



(86) Date de dépôt PCT/PCT Filing Date: 2004/07/28

(87) Date publication PCT/PCT Publication Date: 2005/05/26

(45) Date de délivrance/Issue Date: 2011/11/29

(85) Entrée phase nationale/National Entry: 2005/09/15

(86) N° demande PCT/PCT Application No.: EP 2004/008422

(87) N° publication PCT/PCT Publication No.: 2005/046770

(30) Priorité/Priority: 2003/11/03 (DE203 17 377.5)

(51) Cl.Int./Int.Cl. *A61M 5/315* (2006.01)

(72) Inventeurs/Inventors:

GABRIEL, JOCHEN, DE;
KEITEL, JOACHIM, DE

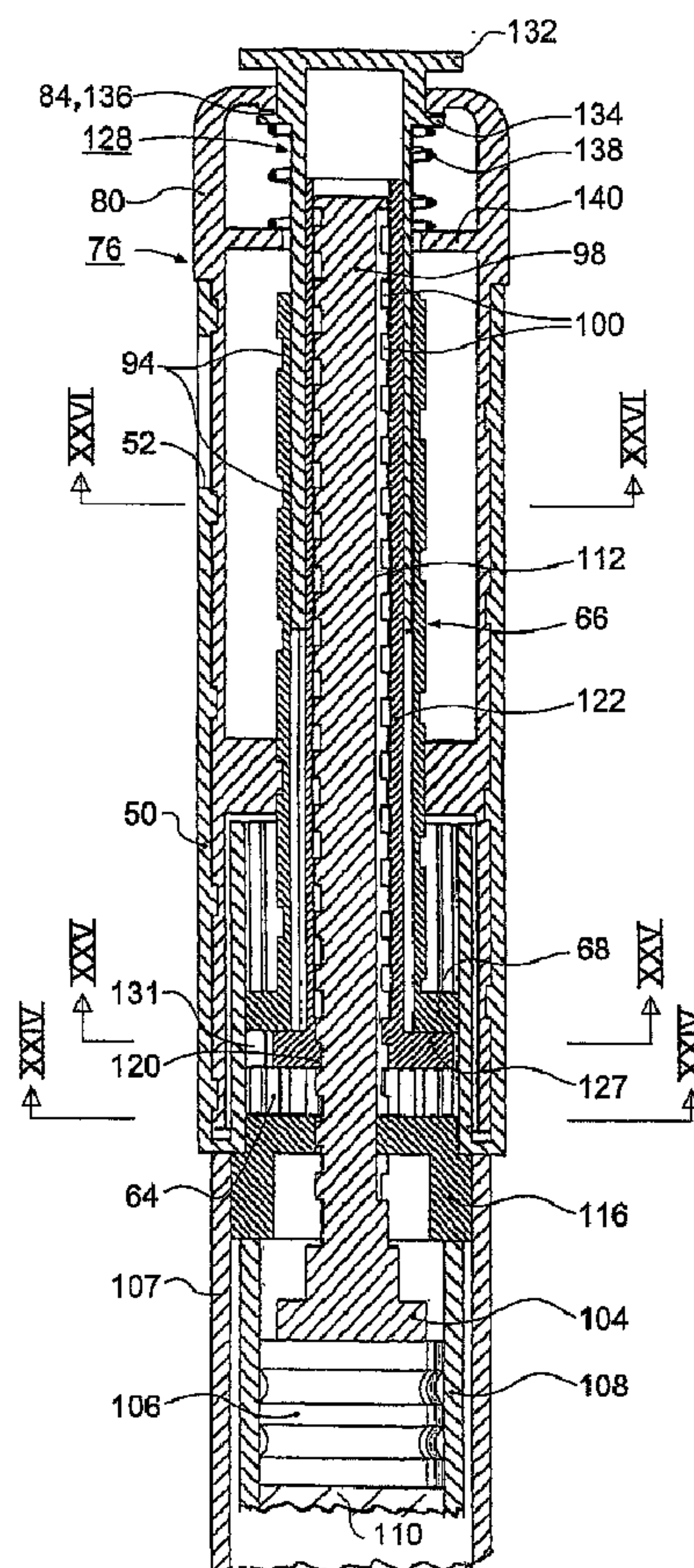
(73) Propriétaire/Owner:

HASELMEIER GMBH, CH

(74) Agent: GOWLING LAFLEUR HENDERSON LLP

(54) Titre : APPAREIL D'INJECTION

(54) Title: INJECTION APPARATUS



(57) Abrégé/Abstract:

An injection apparatus comprises a barrel (50) that is implemented to receive a container (108) with injection fluid (110). It further comprises a piston rod (98), provided with a thread (100), for expelling injection fluid (110) from such a container (108), which

(57) **Abrégé(suite)/Abstract(continued):**

piston rod (98) is guided relative to the barrel (50) in the axial direction (112, 114). Additionally provided is a threaded part (122) whose thread (120) is in engagement with the thread (100) of the piston rod (98), which threaded part (122) is rotatable relative to the piston rod (98) and relative to the barrel (50) in order to set an injection dose, and in that context is axially displaced relative to the piston rod (98) and relative to the barrel (50), which threaded part (122) is also displaced in the injection direction relative to the barrel (50) during an injection operation, and in that context is prevented from rotating relative to the piston rod (98).

ABSTRACT

An injection apparatus comprises a barrel (50) that is implemented to receive a container (108) with injection fluid (110). It further comprises a piston rod (98), provided with a thread (100), for expelling injection fluid (110) from such a container (108), which piston rod (98) is guided relative to the barrel (50) in the axial direction (112, 114). Additionally provided is a threaded part (122) whose thread (120) is in engagement with the thread (100) of the piston rod (98), which threaded part (122) is rotatable relative to the piston rod (98) and relative to the barrel (50) in order to set an injection dose, and in that context is axially displaced relative to the piston rod (98) and relative to the barrel (50), which threaded part (122) is also displaced in the injection direction relative to the barrel (50) during an injection operation, and in that context is prevented from rotating relative to the piston rod (98).

(FIG. 23)

INJECTION APPARATUS

The invention concerns an injection apparatus in which a piston rod is guided in the axial direction.

5 With injection apparatuses, it is desirable for their operation to be easily understandable, i.e. intuitive, and for the patient to have good control over the injection operation, i.e. to be able to understand what is happening.

10 It is therefore an object of the invention to make a new injection apparatus available.

According to the invention, this object is achieved by an injection apparatus that comprises: a barrel that is implemented to receive a container with injection fluid; a piston rod, provided with a thread, for expelling injection
15 fluid from such a container, the piston rod being guided non-rotatably relative to the barrel and in an axial direction. The threaded part is provided with a thread, which is in engagement with the thread of the piston rod. The threaded part is implemented so that its axial location
20 relative to the barrel is modifiable, the threaded part being rotatable relative to the piston rod and relative to the barrel in order to set an injection dose. Therefore the threaded part may be moved, upon setting, in the axial direction relative to the piston rod and relative to the
25 barrel. The threaded part is non-rotatable relative to the piston rod and relative to the barrel in the context of an injection operation, and therefore moving, in the context of an injection operation, in the axial direction relative to the housing and in the injection direction.

30 Before an injection, the patient sets a desired injection dose by rotating the threaded part relative to the piston rod and relative to the barrel, the threaded part being displaced axially relative to the piston rod and relative to the barrel. After insertion of the needle the
35 patient then performs the injection, the threaded part being displaced axially in the injection direction relative

to the barrel and moving together with the piston rod, i.e. not performing a relative motion relative to the latter, since it is prevented from rotating relative to it. A sophisticated interplay of rotary motions and axial motions is thus used on the one hand to set the dose, and on the other hand to inject the previously set dose after the setting operation. Operation in this manner is intuitively easy to understand.

If the patient has inadvertently set the dose too high, he can reduce it again. With an apparatus according to the invention, this "dose correction" is just as simple as setting the dose itself, and is easy to understand.

Further details and advantageous refinements of the invention are evident from the exemplary embodiments, in no way to be understood as a limitation of the invention, that are described below and depicted in the drawings, and from the dependent claims. In the drawings:

FIG. 1 is a side view of the barrel of an injection apparatus according to a preferred embodiment of the invention;

FIG. 2 is an axial section through the barrel of FIG. 1, viewed along line II-II of FIG. 3;

FIG. 3 is a view in the direction of arrow III of FIG. 2;

FIG. 4 is a side view of a setting member serving for dose setting, which is also referred to as a "scale tube";

FIG. 5 is a longitudinal section through the setting member of FIG. 4;

FIG. 6 is a plan view of a pushing member that, in this embodiment, is provided with an external thread;

FIG. 7 is a longitudinal section through the pushing member of FIG. 6, viewed along line VII-VII of FIG. 8;

FIG. 8 is a view in the direction of arrow VIII of FIG. 6;

FIG. 9 is a longitudinal section through a partially assembled injection apparatus according to the invention, in its state after an injection and before an injection dose is set;

5 FIG. 10 is a longitudinal section through an arrangement according to FIG. 9, but after an injection dose is set;

FIG. 11 is a side view in the direction of arrow XI of FIG. 9, the injection apparatus being in the position for
10 the zero dose;

FIG. 12 is a side view analogous to FIG. 11, the injection apparatus being, however, in a position for the 40-unit dose;

FIG. 13 is a plan view of a piston rod, provided with
15 an external thread (left-hand thread), that serves to expel injection fluid from a container (cartridge), viewed in the direction of arrow XIII of FIG. 14;

FIG. 14 is a section through the piston rod, viewed along line XIV-XIV of FIG. 13;

20 FIG. 15 is a plan view of a threaded part that is also referred to as an "advancing part";

FIG. 16 is a longitudinal section through the threaded part of FIG. 15, viewed along line XVI-XVI of FIG. 17;

FIG. 17 is a section viewed along line XVII-XVII of
25 FIG. 15;

FIG. 18 is a plan view of a follower that serves, in certain operating states, to couple the threaded part (FIGS. 5 through 17) to the setting member (FIGS. 4 and 5) in such a way that said part rotates along with said
30 member, but is freely displaceable axially relative to the setting member;

FIG. 19 is a longitudinal section through the follower of FIG. 18, viewed along line XIX-XIX of FIG. 20;

FIG. 20 is a section viewed along line XX-XX of FIG.
35 18;

FIG. 21 is a section through a guidance member that serves for axial guidance of the piston rod in the barrel, viewed along line XXI-XXI of FIG. 22;

FIG. 22 is a view of the guidance member of FIG. 21 in
5 the direction of arrow XXII of FIG. 21;

FIG. 23 is a schematic longitudinal section through an injection apparatus in the assembled state and before an injection dose is set;

FIG. 24 is a section viewed along line XXIV-XXIV of
10 FIG. 23;

FIG. 25 is a section viewed along line XXV-XXV of FIG. 23;

FIG. 26 is a section viewed along line XXVI-XXVI of FIG. 23;

FIG. 27 is a longitudinal section analogous to FIG. 23, but after the setting of an injection dose;

FIG. 28 is a longitudinal section analogous to FIGS. 23 and 27, but during an injection;

FIG. 29 shows a variant of the injection apparatus
20 according to FIGS. 1 through 28, the injection operation being assisted by an energy that is stored in the apparatus by the user while setting the dose;

FIG. 30 shows a second variant that likewise uses the servo assistance of FIG. 29, but in which measures are
25 taken so that the length of torsional spring 148 that is used does not change during operation;

FIG. 31 is a section viewed along line XXXI-XXXI of FIG. 30; and

FIG. 32 is an overall depiction of the injection
30 apparatus.

The description below first explains the general construction and mode of operation of the invention with reference to greatly enlarged and schematized depictions. That is followed by a specific exemplary embodiment in the
35 form of a so-called "pen injector." In the description, the same reference characters are used in each case for

identical or identically functioning parts, and those parts are usually described only once.

Directions of motion are indicated in the manner usual in medicine, i.e.

5 proximal = toward the patient, i.e. in the direction toward the injection needle;

 distal = away from the patient, i.e. in the direction away from the injection needle.

FIG. 1 is a side view of a barrel 50 that has a
10 cylindrical outer side comprising a window 52 that serves for (mechanical) display of the injection dose (see FIG. 12, where a display of 40 units is depicted as an example).

Barrel 50, made of a suitable plastic, has an external tube 54 and an internal tube 56 concentric therewith, which
15 are joined to one another by a bridge part 58 (FIGS. 2 and 3) in such a way that an annular space 60 is formed between them. Internal tube 56 has a length that, in the exemplary embodiment, is equal to approximately four-tenths of the length of external tube 54. Its distal end is labeled 61.

20 Implemented in external tube 54 is an internal thread 62 that, in the exemplary embodiment, is implemented as a coarse thread having an approximately rectangular cross section of the threads, in this case (as an example) as a left-hand thread having a pitch of 10 mm per revolution
25 (the depictions are enlarged for illustrative purposes).

 Provided in this embodiment in internal tube 56 is a spline set 64 whose shape is evident from FIGS. 2 and 3. It has, in this case, twenty longitudinal grooves 65, between which are elevations 67. FIGS. 24 and 25 show spline set 64
30 at a greatly enlarged scale. It serves for axial guidance of a pushing member 66 that is depicted in FIGS. 6 through 8. The latter has at its proximal end a head portion 68 with an enlarged diameter, and provided on that portion is a spline set 70 that is complementary to spline set 64 and
35 is guided therein (see, for example, FIGS. 9 and 10). The proximal end of head portion 68 is labeled 69.

External thread 74 of a setting member 76 (FIGS. 4 and 5) is guided in internal thread 62 (FIG. 2). That member has, between its threads, surfaces on which is applied a dose scale 78 ranging, for example, from "0" to "60," so that setting member 76 can also be called a "scale tube." FIG. 4 shows some of the scale numbers by way of example. Member 76 has at its distal end a setting knob 80 which serves for setting the injection dose and with which the patient injects, by axial pressure, the dose that was set (see FIG. 28 below). Provided in knob 80 is a central opening 82 at whose rim a tooth set 84 is implemented on the proximal side.

Implemented in the interior of setting member 76, on a thread carrier 90 projecting radially inward, is an internal thread 86 that is implemented here as a left-hand coarse thread having a pitch of, for example, 7 mm per revolution. Its threads preferably also have a rectangular cross section.

As is apparent from FIG. 9, thread carrier 90 is provided at a distance from proximal end 88 of setting member 76 such that the latter can be screwed completely into annular space 60 (FIG. 2), thread carrier 90 coming to a stop with its proximal side 92 against distal end 61 of internal tube 56. The distal side of thread carrier 90 is labeled 93.

FIGS. 6 through 8 show pushing member 66. This has an outer thread (left-hand thread) 94 that, in the assembled state (FIGS. 9 and 10), engages into internal thread 86 of setting member 76, so that a rotation of setting member 76 in which it is rotated in the direction of an arrow 96 (FIG. 4) moves setting member 76 in the distal direction, while the same rotation moves pushing member 66 in the proximal direction relative to setting member 76. Pushing member 66 has a cylindrical internal opening 67 that transitions, at the left in FIG. 7, into shoulder 69 extending radially outward.

FIG. 9 shows the above-described parts prior to setting of an injection dose, the "0" dose being displayed in window 52 as shown in FIG. 11. Proximal end 69 of pushing member 66 is here at a distance L1 from the proximal end of bridge part 58.

FIG. 10 shows the parts after setting of a large injection dose, namely after three complete revolutions of setting member 76. The latter has thereby been displaced, for example, 30 mm in the distal direction. At the same time, pushing member 66 has been displaced a distance L3, for example 21 mm, in the proximal direction relative to thread carrier 90. The effect is that proximal end 69 of pushing member 66 has been displaced, as compared with FIG. 9, a distance

$$L4 = L2 - L3 \quad (1)$$

in the distal direction, i.e. in this case

$$30 - 21 = 9 \text{ mm} \quad (2).$$

Those 9 mm are the distance that then determines the injection dose that is injected. This is the result of the fact that pushing member 66, via its spline set 70 (FIGS. 6 and 8), is guided axially in spline set 64 of barrel 50.

With regard to pushing member 66, the same effect would result if the latter were axially guided in part 90 and were driven by an internal thread in internal tube 56. This is referred to as "kinematic reversal," i.e. the two drive connections for pushing member 66 are interchangeable. With the latter variant, the thread would need to be arranged between the outer side of part 68 and the inner side of internal tube 56, i.e. in place of axial guidance system 64, 76. The version depicted is preferred, however, because spline set 64 in the context of the present invention also has the function of a ratchet that becomes effective during dose setting.

Dose setting thus produces oppositely directed motions, i.e. setting member 76 moves rapidly in the distal direction, and pushing member 66 simultaneously moves,

somewhat more slowly, relative to setting member 76 in the proximal direction; as the final result, proximal end 69 of pushing member 66 is displaced a relatively short distance L4 in the distal direction. The arrangement according to
 5 FIGS. 9 and 10 thus acts as a linear gear linkage, and the large motion of setting member 76 has the advantage that a dose can be displayed (in window 52) with large, easily readable digits 78 (see FIGS. 11 and 12). A dose that was inadvertently set too high can also be corrected manually
 10 by turning the setting knob 80, distance L4 then becoming smaller again. In addition, the patient can accurately observe in window 52, during injection, how much he has already injected. Many patients want to have this information.

15 FIGS. 13 and 14 show a threaded rod 98 that is provided with a rectangular coarse thread 100 that, as depicted, is a left-hand thread and has a thread pitch equal, in this example, to 3 mm per revolution. Piston rod 98 has at its distal end a stop 102 that prevents it from
 20 being screwed all the way out; and at its proximal end, i.e. at the bottom in FIGS. 13 and 14, it has a pusher plate 104 with which, in the assembled state as shown in FIG. 23, it rests against rubber piston 106 of a cartridge 108 that is filled with injection fluid 110. It
 25 additionally has a longitudinal groove 112 with which it is axially guided in a part 116 that is depicted in FIGS. 21 and 22 and that engages with a protrusion 114 into longitudinal groove 112. Part 116 has on its outer side a portion comprising a spline set 117 with which, in the
 30 assembled state, it is guided in spline set 64 of barrel 50. The result is to create an axial guidance system 112, 114 of piston rod 98 relative to barrel 50.

