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(54) Title of the Invention: **Fluid valve**
Abstract Title: **Valve cartridge for a live insertion valve for a pipe**

(57) A valve cartridge 211 for a live insertion valve 10 for a pipe 102, the valve cartridge 211 comprising: a valve member 214 comprising a body 215; and an actuation mechanism 216 for moving the valve member 214 such that, in use, the actuation mechanism 216 is configured to move the valve member 214 between an inactive state in which the valve member 214 permits a flow of fluid through a pipe 102 and an active state in which the valve member 214 blocks a flow of fluid through a pipe 102. The actuation mechanism 216 comprises a screw 240 and a corresponding receiver 241 configured to co-operate such that the receiver 241 moves linearly along the screw 240 when the screw 240 rotates relative to the receiver 241. Securing elements 266, preferably threaded, connect radial channels (264, fig 6) and recesses (262, fig 6).

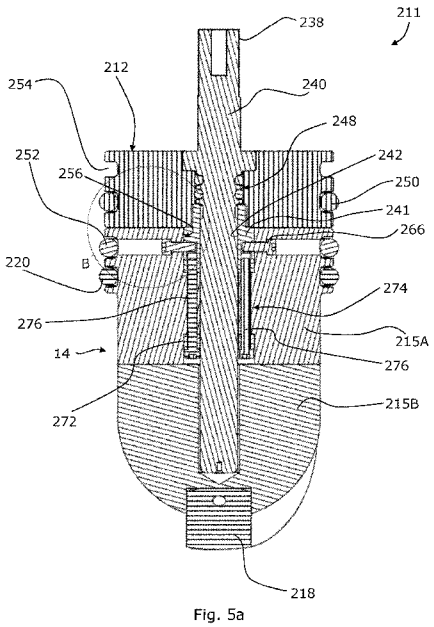

Fig. 5a

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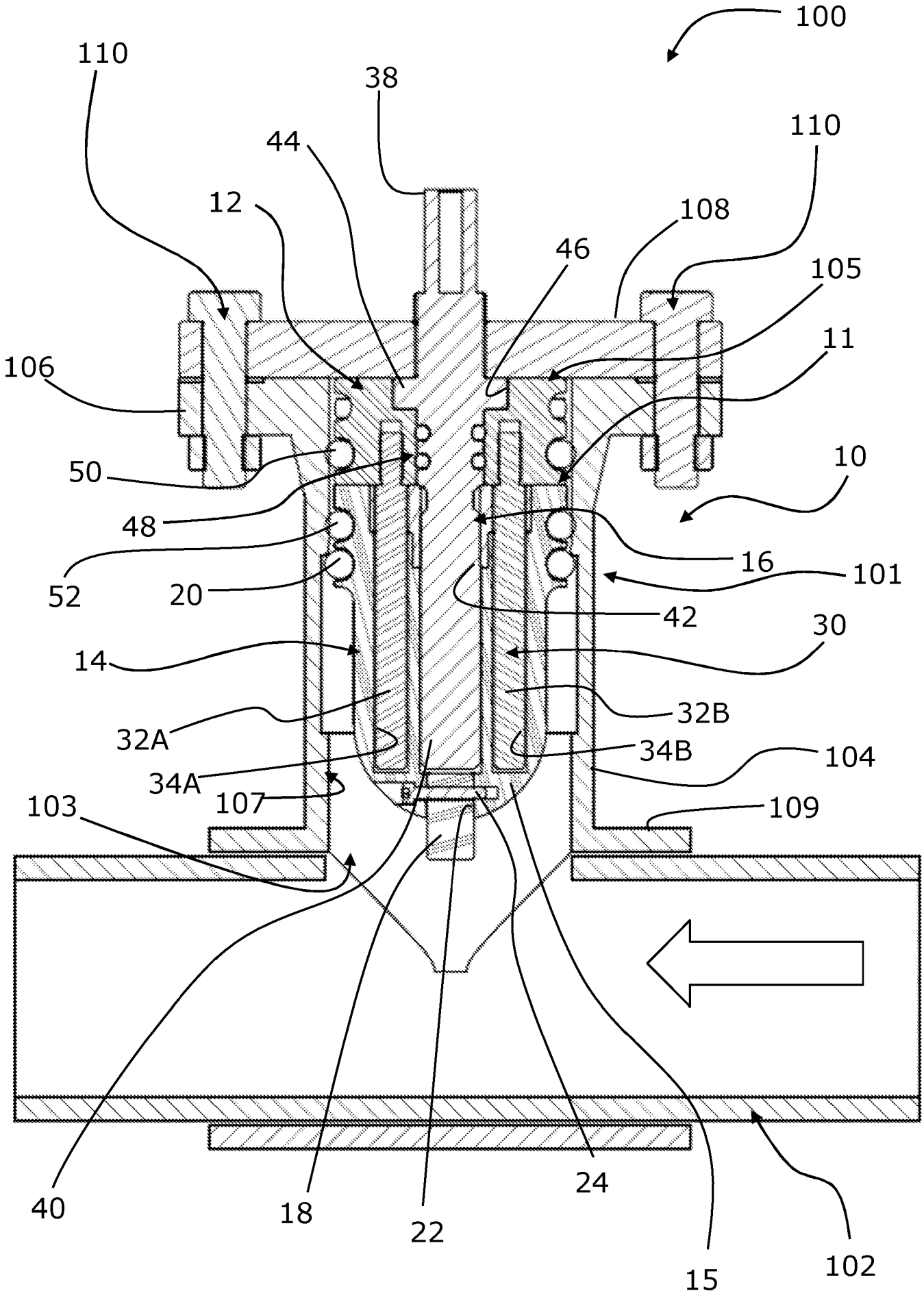
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Fig. 1

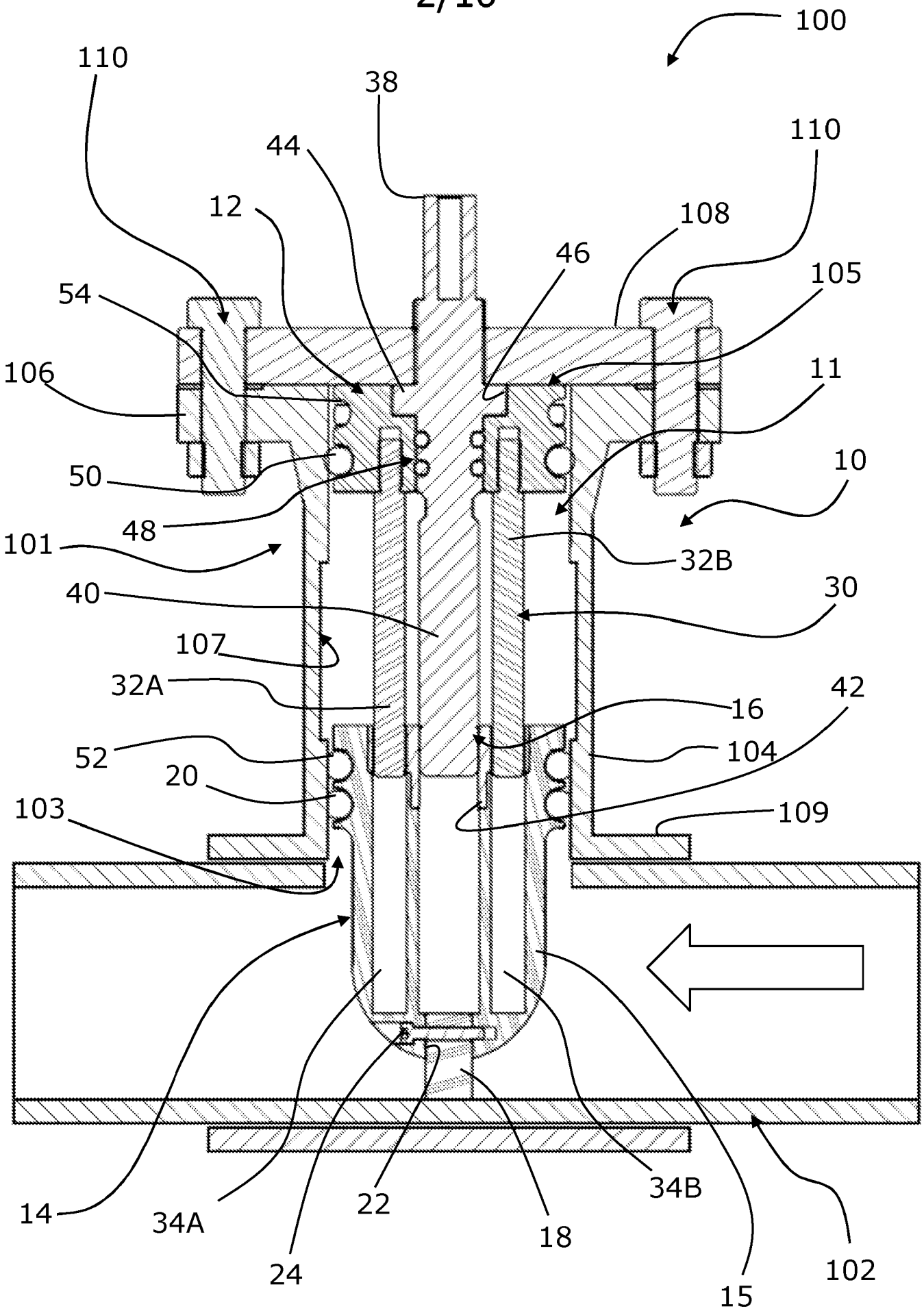
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Fig. 2

