

Description

[0001] The present invention relates to a vibration pump comprising a moving piston in a pump body bounded by a coil, which moving piston cooperates with a second valve arranged in a discharge conduit formed in a communication conduit and with a first valve arranged in the communication conduit, said communication conduit being proximate to the suction port, said first and said second valves having a through hole therebetween.

[0002] The through hole has a lower opening and an upper opening, whereas said first valve comprises an upper end and a lower end.

[0003] The above described configuration is the common configuration of prior art vibration pumps.

[0004] These pumps are generally used for moving fluids, typically water, in devices such as espresso machines and iron boilers.

[0005] Typically, the devices in which these pumps are installed define their construction features and particularly vibration pumps are required to be easily inspected and disassembled, and to have a small size to minimize space requirements.

[0006] In addition to the actual dimensions of the pump body and the coil, prior art pumps have large dimensions due to the accessory components that are generally connected to ensure their operation.

[0007] The parts that are generally used and connected to the intake pipe of pumps include the priming valve required for pump priming.

[0008] This valve is important to ensure that the pump may be restarted, but is a problematic component, as it increases the dimensions of the pump and often causes malfunctioning.

[0009] Also, since vibration pumps are often used in food processing devices, such as coffee machines, they must allow easy inspection, to ensure a high cleanliness level and prevent the formation of agents that may damage the health of users.

[0010] A further drawback of prior art vibration pumps is the difficulty of replacing their individual parts, which is associated with the construction of the pump, obtained by "packing" the various parts of the pump using a deep-drawn bushing that locks the pump body in position relative to the coil.

[0011] Therefore, there exists a yet unfulfilled need for a vibration pump that can obviate the above described drawbacks of the prior art. Particularly, this vibration pump should be manufactured with relatively simple and inexpensive processes, to allow easy fabrication and assembly of the various parts and provide the features that are not available in the prior art, such as the self-priming feature, without requiring the vibration pump to be combined with additional parts that would increase the dimensions of the pump, thereby affecting standardization and, as a result, easy production.

[0012] The present invention achieves the above purposes by providing a pump as described hereinbefore,

in which the first valve abuts by its top end the lower opening of the through hole and by its bottom end the upper opening of the above mentioned moving piston.

[0013] Particularly, the vibration pump of the present invention comprises a pump body that has a conduit for communication between a suction port and a discharge port, in which a fluid flows from the suction port to the discharge port.

[0014] The communication conduit is axially surrounded by a coil that generates a magnetic field for translating a moving piston, the latter being slidably and sealingly received in the communication conduit and having a passage for fluid that extends from a lower mouth located proximate to the suction port to an upper mouth.

[0015] A first valve seat and a first closure member cooperating with said first valve seat are provided at said upper mouth, which closure member is mounted in such a manner as to be movable between a position in which it interferes with the valve seat by closing the passage, i.e. a so-called valve closing position, and a position in which the first closure member does not interfere with the valve seat, whereby the passage is open, i.e. a so-called valve opening position.

[0016] Lower elastic means and upper elastic means are also provided between the moving piston and a lower stationary abutment wall and an upper stationary abutment wall respectively, for axially pushing the moving piston toward ejection from the communication conduit.

[0017] The upper elastic means have a silencing function, i.e. reduce the noise generated by the movement of the plunger in the communication conduit, by preventing impact thereof with the upper wall of the communication channel.

[0018] The operation is such that, when the coil is energized, the moving piston is drawn into the communication conduit by the magnetic flux, against the action of the elastic pushing means, whereas when the coil is de-energized the moving piston is pushed by the elastic means toward ejection from the communication conduit.

[0019] The motion of the moving piston is transferred to the first closure member due to the presence of drive members consisting of an elastic element, which is also stressed by the pressure of the inflowing fluid, the first closure member having one side exposed to fluid pressure.

[0020] The first valve seat communicates with a second valve seat, which is provided at the discharge port, via a through hole.

[0021] A second closure member is provided, which cooperates with the second valve seat and which, like the first closure member, is mounted in such a manner as to be movable between a position in which it interferes with the second valve seat by closing the through hole, i.e. a so-called valve closing position, and a position in which it does not interfere with the second valve seat, whereby the through hole is open, i.e. a so-called valve opening position.