Part 116 as shown in FIGS. 21 and 22 fits with its external tooth set 117 into spline set 64 of barrel 50, and
 35 in the assembled state is retained in that position

because, according to FIG. 23, it rests with its proximal end against the distal end of cartridge 108.

When the apparatus is opened by removing a proximal barrel part 107 from barrel part 50 (FIG. 23), part 116 is then no longer braced by cartridge 108 and can be pulled out of spline set 64 as far as a stop. It thereby becomes freely rotatable and allows piston rod 98 to be screwed in the distal direction back into its initial position, by rotation relative to thread 98. This allows a fresh, full cartridge 108 to be loaded.

During an injection, piston rod 98 displaces piston 106 in the proximal direction, i.e. downward (FIG. 23), and thereby expels injection fluid 110 from container 108. The latter can be replaced when fluid 110 is consumed. The apparatus is usually delivered empty, i.e. without a container (cartridge) 108. Piston rod 98 does not perform any rotary motion during the injection, but instead moves linearly in the proximal direction.

External thread 100 of piston rod 98 is guided in an internal thread 120 of a threaded part 122 (FIGS. 15 through 17) that hereinafter is also referred to as the "advancing part." When threaded part 122 is rotated, it causes an axial displacement of piston rod 98 relative to this part 122. This operation is referred to as the advancing (setting) of the piston rod (98), hence the name "advancing part."

Part 122 has on its cylindrically configured outer side 123 a longitudinal groove 124. Into this engages a radially inwardly projecting protrusion 126 (FIG. 20) of a follower 128 (FIGS. 18 through 20). The latter has a cylindrical internal opening 130 that is slidably displaceable on cylindrical outer side 123 of threaded part 122, protrusion 126 sliding in longitudinal groove 124 and connecting parts 122, 128 nonrotatably to one another (see FIGS. 23 and 26). Cylindrical outer side 123 transitions at

the left into a radially outwardly extending shoulder 125 (see FIGS. 15 through 17).

Advance member 122 has on its proximal side a head part 127 made of an elastic plastic. Head part 127 is integral with a radially resilient detent tongue 129 at whose free end is located a detent member 131 that, as shown in FIG. 25, rests with preload against axial internal spline set 64 of barrel 50 and can latch into the longitudinal grooves 65 of that spline set 64.

During an injection, head 127 along with its detent member 131 is displaced axially in spline set 64.

The coaction of detent member 131 and spline set 64 causes the patient to hear and feel twenty clicks for each revolution of setting member 76 (FIGS. 4 and 5), so that he/she can also set the dose by ear or by feel, since an audible and perceptible signal is generated for each unit. This is important because many diabetics have poor eyesight.

In addition, a dose cannot unintentionally be shifted once it has been set, since a predetermined minimum torque is necessary for any adjustment in either rotation direction.

Lastly, the coaction between detent member 131 and detent spline set 64 also means that a torsional spring 148 as shown in FIGS. 29 through 31 can become effective only when the patient presses (according to FIG. 28) on follower 128 and thereby opens coupling 84, 136, since the connection of detent member 131 to setting member 76 is then interrupted, and torsional spring 148 can consequently rotate setting member 76 or at least can assist the rotation of setting member 76.

Spline set 64 thus has several functions in the context of the exemplary embodiment, since it serves for nonrotatable connection between barrel 50 and parts that must be nonrotatably connected to it, and it also serves to

create a detent connection whose function is independent of the axial position of head part 127.

5 Follower 128 (FIGS. 18 through 20) has at its distal end an actuation plate 132 onto which the patient presses in the proximal direction when injecting (see FIG. 28). Arranged at a distance from plate 132 is a coupling flange 134, which is equipped on its distal side, i.e. on the right in FIGS. 18 and 19, with a tooth set 136 that serves for engagement with tooth set 84 depicted in FIG. 5 and, 10 when engaged, couples parts 76 and 128 non-rotatably to one another.

According to FIG. 23, coupling flange 134 is impinged upon in the distal direction by a compression spring 138. Spring 138 is arranged between coupling flange 134 and a 15 support flange 140 of setting member 76, so that tooth sets 84, 136 are in engagement with one another as long as the patient does not press on actuation plate 132. When he does so, spring 138 is then compressed and tooth sets 84, 136 are brought out of engagement.

20 When setting an injection dose, the patient rotates setting member 76 relative to barrel 50, and in the course of that rotation follower 128 is also rotated, by way of the (closed) coupling 84, 136, through the same rotation angle relative to barrel 50. Because follower 128 is 25 rotating, threaded part 122 also rotates (by way of guidance system 124, 128) relative to barrel 50, the previously described detent connection 64, 131 being actuated in that context.

Because, on the one hand, threaded part 122 is 30 rotating relative to barrel 50 but, on the other hand, piston rod 98 cannot rotate relative to barrel 50 because (as shown in FIG. 24) it is axially guided by protrusion 114, piston rod 98 moves in the proximal direction relative to threaded part 122, but for the reasons described below, 35 its position relative to barrel 50 does not change in that context.

Because setting member 76 is rotating relative to barrel 50, but pushing member 66 is not rotatable relative to barrel 50 as a result of guidance system 64, 70 (FIG. 9), pushing member 66 is displaced relative to barrel 50 in the distal direction by threads 86, 94. The distal motion of pushing member 66 relative to barrel 50 is preferably of the same magnitude as the proximal motion of piston rod 98 relative to threaded part 122.

One consequence of the proximal motion of piston rod 98 relative to threaded part 122 is that threaded part 122 is displaced distally relative to barrel 50, while piston rod 98 does not move relative to barrel 50.

(Alternatively, it would theoretically also be possible for piston rod 98 to be displaced relative to barrel 50 in the proximal direction, while threaded part 122 does not move in the axial direction, i.e. remains stationary. This is prevented, however, by the fact that threaded part 122 can easily execute a motion in the distal direction relative to barrel 50, whereas conversely a motion of piston rod 98 in the proximal direction is greatly impeded by the friction of piston 106 (FIG. 23) in container 108, so that this piston 106 acts as an abutment that prevents a motion of piston rod 98 relative to barrel 50 during the setting operation.)

The conditions occurring in the exemplary embodiment as setting member 76 was rotated through three revolutions were explained in FIG. 10. That member was, as a result, displaced upward a distance $L2 = 30$ mm. At the same time, pushing member 66 was displaced downward a distance $L3 = 21$ mm relative to setting member 66, so that in accordance with equations (1) and (2), pushing member 66 moved a distance $L4 = L2 - L3 = 30 - 21 = 9$ mm upward.

With three complete revolutions of part 76, threaded part 122 (FIGS. 15 through 17) also executes three complete revolutions, thereby causing piston rod 98 in FIG. 23 to be displaced downward 9 mm, i.e. exactly the distance $L4$.

This means in practical terms that in FIG. 23, during a setting motion of setting member 76 (for dose-setting purposes) the location of pusher plate 104 of piston rod 98 relative to rubber piston 106 remains unchanged, i.e. piston rod 98 maintains its location relative to barrel 50 during the setting operation. A change in that location occurs only upon injection. This is a consequence of the fact that the directions and pitches of the three threads described above have a predetermined relationship to one another, and that relationship can be selected in accordance with requirements.

FIG. 27 is an expanded depiction analogous to FIG. 10, and it is evident from it that the location of piston rod 98 has remained unchanged as compared with FIG. 23 despite the setting operation.

FIG. 28 shows an intermediate state in the course of an injection. That injection is initiated by the fact that the patient presses on plate 132 with a force P in the proximal direction. Spring 138 is thereby compressed, and coupling 84, 136 is opened.

By means of force P, optionally amplified by the torque of a torsional spring 148 described below, setting member 76 is screwed back into the position according to FIG. 9 and FIG. 23, since it has a coarse thread that automatically executes a screwing motion under axial pressure. Setting member 76 also causes pushing member 66 to be screwed back into the position shown in FIG. 9 and FIG. 23.

The location of piston rod 98 relative to threaded part 122 remains unchanged during the injection operation, and because pushing member 66 moves downward a distance L4 (FIG. 10) during that operation, threaded part 122 is displaced by pushing member 66 a distance L4 downward, i.e. in the proximal direction, since shoulder 69 of pushing member 66 pushes in the proximal direction against shoulder 125 of threaded part 122.

Piston rod 98 is thus also displaced downward a distance L4 by threaded part 122, pushing rubber piston 106 (FIG. 23) a distance L4 downward in order to expel a corresponding quantity of injection fluid 110 from cartridge 108. The result is therefore that a quantity of injection fluid corresponding to the previously set distance L4 is injected.

Because setting member 76 rotates during the injection operation, the patient can follow the sequence of the injection in window 52 as if in a movie, i.e. he knows at every moment how much he has already injected. When the number "0" appears in scale window 52, the patient knows that he has injected his entire dose.

A "0" is therefore automatically displayed in window 52 at the end of an injection (see FIG. 11) and a new setting operation can begin, so that no calculations, resetting operations, or the like are required of the patient.

FIG. 29 shows a variant in which a torsional spring 148 is arranged between setting member 76 and pushing member 66. Distal end 150 of spring 148 is nonrotatably connected to setting member 76, and proximal end 152 is nonrotatably connected to the distal end of pushing member 66.

Before an injection, the patient rotates setting member 76 and as a result screws it out of barrel 50, as described with reference to FIGS. 9 and 10. In that context, setting member 76 and pushing member 66 rotate relative to one another as described with reference to FIGS. 9 and 10. This rotation loads spring 148 torsionally; this can be reinforced by installing spring 148 with a predetermined preload.

The relative rotation between setting member 76 and pushing member 66 is reversed during an injection, and the injection apparatus returns, for example, from the position

shown in FIG. 10 to the position shown in FIG. 9 as the dose that was set is injected.

The friction of piston 106 (FIG. 23) in container 108 must be overcome in this context, and this is facilitated by the energy that was stored in torsional spring 148 when setting the dose, thus making the injection easier for the patient.

As a comparison of FIGS. 9 and 10 shows, in FIG. 29 spring 148 would not only be loaded in tension but also pulled lengthwise when an injection dose is set; conversely, it would be greatly compressed during an injection, which might cause space problems.

These space problems are avoided in the version according to FIG. 30, in which a displacement member 154 is provided that slides on the cylindrical outer surface of pushing member 66. Displacement member 154 has a protrusion 156 (FIG. 31) that projects radially inward, and pushing member 66 is provided with a longitudinal groove 158 into which that protrusion 156 engages. Proximal end 158 of spring 148 engages, as depicted, into an opening 160 of displacement member 154.

By means of the force of spring 148, displacement member 154 is always held in contact against distal side 93 of thread carrier 90, so that in the variant according to FIGS. 30 and 31, the length of spring 158 does not change during dose setting and injection. As pushing member 66 is rotated, displacement member 154 also executes a corresponding rotation relative to thread carrier 90; for that reason, these parts should be manufactured from a plastic having a low coefficient of friction, or a washer made of PTFE or the like can be provided between these parts.

As already described, the energy stored in spring 148 is not released until coupling 84, 136 is opened by a pressure on plate 132 (see FIG. 28), since this interrupts the connection to detent member 131 depicted in FIG. 25;

before an injection, that member retains spring 148 immovably in its tensioned position provided the detent force is sufficient therefor.

FIG. 32 is an overall depiction of the injection apparatus. The upper, distal part corresponds to the depiction in FIG. 23, to which the reader may therefore be referred. Cartridge 108 is guided in proximal barrel part 107. The latter has at the bottom a thread 168 for screwing on threaded part 170 of a needle 172 whose distal part, in known fashion, pierces a rubber membrane (not depicted) of cartridge 108 and thereby creates a connection between needle 172 and injection fluid 110 in cartridge 108, as is known to one skilled in the art. Needle 172 is usually replaced before each injection.

Many variants and modifications are, of course, possible in the context of the present invention.

CLAIMS

1. An injection apparatus that comprises:

a barrel that is implemented to receive a container with injection fluid;

a piston rod, provided with a thread, for expelling injection fluid from such a container, which piston rod is guided nonrotatably relative to the barrel and in an axial direction;

a threaded part that is provided with a thread, which thread is in engagement with the thread of the piston rod,

which threaded part is implemented so that its axial location relative to the barrel is modifiable,

the threaded part being rotatable relative to the piston rod and relative to the barrel in order to set an injection dose, and therefore moving, upon setting, in the axial direction relative to the piston rod and relative to the barrel; and

the threaded part being non-rotatable relative to the piston rod and relative to the barrel in the context of an injection operation, and therefore moving, in the context of an injection operation, in the axial direction relative to the housing and in the injection direction.

2. The injection apparatus according to claim 1,

wherein a setting member is rotatably arranged in the barrel, the barrel and setting member together having a combined length whose magnitude corresponds, prior to the setting of an injection dose, to a predetermined initial length,

that combined length being increasable, in order to set an injection dose, by way of a relative rotation between the barrel and setting member; and

that combined length being returnable back to the predetermined initial length during an injection, likewise by way of a relative rotation between the barrel and setting member.

3. The injection apparatus according to claim 2,

wherein a follower is provided which is coupled to the setting member in such a way that a rotational motion of the setting member that occurs in order to set a dose is transferred to the follower (FIG. 27); and

a rotational motion of the setting member that occurs in the context of an injection (FIG. 28) is not transferred to the follower.

4. The injection apparatus according to claim 3,

wherein the threaded part is connected to the follower in such a way that a rotational motion of the follower, but not an axial displacement of the follower relative to the barrel, is transferred to the threaded part.

5. The injection apparatus according to any of claims 2 to 4,

wherein a pushing member is provided that is connected to the barrel via a first drive connection and to the setting member via a second drive connection,

one of these drive connections being configured as a second thread and the other drive connection as an axial guidance system, so that the pushing member moves relative to the barrel in a predetermined direction when the setting

member is moved, likewise in that predetermined direction, by means of a rotation relative to the barrel.

6. The injection apparatus according to any of claims 2 through 5, wherein a third thread is arranged between the barrel and setting member, for length adjustment.

7. The injection apparatus according to claim 6, wherein the pitches of the three threads are coordinated with one another in such a way that during the setting of an injection dose, the motion of the pushing member in a predetermined direction is of at least the same magnitude as the motion of the threaded part in that direction.

8. The injection apparatus according to claim 6 or 7, wherein portions of the setting member that are located in the region of the third thread are provided with scale values for displaying the injection dose that is set.

9. The injection apparatus according to claim 8, wherein the barrel is provided with a window for displaying at least one of the scale values.

10. The injection apparatus according to any of claims 6 through 8,

wherein the second thread and the third thread have identical thread directions.

11. The injection apparatus according to claim 10,
wherein the thread pitch of the third thread is
greater in absolute value than the thread pitch of the
second thread.

12. The injection apparatus according to claim 10 or
11,
wherein the thread direction of the first thread
corresponds to that of the third thread.

13. The injection apparatus according to claim 12,
wherein the thread pitch of the first thread is
smaller in absolute value than the thread pitch of the
third thread.

14. The injection apparatus according to any of
claims 5 through 8,
wherein the pushing member is provided on its proximal
side with a contact member which is implemented for contact
against a distal side of the threaded part in order, during
an injection, to displace the piston rod via the threaded
part in the proximal direction, and to expel injection
fluid from the container.

15. The injection apparatus according to claim 3 or
4,
wherein a controllable coupling is provided which, in
the closed state, enables transfer of a torque from the
setting member to the follower.

16. The injection apparatus according to claim 15,
wherein the controllable coupling is implemented so that it transfers the rotational motion of the setting member to the follower during the setting of an injection dose.

17. The injection apparatus according to claim 15 or 16,

wherein the controllable coupling is implemented so that it does not transfer a rotational motion of the setting member to the follower during an injection.

18. The injection apparatus according to any of claims 15 to 17,

wherein the controllable coupling is implemented so that it is opened by means of an operation occurring at the beginning of an injection.

19. The injection apparatus according to claims 15 through 18,

wherein the controllable coupling is controllable in such a way that after completion of an injection, it returns to the closed state; and

it remains closed during dose setting, so that a rotation of the setting member that is accomplished for dose setting is transferred by way of the controllable coupling to the threaded part.

20. The injection apparatus according to any of claims 5 through 8,

wherein the second thread is implemented as a second drive connection for the pushing member.

21. The injection apparatus according to any of claims 5 through 8,

wherein the thread pitches of the first, second, and third threads are dimensioned such that during the setting operation, a rotation of the setting member has substantially no influence on the location of the piston rod relative to the housing.

22. The injection apparatus according to any one of claims 1 to 21,

wherein a torsional spring is provided and is arranged in such a way that energy is stored in it when a dose is set, and energy is released from it during an injection operation.

23. The injection apparatus according to claim 22, wherein the torsional spring is arranged between the setting member and the pushing member, a relative rotation between those parts modifying the torque generated by the torsional spring.

24. The injection apparatus according to claim 23, wherein the torsional spring is joined nonrotatably but axially displaceably to the pushing member.

25. The injection apparatus according to any one of claims 1 to 24,

wherein a detent connection is provided between

- the barrel and
- a part connectable via a controllable coupling to the setting member.

26. The injection apparatus according to claim 25, wherein there is provided in the barrel a spline set that coacts with a detent member that is axially displaceable relative to the barrel, in order to produce rotational detent positions that are independent of the relative axial locations of the detent member and barrel.