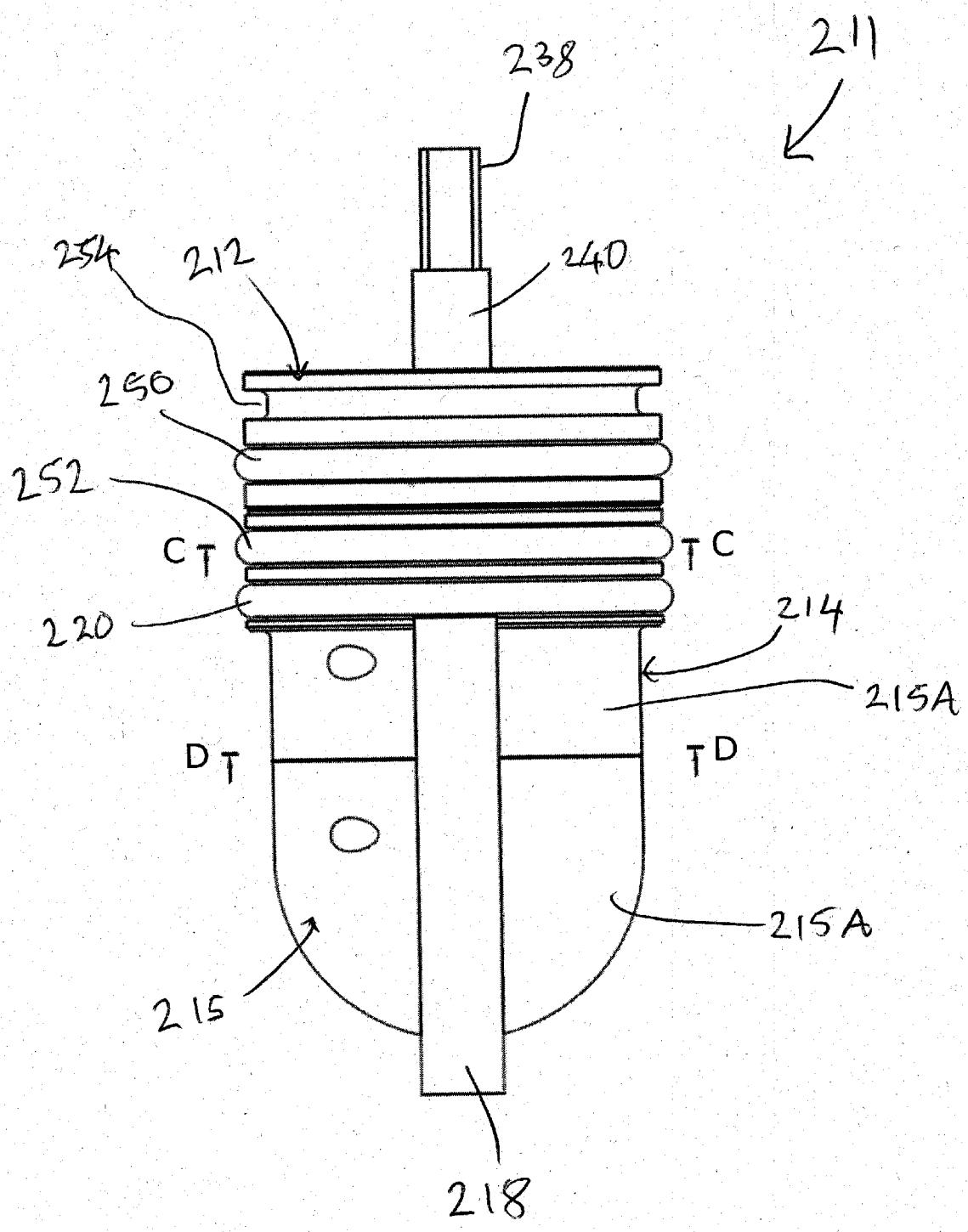

Fig. 3a

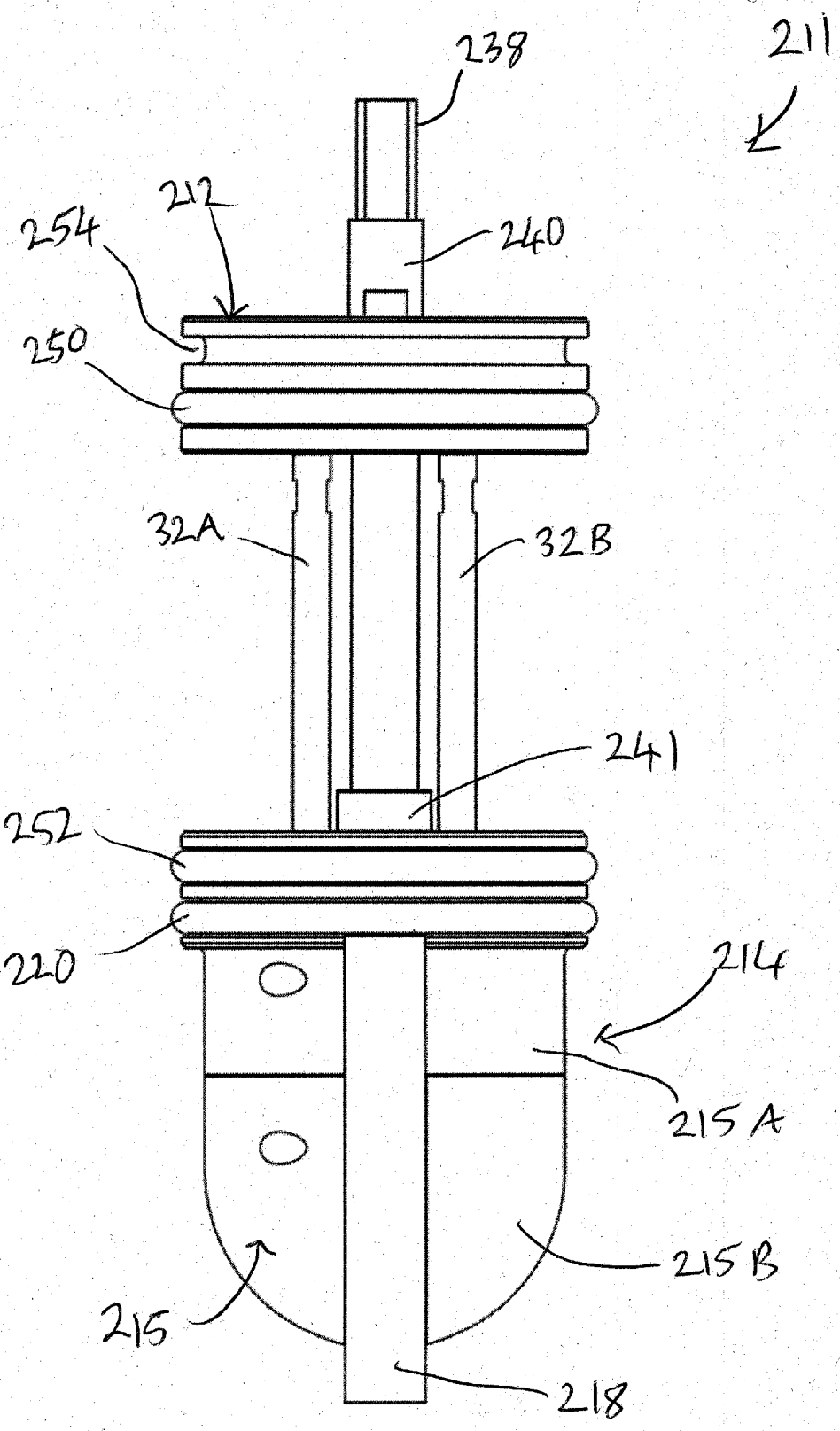
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Fig. 3b

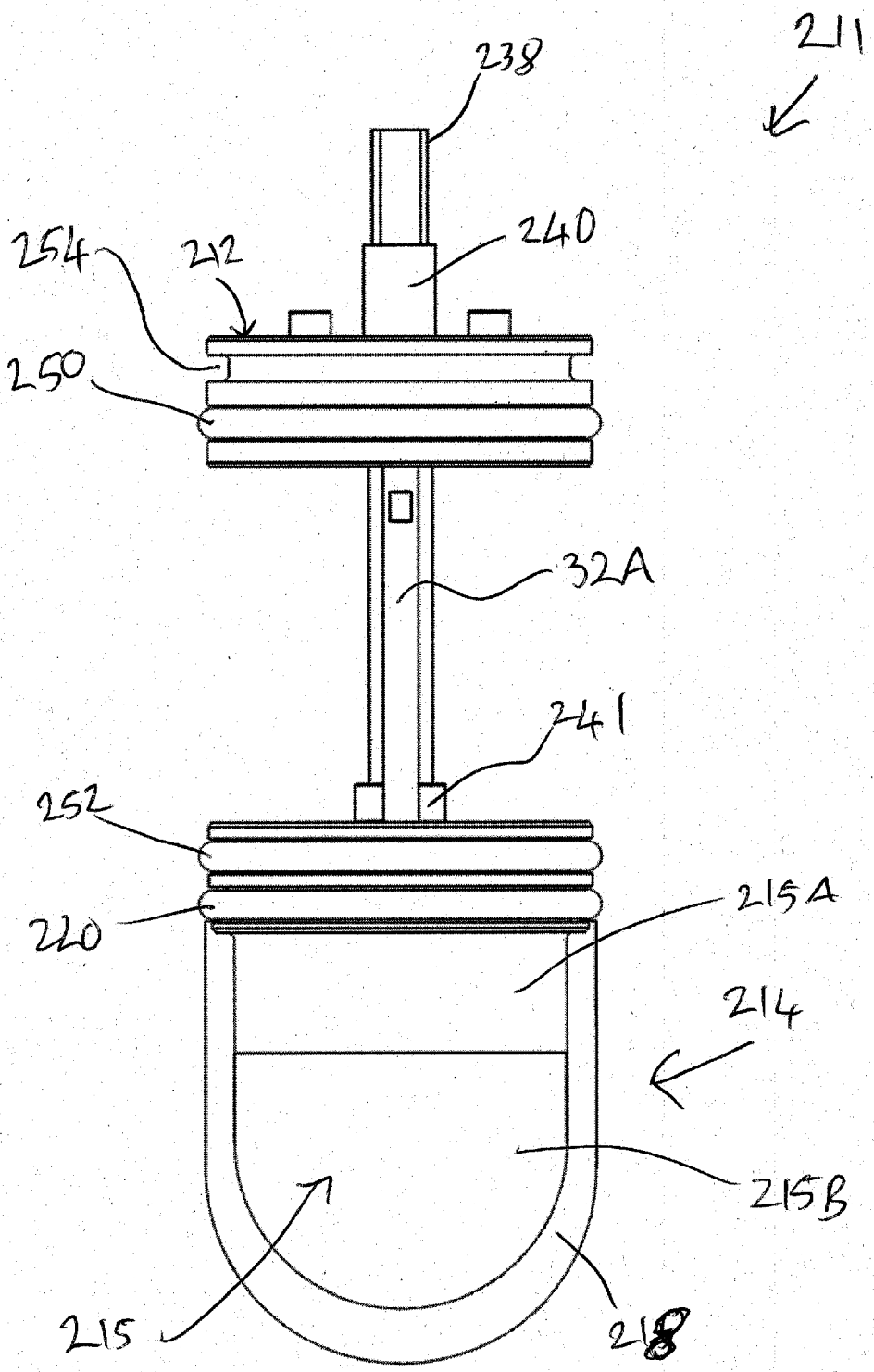

Fig. 3c

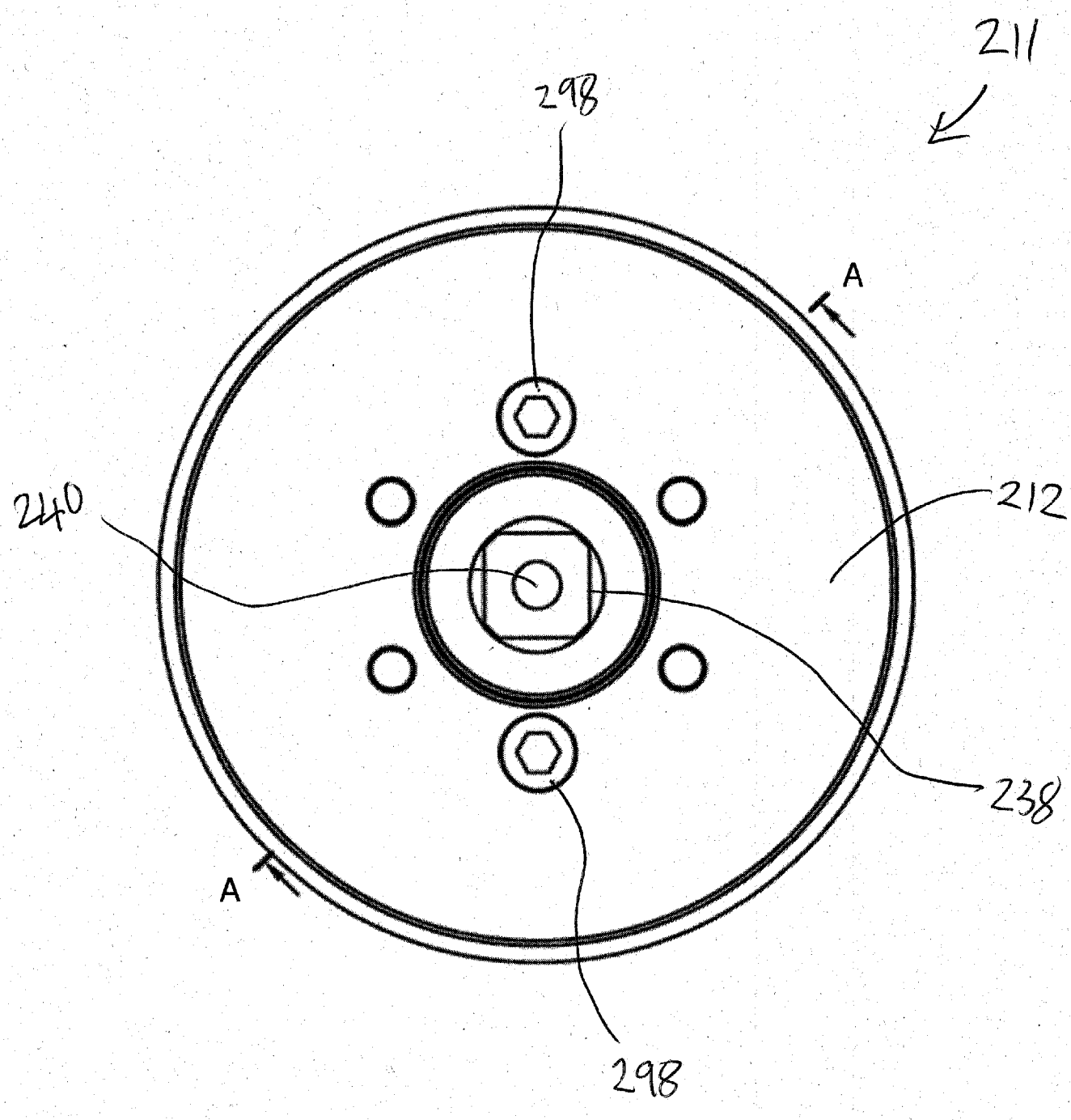

Fig. 4

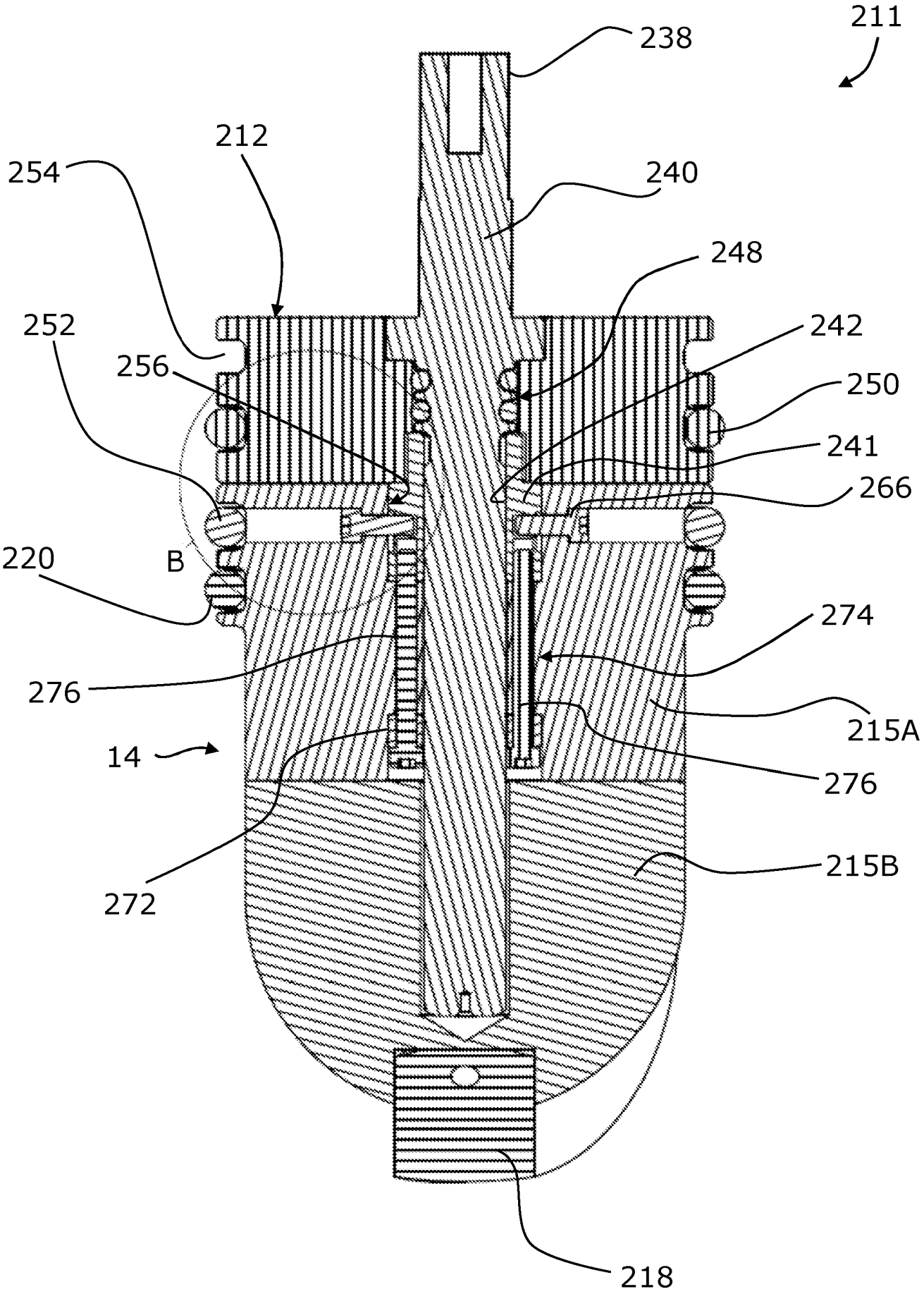
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Fig. 5a