[0022] The first closure member consists of a circular

body having a flat top end, such that, when the coil is de-energized, the flat top end abuts proximate to the inlet of the through hole.

[0023] This configuration allows normal operation of prior art vibration pumps and ensures the self-priming feature because, as more clearly shown by certain embodiments that will be described below, the particular shape of the first closure member allows the moving piston to be displaced to a greater extent, and causes the flat top end to about proximity to the inlet of the through hole.

[0024] This will compress all the fluid contained in the area between the two valve seats, and minimize air formation in such area. Since air is a compressible fluid that generates a damping effect, preventing the pump from being primed otherwise than using a special priming valve, as air formation is decreased, the damping effect is also dramatically decreased, thereby allowing pump priming without requiring any additional parts.

[0025] The reduced size of the various parts of the vibration pump makes it particularly difficult to secure the spring that transfers piston motion to the first closure member, whereby the vibration pump of the present invention will preferably but not exclusively have two possible configurations.

[0026] In a first configuration, the first closure member has a bottom end with coupling means for attachment to the elastic element, which consist of a hook element engaging in a corresponding loop of the elastic element.

[0027] Otherwise, the first closure member has a bottom end consisting of an elongate member extending toward the lower mouth, which elongate member has a through hole oriented perpendicular to the longitudinal axis of the pump body, which hole engages in a corresponding loop of the elastic element.

[0028] The spring connected to the first closure member may be formed in any manner known in the art, but is preferably designed to provide the required elastic force while ensuring an adequate fluid flow.

[0029] Therefore, the spring may be arranged to have its turns located at a given distance, or to have a first straight coupling part followed by an elastic part composed of the turns.

[0030] According to an improvement, the second closure member has a side exposed to pressure of the fluid that flows out of the first valve seat, an elastic element being interposed between the second closure member and the discharge port, whose compression/extension opens/closes the second valve seat respectively.

[0031] Furthermore, the second closure member also has an element that extends toward the first closure member, such that, when the moving piston is in its limit stop position, the element abuts the flat top end of the first closure member.

[0032] The provision of the element that extends toward the first closure member is a particularly advantageous characteristic because, especially in case of dry operation, it prevents the second closure member from

sticking with the walls of the second valve seat.

[0033] Since closure members are generally made of a soft plastic material, such as rubber or the like, when they are not properly lubricated, such as during dry operation, they tend to stick with the walls of the valve seat, thereby affecting pump operation.

[0034] The abutment of the first closure member against the second closure member, due to the presence of the above-mentioned element, avoids such drawback.

[0035] Preferably, the moving piston consists of a hollow cylindrical body in which the passage extends from a lower mouth to an upper mouth, the hollow cylindrical body consisting of a lower part proximate to the lower mouth and a radially narrower portion proximate to the upper mouth.

[0036] The lower part is preferably made of a ferromagnetic material, such as iron or the like, coated with a plastic material.

[0037] In prior art vibration pumps, the moving piston is made of metal, but is required to have well-defined properties, i.e. adequate ferromagnetic properties, as well as corrosion-preventing features, and easily magnetizable materials are generally prone to corrosion. Furthermore, it should undergo accurate grinding, to avoid rubbing wear as it moves.

[0038] The above construction of the piston, which is thus composed of a part made of a magnetic material coated with a plastic material, provides important advantages in terms of costs and functions, as it allows the use of an easily magnetizable metal material, such as iron, without caring about corrosion because it is entirely coated with a plastic material.

[0039] Also, the plastic coating does not require expensive grinding.

[0040] The radially narrower portion may be made of any material, preferably stainless steel.

[0041] According to a variant embodiment, the coil is housed in an outer casing, which is coaxial with the pump body and encircles its outer surface. The ends of the coil are connected to a power source via a diode and a thermal protection device, which diode and which thermal protection device are both housed in the outer casing.

[0042] The possibility of housing the thermal protection device in direct connection to the diode, within the thickness of the wall of the outer casing provides a undoubted advantages for the manufacture of the vibration pump of the present invention.

[0043] First, the thermal protection device, which may be a thermal pellet or the like, may be produced in series with the diode, such that a single part may be simply produced, to be introduced into the outer case and connected to the ends of the coil, without requiring the thermal protection device to be introduced in an outer pocket after production, like in current prior art pumps.

