicator barrel having numerals arranged along a helical path on an outer surface thereof.

- 15 According to a first embodiment of the present invention, the injection device may further comprise



- a housing,

- a piston rod having a threaded outer surface with a drive track arranged in a longitudinal direction of the outer surface of the piston rod,

5 wherein the dose setting member is rotatably mounted and defines a passage for the piston rod, the dose setting member further having a guiding track arranged on an inner surface thereof,

- a rotatable drive member being adapted to at least partly engage with at least part of the drive track of the piston rod so as to drive the piston rod,

10 wherein the dose indicator barrel has a part engaging at least part of the guiding track of the dose setting member, the dose setting member and the dose indicator barrel being movable in relation to each other, the dose indicator barrel further having a threaded outer surface cooperating with a threaded inner portion of the housing whereby the dose indicator barrel undergoes a combined translational and rotational movement in relation to the housing upon rotation of the dose setting member, and

15 wherein the injection device has a threaded portion cooperating with the threaded outer surface of the piston rod so that rotation of the piston rod relative to the housing results in a longitudinal movement of the piston rod.

20 It is to be understood that the drive track does not necessarily extend over the full length of the piston rod. For example, the drive track may in some cases only extend over a part of the full length of the piston rod. Also, the drive track arranged in the piston rod may be an indentation or groove in the longitudinal direction of the piston rod. Alternatively, it may also be a planar surface or two opposing planar surfaces.

Similarly, it is to be understood that other arrangements in terms of the positioning of the threaded portion of for example the dose indicator barrel may be arranged differently.

25 According to a second embodiment of the present invention, the injection device further comprises

- a housing,

- a piston rod having a threaded outer surface with a track arranged in a longitudinal direction of the outer surface of the piston rod,

wherein the dose setting member is rotatably mounted and defines a passage for the piston rod, the dose setting member further having a guiding track arranged on an inner surface thereof,

- a rotatable drive member having a threaded portion cooperating with at least part of the threaded outer surface of the piston rod,

wherein the dose indicator barrel has a part engaging at least part of the guiding track of the dose setting member, the dose setting member and the dose indicator barrel being movable in relation to each other, the dose indicator barrel further having a threaded outer surface cooperating with a threaded inner portion of the housing whereby the dose indicator barrel undergoes a combined translational and rotational movement in relation to the housing upon rotation of the dose setting member, and

wherein the injection device has a portion at least partly engaging the track of piston rod so that rotation of the drive member relative to the housing results in a longitudinal movement of the piston rod.

The drive member may be adapted to be connected to the dose setting member via a ratchet. This ratchet allows the dose setting member to be rotated in both directions so that a given dose may be either increased or reduced. Due to the force provided by the torsion spring onto the ratchet, the dose setting member will remain in any position - i.e. dose value - to which it has been brought.

The dose setting member may be adapted to be separated from the driving member. This separation may be achieved in several ways. In one way the separation may be obtained by a retraction of the dose setting member in the axial direction of the injection device. The retraction of the dose setting member must be over a distance sufficient to detach the dose setting member or the drive member from the teeth of the ratchet. Other separation mechanisms, such as pushing the dose setting member or twisting the dose setting member are also applicable.

The torsion spring may be arranged between the housing and the dose setting member in such a way that when the dose setting member is rotated around the piston rod, the torsion spring is strained. The torsion spring may be a helical spring which extends coaxially with the

piston rod, and which interconnects the housing and the dose setting member in such a way that rotation of the dose setting member, in order to set the dose, strains the torsion spring.

The injection device may further comprise a locking member adapted to fixate the piston rod in such a way that no relative rotation of the piston rod and the housing is possible when the locking member is in its locking position. This fixation may be provided by a direct engagement of the locking member into the track of the piston rod, or via the drive member. The injection device may further comprise a release button adapted to release the locking member from its locking position. Preferably, the release button is positioned in the distal half of the length of the injection device.

The injection device may further comprise a first stopping member for defining an outer position of the dose indicator barrel. This outer position of the dose indicator barrel may correspond to a maximum obtainable dose. Another outer position of the dose indicator barrel, given by a second stopping member, may define a stop for providing further doses. The stopping members may form integral parts of the inner surface of the housing.