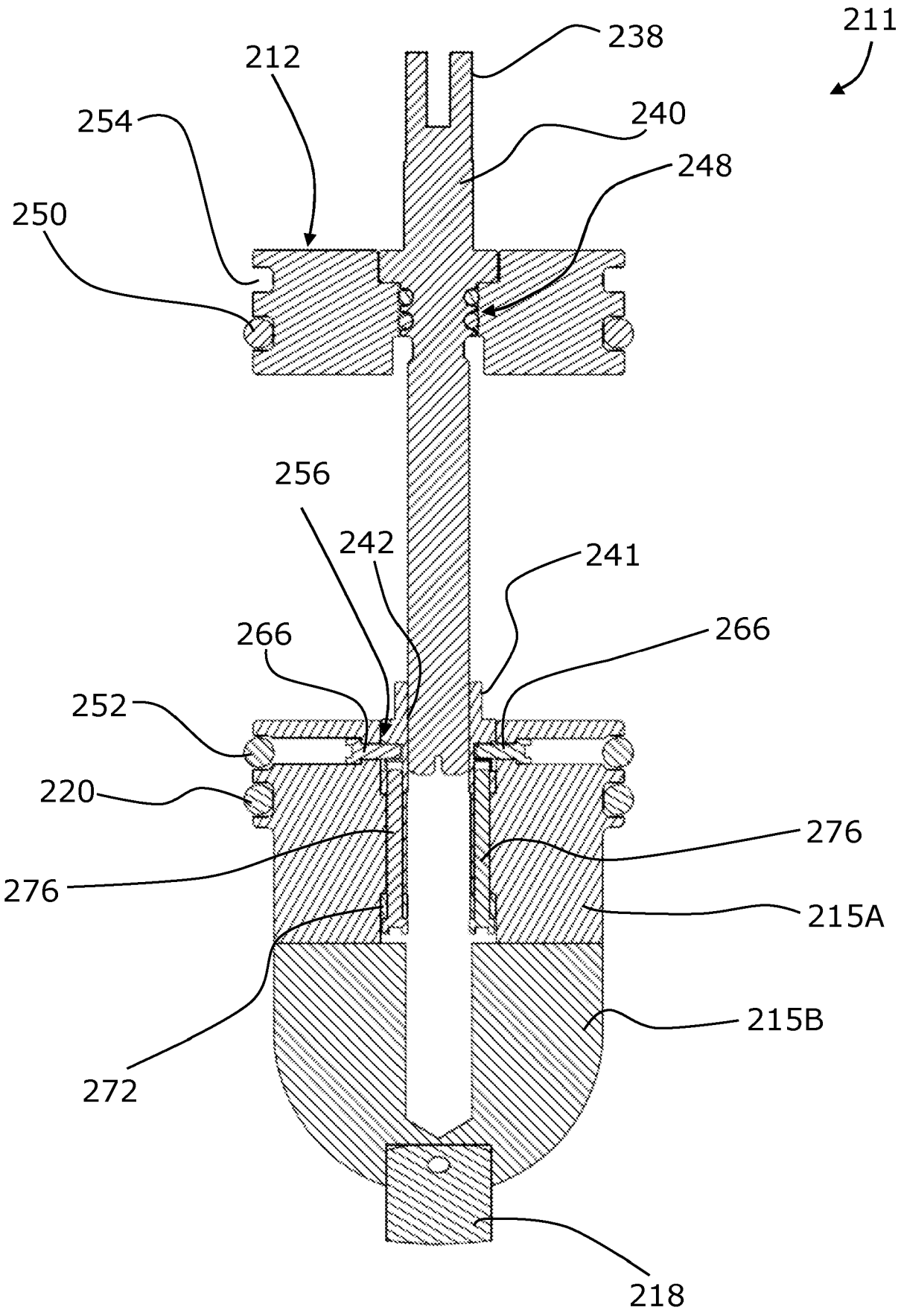
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Fig. 5b

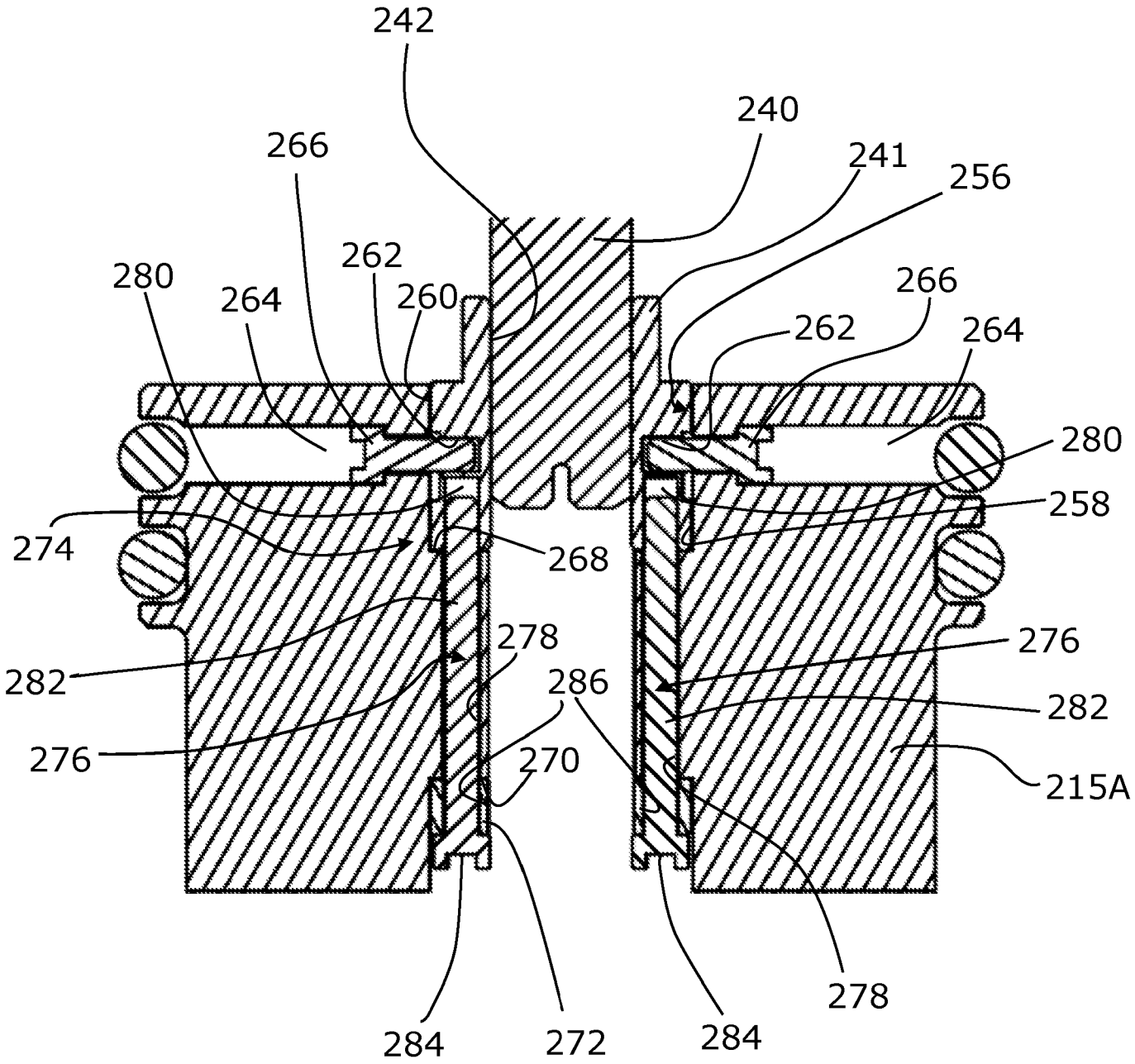
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Fig. 6