[0044] Thus, the diode and the thermal protection device may be processed in automatic processing lines by simple overmolding, without requiring any later molding that might wear both the thermal protection device and

the diode.

[0045] Also, no further connection is required in addition to the connection to the ends of the coil and to the part formed by joining the thermal protection device and the diode, which will facilitate assembly of the vibration pump and standardization thereof.

[0046] Finally, the manufacture of the outer casing is also facilitated because thermal protection device pocket that is provided in prior art pumps is eliminated.

[0047] In a possible embodiment, the diode may be arranged externally and not be integrated in the outer casing, to prevent the diode from being exposed to excessively high temperatures and pressures, which will require the selection high-performance diodes, and lead to an inevitable cost increase.

[0048] According to a further variant embodiment, the outer casing is formed of a metal tubular cylindrical body, which holds the coil within the thickness of its side walls.

[0049] The provision of a metal outer casing provides advantages in terms of optimized action of the coil-generated magnetic field, as it allows conveyance of the magnetic flux without requiring especially mounted conveying member.

[0050] In a variant embodiment of the inventive pump, a flow sensor is provided, which axially extends along the discharge port and consists of a coil that encircles the discharge port for sensing the movement of the moving piston.

[0051] This will advantageously provide a flow sensor with minimized space requirements, to receive pump flow information without requiring connection to a flow sensor external to the pump, that would cause drawbacks in terms of space requirements, connections and operation.

[0052] The need for a vibration pump that might maximize standardization in pump construction, and thus decrease manufacturing costs, that guided part of the characteristics as described above, also led to a change of the pump body that might implement this concept in an optimized manner.

[0053] Therefore, according to a variant embodiment, the pump body is composed of two parts, i.e. a first part cooperating with a second part.

[0054] The second part has having a lower annular band which is fitted into an upper circular ring of the first part, the circular ring and the annular band (having at least one hole each, such that, when they are fitted one into the other, the hole on the circular ring is coincident with the hole on the annular band).

[0055] An element is also provided, which at least partially encircles the circular ring and has an engagement tooth to be fitted into the holes for locking the first part in position to the second part.

[0056] A pump body made up of two parts can be more easily manufactured and has lower maintenance requirements, because the two parts may be manufactured and processed separately and later coupled.

[0057] Also, the two parts may be coupled in unremovable or removable fashion. For example the engaging

tooth of the element in the holes may be glued or bonded, or a shape- or friction-fit arrangement may be provided, such that the engaging tooth is fitted into the holes and cause temporary deformation thereof.

[0058] Preferably, the two parts are made of plastic.

[0059] According to a further improvement, the first part comprises the suction port and the communication conduit, whereas the second part comprises the discharge port, the first valve seat and the second valve seat.

[0060] Advantageously, the first part is fitted into the outer casing of the coil and has at least one lateral tab that cooperates with a corresponding housing seat formed on a support element for supporting the outer casing.

[0061] This arrangement allows quick coupling of the various parts of the pump, without necessarily requiring the use of deep-drawn bushings to enclose the entire pump body with the remaining parts, like in current prior art pumps.

[0062] In a possible embodiment, at least two bushings may be interposed between the pump body and the coil, said at least two bushings being spaced by a ring made of an elastic material.

[0063] This ring is mounted in a compressed configuration and allows the two bushings to be fixed in position, and eliminate any clearance, vibration and relative movement of the various parts of the pump, particularly the coil and the pump body.

[0064] These and other features and advantages of the invention will be more apparent from the following description of a few embodiments shown in the accompanying drawings, in which:

Fig. 1 is a sectional view of a first embodiment of the vibration pump of the present invention, as taken along a longitudinal plane;

Figs. 2a to 2e show certain details of the section of Fig. 1, particularly a few characteristics of the first closure member of the pump of the present invention;

Figs. 3a and 3b show views of the moving piston of the vibration pump of the present invention;

Figs. 4a to 4d show views of the outer casing of the coil, for prior art vibration pumps and for the vibration pump of the present invention respectively;

Figs. 5a and 5b show two views of the flow sensor of the vibration pump of the present invention;

Figs. 6a to 6c show various embodiments of the pump body of the vibration pump of the present invention;

Figs. 7a to 7c show a different embodiment of the pump of the present invention, particularly referring to the outer casing of the coil;

Fig. 8a is an exploded view of the pump of a possible embodiment of the present invention;

Fig. 8b is a sectional view of the pump of a possible embodiment of the present invention.