27. The injection apparatus according to claim 25 or 26,

wherein the detent connection is implemented in such a way that by means of a first predetermined minimum torque it is adjustable in a rotation direction that increases the injection dose, and by means of a second predetermined minimum torque it is adjustable in a rotation direction that decreases the injection dose.

28. The injection apparatus according to claim 27, wherein the first and the second predetermined minimum torque are of substantially equal magnitude.

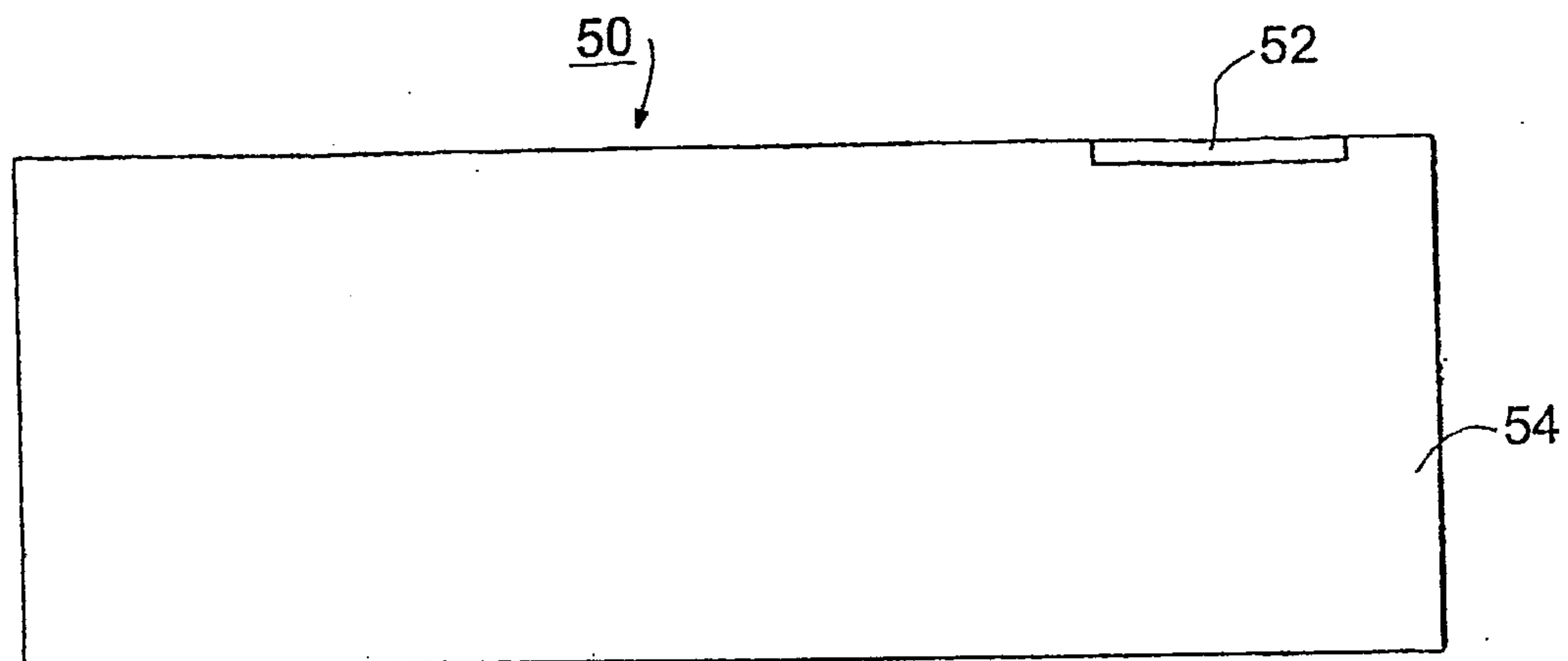


Fig.1

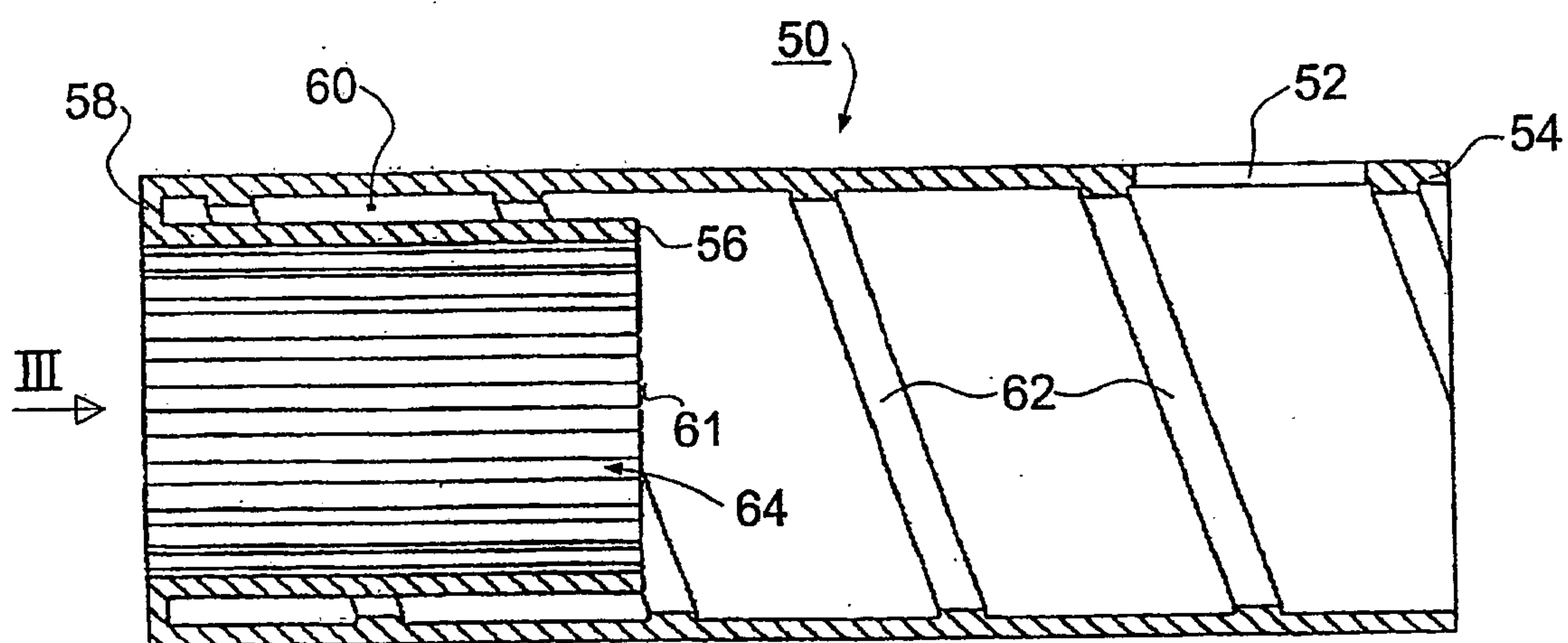


Fig.2

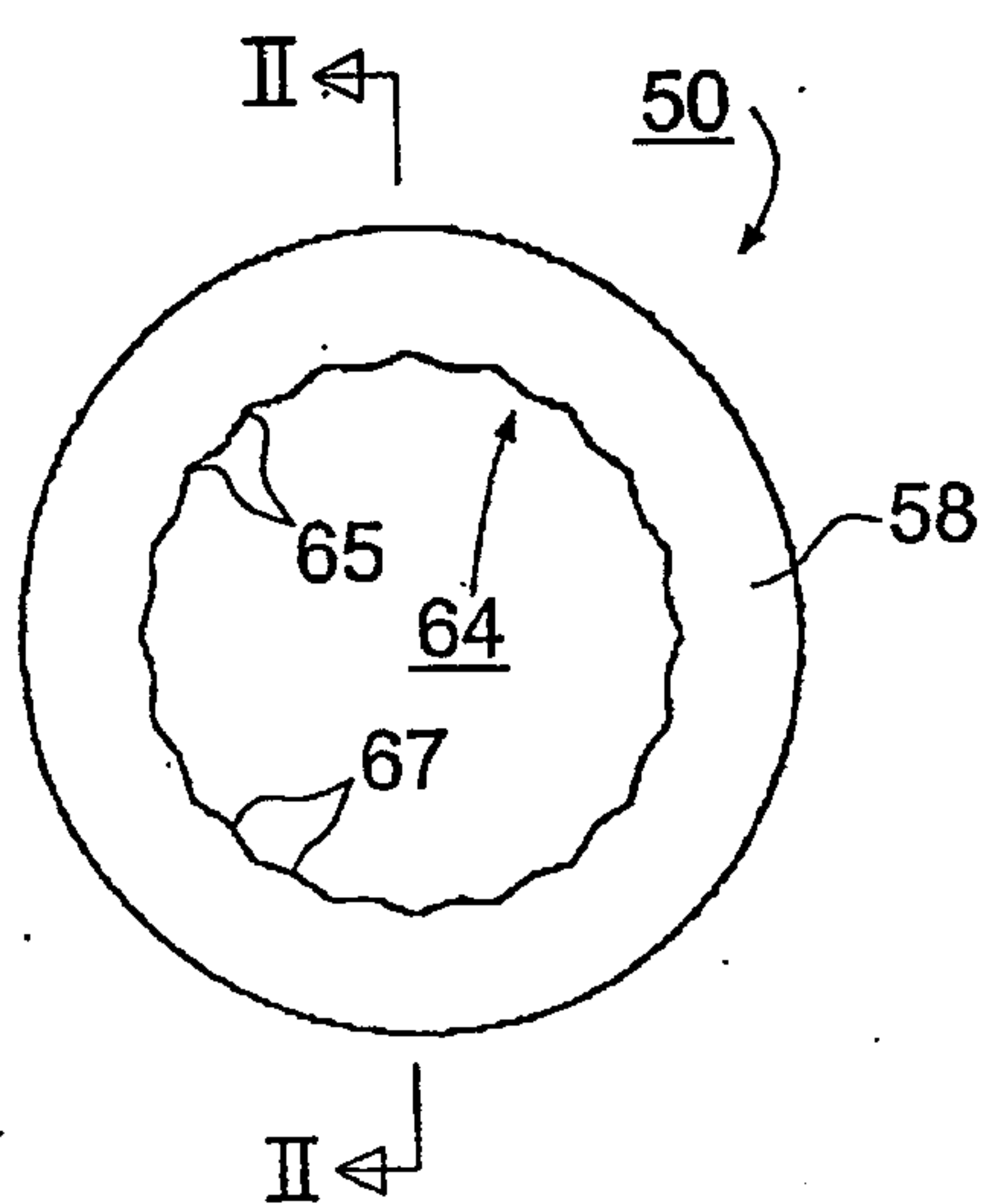


Fig.3

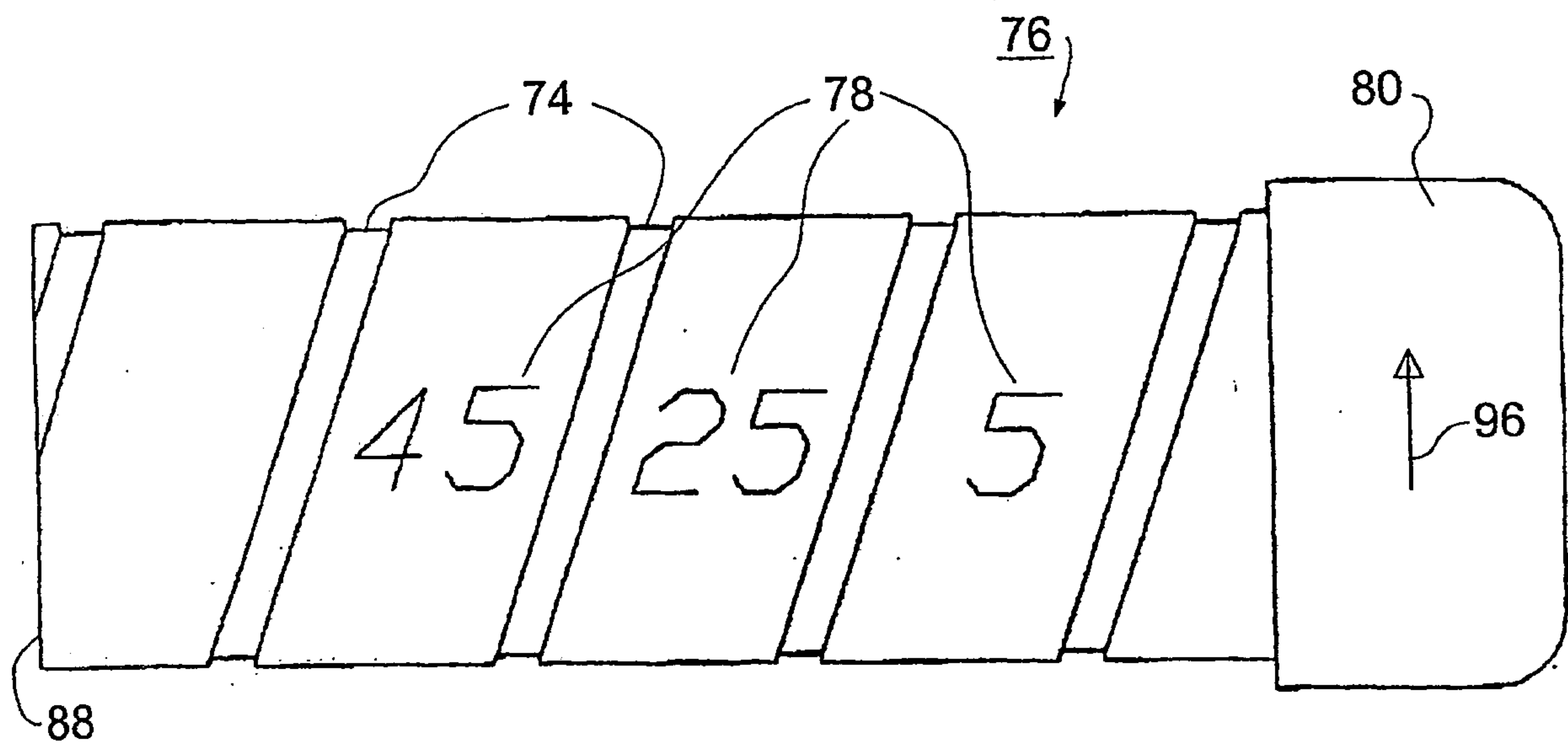


Fig.4

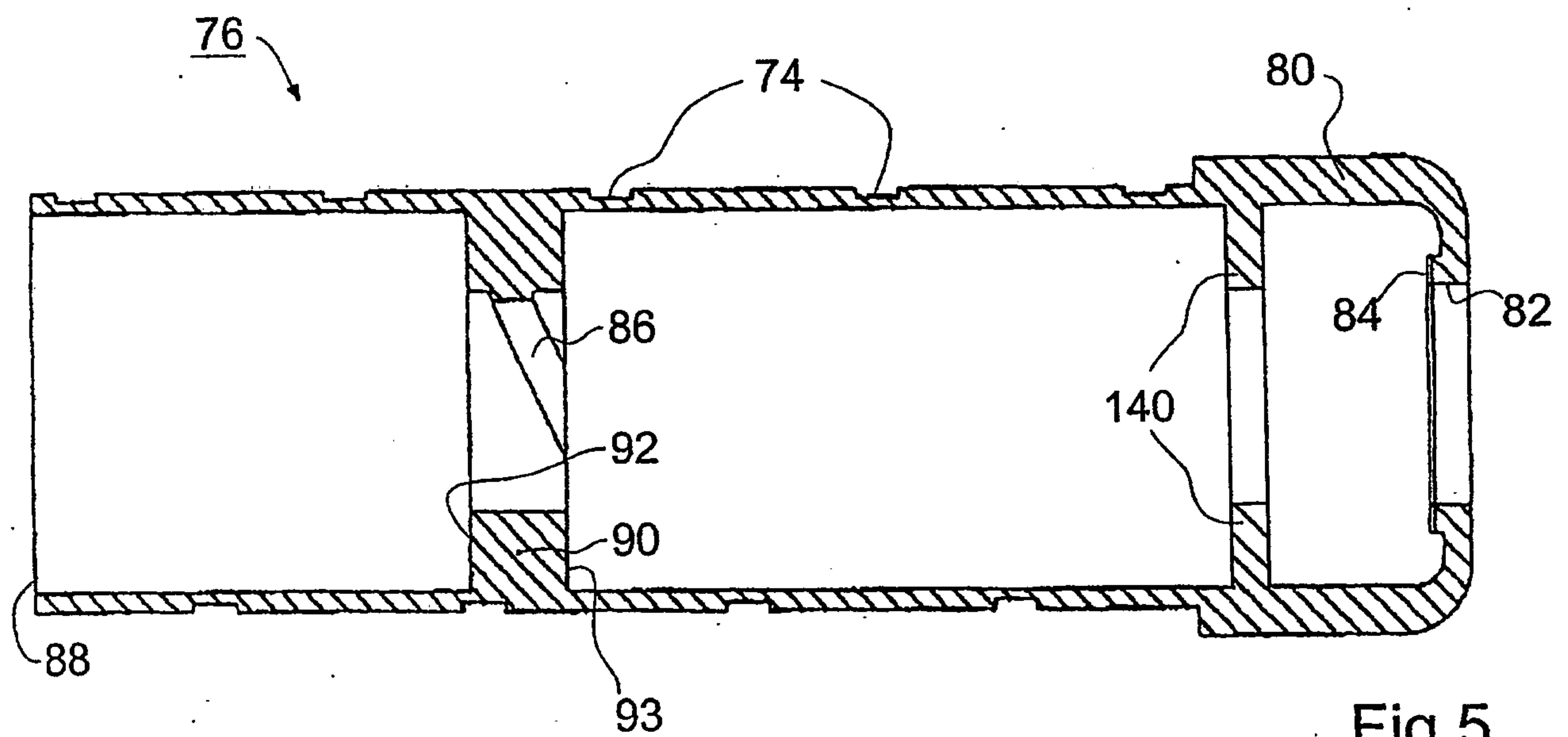


Fig.5

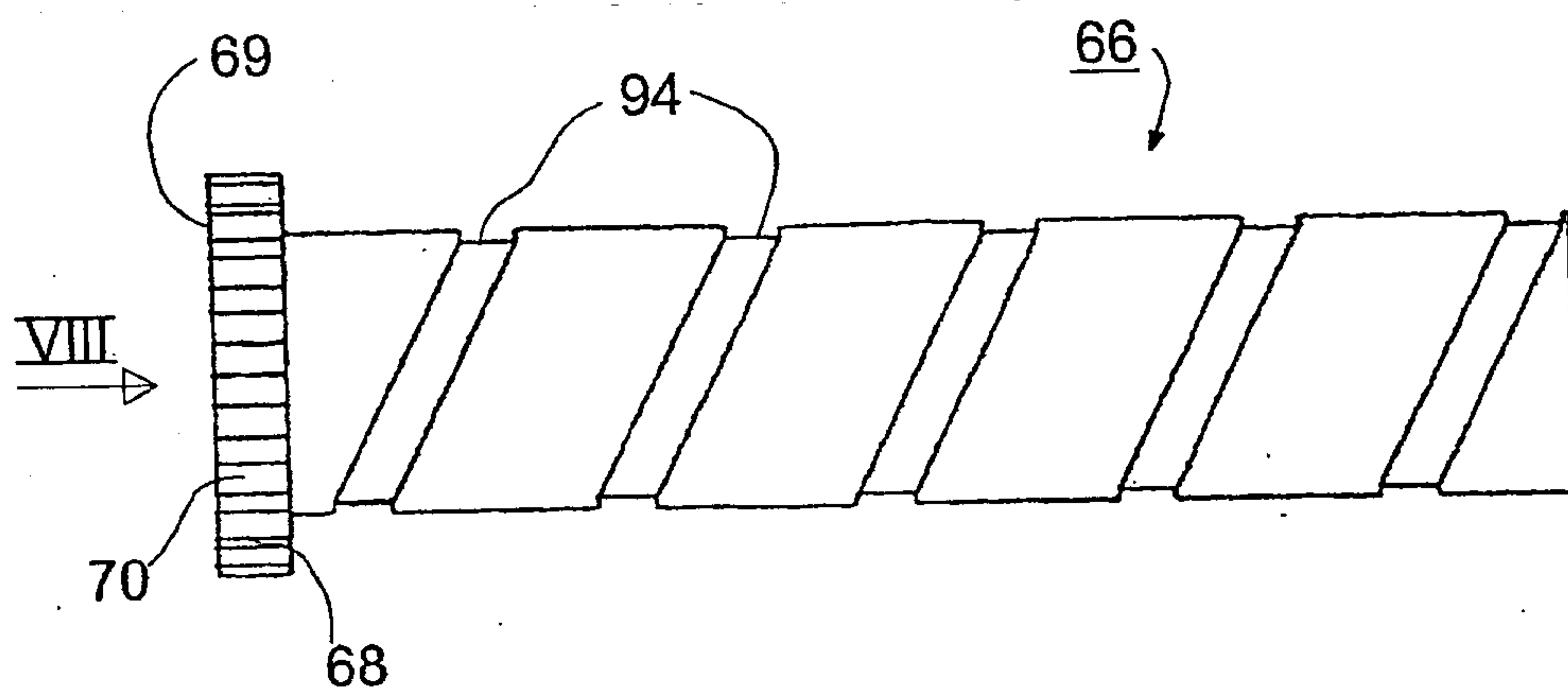


Fig.6

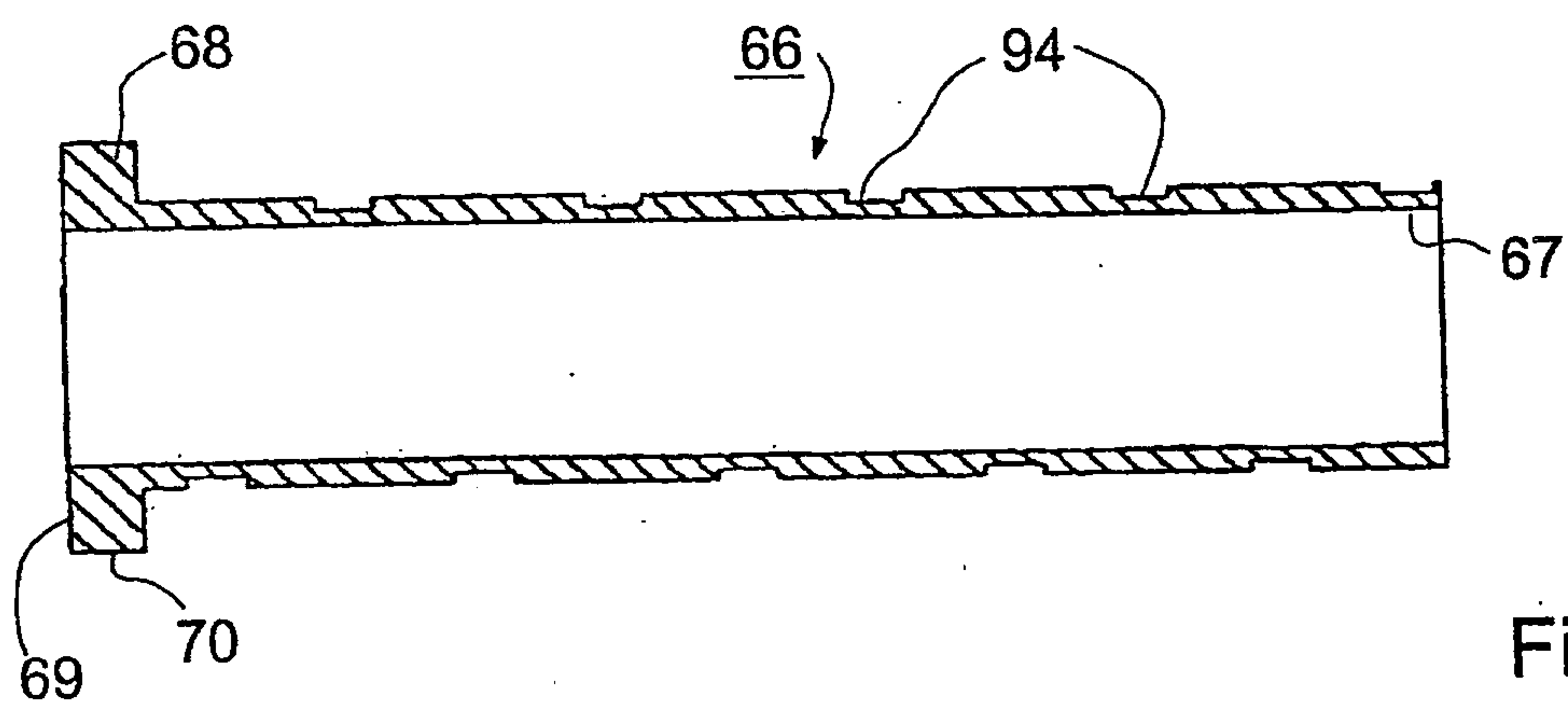


Fig.7