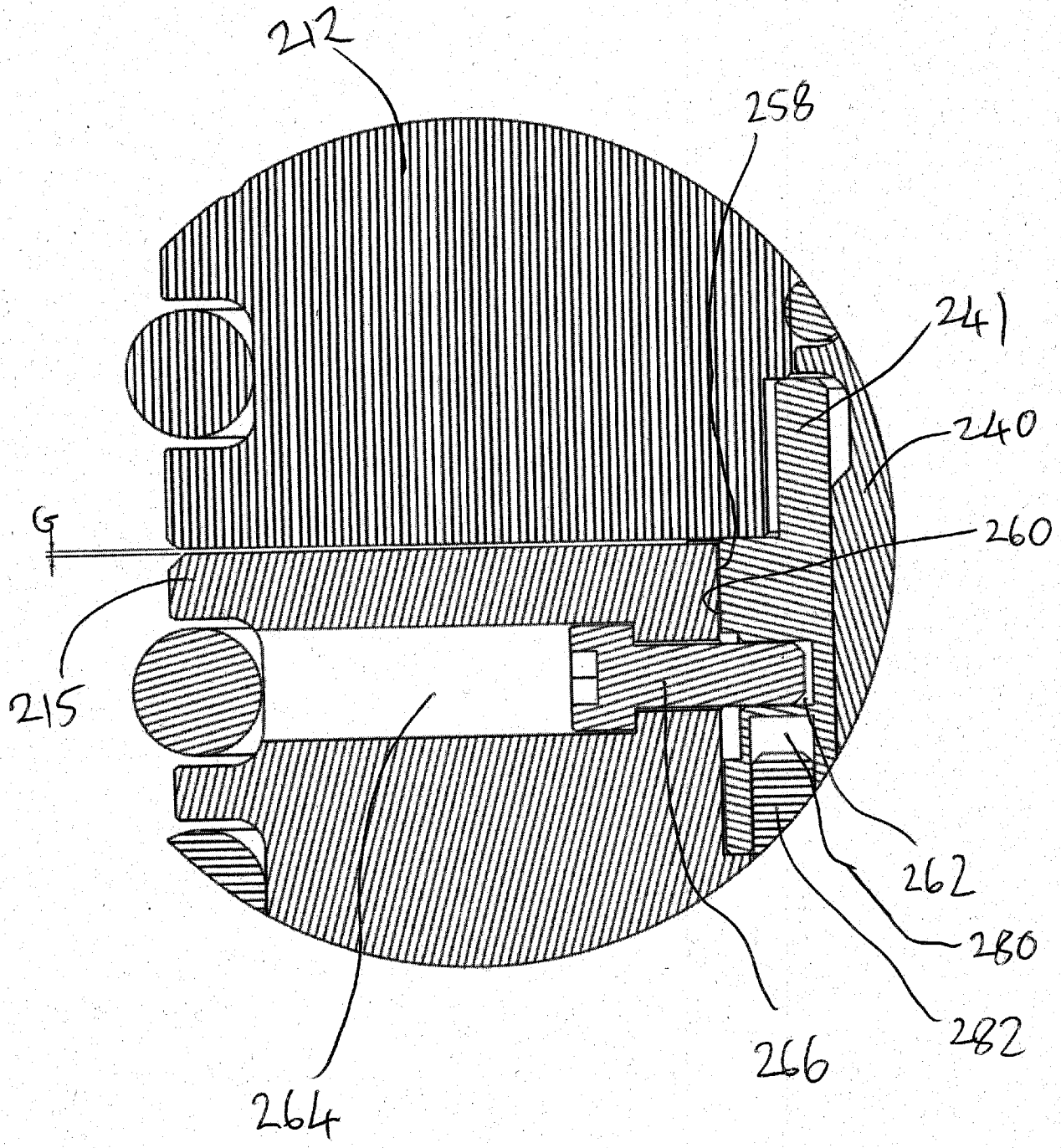

Fig. 7

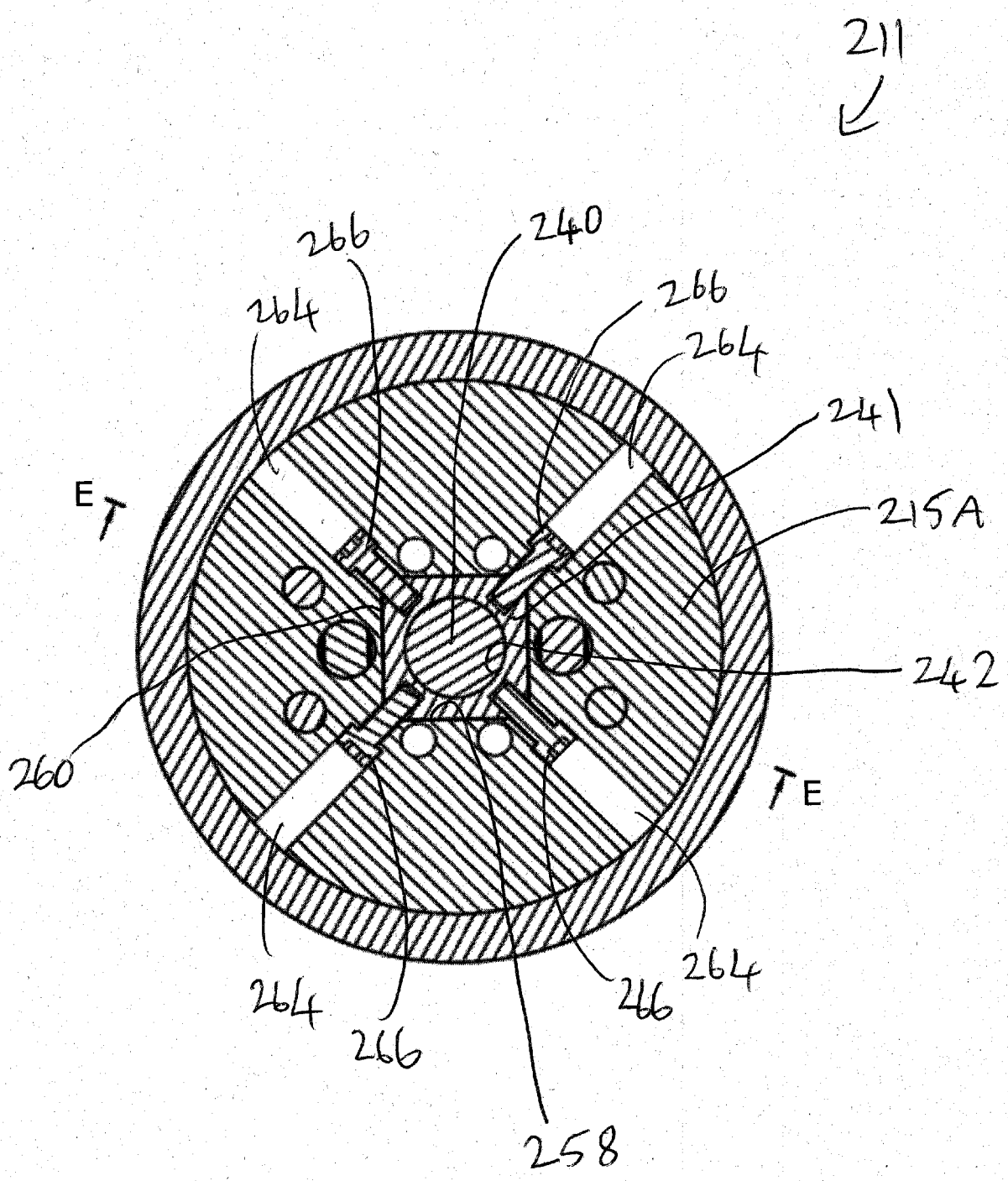

Fig. 8

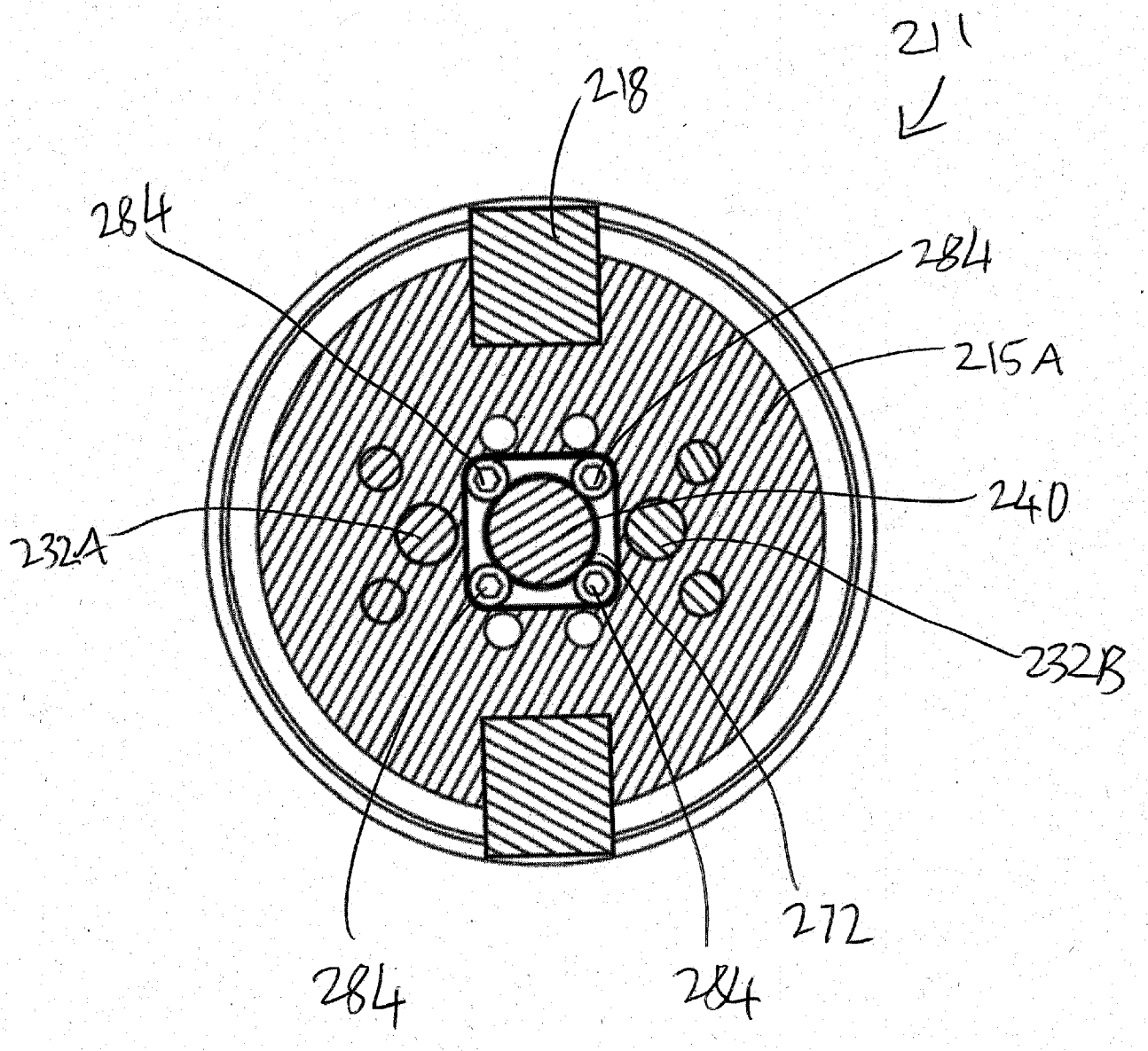

Fig. 9

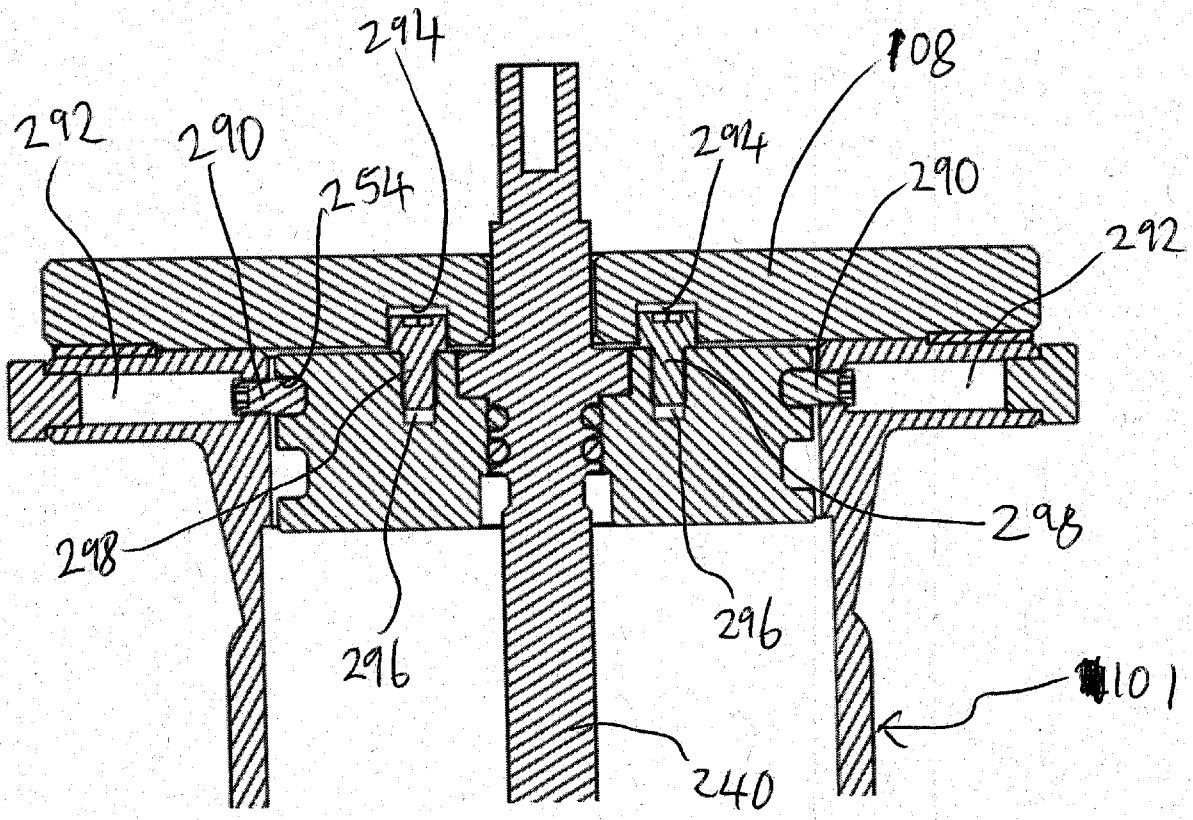

Fig. 10

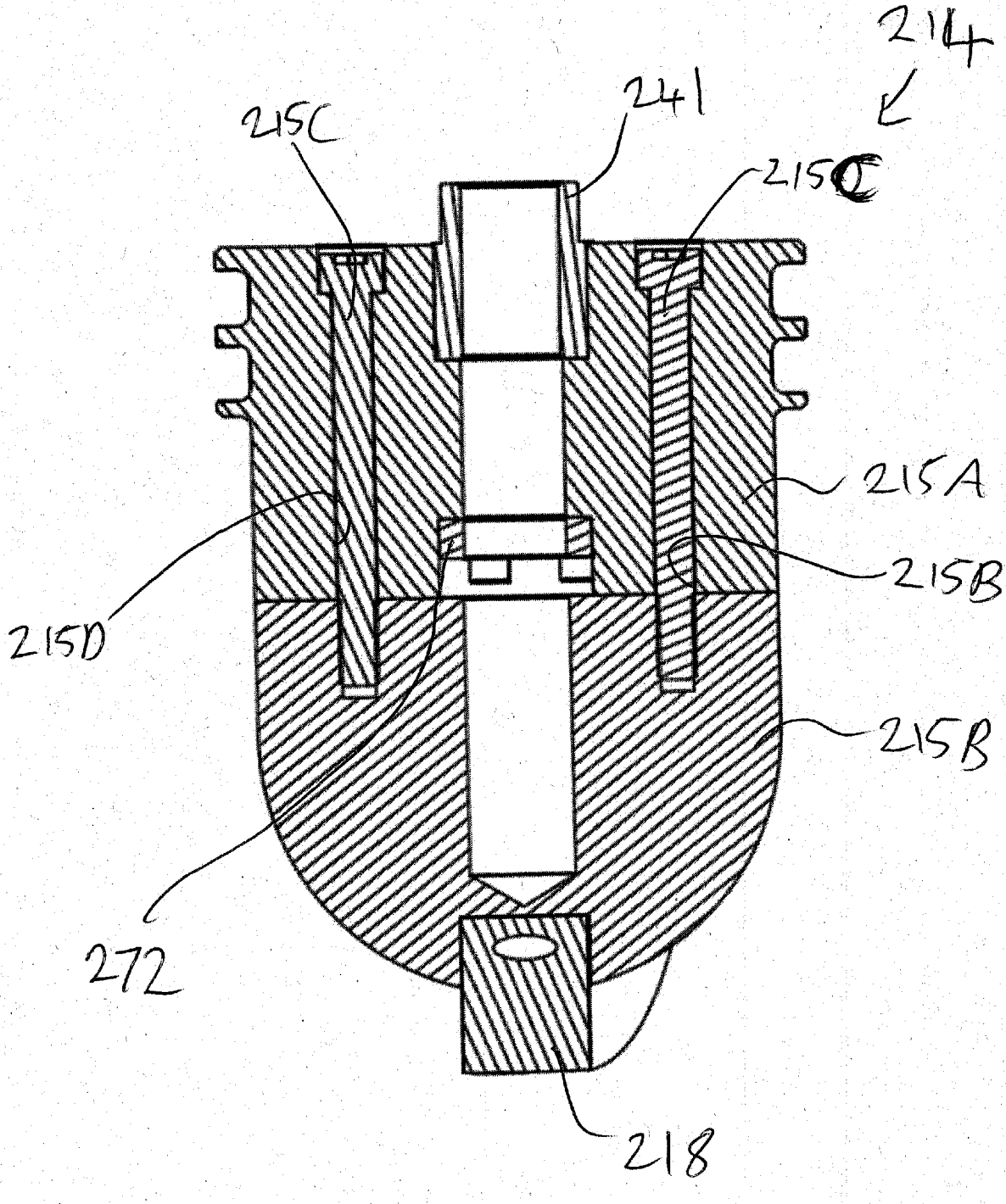

Fig. 11

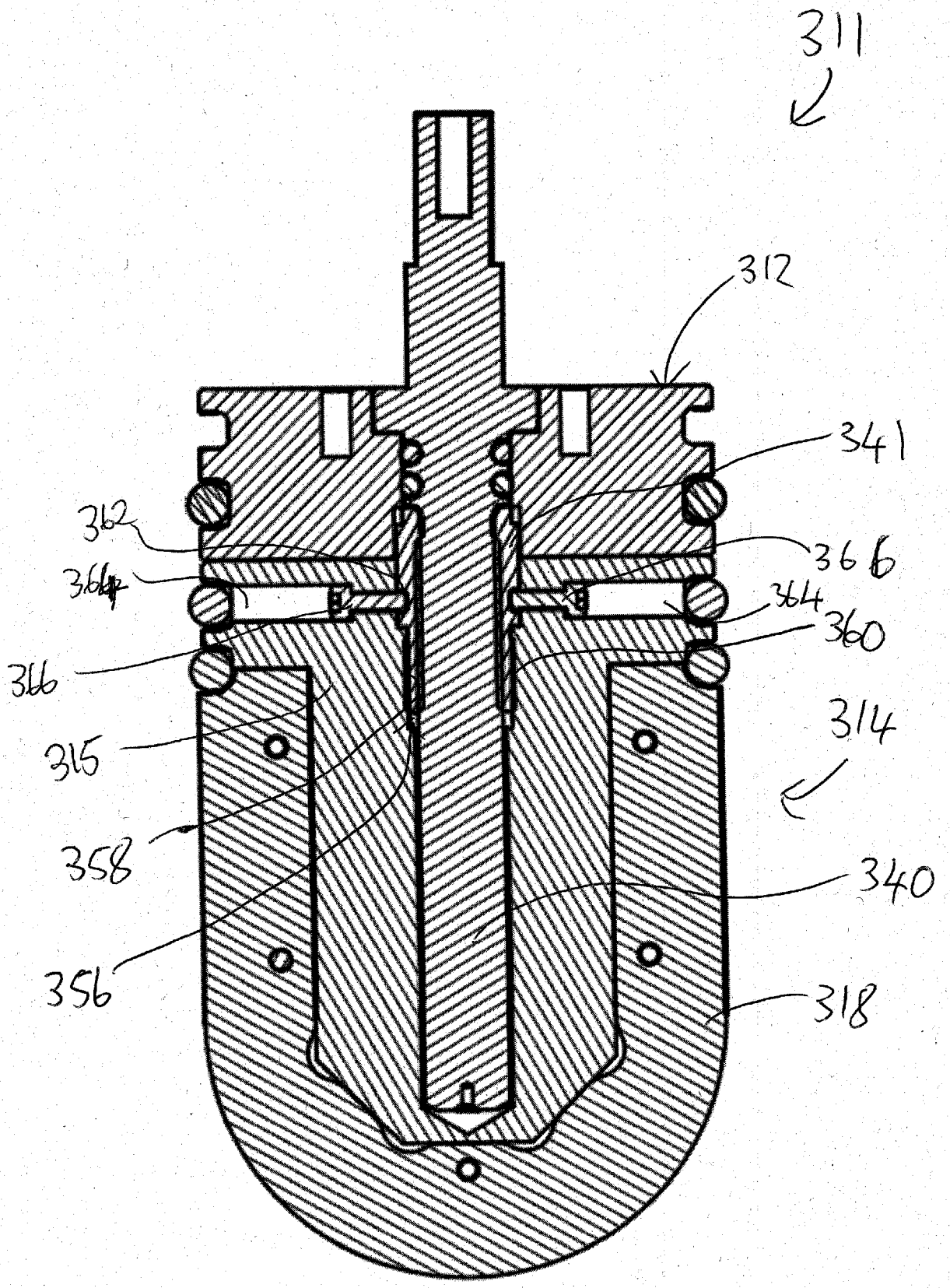

Fig. 12

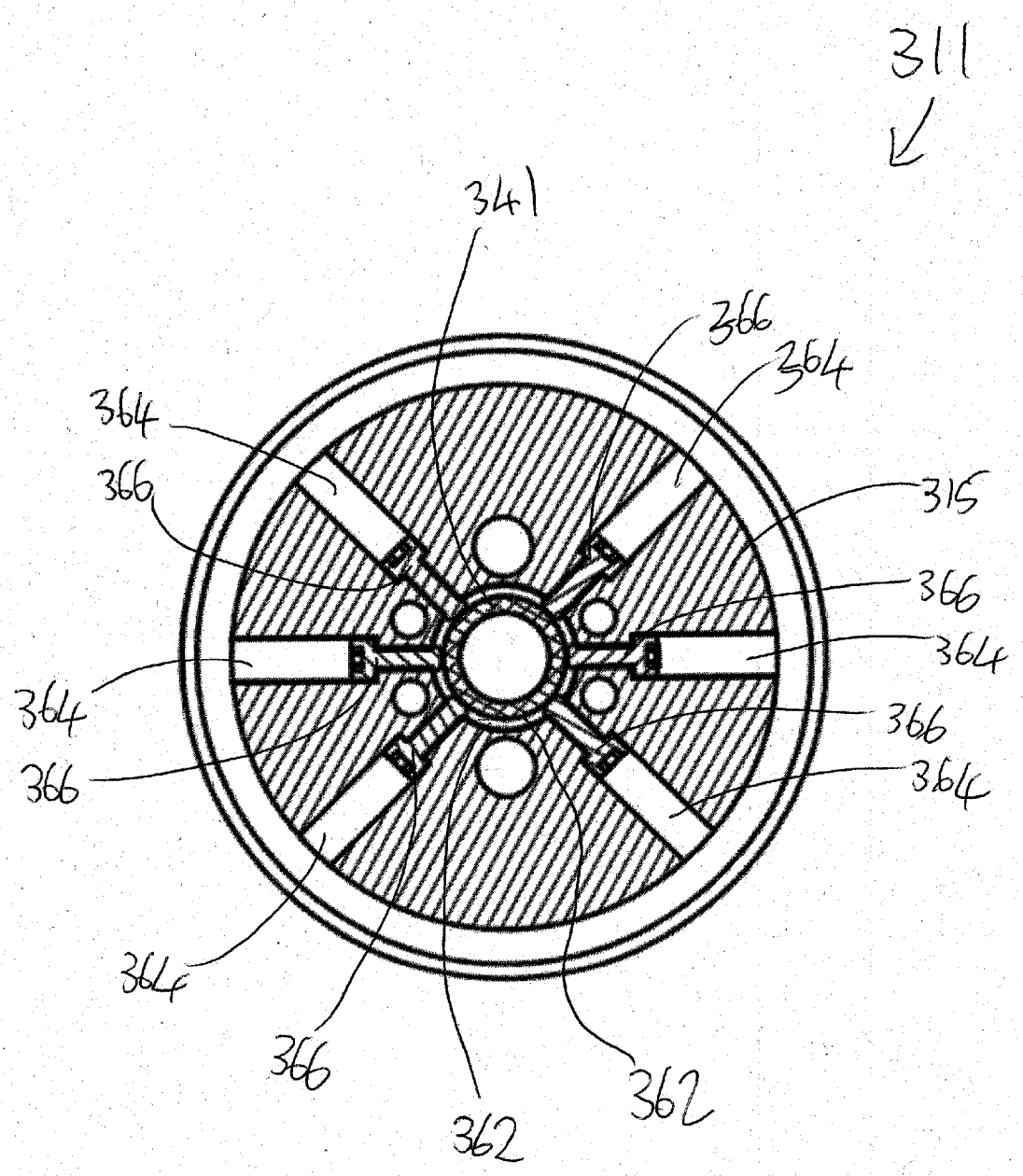

Fig. 13

Fluid Valve

FIELD

The present disclosure relates to a valve cartridge for a live insertion valve for a pipe, a kit of parts including said valve cartridge and a casing for attachment to a pipe, and a live insertion valve assembly including said valve cartridge and said casing.

BACKGROUND

There is sometimes a need to block a flow along a pipe in a fluid distribution network, such as a water mains distribution network, e.g. in order to carry out maintenance or repair. Various valves exist which are intended for this purpose.

Live insertion valves are a particular type of valve used in water distribution networks. Live insertion valves can be installed under live pressure and thus require no shutdown of the fluid network. This makes live insertion valves suitable for emergency repairs, as well as other applications.

Commonly, a casing is provided including a first portion, which surrounds a pipe to which the valve is to be fitted, and a second portion extending from the first portion in a direction transverse to the pipe. An opening in a side wall of a pipe is created in line with the second portion of the valve casing such that a live insertion valve cartridge can be installed via the second portion of the casing. In such applications, the live insertion valve cartridge typically includes a valve member which is introduced to the pipe via the second portion of the casing and through the opening in the side wall of the pipe. The valve member is arranged to move between an inactive state, in which fluid is permitted to flow along the pipe, and an active state, in which fluid is blocked from flowing along the pipe.

A leadscrew mechanism consisting of a leadscrew and a lead nut coupled to a body of the valve member is a known means for moving the valve member. It is known to secure the lead nut to the body via fasteners (e.g. bolts) which are screwed through the lead nut into threads in the body of the valve member.

The present disclosure aims to overcome or at least mitigate one or more problems associated with the prior art.

SUMMARY

According to a first aspect of the disclosure, a valve cartridge for a live insertion valve for a pipe is provided, the valve cartridge comprising a valve member comprising a body, wherein the valve cartridge is configured such that, in use, the valve member is moveable between an inactive state in which the valve member permits a flow of fluid through a pipe, and an active state in which the valve member blocks a flow of fluid through a pipe.