[0065] It shall be noted that the figures described below are only intended to provide a better understanding of certain features of the vibration pump of the present invention, but shall not limit the concepts as claimed herein in any manner.

[0066] The object of the present document is to claim construction features that are designed to improve the operation of prior art vibration pumps.

[0067] Particularly referring to Figures 1 to 2e, the vibration pump of the present invention comprises a pump body 1 that has a communication conduit 21 for communication between a suction port 22 and a discharge port 23, in which communication conduit 21 a fluid flows from the suction port 22 to the discharge port 23.

[0068] A coil 4 is provided, which axially extends along the communication conduit 22, preferably with the coil turns 4 coaxial with the communication conduit 21. The coil 4 is designed to generate a magnetic field for translating a moving piston 3, which is slidably and sealingly received in the communication conduit 21 and has a passage 30 for fluid that extends from a lower mouth 31 located proximate to the suction port 22 to an upper mouth 32.

[0069] A first valve seat 24 and a first closure member 33 cooperating with such first valve seat 24 are provided at the upper mouth 32, which closure member is mounted in such a manner as to be movable between a position in which it interferes with the valve seat 24 by closing the passage 30, i.e. a so-called valve closing position, and a position in which the first closure member 35 does not interfere with the valve seat 24, whereby the passage 30 is open, i.e. a so-called valve opening position.

[0070] The moving piston 3 is supported by elastic means, and particularly lower elastic means 13 are placed between the moving piston 3 and a lower stationary abutment wall 11 and upper elastic means 14 are placed between the moving piston 3 and an upper abutment wall 12.

[0071] These upper 14 and lower 13 elastic means are springs for axially pushing the moving piston 3 toward ejection from the communication conduit 22.

[0072] When the coil is energized 4, the moving piston 3 is drawn into the communication conduit 22 by the magnetic flux, against the action of the elastic pushing means 13 and 14, whereas when the coil 4 is de-energized the moving piston 3 is pushed by the elastic means 13 and 14 toward ejection from the communication conduit 22.

[0073] The moving piston 3 is connected with drive members for transferring the motion thereof to the first closure member 33, which members include an elastic element 34. Also, the first closure member has one side exposed to the pressure of the inflowing fluid.

[0074] The elastic element 34 may be any spring known in the art.

[0075] Figure 2e shows a possible embodiment thereof, in which the elastic element 34 is composed of a first part 342 connected to the first closure member 33 and a second part 343 consisting of metal turns.

[0076] The first part 342 ensures coupling to the first closure member 33, thereby affording a high fluid flow into the radially narrowing portion 37 of the moving piston 3.

5 **[0077]** On the other hand, the second part 343 provides the elasticity required of the elastic element 34.

[0078] Likewise, the elastic element 34 may consist of a spring with turns located at a given distance, to allow fluid flow.

10 **[0079]** The first valve seat 24 communicates with a second valve seat 25 via a through hole 26, said second valve seat being provided at the discharge port 23.

[0080] The second valve seat 25 cooperates with a second closure member 35, which is mounted in such a manner as to be movable between a position in which it interferes with the second valve seat 25 by closing the through hole 26, i.e. a so-called valve closing position, and a position in which the second closure member 35 does not interfere with the second valve seat 25, whereby the through hole 26 is open, i.e. a so-called valve opening position.

20 **[0081]** The first closure member 33 consists of a circular body having a flat top end 331, such that, when the coil 4 is de-energized, the flat top end 331 abuts proximate to the inlet of the through hole 26.

25 **[0082]** During ordinary operation of the vibration pump of the present invention, fluid flows into the communication conduit 21 through the suction port 22, then it enters the passage 30 through the lower mouth 31 until it comes close to the upper mouth 32 of the first valve seat 24.

30 **[0083]** When the coil 4 is energized through a power source that supplies electric current into the coil 4, it generates a magnetic field that pushes the moving piston 3 downwards, i.e. toward the suction port 22. The fluid that flows into the lower mouth 31 acts upon the side of the closure member 33 in the upper mouth 32 and pushes the closure member 33 toward the second valve seat 25. The first valve seat 24 opens and allows the flow to exit the passageway created between the side walls 301 of the passage 30 and the first closure member 33.