In a third embodiment, the display member may comprise a counting device having two or more display wheels having numerals arranged on an outer surface thereof. In this second embodiment the counting device may have a first and a second wheel. When the dose setting member is rotated, the first wheel is rotated via an optional gear mechanism, such as a planet gear. This first wheel may contain numerals with an incremental of one. The total scale on this wheel may be from 0 to 9. The second wheel next to the first wheel also contains numerals with an incremental of 1. However, this second wheel "counts" the number of revolutions of the first wheel, or alternatively, it "counts" the tens of the first wheel with an incremental of one.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will now be described in further details with reference to the accompanying figures, wherein

Fig. 1 shows a cross-sectional view of a first embodiment of the injection device according to the present invention,

Fig. 2 shows a cross-sectional view (rotated 90 degrees compared to Fig. 1) of a first embodiment of the injection device according to the present invention,

Fig. 3 shows a detailed cross-sectional view of a first embodiment of the present invention,

Fig. 4 shows a detailed cross-sectional view of a second embodiment of the present invention, and

Fig. 5 shows a detailed cross-sectional view of a third embodiment of the present invention.

While the invention is susceptible to various modifications and alternative forms, specific embodiments have been shown by way of example in the drawings and will be described in detail herein. It should be understood, however, that the invention is not intended to be limited to the particular forms disclosed. Rather, the invention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the appended claims.

0 DETAILED DESCRIPTION OF THE INVENTION

In its most general aspect the present invention relates to an injection device comprising a torsion spring in combination with a rotatable dose indicator mechanism capable of being rotated at least one revolution - i.e. over an angle larger than 360 degrees. For example, the dose indicator mechanism may be implemented as a barrel (see Figs. 1-4) or as interconnected wheels (see Fig. 5), the latter being operated as a counting device. In order to increase the angular resolution compared to known dose indicator mechanisms the dose indicator mechanism of the present invention is rotatable over an angle of rotation corresponding to at least one revolution. The fact that the dose to be ejected is displayed over at least one revolution allows that the dose setting scale may contain at least 50, 60, 70, 80, 90, 100 units with an incremental of one.

Figs. 1-3 show a cross-sectional view of the injection device according to a first embodiment of the present invention. The dose of medicament to be ejected from the injection device is set by rotating dose setting member 1. The dose setting member 1 is attached to the housing 5 of the injection device via torsion spring 12. When the dose setting member 1 is rotated in order to set a dose to be ejected from the injection device, energy is accumulated in torsion spring 12. This energy may be released by releasing locking member 4 whereby the piston rod 2 will rotate and move in the distal direction of the injection device. The distal movement of the piston rod 2 is caused by a rotational movement of the piston rod 2 itself in that the piston rod 2 has a threaded outer surface. The threads of the piston rod 2 engage and co-operate with a threaded portion 3 of the injection device causing the piston rod 2 to perform the distal and axial movement.

The inner surface of housing 5 of the injection device is provided with threads 10. These threads are adapted to engage and co-operate with outer threads 8 of a dose indicator barrel

9. The dose indicator barrel 9 engages with sliding track 11 of the dose setting member 1 in such a way that the dose indicator barrel 9 is able to slide in said sliding track 11 in an axial direction of the injection device.

5 When the dose setting member 1 is rotated in order to set a dose, the dose indicator barrel 9 rotates with the dose setting member 1 causing the dose indicator barrel 9 to be axially displaced relative to the housing 5. A window is provided in the housing 5 of the injection device. Through this window, the user of the injection device may view the actual dose setting level from numerals (not shown) provided on an exterior surface of the dose indicator barrel 9. The numerals are arranged along a helical path.

10 An advantage of having the numerals arranged along a helical-like path is that a higher angular resolution is obtainable when a dose is to be set. Due to this higher angular resolution a dose can be set with a significantly higher accuracy. This greater accuracy is obtained since the helical-like path allows for more numerals to be arranged on the dose indicator barrel 9 compared to numerals arranged at the same height on the surface of the
15 dose indicator barrel 9.

When a dose has been ejected from the injection device, the dose indicator barrel 9 is adapted to be rotated back to its initial position and it is thereby ready to be set to a new dose. The same applies for an injection device applying a counting device as a dose meter.

20 As already mentioned, the piston rod 2 has a threaded outer surface. This threaded outer surface engages and co-operates with a threaded portion 3 of the injection device. The piston rod 2 is driven by the drive member 6 that engages a track in piston rod 2. The axial movement of the piston rod 2 is provided by rotating piston rod 2 in the threaded portion 3 of the injection device. Drive member 6 may be locked by the locking member 4. In its locked position, drive member 6 is prevented from rotating. In order to release the drive
25 member 6, the user of the injection device may activate a spring-loaded push button 15 whereby drive member 6 causes the piston rod 2 to rotate in threaded part 3 of the housing whereby the piston rod 2 rotates and travels in the distal direction of the injection device. Thus, when the drive member 6 is released, the injection device ejects automatically. During ejection, the dose indicator barrel returns to zero dose.