Optionally, the valve cartridge comprises an actuation mechanism for moving the valve member such that, in use, the actuation mechanism is configured to move the valve member between the active and inactive states.

Optionally, the actuation mechanism is configured to move the valve member linearly such that, in use, the valve member is moveable in a direction transverse to a pipe, in order to move between the active and inactive states.

Optionally, the actuation mechanism comprises a rotatable member, wherein rotation of the rotatable member in a first direction causes linear movement of the valve member in a first direction, and rotation of the rotatable member in a second direction causes linear movement of the valve member in the opposite direction.

Optionally, the valve cartridge further comprises an anti-rotation arrangement configured such that, in use, the anti-rotation arrangement is arranged to inhibit rotation of the valve member relative to a pipe.

Optionally, the anti-rotation arrangement comprises one or more projections, optionally a pair of spaced apart rods, configured to be fixed relative to a pipe when in use, and a corresponding one or more channels in the valve member for receiving the projections.

Optionally, the actuation mechanism comprises a screw and a corresponding receiver (e.g. nut) in the valve member, wherein the receiver comprises an axial bore for receiving the screw, and wherein the screw and receiver are configured to co-operate such that the receiver moves linearly along the screw when the screw rotates relative to the receiver.

Optionally, the receiver is coupled to a socket of the body. Optionally, the receiver is coupled to the socket of the body via one or more securing elements (e.g. fasteners).

The receiver being coupled to a socket in the body of the valve member (e.g. as opposed to being integrally formed with the body of the valve member) allows different materials to be used for the body and the receiver. For example, a comparatively lighter, cheaper and/or softer material can be used for the body (e.g. a plastics material) while a comparatively heavier, more expensive and/or harder material can be used for the receiver (e.g. a metallic material).

Optionally, the screw is a leadscrew and the receiver is a lead nut, wherein the leadscrew and axial bore of the lead nut comprise complementary threads.

A leadscrew mechanism of this kind is relatively cheap and reliable and has a small number of moving parts (e.g in comparison to a ball screw or roller screw mechanism).

Optionally, the actuation mechanism comprises a ball screw mechanism.

Optionally, the actuation mechanism comprises a roller screw mechanism.