35 **[0084]** Now, the pressure of the fluid above the first closure member 33, i.e. in the through hole 26 increases and pushes, in combination with the action of the elastic element 34, the first closure member 33 downwards thereby closing the first valve seat 24.

40 **[0085]** The coil 4 is de-energized and the lower elastic elements 13 push the moving piston to extraction from the communication conduit 21, such that the first closure member presses the fluid between the two valve seats 24 and 25 by its flat top end 331.

45 **[0086]** As the fluid is compressed, the second valve seat 25 can be opened and the second closure member 35 is pushed toward the discharge port 23, whereupon the fluid flows beyond the second valve seat 25 and comes out of the discharge port 23.

50 **[0087]** Preferably, the second closure member 35 has a side exposed to pressure of the fluid that flows out of the first valve seat 24, an elastic element 38 being inter-

posed between the second closure member 35 and the discharge port 23, whose compression/extension opens/closes the second valve seat 25 respectively.

[0088] Once the pressurized fluid flows beyond the second valve seat 25 and pressure in the through hole 26 decreases, the spring 38, which was initially compressed by fluid pressure will allow the second closure member 35 to move back to its position and close the second valve seat 25.

[0089] Particularly referring to Figures 2a and 2b, a variant embodiment of the first closure member 33 has a bottom end with coupling means for attachment to the elastic element 34, which consist of a hook element 332 engaging in a corresponding loop 341 of the elastic element 34.

[0090] The hook element 332 has a lateral opening 333 for facilitating insertion of the loop 341, said opening 333 extending toward the elastic element 34 through a slit that widens to form a housing seat 334 for stably housing the loop 341.

[0091] Otherwise, and particularly referring to Figure 2c, the first closure member 33 has a bottom end consisting of an elongate member 335 extending toward the lower mouth 31, and having a through hole oriented perpendicular to the longitudinal axis of the pump body 1, which hole engages in a corresponding loop 341 of the elastic element 34.

[0092] Still referring to Figures 2a to 2e, the second closure member 35 preferably has an element 351 that extends toward the first closure member 33, such that, when the moving piston 3 is in its limit stop position, the element 351 abuts the flat top end 331 of the first closure member 33.

[0093] The abutment of the second closure member 35 against the first closure member 33 allows the second closure member to be pushed toward the discharge port 23, whereby the second closure member 35 is moved away from the walls of the second valve seat 25, which is a particularly advantageous feature in case of dry operation of the pump.

[0094] Depending on the length of the element 351 a housing surface 336 may be formed on the flat top end 331 of the first closure member 33, as shown in Figure 2a.

[0095] Figures 3a and 3b show the moving piston of the vibration pump of the present invention according to a possible embodiment, as viewed in a perspective view and a sectional view along a longitudinal plane respectively.

[0096] The moving piston 3 consists of a hollow cylindrical body in which the passage 30 extends from a lower mouth 31 to an upper mouth 32.

[0097] The hollow cylindrical body consists of a lower part 36 proximate to the lower mouth 31 and a radially narrower portion 37 proximate to the upper mouth 32.

[0098] The lower part 36 and the radially narrower portion 37 may be formed of one piece and from any material that may be suitable for the purpose, and may also be of any length, to conform with the pump body 1.

[0099] According to the variant as shown in Figures 3a and 3b, the lower part 36 and the radially narrower portion 37 are two distinct parts, made of different materials. Particularly, the lower part 36 consists of a core 361 made of a ferromagnetic material, such as iron or the like, coated with plastic coating layer 362.

[0100] The radially narrower portion 37 is preferably made of stainless steel, and may be fixed to the lower part 36 by embedding its lower terminal 371 in the plastic coating 362.

[0101] Alternatively, the plastic coating 362 may also cover the entire radially narrower portion 37.

[0102] Particularly referring to Figures 3a and 3b, the moving piston comprises two openings 38 for discharging any excess liquid that flows in through the lower mouth 31 and is not pushed into the discharge port 23.

[0103] Figures 4a and 4b show two views of the outer casing of the coil, for prior art vibration pumps and for the vibration pump of the present invention respectively.