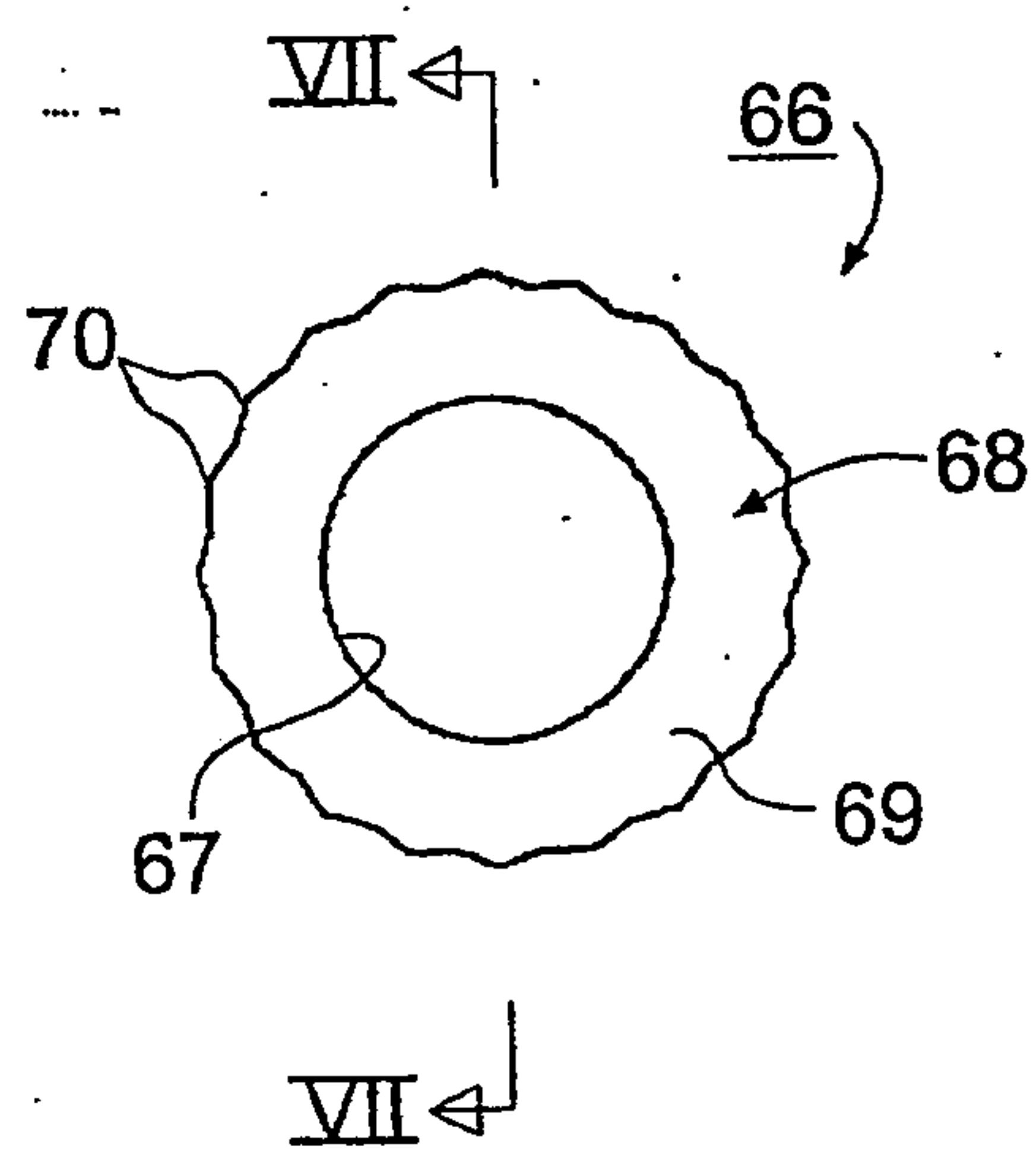


Fig.8

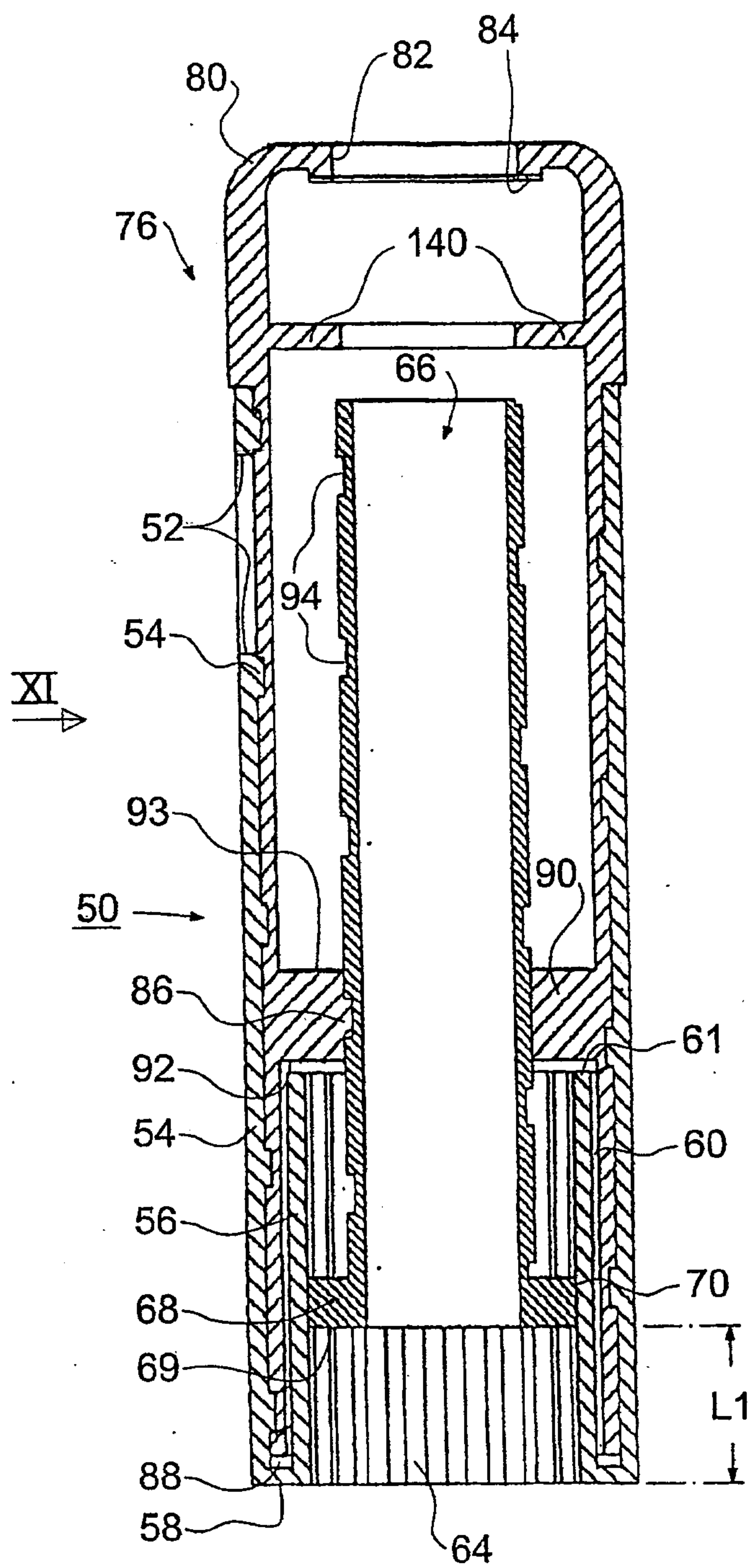


Fig.9

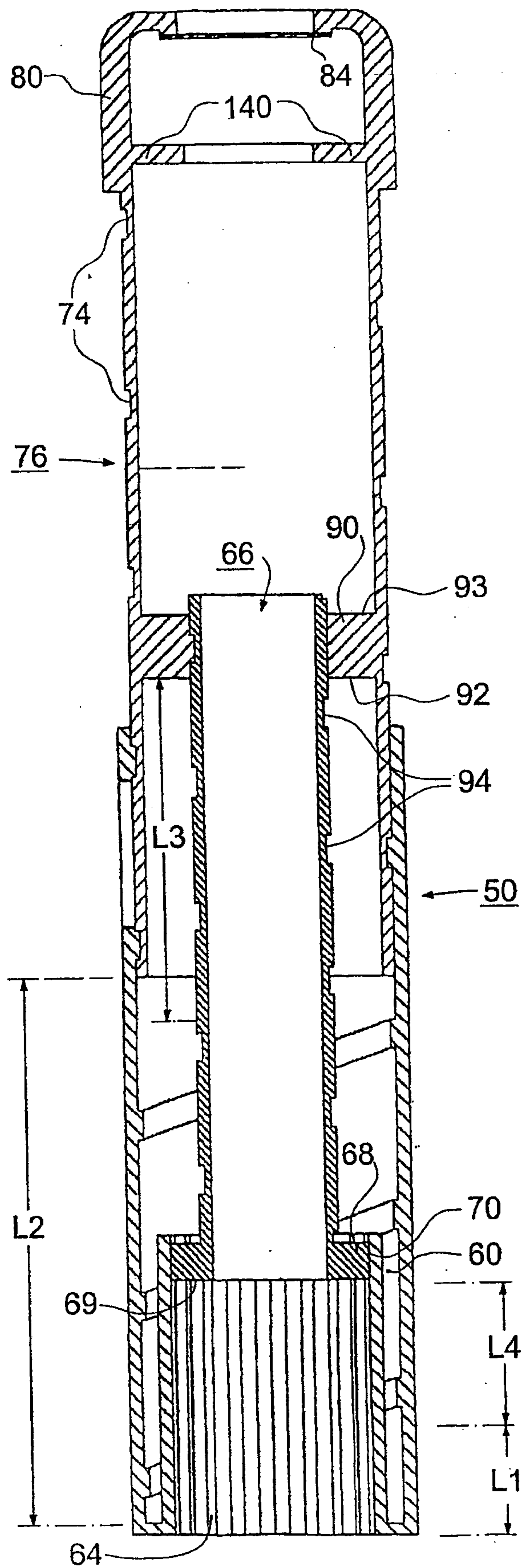


Fig.10

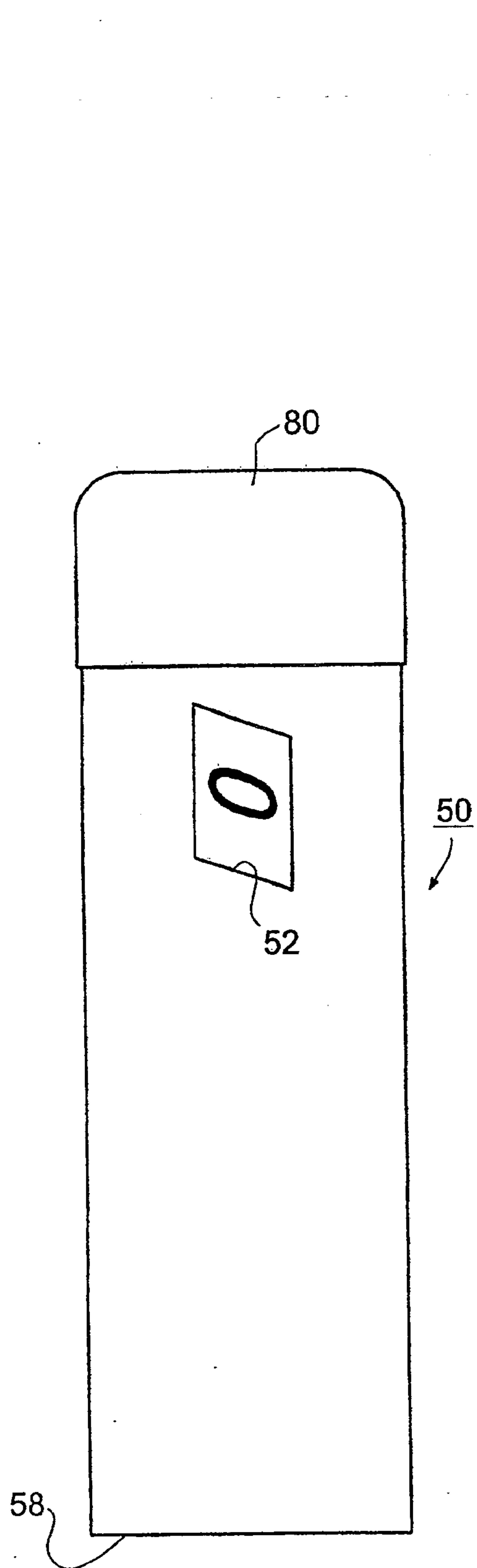


Fig. 11

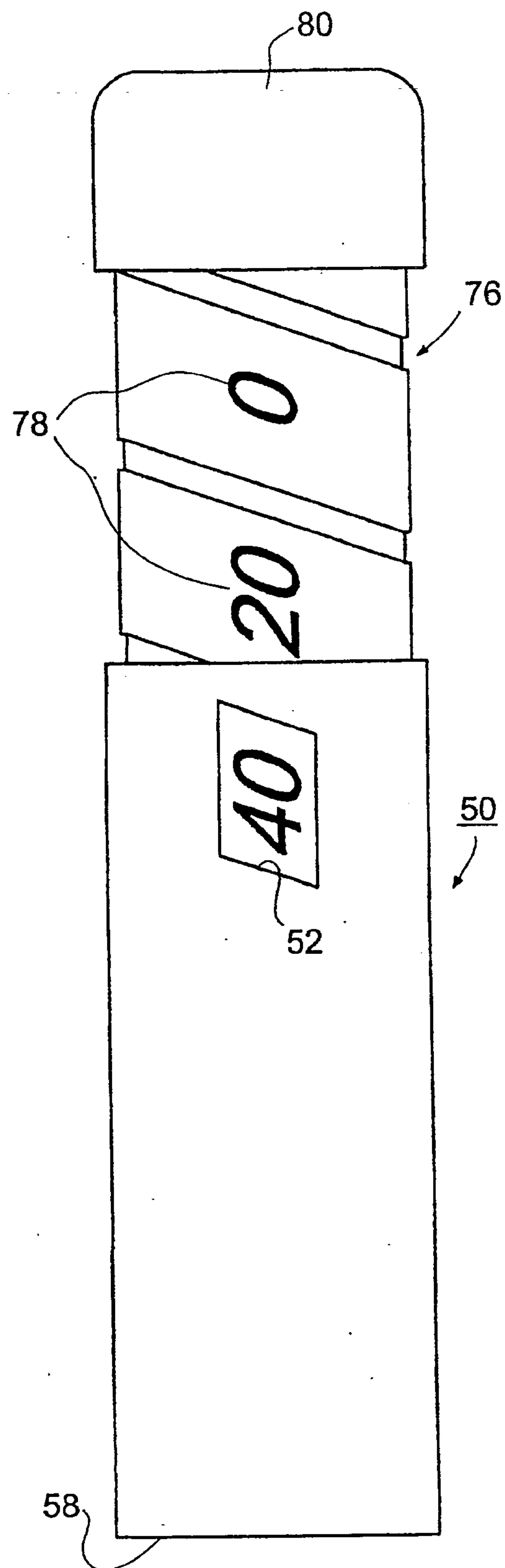


Fig. 12

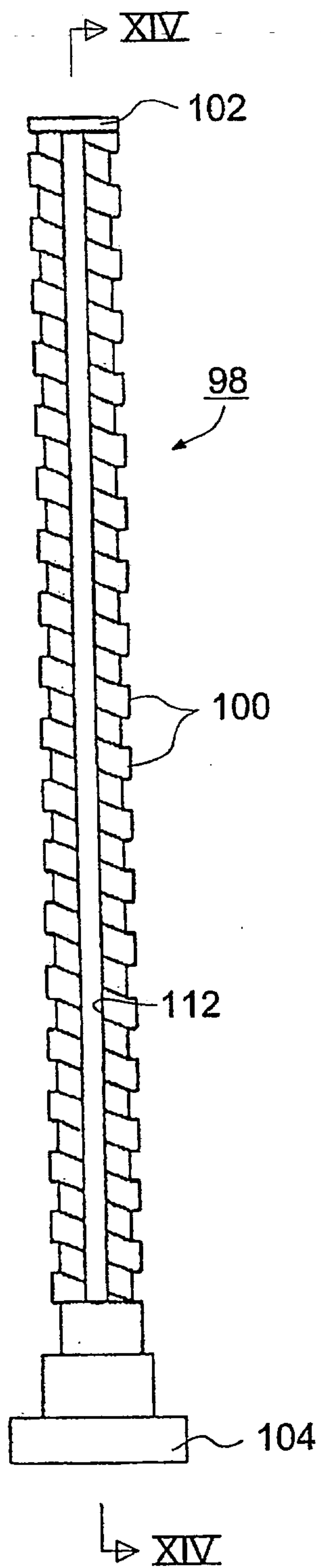


Fig.13

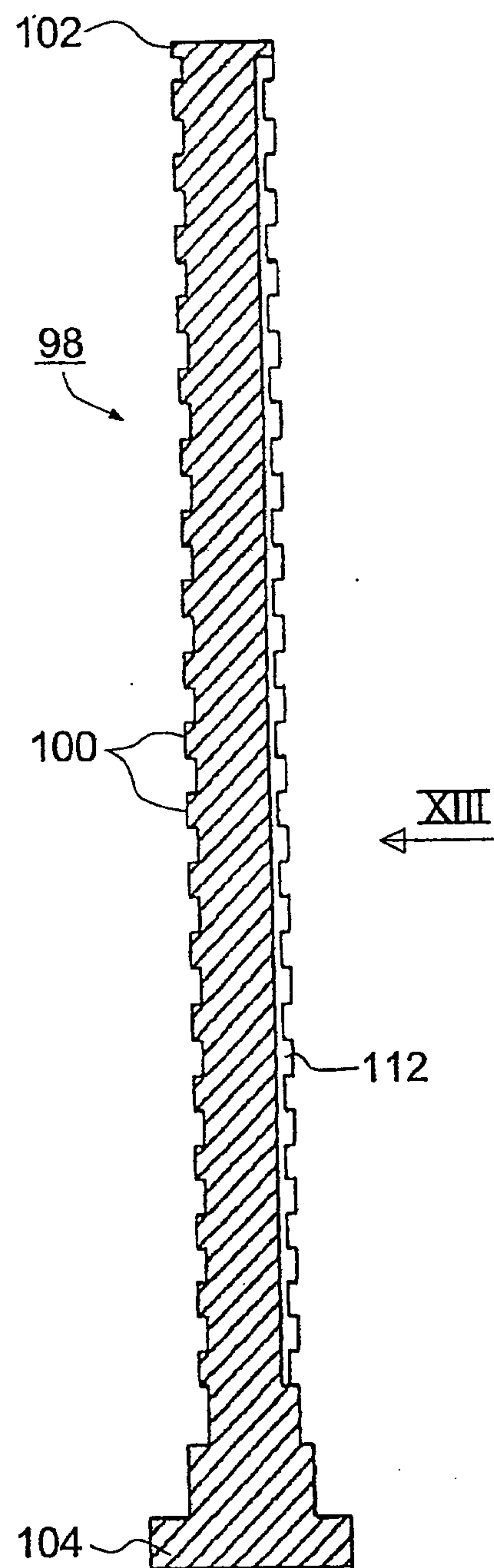
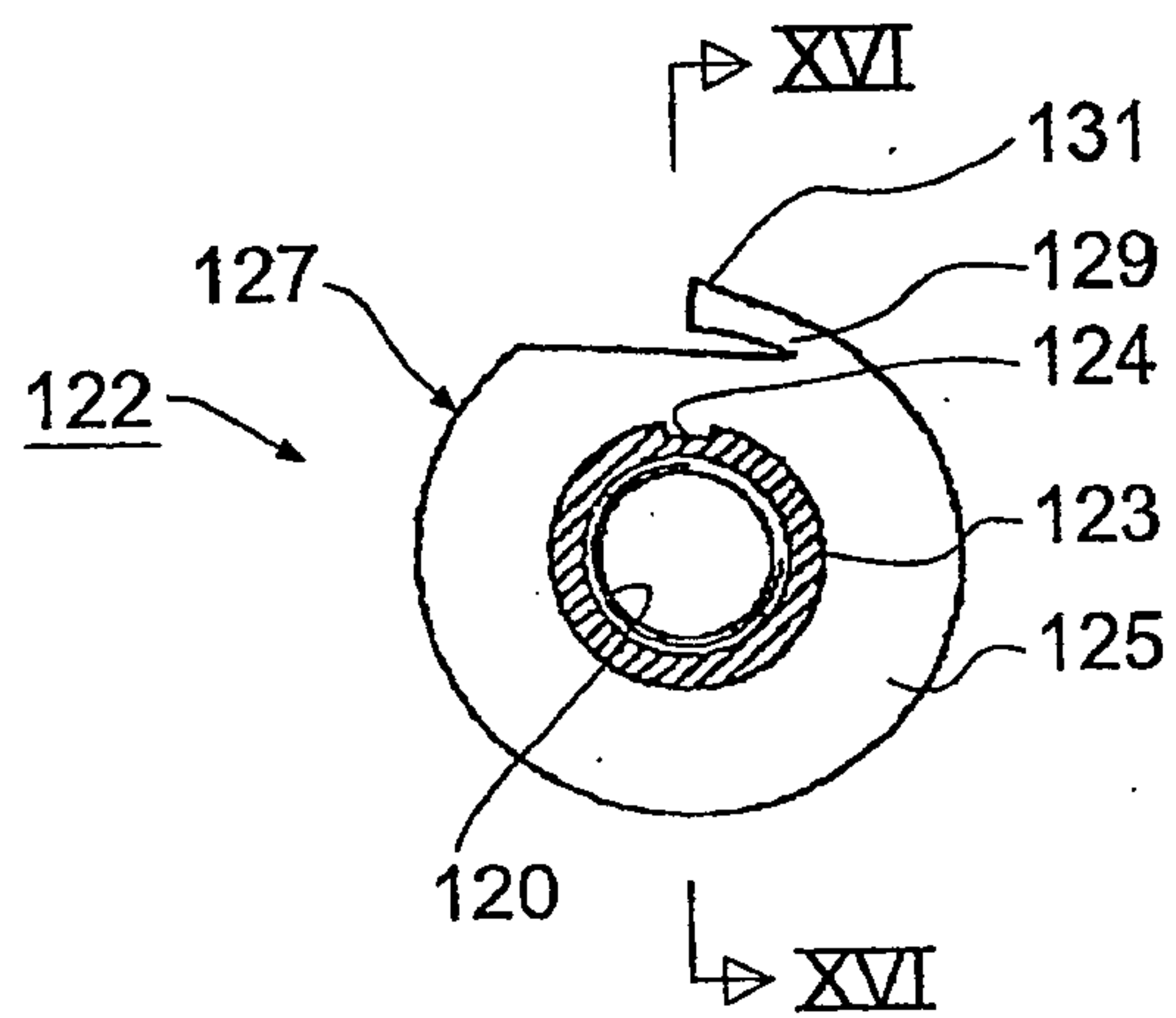
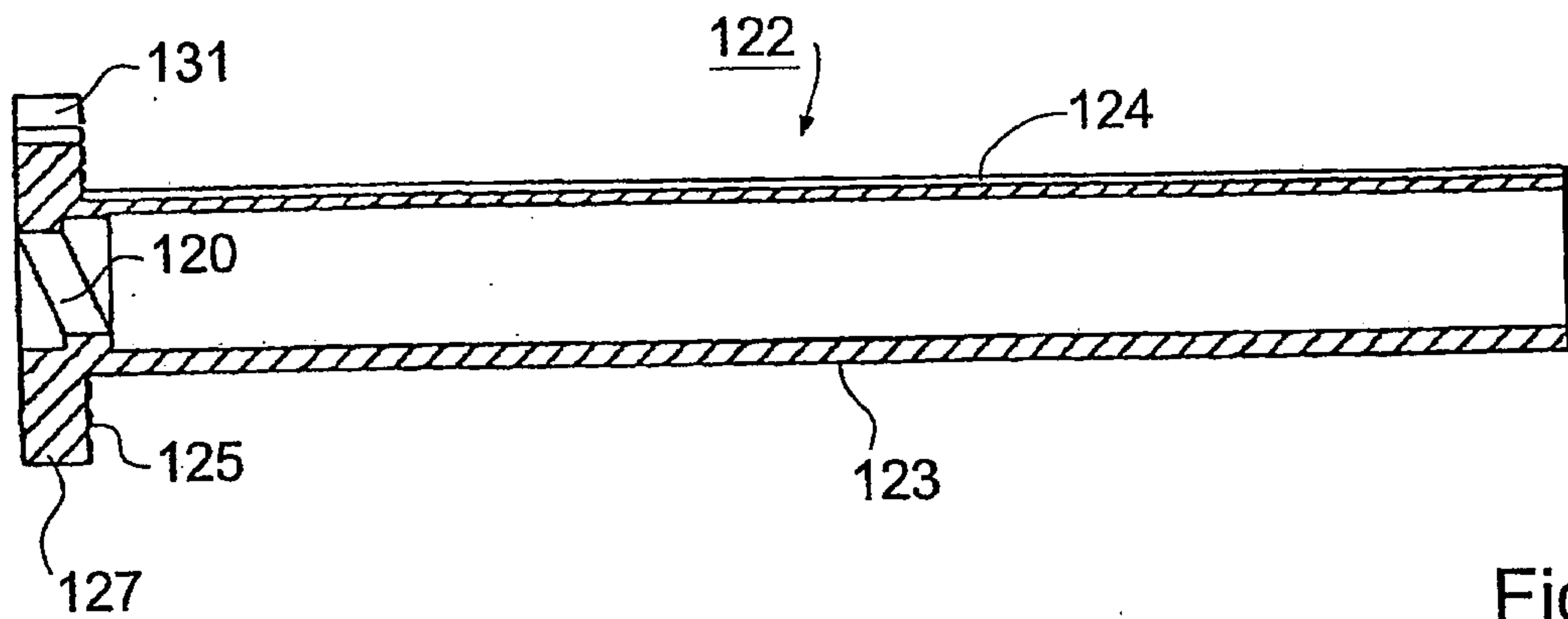
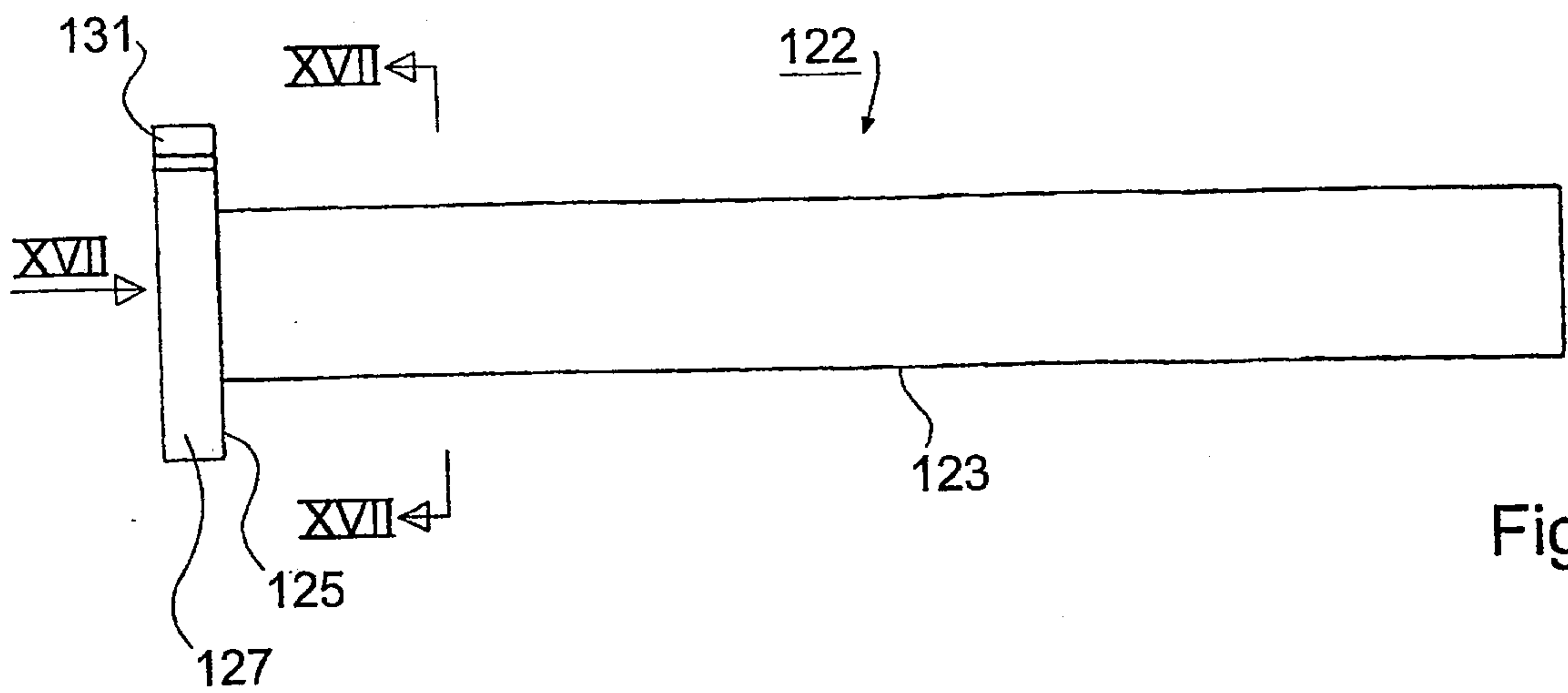