Optionally, the socket defines a first surface (e.g. shoulder) for abutment with the receiver, wherein the body of the valve member comprises one or more second surfaces (e.g. shoulders) for abutment with one or more support elements, and wherein the valve member further comprises a clamping arrangement configured to urge the receiver and one or more support elements towards the respective first and second surfaces to clamp the receiver to the body.

In prior art systems, a leadscrew mechanism consisting of a leadscrew and a lead nut coupled to a body of the valve member are arranged to move the valve member. It is known to secure the lead nut to the body via fasteners (e.g. bolts) which are screwed through the lead nut into threads in the body of the valve member, the body typically being made from a plastics material. A problem with this means for fastening the lead nut to the body of the valve member is that threads of the body shear more easily than threads of stronger materials such as metallic materials. This can result in disengagement of the lead nut from the body when a large separation force is applied.

The disclosed clamping arrangement being configured to urge the receiver and one or more support elements towards the respective first and second surfaces to clamp the receiver to the body results in a more robust connection than when the receiver is secured to the body via fasteners which pass through the receiver and are held by threads in the body. The clamping arrangement is particularly beneficial when the body is made of

comparatively soft material (e.g. plastics material) which is unsuitable for receiving threaded fasteners subjected to high shear forces.

Optionally, the first surface extends radially and/or the second surface extends radially. Optionally, the first and second surfaces each extend radially and face in opposite axial directions.

Optionally, the clamping arrangement comprises one or more connecting elements for coupling the receiver to the one or more support elements.

Optionally, the one or more connecting elements are provided to extend between the receiver and the or each support element.

Optionally, the one or more connecting elements extend in a corresponding one or more axial through-holes of the body between the first and second surfaces.

The connecting element(s) extending through corresponding axial through-holes in the body provides resistance to lateral movement of the connecting element(s) relative to the body, which thus inhibits lateral movement and/or rotation of the receiver and the or each support element relative to the body.

Optionally, the one or more connecting elements extend at least partially into a corresponding one or more axial holes of the receiver;

Optionally, the or each connecting element comprises a shaft of a fastener comprising a thread and the or each axial hole of the receiver comprises a complementary thread for coupling the shaft to the receiver.

In this way, as a connecting element is rotated within the axial hole of the receiver, the complementary threads cause the receiver to move linearly (i.e. towards the first surface).

Optionally, the one or more support elements and one or more connecting elements are discrete components.

Optionally, the or each support element is integrally formed with a connecting element, optionally, wherein the or each support element comprises a head of a fastener and the respective connecting element comprises a shaft of the fastener.

Optionally, the one or more connecting elements extend at least partially into a corresponding one or more axial holes of the one or more support elements; optionally, wherein the one or more support elements comprise a support element comprising two or more axial holes for at least partly receiving two or more respective connecting elements.

Such a support element can be used to distribute a force applied by the two or more connecting elements over the entire area of the support element (i.e. including the area between the two connecting elements) which increases the area of contact with the second surface.

Optionally, the axial holes of the one or more support elements are through-holes, wherein the or each connecting element is a fastener comprising a shaft configured to extend through a respective through-hole of the one or more support elements and a head configured to push a respective support element towards the second surface.

Optionally, the socket comprises a first formation and the receiver comprises a second formation configured to engage the first formation to inhibit relative rotation between the receiver and the body.

Such first and second formations inhibit rotation of the receiver within the socket, which facilitates effective functioning of the actuation mechanism.

Furthermore, where axial fasteners are used to secure the receiver to the body, such fasteners experience a shear force when the receiver is urged rotationally relative to the socket. Therefore, the first and second formations reduces such shear forces and facilitate a more robust connection between the receiver and the socket.

Optionally, the first formation comprises an inner wall of the socket, and wherein the second formation comprises a periphery of the receiver configured to engage the inner wall of the socket.

Optionally, the inner wall of the socket comprises a multifaceted inner wall, e.g. a square, hexagonal or other polygonal shape in plan view, and the periphery of the receiver defines a corresponding multifaceted periphery, e.g. square, hexagonal or other polygonal shape in plan view.

Such an inner wall and periphery provides a simple means for inhibiting relative rotation between the receiver and the socket.

Optionally, the receiver comprises a periphery having a radial recess (e.g. radial groove and/or radial bore), and wherein the body of the valve member comprises a radial channel aligned with the radial recess, such that a securing element can be received within the channel of the body and the radial recess of the receiver to inhibit movement of the receiver relative to the body, optionally, to inhibit axial and/or rotational movement.

Such an arrangement provides a means for inhibiting movement between the receiver and the body which can be used in addition to, or instead of, other securing means such as axial fasteners or a clamping arrangement.

Optionally, the body of the valve member comprises a plurality of radial channels and the receiver comprises a plurality of corresponding radial recesses for receiving a corresponding plurality of securing elements; optionally, wherein the plurality of radial channels are distributed circumferentially around the body and the plurality of radial recesses are distributed circumferentially around the receiver.

Having a plurality of such radial channels/recesses for receiving a plurality of securing elements, further increases the robustness of the connection between the receiver and the socket.

Optionally, the or each radial recess is threaded for receiving a threaded securing element, and/or each radial channel is threaded for receiving a threaded securing element.

Such threads provide a means for securing the securing elements in place to provide a robust connection between the receiver and the socket.

Optionally, the body comprises a first body portion releasably coupled to a second body portion.

Having a first body portion releasably coupled to a second body portion allows the valve member to be disassembled for maintenance or repair. In addition, the first body portion may be configured to fit within a valve casing of a certain diameter and the second body portion may be replaceable with other second body portions of different size to fit different pipe diameters. In this way, the valve cartridge can be reconfigured by replacement of the second body part (and any associated seals) without having to replace the entire valve cartridge.

Optionally, the first body portion comprises the first and second surfaces, and wherein the second surface and one or more support elements are covered by the second body portion, when assembled.

In this way, the side of the clamping arrangement opposite the socket (i.e. the side embedded within the body) can be accessed for tightening/loosening of the clamping arrangement, e.g. for repair or maintenance.

Optionally, the body of the valve member is made of a plastics material, optionally of a thermoplastics material, optionally of an acetal material, and wherein the receiver is made of a comparatively harder material, e.g. a metal material, optionally of [insert best material here].

Such plastics materials are suitable for the body of the valve member because they are relatively cheap and lightweight compared to metallic materials.

A receiver made from a comparatively harder material facilitates effective functioning of the actuation mechanism (since the harder material is harder wearing and withstands greater forces applied during actuation of the actuation mechanism).

Optionally, the receiver projects axially beyond the valve body.

In this way, if the actuation mechanism is over-actuated when retracting the valve member towards a fixed portion of the valve cartridge, the receiver contacts the fixed portion before the body does. Therefore, any abutment force which bears down on top of the valve member is absorbed by the receiver (which is typically made of comparatively hard material such as metallic material).

Optionally, the valve member comprises one or more seals, optionally compressible seals, for inhibiting leakage around the valve member when the valve member is in the active state in use.

Such seals facilitate effective functioning of the valve member.

Optionally, the valve cartridge comprises a fixed portion for locating the valve cartridge in position when in use, and wherein the actuation mechanism is configured to move the valve member relative to the fixed portion.

Optionally, the screw is coupled to the fixed portion, wherein the valve cartridge further comprises a thrust bearing provided between the fixed portion and the screw.

Optionally, the screw is coupled to the fixed portion, wherein the valve cartridge further comprises a sealing arrangement between the screw and the fixed portion.

Optionally, the fixed portion comprises one or more radial recesses (e.g. radial groove(s) and/or radial bore(s)) for receiving one or more securing elements extending from a valve casing to inhibit movement of the fixed portion relative to said casing, optionally, to inhibit axial and/or rotational movement.

According to a further aspect of the invention, a kit of parts for a live insertion valve for a pipe is provided, the kit of parts comprising a valve cartridge as disclosed herein, and a cover plate for covering the valve cartridge when the valve cartridge is located in a pipe in use. Optionally, wherein the fixed portion and/or the cover plate comprises one or more axial bores configured to engage with one or more corresponding axial elements aligned with the axial bores, to inhibit relative rotation between the fixed portion and the cover; optionally, wherein the one or more axial elements comprise one or more pins or fasteners which are received within axial bores of both the fixed portion and the cover plate; optionally wherein the one or more axial elements comprise projections integrally formed with the fixed portion and/or cover plate.

Optionally, the kit of parts further comprises a casing for coupling to a pipe, wherein the casing comprises a cylindrical channel configured to receive at least part of the valve cartridge and wherein the casing is arranged such that, when in use and coupled to a pipe, the cylindrical channel extends in a direction transverse to said pipe.

Optionally, the casing comprises one or more radial channels configured to align with the one or more radial recesses of the fixed portion of the valve cartridge, such that one or more securing elements can be received within the channel(s) of the casing and within the radial recess(es) of the fixed portion to inhibit movement of the fixed portion relative to the casing, optionally, to inhibit axial and/or rotational movement.

According to a further aspect of the invention a live insertion valve assembly is provided, the live insertion valve assembly comprising:

a pipe comprising a side wall having a pipe opening;

a casing comprising a cylindrical channel configured to surround the opening and to extend in a direction transverse to the pipe; and

a valve cartridge as disclosed herein, wherein the valve cartridge is configured to be at least partially located within the cylindrical channel.

BRIEF DESCRIPTION OF FIGURES

Embodiments of the disclosure will now be described, by way of example only, with reference to the following figures, in which:

Figure 1 depicts a live insertion valve assembly, when the valve is in an inactive state, shown in cross-section along a longitudinal axis of the pipe;

Figure 2 shows the live insertion valve assembly of Figure 1, with the valve in the active state;

Figures 3a and 3b are side views of a valve cartridge for a live insertion valve according to an embodiment disclosed herein, in inactive and active states respectively;

Figure 3c is a front view of the valve cartridge of Figures 3a and 3b in the active state;

Figure 4 is a plan view of valve cartridge of Figures 3a to 3c;

Figures 5a and 5b are sectional views of the valve cartridge of Figures 3a to 4 taken along line A-A in inactive and active states respectively;

Figure 6 is an enlarged view of the lead nut, first body portion and clamping arrangement of the valve cartridge of Figure 5b;

Figure 7 is an enlarged view of area B of Figure 5a showing the interface between the valve member and fixed portion of the valve cartridge;

Figure 8 is a sectional view of the valve cartridge of Figures 3a to 7 taken along line C-C;

Figure 9 is a sectional view of the valve cartridge of Figures 3a to 8 taken along line D-D;

Figure 10 is a sectional view of the fixed portion of the valve cartridge of Figures 3a to 9 coupled to a valve casing and cover of a live insertion valve;

Figure 11 is a side sectional view of the valve cartridge of Figures 3a to 9 taken along line E-E;

Figure 12 is a side sectional view of a valve cartridge according to a further embodiment;

Figure 13 is a plan sectional view of the valve cartridge of Figure 12.

DETAILED DESCRIPTION

Referring firstly to Figures 1 and 2, a live insertion valve assembly of the kind disclosed in UK patent application no. 2111743.7 is indicated generally at 100. The live insertion valve assembly 100 includes a section of a pipe 102 and a valve 10 coupled to the pipe 102.

In the illustrated valve assembly, the pipe 102 is part of a water distribution network and the valve 10 is a live insertion valve. It will be appreciated that the valve 10 may be installed in a pipe of any type of fluid flow network.

The live insertion valve assembly 100 includes a casing 101 coupled to the pipe 102. The valve 10 includes a valve cartridge 11 arranged to be located in the casing 101 such that the valve cartridge 11 is configured to move between an inactive state, in which fluid is permitted to flow along the pipe 102, and an active state, in which fluid is blocked from flowing along the pipe 102.

The casing 101 includes a saddle portion 109 for securing around the circumference of the pipe 102, and a channel body 104 extending from the saddle portion 109 in a direction transverse to the pipe 102. The casing 101 is arranged to cover the opening 103 in the pipe 102, such that the channel body 104 surrounds the opening 103. In particular, the channel body 104 and the opening 103 are coaxial.

The saddle portion 109 is substantially tubular (i.e. it surrounds the pipe 102. In alternative valve assemblies, the saddle portion 109 is formed in a two-part construction with a first saddle portion for covering a first portion of the pipe 102 (e.g. an upper portion) and a second saddle portion for covering a second portion of the pipe 102. It will be understood that in such valve assemblies the first and second saddle portions are configured for attachment to each other (e.g. via fasteners).

In alternative valve assemblies, the saddle portion 109 is welded around the opening 103 of the pipe 102 (e.g. the lower portion of the saddle portion 109 may be omitted).

In alternative embodiments, the channel body 104 is welded around the opening 103 of the pipe 102 (e.g. the entire saddle portion 109 may be omitted).

The casing 101 also includes a flange portion 106 coupled to the channel body 104 (e.g. integrally formed with the channel body 104), which defines an opening 105. As can be seen in Figures 1 and 2, the opening 105 is provided at an end of the casing 101 distal the pipe 102. The valve cartridge 11 is configured for deployment through the opening 105.

The channel body 104 and the flange portion 106 together define a cylindrical channel 107 in which the valve cartridge 11 is located.

The valve assembly also includes a cover plate 108 arranged for attachment to the flange portion 106 by fasteners 110, such that, when the cover 108 is attached to the flange 106, the opening 105 is covered.