[0104] Both in prior art vibration pumps and in the vibration pump of the present invention, the coil 4 is housed in an outer casing 41 which is coaxial with the pump body 1 and surrounds the outer surface of the pump body 1.

[0105] The outer casing 41 is generally obtained by a plastic overmolding process that is designed to cover the coil.

[0106] In prior art vibration pumps, the ends of the coil are connected to a power source through a diode and through contacts 411 connected to electric current.

[0107] A thermal protection device is also provided, which is connected to the contacts 411 to avoid malfunctioning or failure of the circuit.

[0108] As shown in Figure 4a, the outer case 41 of prior art pumps has an outer pocket 412 for receiving the thermal protection device, particularly a thermal pellet 412 which is also later connected to the contacts 411.

[0109] The vibration pump of the present invention eliminates the outer pocket 412 while maintaining the presence of the thermal protection device 413.

[0110] Particularly, Figure 4b shows a view as taken along a plane perpendicular to the longitudinal plane of the outer casing 41.

[0111] The outer casing 41 surrounds the coil 4, which is supported by a support element, formed of one piece with or separately from said outer casing 41, in which the pump body 1 is introduced, particularly through the through hole 415.

[0112] The outer casing may be formed and fixed to the coil in any known manner, but is preferably obtained by overmolding of a plastic material adapted to cover the coil 4.

[0113] The diode and the thermal protection device 413 are introduced into the outer casing 41, to be later connected to the contacts 411.

[0114] The diode and the thermal protection device 413 are joined into a single part 417, which is later introduced into the outer casing 41 in any manner.

[0115] For example, the outer casing 41 may have a

housing compartment 416 formed in its thickness, for receiving both the diode and the thermal protection device 413, i.e. the part 417.

[0116] Once the diode and the thermal protection device 413 are introduced into the housing compartment 416, they are connected to the contacts 411 preferably directly during fabrication of the coil 4, which will avoid the need of making connections after mounting the outer casing 41 to the pump body 1.

[0117] Figure 4c shows a possible embodiment of the above mentioned part 417, which consists of an outer enclosure that contains the diode and the thermal protection element.

[0118] The part 417 has two end elements 4171 that are later designed to be connected to the contacts 411.

[0119] Figure 4d shows a possible embodiment of the pump of the present invention, in which the diode 419 is connected outside the outer casing and is visible.

[0120] In addition to the above advantages, this configuration facilitates soldering of the diode to the electric contacts.

[0121] Figures 5a and 5b show two views of the flow sensor of the vibration pump of the present invention, namely a perspective view and a sectional view as taken along a longitudinal plane.

[0122] Figure 5a shows the discharge port 23 around which a flow sensor 5 extends, the latter consisting of a coil 51 that encircles the discharge port 23.

[0123] Figure 5b shows the coil 51 that detects the movement of the moving piston 3 and generates an electric current proportional to the number of displacements of the moving piston 3, the electric current being detected by connecting the ends of the coil 52 to any device, such as an ammeter or the like known in the art.

[0124] One of the purposes of the vibration pump of the present Patent Application is the formation of a pump body 1 that can be easily assembled and inspected, and further has a low fabrication cost.

[0125] Therefore, Figs. 6a to 6c show a possible embodiment of the pump body 1 of the pump of the present invention.

[0126] In this variant embodiment, the pump body 1 is composed of two parts, i.e. a first part 15 that cooperates with a second part 16, i.e. such that the second part 16 fits into the first part 15 and is coupled thereto.

[0127] The second part 16 has having a lower annular band 161 which is fitted into an upper circular ring 151 of the first part 15.

[0128] The second part 16 may be locked in position with the first part 15 by gluing, i.e. by placing a layer of glue material on the outer surface of the lower annular band 161 and/or the inner surface of the circular ring 11.

[0129] Otherwise, both the circular ring 151 and the annular band 161 may be designed with at least one hole 152, 162 each such that, when fitted one into the other, the hole on the circular ring 151 coincides with the hole on the annular band 161.

[0130] Now, the second part 16 is fixed to the first part

15 by means of an element 17 that at least partially encircles the circular ring 151 and has an engagement tooth 171 to be fitted into the holes 152, 162 for locking the first part 15 in position with the second part (16).