Fig.14



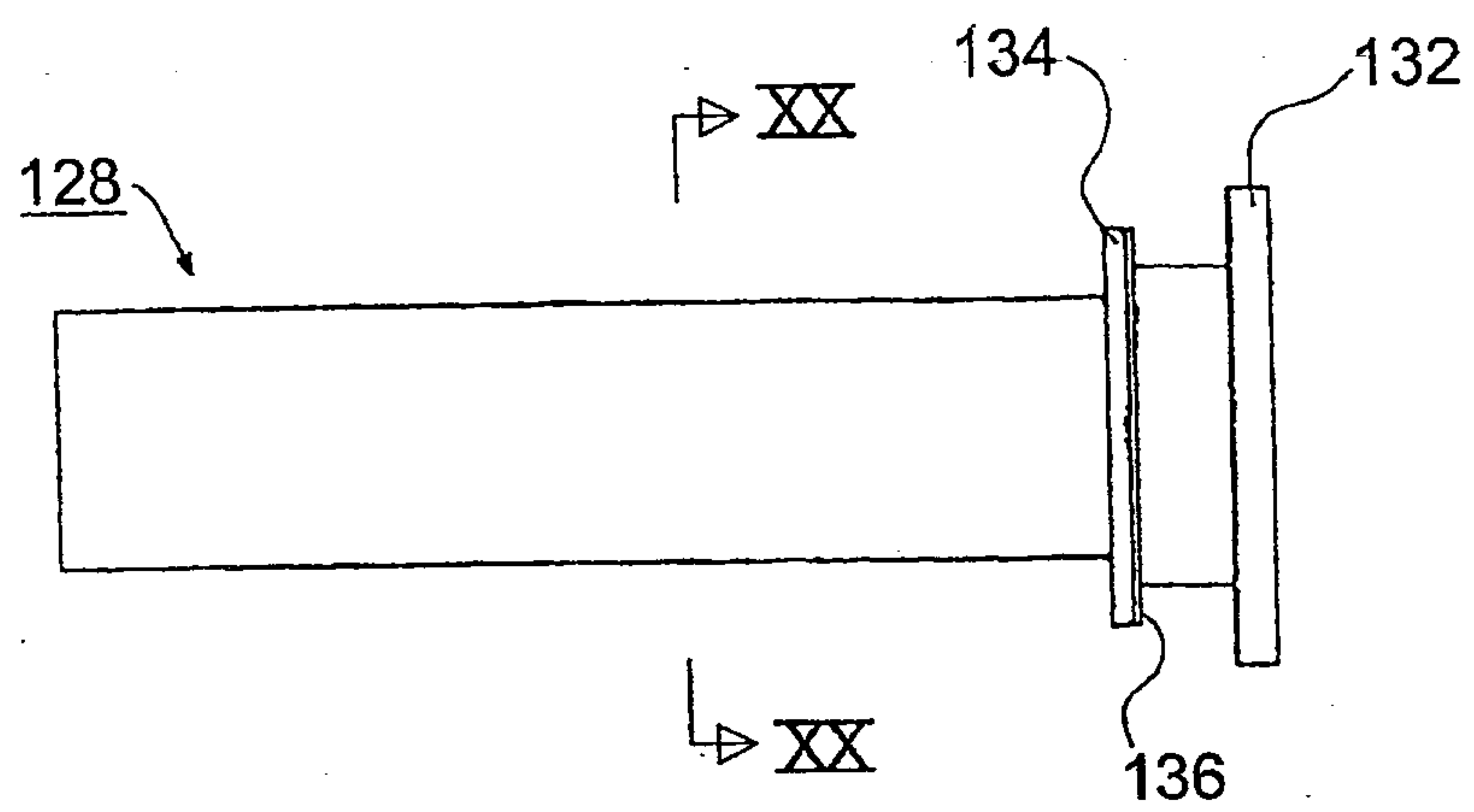


Fig.18

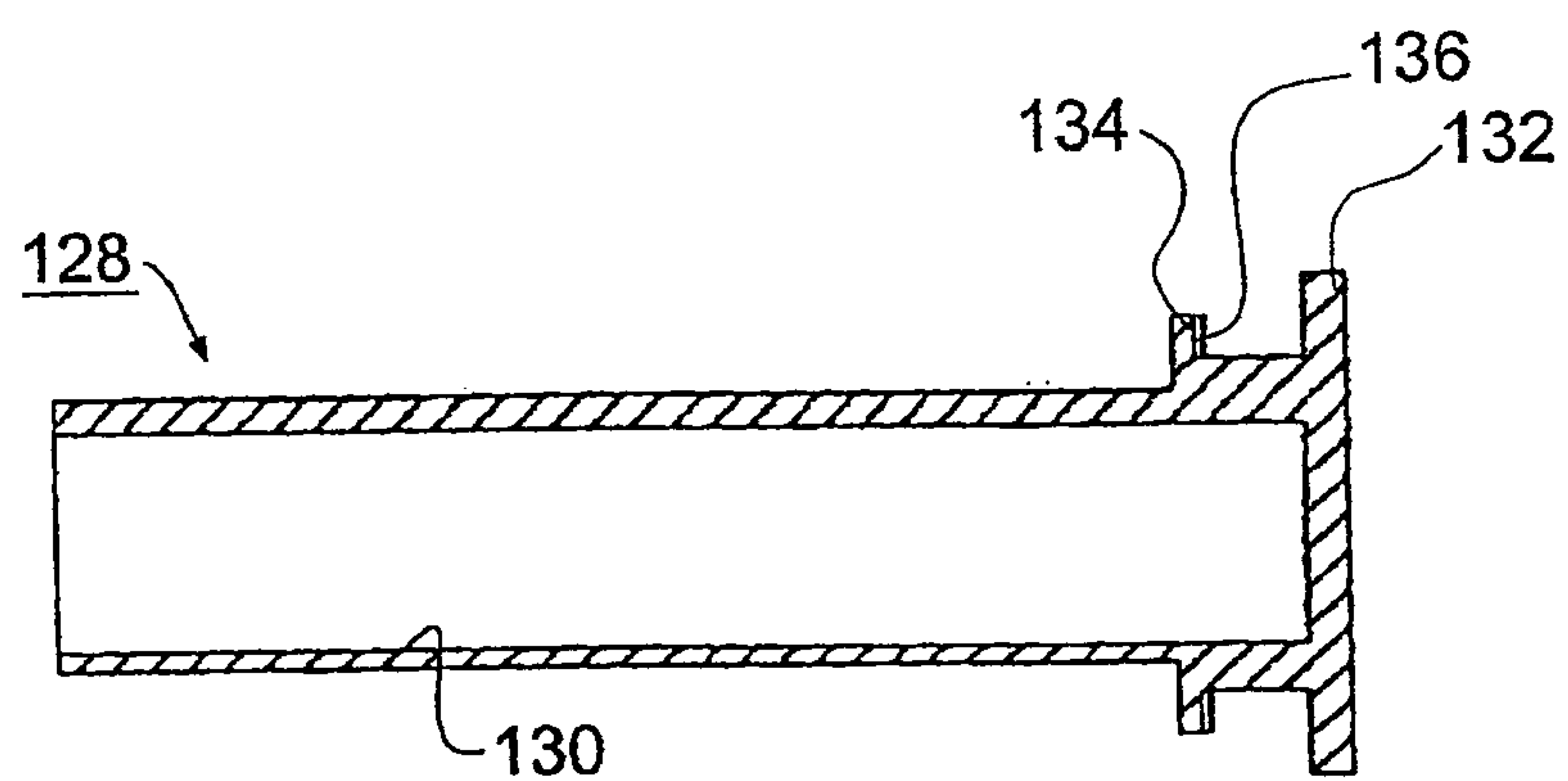


Fig.19

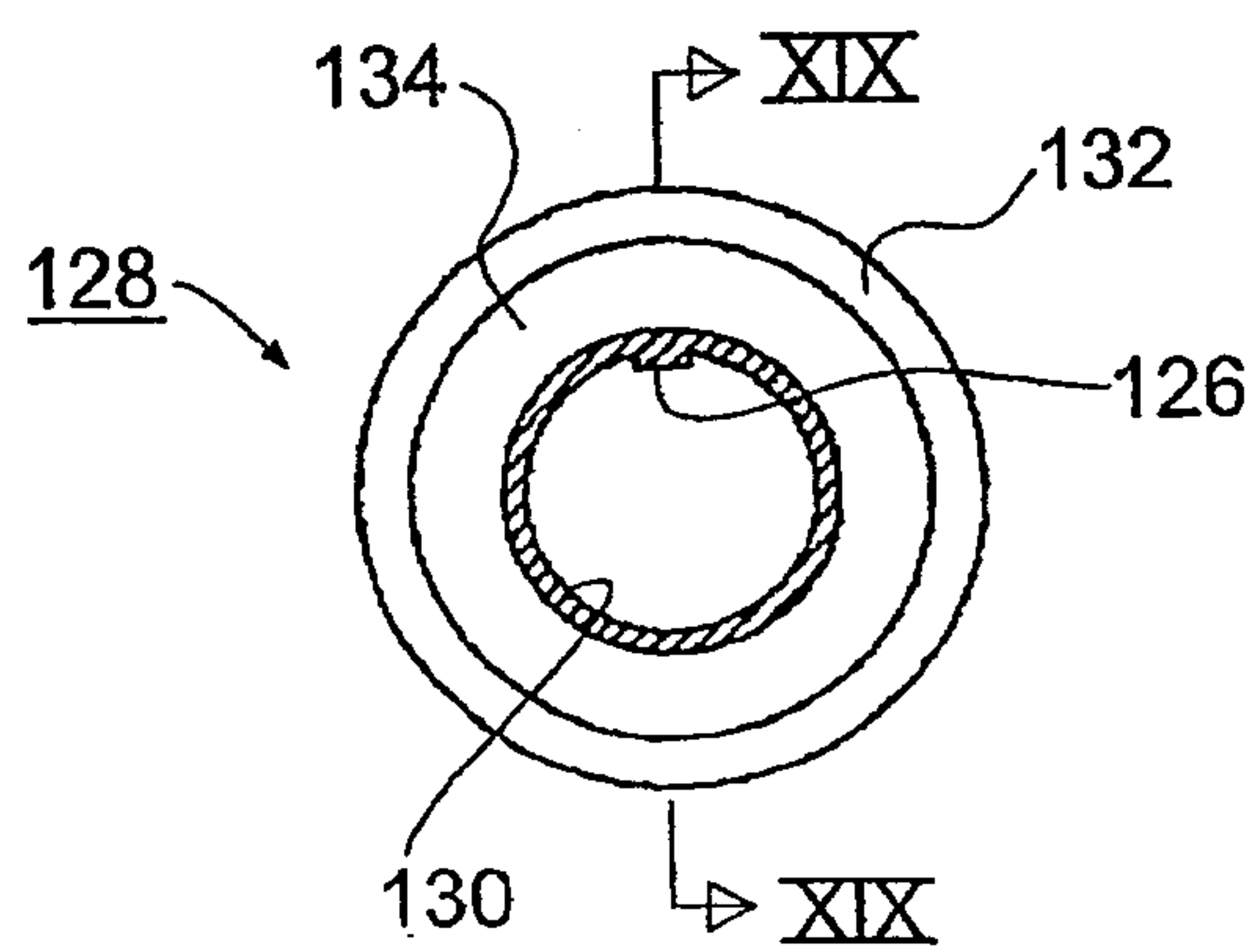


Fig.20

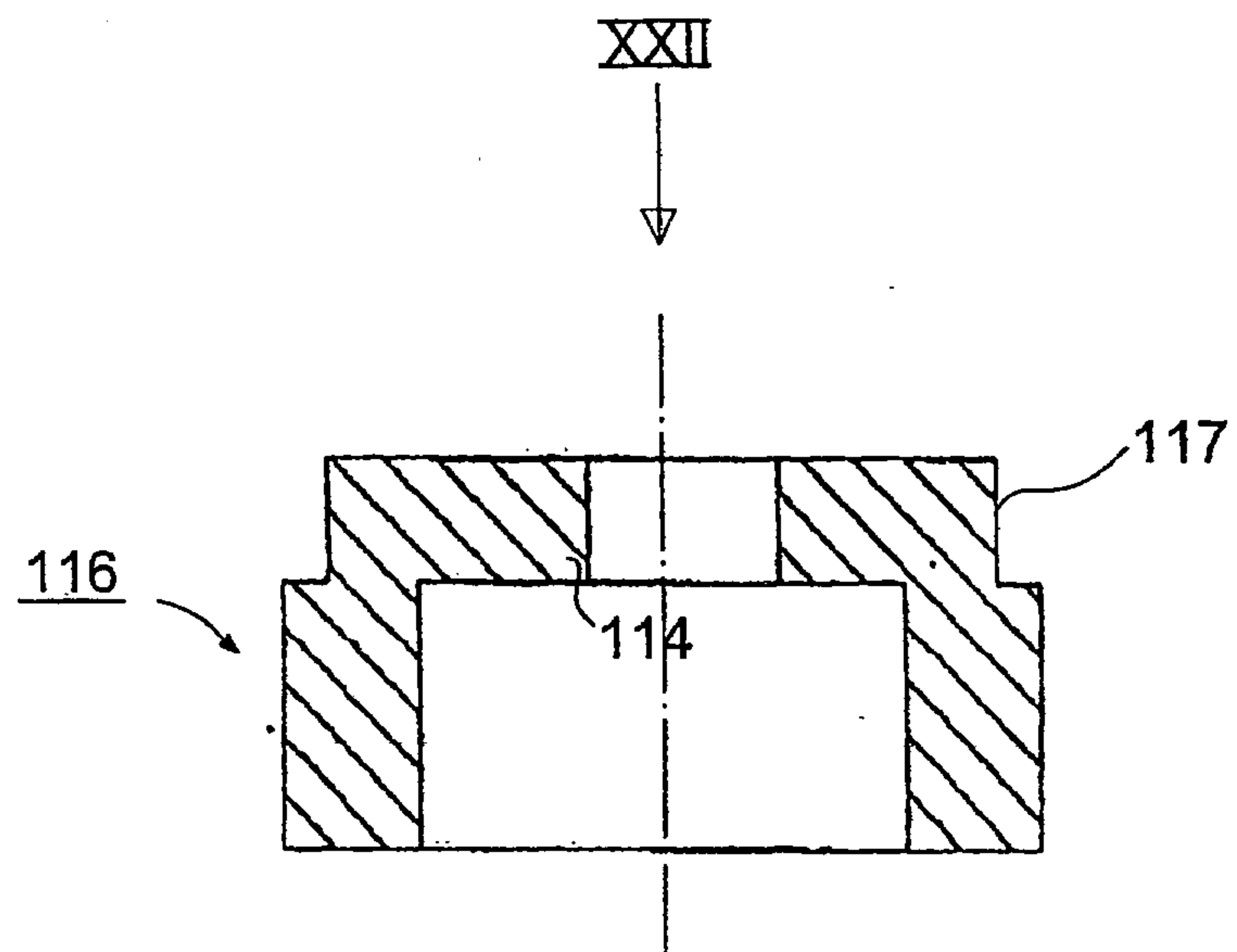


Fig.21

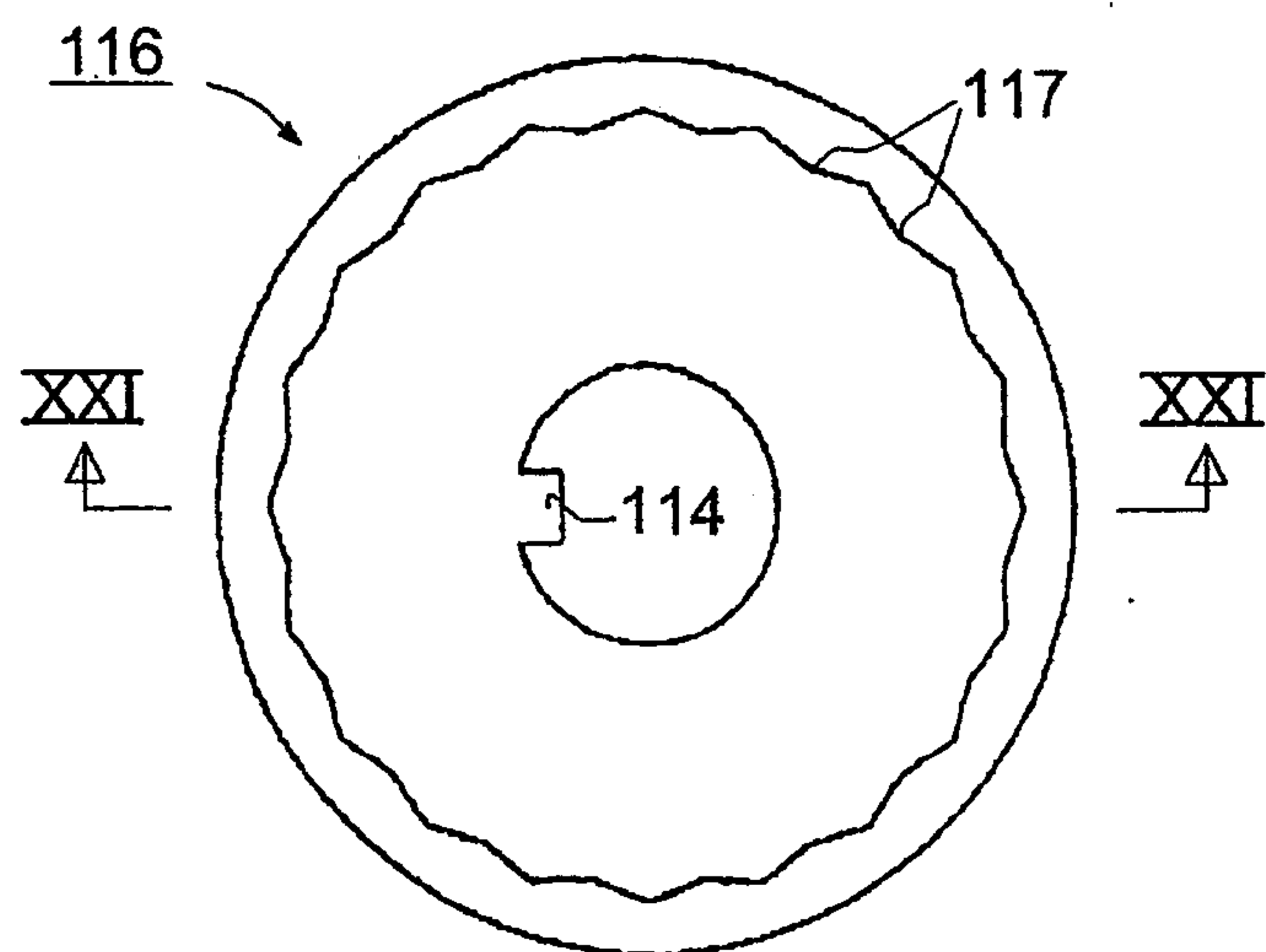


Fig.22