30 The dose setting member 1 and the drive member 6 are mechanically connected via a self-tightening ratchet 13. Preferably, the self-tightening ratchet 13 has saw-toothed teeth with approximately vertical oriented flanks as the self-tightening flanks.

In order to reset or reduce an already set dose, the dose setting member 1 is arranged to be axially retractable over a distance corresponding to the height of the teeth of the one-way ratchet 13. Thus, by pulling the dose setting member 1 back, and thereby disengage the dose setting member 1 from the drive member 6, an already set dose can be reduced or even reset. The amount of reduction obviously depends on the angle of rotation (in the opposite rotation direction as when a dose is set) of the dose setting member 1.

The self-tightening ratchet may be formed as a separate component having first and second engaging parts. Alternatively, one of these parts may form an integral part of the dose setting member 1, or alternatively, an integral part the drive member 6.

Fig. 4 shows a second embodiment of the present invention. Compared to the first embodiment, the drive member 6 has a threaded portion cooperating with the threaded outer surface of the piston rod 2. The main difference compared to the first embodiment is that the piston rod 2 is no longer rotatable relative to the housing 5. This non-rotatable relationship is ensured in that the housing of the injection device has a key 14 which at least partly engages the track 7 of piston rod 2. Thus, when the drive member 6 is free to rotate relative to the housing 5 the piston rod 2 will undergo a translational movement along the axial direction of the injection device.

Fig. 5 shows a third embodiment of the present invention. In this embodiment the dose indicator barrel of the first and second embodiment has been replaced by a counting device having two wheels 15, 16. In principle the number of wheels may be chosen arbitrary, but for simplicity, a counting device having only two wheels is illustrated in Fig. 5. The counting device is operated as follows: When the dose setting member 1 is rotated, the wheel closest to the dose setting member 15 is rotated via an optional planet gear 17. This wheel contains numerals with an incremental of one. The total scale on this wheel may contain 10 units distributed over a scale from 0 to 9, or alternatively, the total scale may contain for example 20 units distributed over two scales each having a scale from 0 to 9.

The second wheel 16 next to the first wheel 15 also contains numerals with an incremental of 1. However, this second wheel "counts" the number of revolutions of the first wheel, or alternatively, it "counts" the tens of the first wheel with an incremental of one. Alternatively, the second wheel "counts" the number of half resolutions of the first wheel in case the first wheel contains a scale having 20 units.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:-

1. An Injection device comprising
 - a housing with an inner surface provided with threads,
 - a dose setting member adapted to set a dose to be ejected from the injection device,
 - a torsion spring operatively connected to the dose setting member, such that energy is accumulated in the torsion spring upon rotation of the dose setting member, and released to eject the set dose automatically,
 - a rotatably mounted display member threadably engaged with the threads of the housing and operatively connected with the dose setting member such that when the dose setting member is rotated in order to set a dose, the display member rotates with the dose setting member causing the display member to be axially displaced relative to the housing and adapted to display the dose to be ejected from the injection device in accordance with a setting of the dose setting member, the rotatably mounted display member being rotatable over an angle corresponding to at least one revolution of the display member.
2. An injection device according to claim 1, wherein the display member is adapted to be moved between two end positions, said two end positions defining an operation range of the display member, said operation range being associated with a substantially linear working range of the torsion spring.
3. An injection device according to claim 1 or claim 2, wherein the display member comprises a dose indicator barrel having numerals arranged along a helical path on an outer surface thereof.
4. An injection device according to claim 2 or claim 3, further comprising
 - a housing,
 - a piston rod having a threaded outer surface with a drive track arranged in a longitudinal direction of said outer surface,
 wherein the dose setting member is rotatably mounted and defines a passage for the piston rod, the dose setting member further having a guiding track arranged on an inner surface thereof,
 - a rotatable drive member being adapted to at least partly engage with at least part of the drive track of the piston rod so as to drive the piston rod,

wherein the dose indicator barrel has a part engaging at least part of the guiding track of the dose setting member, the dose setting member and the dose indicator barrel being movable in relation to each other, the dose indicator barrel further having a threaded outer surface cooperating with a threaded inner portion of the housing whereby the dose indicator barrel undergoes a combined translational and rotational movement in relation to the housing upon rotation of the dose setting member, and wherein the injection device has a threaded portion cooperating with the threaded outer surface of the piston rod so that rotation of the piston rod relative to the housing results in a longitudinal movement of the piston rod.