This allows the valve cartridge 11 to be inserted or removed from the casing 101 (i.e. when the cover plate 108 is detached from the flange portion 106) whilst inhibiting ingress of dirt/debris or damage to the valve 10 in operation (i.e. when the cover plate 108 is attached to the flange portion 106).

The valve cartridge 11 includes a fixed portion 12 and a valve member 14. The valve member 14 has a body 15.

The fixed portion 12 is arranged to facilitate correct positioning of the valve cartridge 11 within the casing 101 and pipe 102. In particular, the fixed portion 12 is fastened to the cover plate 108 and/or the casing 101.

The valve member 14 is configured to move between an inactive state (as depicted in Figure 1), in which the valve member 14 permits a flow of fluid through the pipe 102, and an active state (as depicted in Figure 2) in which the valve member 14 blocks a flow of fluid through the pipe 102.

The valve cartridge 11 includes a leadscrew mechanism 16 (described in more detail below) for moving the valve member 14 between the active and inactive states (i.e. for moving the valve member 14 relative to the fixed portion 12). In other words, the leadscrew mechanism 16 is configured to move the valve member 14 linearly in first and second opposite linear directions transverse to the pipe 102 (i.e. upwards and downwards

in the view of Figures 1 and 2), in order to transition between the active and inactive states.

The valve member 14 has a first seal 18 for blocking a flow of fluid through the pipe 102 when the valve member 14 is in the active state. The valve member 14 also has a second seal 20 for blocking a flow of fluid in a direction transverse to the pipe 102 (i.e. for blocking flow of fluid along the cylindrical channel 107 defined by the channel body 104 and flange portion 106). It will be understood that when the valve member 14 blocks a flow of fluid through the pipe 102, pressure builds upstream of the valve member 14 which urges fluid in a transverse direction along the cylindrical channel 107, but that such a transverse flow is inhibited by the second seal 20.

The first seal 18 is a gate seal which is configured to extend in a first plane perpendicular to a longitudinal axis of the pipe 102. In particular, the first seal 18 is a U-shaped gate seal, but in alternative valve assemblies the first seal 18 has a different shape. The first seal 18 is fitted in a receiving groove 22 of the valve member 14, which provides a convenient means for securing the first seal 18 to the valve member (e.g. via fasteners 24 which extend across the receiving groove 22 and through the first seal 18). The receiving groove 22 has opposing inner faces connected by a perpendicular joining surface, which provides a tortuous path around an inner edge of the first seal 18 to inhibit leakage through the inner edge of the first seal 18.

The second seal 20 is arranged to act along a second plane which is perpendicular to the first plane of the first seal 18. In particular, the second seal 20 is an annular seal, which inhibits leakage around an entire circumference of the cylindrical channel 107. In the illustrated valve assembly, the second seal 20 is an O-ring, which provides particularly effective circumferential sealing.

The first and second seals 18, 20 are formed of a compressible material, which allows the seals 18, 20 to adapt to a certain extent to the shape of the pipe 102 and channel 107.

In addition to the first and second seals 18, 20 of the valve member 14, the valve cartridge 11 also includes a number of other seals which provide additional sealing in a transverse direction (e.g. to provide back-up sealing in the event that fluid manages to pass between the second seal 20 and the wall of the channel 107). For example: a sealing arrangement 48 in the form of two O-rings is provided between the leadscrew 40 and the fixed portion 12; a seal 50 (e.g. O-ring) is provided on the fixed portion 12 for sealing the fixed portion 12 against the flange portion 106; and a back-up seal 52 is provided on the valve member

14 above the second seal 20 as an additional seal for sealing the valve member 14 against the wall of the channel 107. Each of the seals 20, 48, 50, 52 is fitted in a corresponding annular groove in the fixed portion 12, valve member 14 or leadscrew 40 respectively.

The valve cartridge 11 has an anti-rotation arrangement 30 configured to inhibit rotation of the valve member 14 relative to the pipe 102. Such an anti-rotation arrangement 30 improves sealing by preventing rotation which could lead to gaps forming between the first seal 18 and the pipe 102. Fixing the valve member 14 rotationally also facilitates use of the leadscrew actuation mechanism 16, which will be described in more detail below.

The anti-rotation arrangement 30 includes a pair of spaced apart rods 32A, 32B fastened to the fixed portion 12 (i.e. fixed relative to the pipe 102) and a corresponding pair of spaced apart channels 34A, 34B in the valve member 14 for receiving the spaced apart rods 32A, 32B. Such an anti-rotation arrangement 30 permits linear movement of the valve member 14 (since the rods 32A, 32B can slide within the channels 34A, 34B) but inhibits rotational movement, since the rods 32A, 32B cannot move in a transverse direction relative to a longitudinal axis of the channels 34A, 34B.

In alternative valve assemblies, the rods 32A, 32B are coupled to the valve member 14 and the corresponding channels 34A, 34B are provided in the fixed portion.

In alternative valve assemblies, the anti-rotation arrangement 30 has only a single rod and corresponding channel. In such valve assemblies, the rod and channel are off-centre with respect to a longitudinal axis of the valve cartridge 11, and relative rotation between the fixed portion 12 and the valve member 14 around the rod is inhibited by the fixed portion 12 and valve member 14 being a close fit with the cylindrical channel 107 of the casing 101. In other words, the valve cartridge 11 and casing 101 are configured so that eccentric rotation of the fixed portion 12 and/or the valve member 14 about the rod is inhibited.

In alternative valve assemblies, the anti-rotation arrangement 30 has one or more different sorts of projections (e.g. elongate projections with a non-circular cross-section) and corresponding channels (e.g. elongate channels of corresponding non-circular cross-section).

In alternative valve assemblies, the anti-rotation arrangement 30 is provided in the form of complementary engagements between the valve member 14 and the casing 101 (e.g.

corresponding hex profiles or lugs on the valve member 14 and complementary linear grooves in the channel body 104, etc.).

The leadscrew mechanism 16 has a leadscrew 40 and a corresponding bore 42 in the valve member 14 for receiving the leadscrew 40. The leadscrew 40 and bore 42 have complementary threads. It will be understood that, because the anti-rotation arrangement 30 inhibits rotation of the valve member 14 relative to the pipe 102, the complementary threads of the leadscrew 40 and bore 42 will cause the valve member 14 to move linearly when the leadscrew 40 is rotated (i.e. to transition between the active and inactive states).

Having such a leadscrew 40 allows standard rotational tools (e.g. allen keys, spanners, screw drivers and the like) to be used to actuate the valve member 14. In particular, the leadscrew 40 extends through the cover plate 108 so that such tools can be coupled to an engagement portion 38 (e.g. a socket or hex) at an exposed end of the leadscrew 40.

The leadscrew 40 is coupled to the fixed portion 12 by a flange portion 44 of the leadscrew 40 which sits in a corresponding annular seat 46 in the fixed portion 12. In some valve assemblies, a thrust bearing is provided between the fixed portion 12 and the leadscrew 40 (i.e. between the flange portion 44 of the leadscrew 40 and the seat 46 of the fixed portion). Such a thrust bearing facilitates easy rotation of the leadscrew 40 (e.g. using unpowered hand tools).

In alternative valve assemblies, the actuation mechanism 16 is a ballscrew mechanism, roller screw mechanism or other type of linear actuator mechanism instead of a leadscrew mechanism.

To install the valve 10, the casing 101 is attached to the pipe 102 and the opening 103 is cut through the pipe 102 such that there is fluid communication therebetween. Sometimes, the pipe opening 103 is cut first and then the casing 101 is coupled to the pipe, and sometimes the order is reversed (i.e. the pipe opening 103 is cut by tools inserted through the casing 101). Flow of fluid from a pipe which is in service may be controlled via a temporary slide gate. In this way, the live insertion valve can be fitted to a pipe without requiring shutdown of a portion of the fluid network.

Once the casing 101 has been attached to the pipe 102 the valve cartridge 11 is inserted through the opening 105 of the casing 101. The cover plate 108 is fastened to the flange portion 106 of the casing 101 so that the valve cartridge 11 is sealed within the pipe arrangement 100 defined by the pipe 102 and the casing 101. Typically, the valve cartridge

11 will be installed in the inactive configuration illustrated in Figure 1 (i.e. with the valve member 14 proximal the fixed portion 12), so that the first seal 18 does not block the flow of fluid along pipe 102, 1102 initially.

When it is desired to actuate the valve 10, an operator uses a suitable tool to rotate the leadscrew 40 in a first direction (e.g. clockwise), which causes the valve member 14 to move downwards. The operator continues to turn the leadscrew 40 until it is no longer possible to keep rotating and/or a predetermined number of turns has been applied. At this point, the valve member 14 will be in the active state illustrated in Figure 2, and flow of fluid will be blocked along the pipe 102 (by first seal 18) and blocked along the channel 107 (by second seal 20). This allows maintenance or repair to be carried out downstream of the valve 10.

When it is desired to open the valve 10 (e.g. when downstream maintenance or repair has been completed), the operator uses a suitable tool to rotate the leadscrew 40 in a second direction (e.g. anti-clockwise), which causes the valve member 14 to move upwards. This will quickly allow some flow around the first seal 18 and along the pipe 102. However, typically the operator will continue to rotate the leadscrew 40 in the second direction until it is no longer possible to keep rotating and/or a predetermined number of turns have been applied. At this point, the valve member 14 will be in the inactive state illustrated in Figure 1.

The process described above can be repeated as and when it is desirable to block/permit flow of fluid along the pipe 102.

Referring now to Figures 3a to 11, a valve cartridge according to an embodiment is indicated at 211. The valve cartridge 211 is configured for use in a live insertion valve assembly of the kind described above in relation to Figures 1 and 2. In other words, the valve cartridge 211 can replace the valve cartridge 11 in the valve assembly 100 of Figures 1 and 2. Common features between the valve cartridge 11 of Figures 1 and 2 and the valve cartridge 211 of this embodiment are given the prefix "2" and only differences between the valve cartridges will be discussed in detail.

The valve cartridge 211 has a leadscrew mechanism 216 which includes a leadscrew 240 and a lead nut 241 which defines an axial bore 242. The lead nut 241 is coupled to a socket 256 in the body 215 of the valve member 214. The leadscrew 240 and axial bore 242 have complementary threads, which are configured to co-operate such that the lead

nut 241 moves linearly along the leadscrew 240 when the leadscrew 240 rotates relative to the lead nut 241.

As best illustrated in Figures 5a to 6, the socket 256 defines a first surface 268 (i.e. a shoulder) for abutment with the lead nut 241, and the body 215 of the valve member 214 defines a second surface 270 (i.e. shoulder) for abutment with a support element 272. In the illustrated embodiment, the first and second surfaces 268, 270 each extend radially and face opposite axial directions. In alternative embodiments, the first and/or second surface 268, 270 has a different configuration (e.g. the first and/or second surface 268, 270 may be angled relative to the bore 242).

The valve member 214 has a clamping arrangement 274 configured to urge the lead nut 241 and support element 270 towards the respective first and second surfaces 268, 270 to clamp the lead nut 241 to the body 215. The clamping arrangement 274 includes a plurality of connecting elements 276 for coupling the lead nut 241 to the support element 272. The connecting elements 276 extend between the lead nut 241 and the support element 272. In particular, the connecting elements 276 extend in a corresponding plurality of axial through-holes 278 of the body 215 between the first and second surfaces 268, 270.

In the illustrated embodiment, the connecting elements 276 are fasteners having a shaft 282 and a head 284. The shafts 282 are threaded and the free ends of the shafts 282 are received in complementary threaded axial holes 280 in the lead nut 241. In this way, as the shafts 282 of the connecting elements 276 are rotated within the axial holes 280 of the lead nut 241, the complementary threads cause the lead nut 241 to move linearly (i.e. towards the first surface 268).

The support element 272 has a plurality of axial through-holes 286 for receiving the shafts 282 of the connecting elements 276 (e.g. as illustrated in Figure 9). The heads 284 of the connecting elements 276 are configured to push the support element 272 towards the second surface 270 as the shafts 282 are rotated within the threaded axial holes 280 in the lead nut 241.

It will therefore be understood that rotating the connecting elements 276 in a tightening direction causes a simultaneous urging of the lead nut 241 and the support element 272 towards each other so that they each abut against the respective first or second surface 268, 270, which clamps the lead nut 241 to the socket 256 of the body 215.

In alternative embodiments, the lead nut 241 has through-holes and the support bracket 272 has threaded holes. In such embodiments, the connecting elements 276 are flipped upside down so that the heads 284 are configured to push the lead nut 241 towards the first surface 268 and the threaded shaft 282 is configured to engage the threaded holes of the support element 272 to pull the support element 272 towards the second surface 270.

In alternative embodiments, the support element 272 is omitted. In such embodiments, the heads 284 engage directly with the second surface 270 of the body 215. In such embodiments, the heads 284 can be thought of as support elements, whereas the shafts 282 are connecting elements which are integrally formed with the heads 284.

To facilitate effective functioning of the leadscrew mechanism 216, the socket 256 has a first formation 258 and the lead nut 241 has a second formation 260 configured to engage the first formation 258 to inhibit relative rotation between the lead nut 241 and the body 215. In particular, the first formation 258 is a multifaceted inner wall of the socket 256, and the second formation 260 is a multifaceted periphery of the lead nut 241. In the illustrated embodiment, the multifaceted inner wall 258 and multifaceted peripheral wall 260 are square in plan view (e.g. as best illustrated in Figure 8). In alternative embodiments, the multifaceted inner wall 258 and/or multifaceted peripheral wall 260 are of alternative shape (e.g. hexagonal or other polygonal shape in plan view). In alternative embodiments, the first formation 258 and second formation 260 are of a different configuration (e.g. the first formation 258 may include one or more projections from the socket 256 and the second formation 260 may include one or more corresponding recess for receiving the projections, or vice versa).