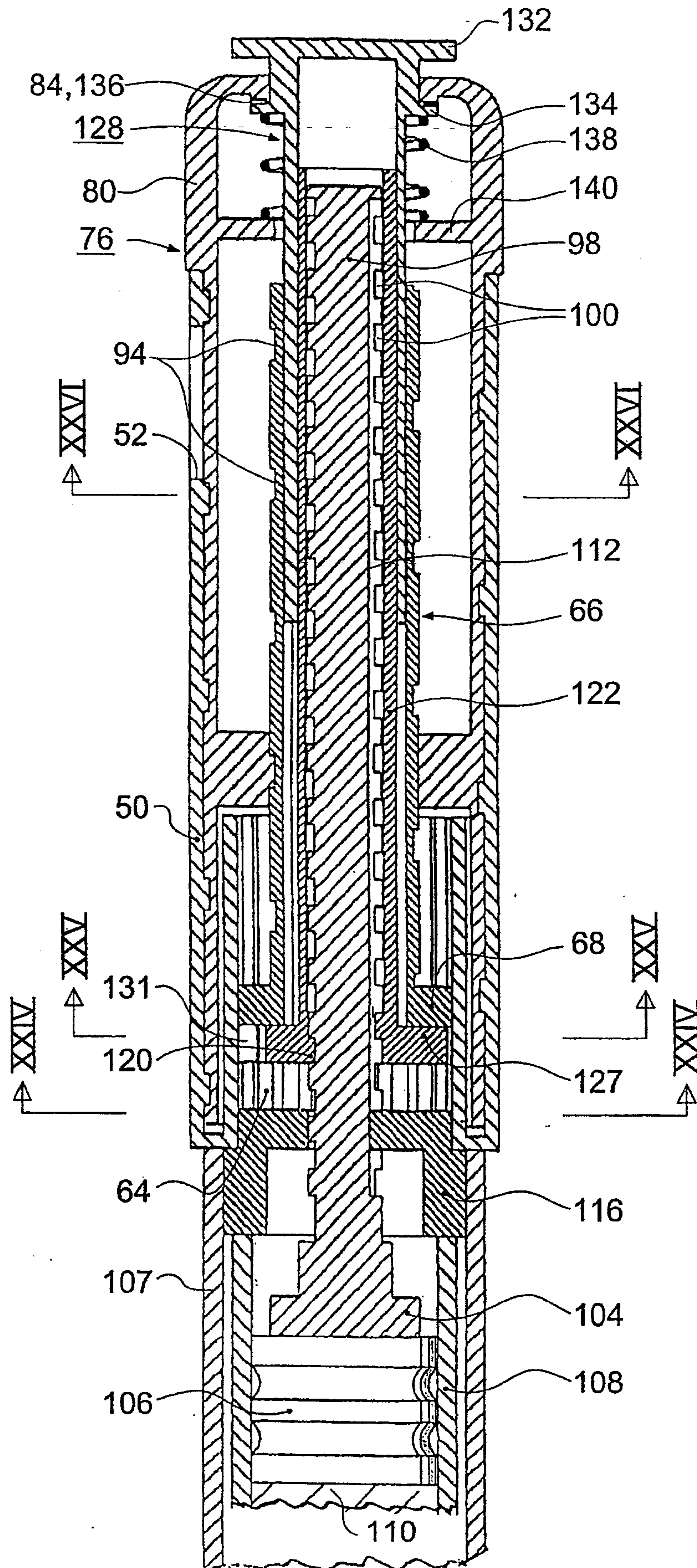


Fig.23

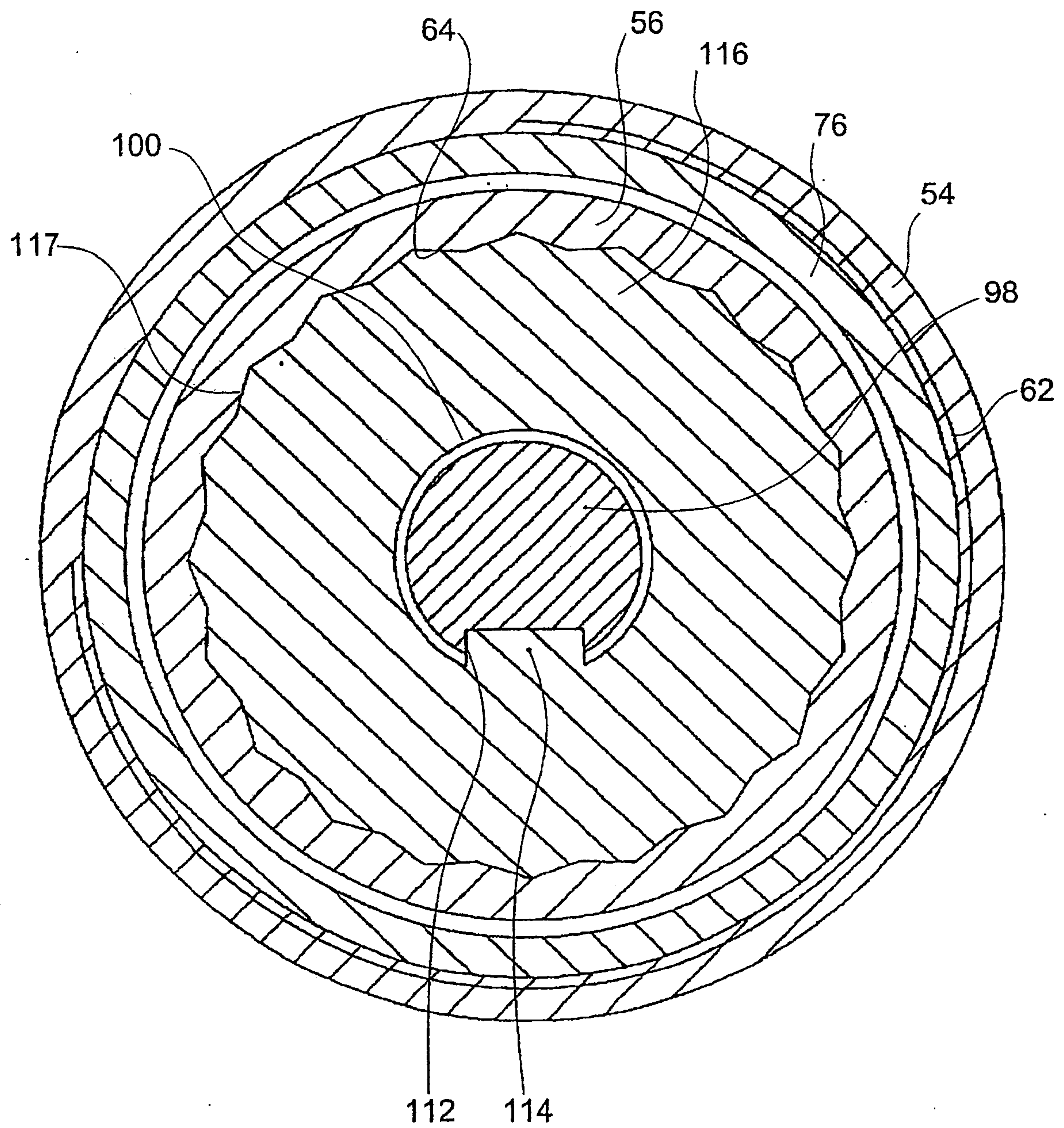


Fig.24

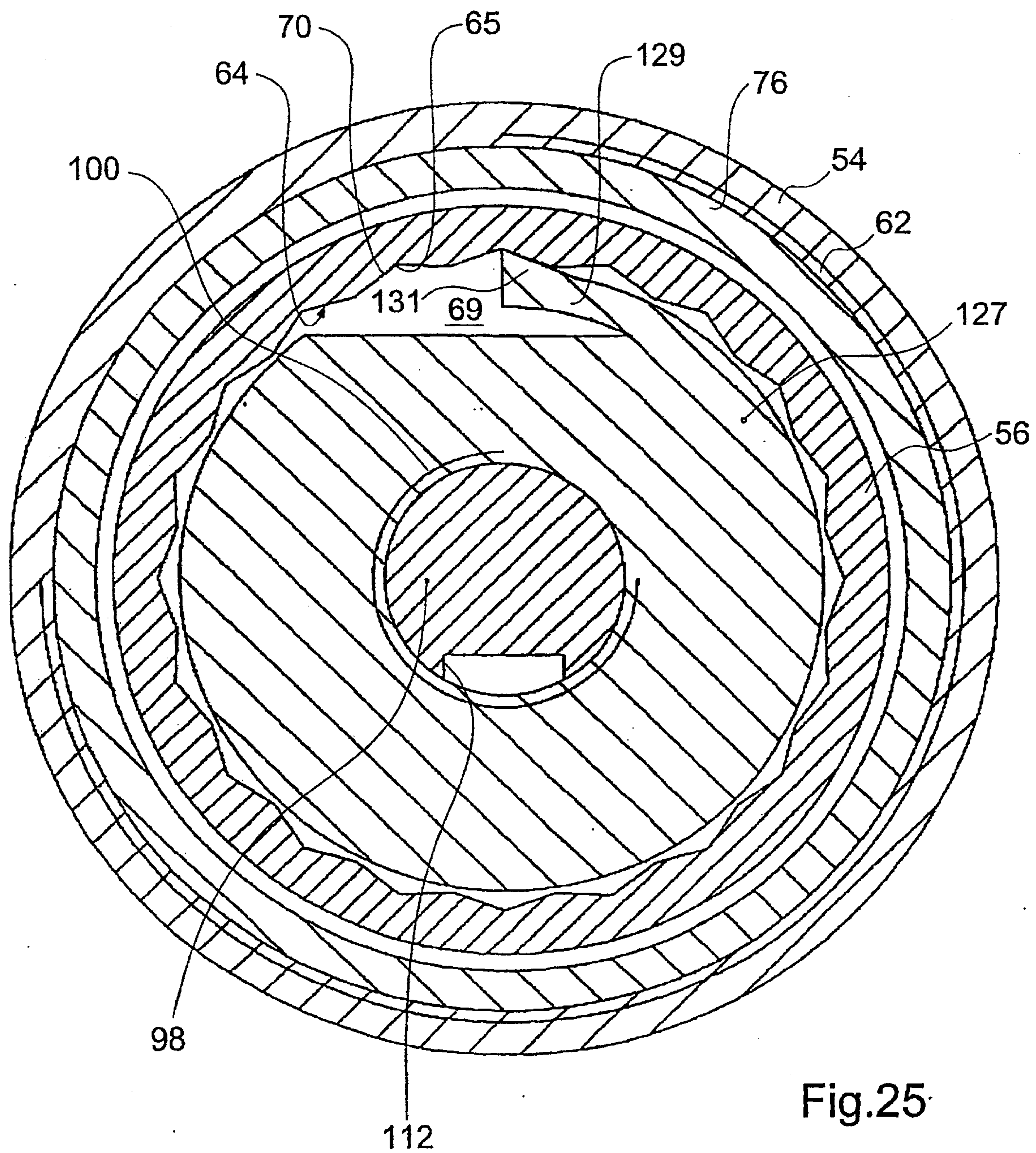


Fig.25

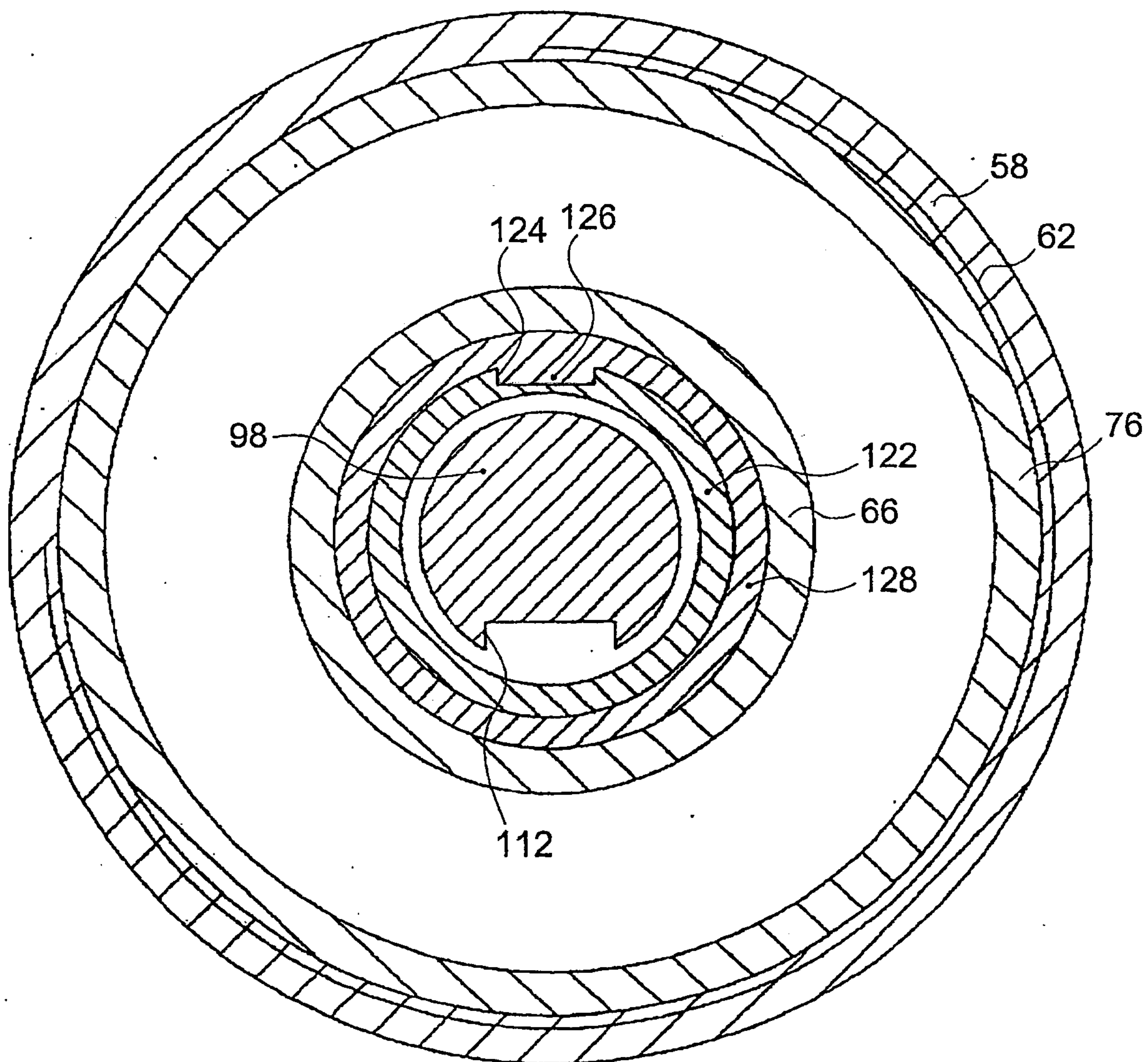


Fig.26

15/19

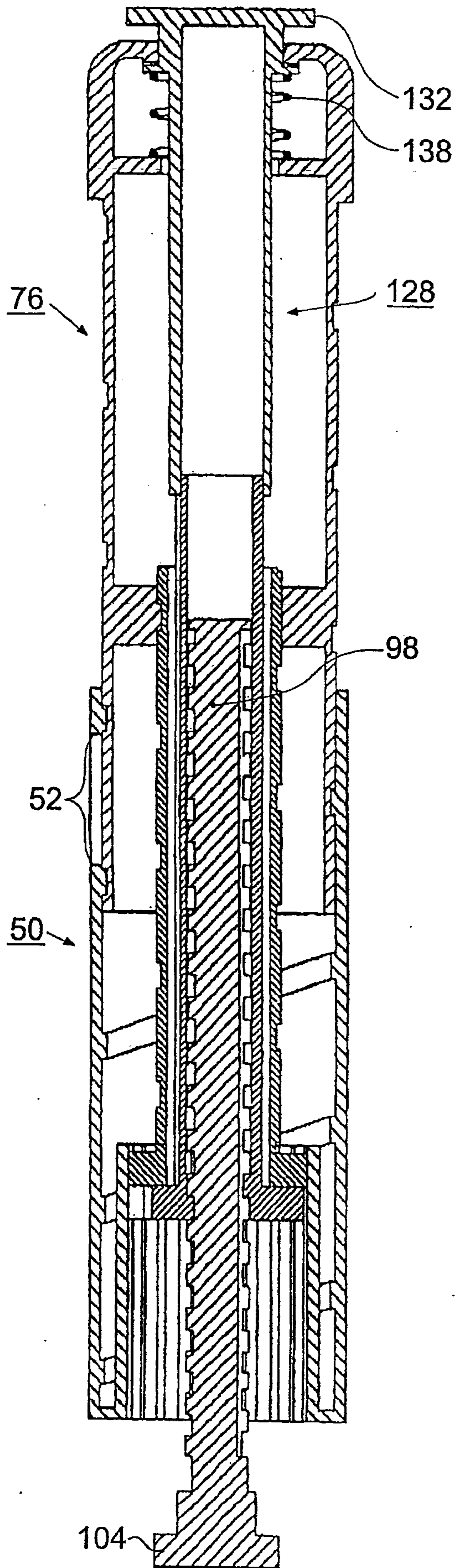


Fig.27