5. An injection device according to claim 2 or claim 3, further comprising
- a housing,
 - a piston rod having a threaded outer surface with a track arranged in a longitudinal direction of said outer surface,

wherein the dose setting member is rotatably mounted and defines a passage for the piston rod, the dose setting member further having a guiding track arranged on an inner surface thereof,

- a rotatable drive member having a threaded portion cooperating with at least part of the threaded outer surface of the piston rod,

wherein the dose indicator barrel has a part engaging at least part of the guiding track of the dose setting member, the dose setting member and the dose indicator barrel being movable in relation to each other, the dose indicator barrel further having a threaded outer surface cooperating with a threaded inner portion of the housing whereby the dose indicator barrel undergoes a combined translational and rotational movement in relation to the housing upon rotation of the dose setting member, and

wherein the injection device has a portion at least partly engaging the track of piston rod so that rotation of the drive member relative to the housing results in a longitudinal movement of the piston rod.

6. An injection device according to claim 4 or claim 5, wherein the drive member is adapted to be connected to the dose setting member via a ratchet.

7. An injection device according to any of claims 4 to 6, wherein the torsion spring is arranged between the housing and the dose setting member in such a way that when the dose setting member is rotated around the piston rod, the torsion spring is strained.

8. An injection device according to claim 7, wherein the torsion spring is a helical spring which extends coaxially with the piston rod.

9. An injection device according to any of claims 4 to 8, further comprising a locking member adapted to fixate the piston rod in such a way that no relative rotation between of the piston rod and the housing is possible when the locking member is in its locking position.

5 10. An injection device according to claim 9, further comprising a release button adapted to release the locking member from its locking position.

11. An Injection device according to claim 10, wherein the release button is positioned in the distal half of the length of the injection device.

10 12. An Injection device according to any of claims 4 to 11, further comprising a stopping member for defining an outer position of the dose indicator barrel, the outer position of the dose indicator barrel corresponding to a maximum obtainable dose.

13. An injection device substantially as herein described with reference to any one of the embodiments of the invention illustrated in the accompanying drawings and/or examples.

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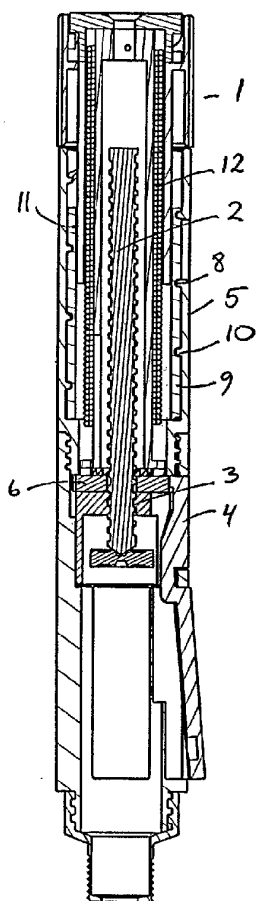