As best illustrated in Figures 5a to 8, the periphery 260 of the lead nut 241 has a plurality of radial recesses 262 (i.e. radial bores) distributed circumferentially around the lead nut 241. The body 215 of the valve member 214 has a plurality of radial channels 264 distributed circumferentially around the body 215 and aligned with the radial recesses 262. A plurality of securing elements 266 are received within the channels 264 of the body 215 and the radial recesses 262 of the lead nut 241 to inhibit movement of the lead nut 241 relative to the body 215. In particular, because the radial recesses 262 are radial bores and the securing elements 266 are a close fit with the radial recesses 262 and radial channels 264, the securing elements 266 inhibit both axial and rotational movement. The securing elements 266 thus act as an additional securing means, which is particularly advantageous in the event that the clamping arrangement 274 is loosened or damaged or

the first and second formations 258, 260 are damaged or otherwise not functioning correctly.

In other embodiments, the securing elements may be the primary or only securing means to prevent relative movement between the lead nut and the body 215.

In the illustrated embodiment, the radial recesses 262 are threaded and the securing elements 266 have complementary threads. In alternative embodiments, the radial channels 264 are threaded and the securing elements 266 have complementary threads. In either case, the securing elements 266 are held in place in the radial channels 264 and recesses 262 by engaging the complementary threads.

In alternative embodiments, the radial recesses 262 are grooves and the securing elements 266 can move along the grooves. It will be understood that in such embodiments, the securing elements 266 only inhibit axial movement

As best illustrated in Figure 11, the body 215 has a first body portion 215A releasably coupled to a second body portion 215B. In particular, the first and second body portions are connected to each other via fasteners 215C received within bores 215D within the first and second body portions 215A, 215B.

The first body portion 215A includes the first and second surfaces 268, 270 and the clamping arrangement 274 (as illustrated in Figure 6). The second surface 270, support element 272 and connecting elements 276 are covered by the second body portion 215B, when assembled (as illustrated in Figures 5a and 5b). In this way, the clamping arrangement 274 can be accessed for assembly, repair or maintenance (i.e. the heads 284 of the connecting elements 276 can be turned) when the second body portion 215B is disengaged from the first body portion 215A.

The first body portion 215A is configured to fit within the casing 101 of a valve assembly 100, and the second body portion 215B is interchangeable with other second body portions 215B of different size to fit pipes 102 of different pipe diameters. In this way, the valve cartridge 211 can be reconfigured by replacement of the second body part 215B (and any associated seals, such as gate seal 18) without having to replace the entire valve cartridge 211.

In the illustrated embodiment, the body 215 of the valve member 214 is made of acetal material. In alternative embodiments, the body 215 is made of a different material (e.g.

another type of thermoplastics material, or a different type of plastics material). The lead nut is made of a different type of material to the body 215, which is comparatively harder than the material of the body 215. In the illustrated embodiment, the lead nut 241 is made of naval brass or high tensile brass. In some embodiments, the lead nut 241 is made of another material, e.g. another type of brass or another type of metal material.

As best illustrated in Figure 7, the lead nut 241 projects axially beyond the valve body 215. In this way, if the leadscrew mechanism 216 is over-actuated when retracting the valve member 214 towards the fixed portion 212, the lead nut 241 contacts the fixed portion 212 before the body 215 does (e.g. see gap G of Figure 7). Therefore, any abutment force which bears down on top of the valve member 214 is absorbed by the lead nut 241 (which is made of comparatively hard material).

Referring now to Figure 10, the fixed portion 212 has an annular groove 254 for receiving a plurality of securing elements 290 extending from the valve casing 101 to inhibit axial movement of the fixed portion 212 relative to the casing 101. In particular, the securing elements 290 extend through radial channels 292 in the valve casing 101 which are aligned with the annular groove 254. In some embodiments, the securing elements 290 are threadedly engaged in the radial channels 292 to secure them in place.

The cover plate 108 has a plurality of axial bores 294 which are aligned with axial bores 296 in the fixed portion 212 of the valve cartridge 211. Bolts 298 are secured to the axial bores 296 in the fixed portion 212 with the heads of the bolts 298 protruding axially from the fixed portion 212. In other words, the heads of the bolts 298 are axial projections of the fixed portion 212. The heads of the bolts 298 fit within the axial bores 294 of the cover plate 108. In this way, rotation between the fixed portion 212 and the cover plate 108 (and thus between the fixed portion 212 and the valve casing 101) is inhibited.

In alternative embodiments, the annular groove 254 is replaced by a plurality of radial recesses for receiving the plurality of securing elements 290. In such embodiments, the securing elements 290 inhibit both axial and rotational movement of the fixed portion 212 relative to the casing 101.

Referring now to Figures 12 and 13, a valve cartridge according to a further embodiment is indicated at 311. The valve cartridge 311 is configured for use in a live insertion valve assembly of the kind described above in relation to Figures 1 and 2. In other words, the valve cartridge 311 can replace the valve cartridge 11 in the valve assembly 100 of Figures 1 and 2. Common features between the valve cartridges 11, 211 of Figures 1 to 11 and

the valve cartridge 311 of this embodiment are given the prefix "3" and only differences between the valve cartridges will be discussed in detail.

In the illustrated embodiment, the lead nut 341 has a threaded periphery 360 which engages a threaded inner wall 358 of the socket 356. The lead nut 341 has an annular groove 362 instead of the radial recesses 262. Similarly to the previous embodiment, the body 315 has radial channels 364 for receiving securing elements 366.

The securing elements 366 inhibit axial movement of the lead nut 341 out of the body 315. Furthermore, because the lead nut 341 is threadedly engaged with the socket 356 of the body 315, and rotational movement between the lead nut 341 and the socket 356 results in axial movement of the lead nut 341 relative to the body 315. Therefore, the securing elements 366, by resisting such an axial movement, also inhibits rotational movement between the lead nut 341 and the socket 356.

In addition, the securing elements 366 may be tightened against the inner wall of the groove to provide a clamping action which further resists rotational movement of the lead nut 341 relative to the body 315.

Although the present disclosure has been described in relation to one or more embodiments, it will be appreciated that various changes or modifications can be made without departing from the scope of the disclosure as defined in the appended claims.

For example, although valve cartridges have been disclosed herein in the context of a live insertion valve, it will be appreciated that the valve cartridges and/or valve members can be used with any suitable valve arrangement;

In alternative embodiments, the actuation mechanism 16 is a ballscrew mechanism, roller screw mechanism or other type of linear actuator mechanism instead of a leadscrew mechanism. It will be understood that in such embodiments the lead nut 241, 341 would be replaced by a ball or roller nut with a different type of axial bore. However, the means for securing the ball or roller nut to the body 215, 315 of the valve member 214, 314 would be the same. In other words, the valve member 214, 314 would still include: the same clamping arrangement 274, 374; and/or radial recesses/grooves 262, 362, radial channels 264, 364 and securing elements 266, 366).

It should also be noted that whilst the appended claims set out particular combinations of features described above, the scope of the present disclosure is not limited to the particular

combinations hereafter claimed, but instead extends to encompass each feature herein disclosed in isolation, as well as any combination of features herein disclosed.

It will be understood that the term "radial" used throughout this specification shall be interpreted as approximately perpendicular to the rotational axis of the screw. Similarly, it will be understood that the term "axial" used throughout this specification shall be interpreted as approximately parallel to the rotational axis of the screw.

CLAIMS

1. A valve cartridge for a live insertion valve for a pipe, the valve cartridge comprising:

a valve member comprising a body; and

an actuation mechanism for moving the valve member such that, in use, the actuation mechanism is configured to move the valve member between an inactive state in which the valve member permits a flow of fluid through a pipe and an active state in which the valve member blocks a flow of fluid through a pipe;

wherein the actuation mechanism comprises a screw and a corresponding receiver coupled to a socket in the body of the valve member;

wherein the receiver comprises an axial bore for receiving the screw and wherein the screw and receiver are configured to co-operate such that the receiver moves linearly along the screw when the screw rotates relative to the receiver;

wherein the receiver comprises a periphery having a radial recess, and wherein the body of the valve member comprises a radial channel aligned with the radial recess, such that a securing element can be received within the channel of the body and the radial recess of the receiver to inhibit movement of the receiver relative to the body.

2. The valve cartridge of claim 1, wherein the screw is a leadscrew and the receiver is a lead nut, wherein the leadscrew and axial bore of the lead nut comprise complementary threads.

3. The valve cartridge of claim 1 or 2, wherein the socket defines a first surface for abutment with the receiver, wherein the body of the valve member comprises one or more second surfaces for abutment with one or more support elements, and wherein the valve member further comprises a clamping arrangement configured to urge the receiver and one or more support elements towards the respective first and second surfaces to clamp the receiver to the body.

4. The valve cartridge of claim 3, wherein the clamping arrangement comprises one or more connecting elements for coupling the receiver to the one or more support elements.

5. The valve cartridge of claim 4, wherein the one or more connecting elements are provided to extend between the receiver and the or each support element.

6. The valve cartridge of claim 5, wherein the one or more connecting elements extend in a corresponding one or more axial through-holes of the body between the first and second surfaces.

7. The valve cartridge of claim 5 or 6, wherein the one or more connecting elements extend at least partially into a corresponding one or more axial holes of the receiver.

8. The valve cartridge of any of claims 4 to 7, wherein the one or more support elements and one or more connecting elements are discrete components; or wherein the or each support element is integrally formed with a connecting element.

9. The valve cartridge of any of claims 4 to 8, wherein the one or more connecting elements extend at least partially into a corresponding one or more axial holes of the one or more support elements.

10. The valve cartridge of claim 9, wherein the axial holes of the one or more support elements are through-holes, wherein the or each connecting element is a fastener comprising a shaft configured to extend through a respective through-hole of the one or more support elements and a head configured to push a respective support element towards the second surface.

11. The valve cartridge of any preceding claim, wherein the socket comprises a first formation and the receiver comprises a second formation configured to engage the first formation to inhibit relative rotation between the receiver and the body.

12. The valve cartridge of claim 11, wherein the first formation comprises an inner wall of the socket, and wherein the second formation comprises a periphery of the receiver configured to engage the inner wall of the socket.

13. The valve cartridge of claim 12, wherein the inner wall of the socket comprises a multifaceted inner wall, and the periphery of the receiver defines a corresponding multifaceted periphery.

14. The valve cartridge of any preceding claim, wherein the radial recess comprises a radial groove and/or radial bore.

15. The valve cartridge of any preceding claim, wherein the radial channel is aligned with the radial recess, such that a securing element can be received within the channel of the body and the radial recess of the receiver to inhibit axial and/or rotational movement of the receiver relative to the body.

16. The valve cartridge of any preceding claim, wherein the body of the valve member comprises a plurality of radial channels and the receiver comprises a plurality of corresponding radial recesses for receiving a corresponding plurality of securing elements.

17. The valve cartridge of claim 16, wherein the plurality of radial channels are distributed circumferentially around the body and the plurality of radial recesses are distributed circumferentially around the receiver.

18. The valve cartridge of any preceding claim, wherein the or each radial recess is threaded for receiving a threaded securing element, and/or each radial channel is threaded for receiving a threaded securing element.

19. The valve cartridge of any preceding claim, wherein the body comprises a first body portion releasably coupled to a second body portion.

20. The valve cartridge of claim 19 when dependent on claim 3, wherein the first body portion comprises the first and second surfaces, and wherein the second surface and one or more support elements are covered by the second body portion, when assembled.

21. The valve cartridge of any preceding claim, wherein the body of the valve member is made of a plastics material, and wherein the receiver is made of a comparatively harder material.

22. The valve cartridge of any preceding claim, wherein the receiver projects axially beyond the valve body.

23. The valve cartridge of any preceding claim, wherein the valve member comprises one or more seals for inhibiting leakage around the valve member when the valve member is in the active state in use.

24. The valve cartridge of any preceding claim, wherein the valve cartridge comprises a fixed portion for locating the valve cartridge in position when in use, and wherein the actuation mechanism is configured to move the valve member relative to the fixed portion.

25. A live insertion valve assembly comprising:

a pipe comprising a side wall having a pipe opening;

a casing comprising a cylindrical channel configured to surround the opening and to extend in a direction transverse to the pipe; and

a valve cartridge according to any preceding claim, wherein the valve cartridge is configured to be at least partially located within the cylindrical channel.

Intellectual Property Office

Application No:	GB2408669.6	**Examiner:**	Mr Jason Clee
Claims searched:	1-25	**Date of search:**	24 June 2024

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
A	-	US 2013/193356 A1 (COLLISON et al.) especially see the anti-rotation retainer pins 312

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
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Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

F16K; F16L

The following online and other databases have been used in the preparation of this search report

WPI, EPODOC

International Classification:

Subclass	Subgroup	Valid From
F16K	0003/02	01/01/2006
F16K	0027/04	01/01/2006
F16K	0031/50	01/01/2006
F16L	0055/10	01/01/2006