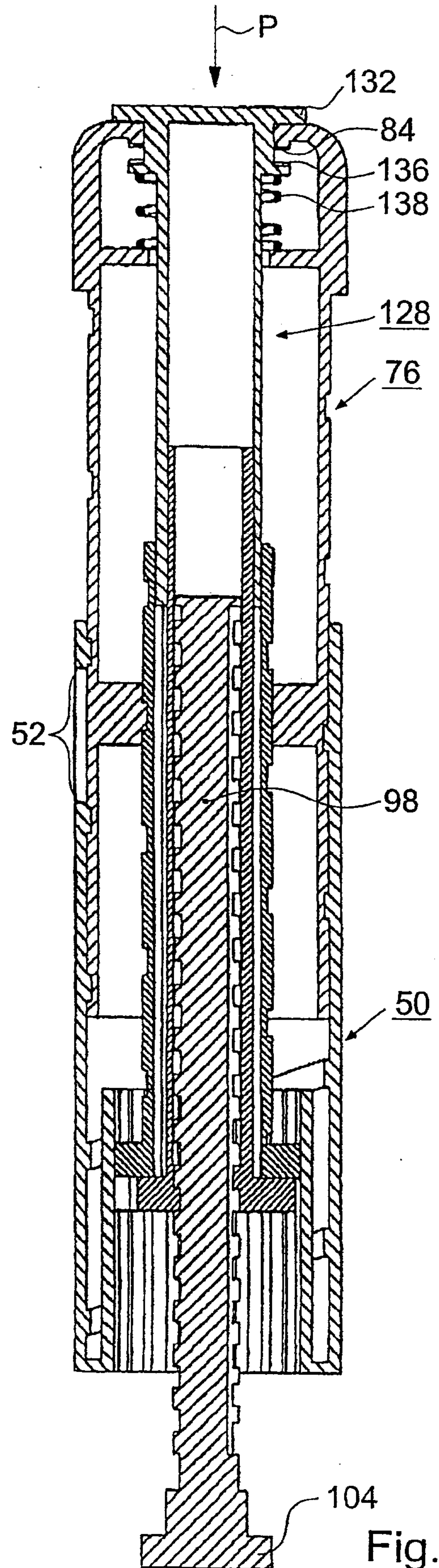


Fig.28

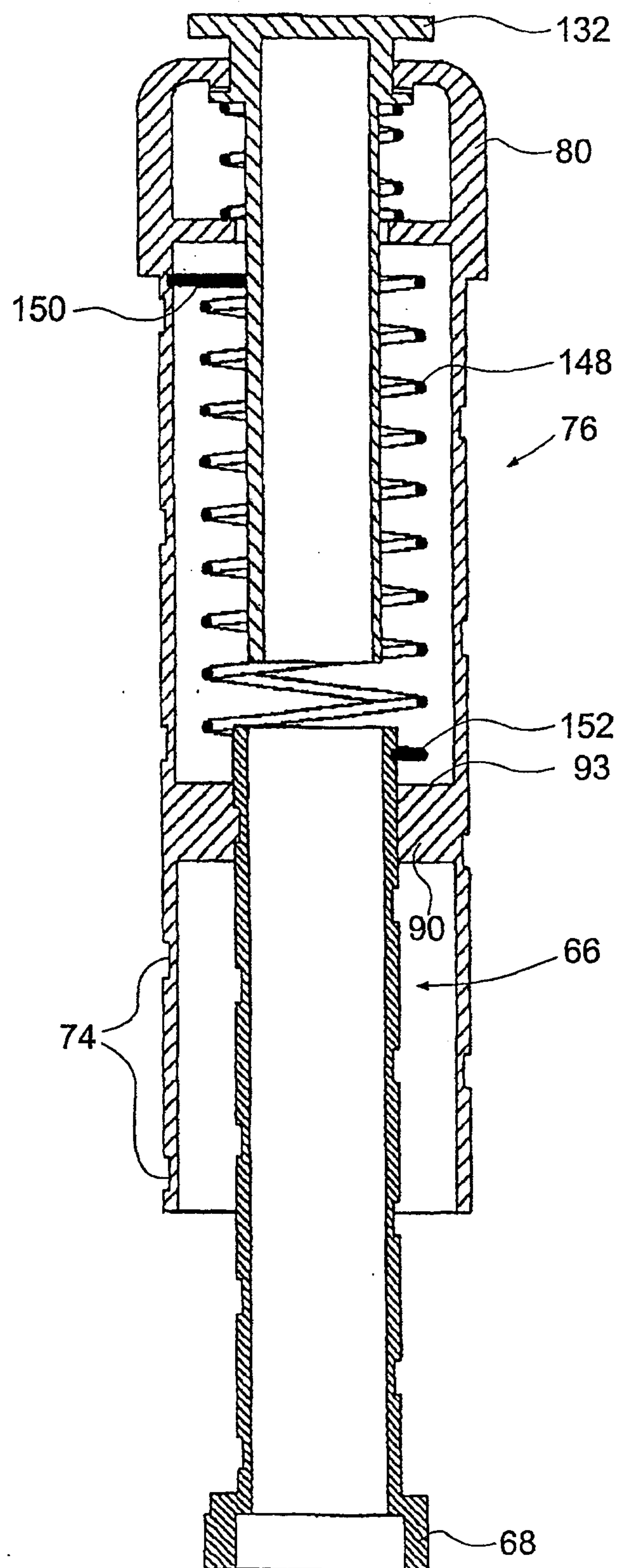


Fig.29

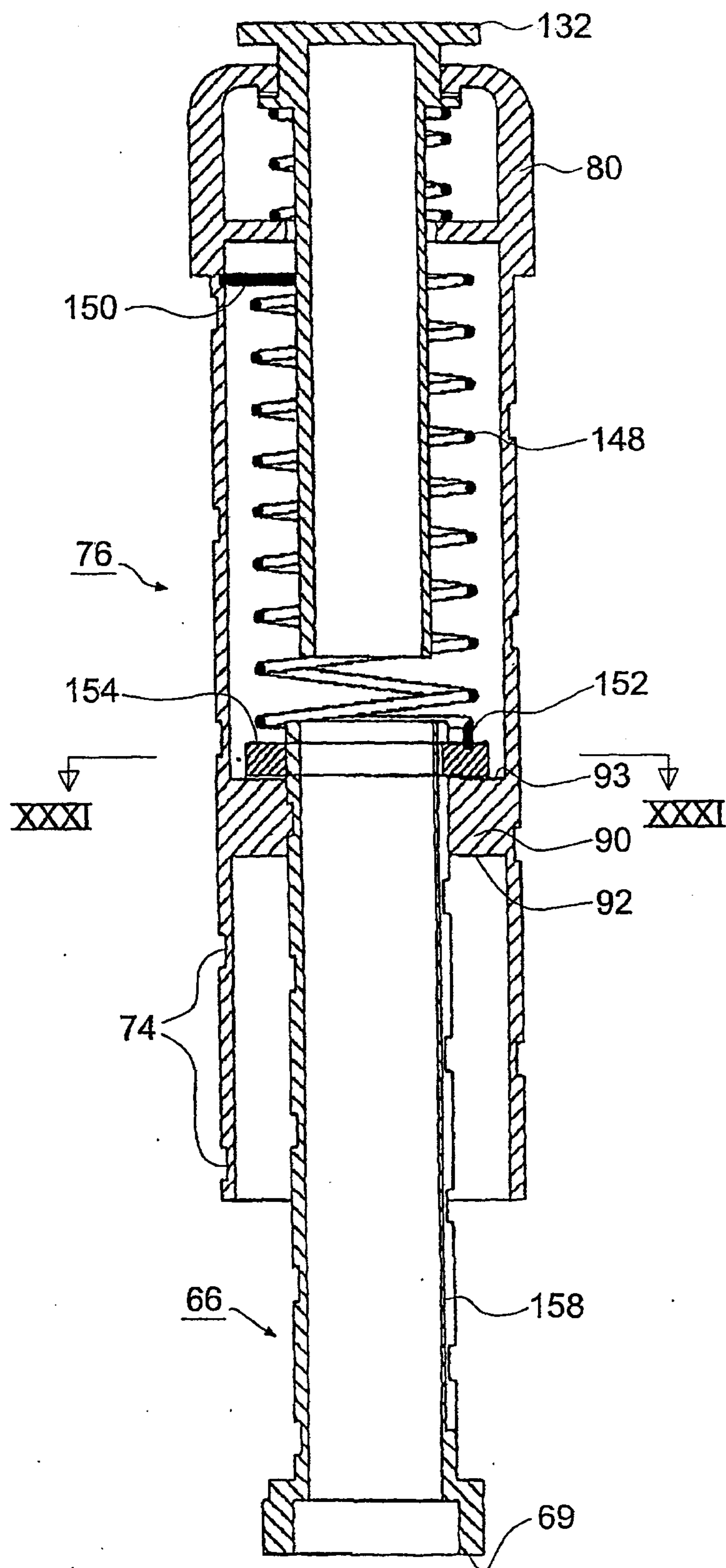


Fig.30

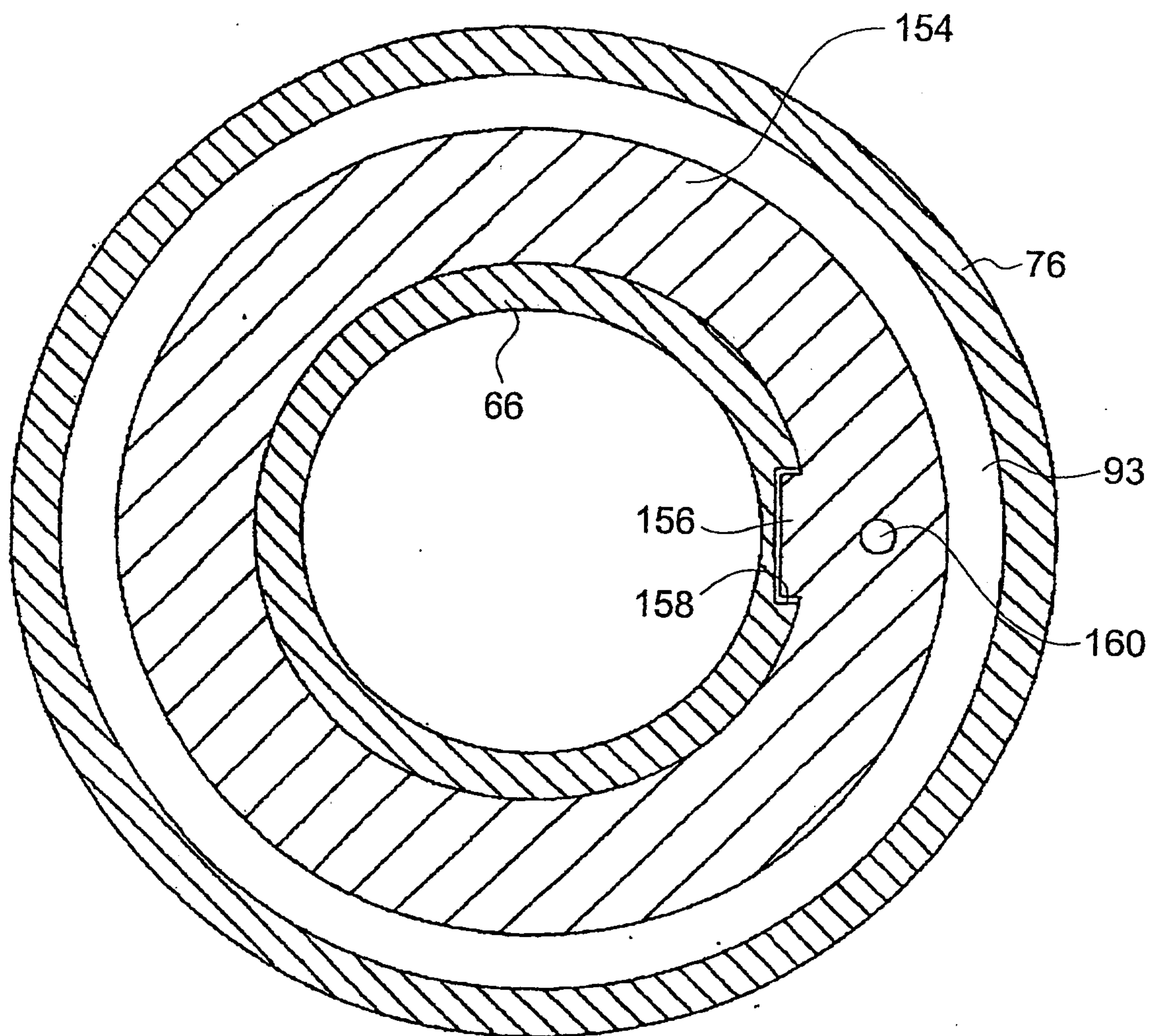


Fig.31

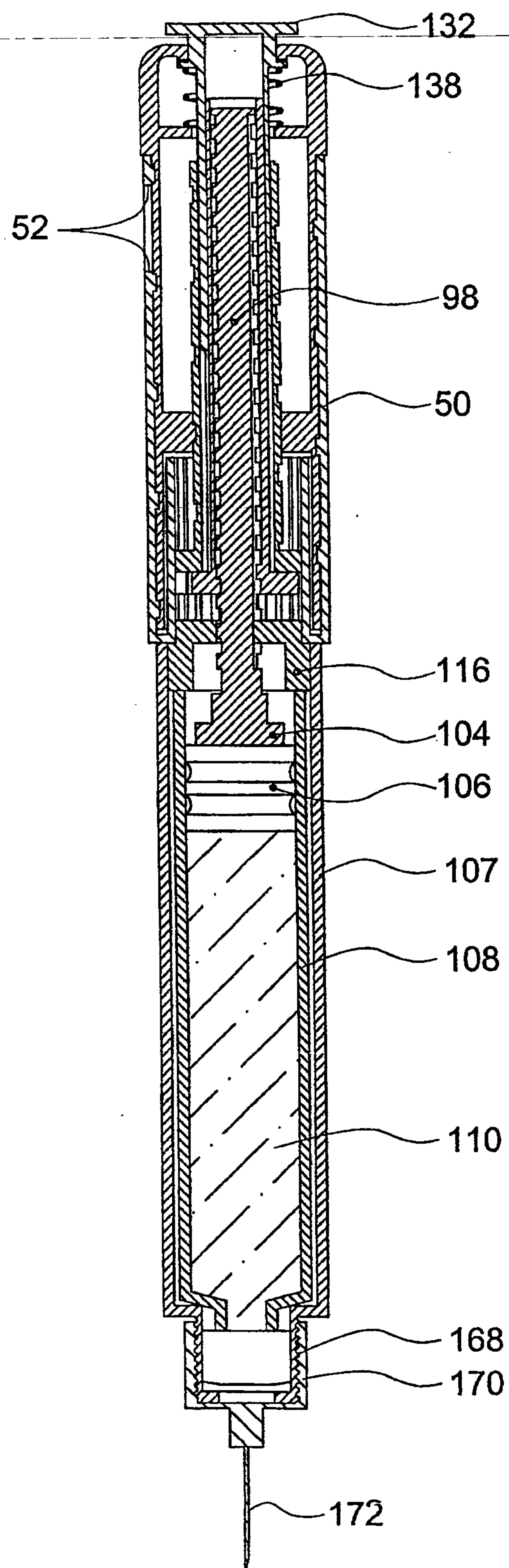


Fig.32

ERSATZBLATT (REGEL 26)