Fig. 1

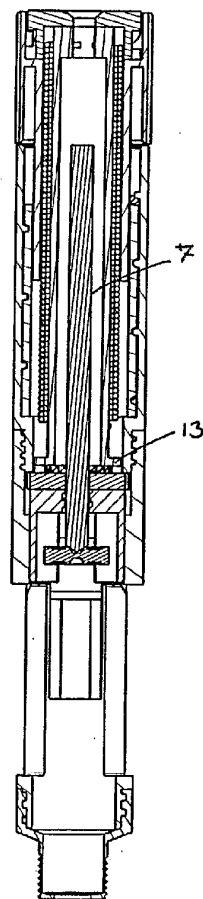


Fig. 2

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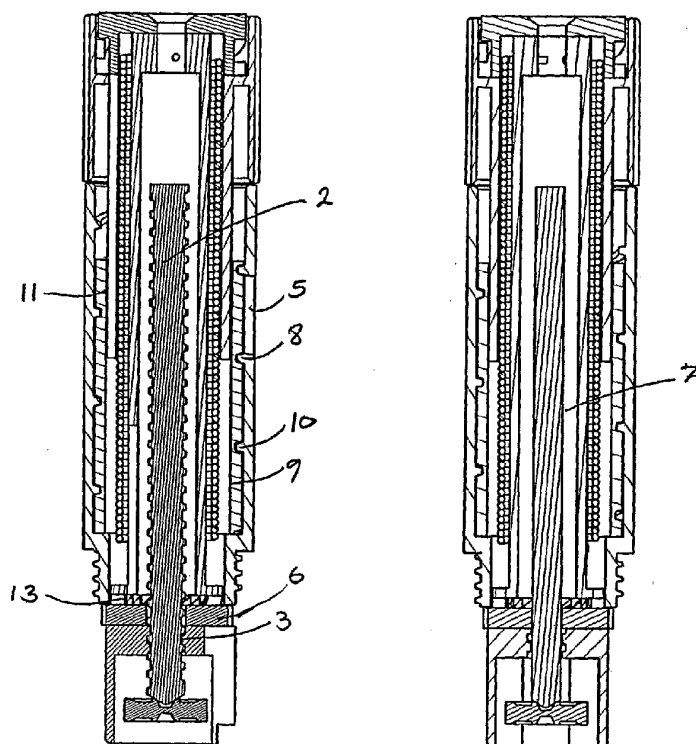


Fig. 3

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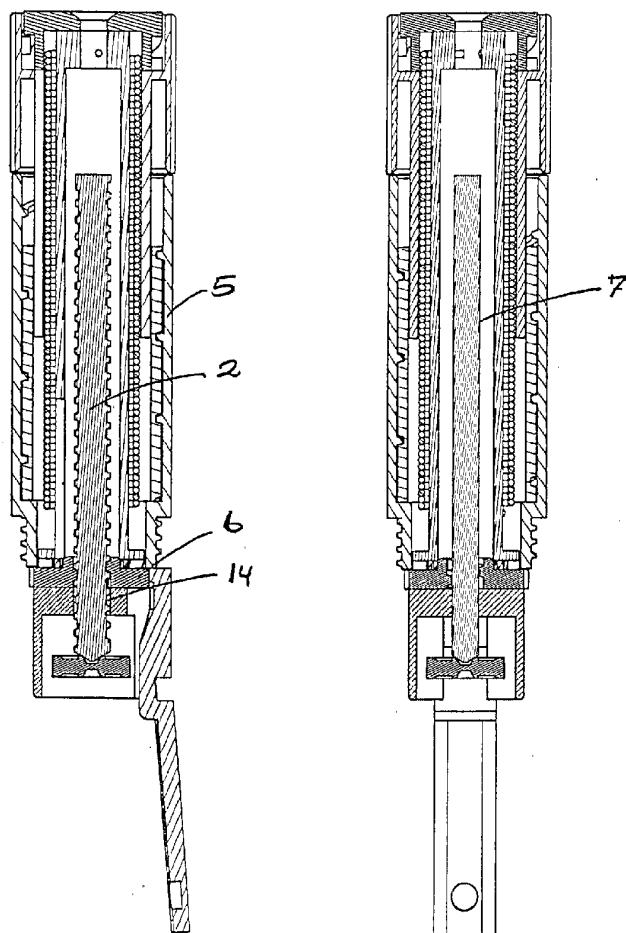


Fig. 4

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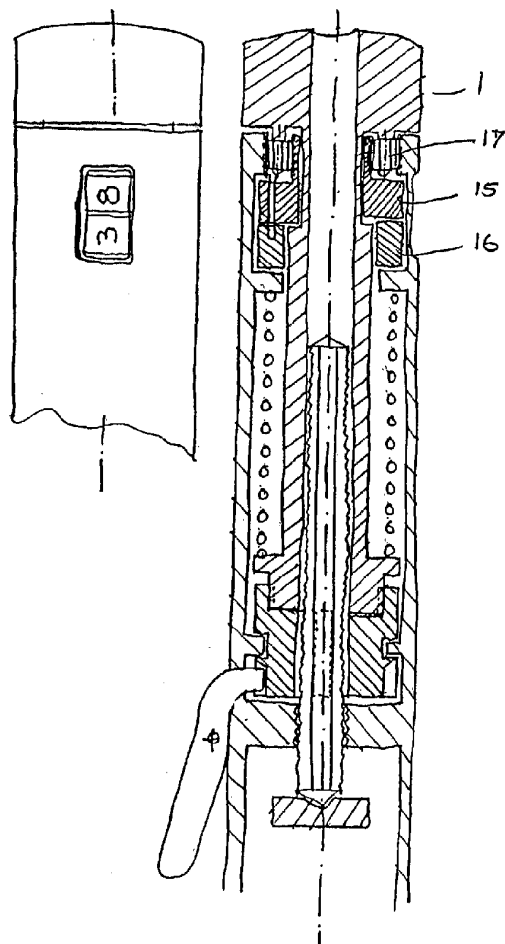


Fig. 5