[0131] In the particular case of Figures 6a and 6b, two half-round elements 17 are provided, each having two engaging teeth 171 that encircle almost the entirety of the circular ring 151.

[0132] Preferably, the first part 15 comprises the suction port 22 and the communication conduit 21, whereas the second part 16 comprises the discharge port 23 the first valve seat 24 and the second valve seat 25.

[0133] The first part 15, the second part 16 and the elements 17 are preferably made of plastic, which will provide the advantages related to this material, i.e. low cost and easy processing and will allow a form fit between the engaging teeth 171 and the holes 152, 162.

[0134] By providing a lead-in surface for the engaging teeth 171 in the holes, the teeth 171 may be fitted into the holes 152 and 162, with the shape of each engaging tooth being temporarily deformed to create a joint once the tooth 171 has been inserted.

[0135] This method is known in the art and may be used as an alternative to any prior art method for fitting the teeth 171 in the holes.

[0136] Once the first part 15 has been formed, the moving piston 3 is inserted, with the elastic means that support it, whereupon the second part is introduced into the first part and if fixed using the circular elements 17.

[0137] According to a further improvement, the first part 15 is fitted into the outer casing 41 of the coil 4 and has at least one lateral tab 153 that cooperates with a corresponding housing seat formed on a support element 6 for supporting the outer casing 41.

[0138] Particularly referring to Figures 6b and 6c, the first part 15 of the pump body 1 has two lateral tabs 153 that engagingly fit into two corresponding housing seats of the support element 6.

[0139] Preferably, the two lateral tabs 153 are arranged in such positions that the plane that joins them is perpendicular to the junction plane of the two half-round elements 17, such that the vibrations generated by the movement of the moving piston 3 do not loosen the joint among all the parts of the vibration pump of the present invention.

[0140] The support element 6 has the purpose of optimizing the action of the magnetic field generated by the coil 4 by conveying the magnetic flux.

[0141] Figures 7a to 7c show a variant embodiment of the vibration pump of the present invention, in which the support element 6 is not used.

[0142] In this variant embodiment, the outer casing 41 consists of a metal tubular cylindrical body.

[0143] The outer casing 41 has a housing compartment 418 in the thickness of the side walls, for accommodating the coil 4.

[0144] Therefore, the coil 4 is wound around the support element and both are accommodated in the thick-

ness of the side walls of the outer metal casing 41.

[0145] The outer metal casing 41 has an aperture 419 for receiving the contacts 411 that are designed to be connected to the ends of the coil to supply power thereto.

[0146] The use of an outer casing 41 made of metal allows the magnetic flux to be conveyed without using the support element 6.

[0147] Figure 7c shows how the various parts of the pump may be assembled using the variant embodiment of the outer casing 41 as shown in the previous figures.

[0148] The pump body 1 is introduced into the through hole 415, whereupon it is locked in position by an upper bushing 71 and a lower bushing 72.

[0149] As clearly shown by the description and the figures, the variant embodiment of the outer casing 41 of Figures 7a to 7c may be provided in combination with any pump body 1, namely also with the pump body 1 of Figures 6a and 6b.

[0150] Figures 8a and 8b show a variant embodiment of the pump, as viewed in sectional and exploded views respectively, where two bushings 8 are interposed between the pump body 1 and the coil 4.

[0151] An elastic ring 81 is placed between the two bushings 8 and is mounted in a compressed configuration, such that once the parts of the pump are assembled, the elastic ring 81 axially pushes the two bushings 8 and holds them in position.

[0152] The decompression of the elastic ring 81 locks the coil 4 in position and avoids any relative rotation and any vibration among the various parts of the pump.

[0153] Furthermore, as shown in Figure 8b, the pump body 1 may be at least partially equipped with a rough outer surface, which helps to reduce the rotation of the pump 1 caused by the movement of the moving piston 3.

[0154] The construction of the individual parts of the vibration pump as described herein allows each part to be fabricated separately and later assembled with the others.

Claims

1. A vibration pump comprising a moving piston (3) in a pump body (1) bounded by a coil (4), which moving piston (3) cooperates with a second valve arranged in the discharge conduit formed in a communication conduit (21) and with a first valve arranged in the communication conduit (21), said communication conduit being proximate to the suction port (22), said first and second valves having a through hole (26) therebetween, said through hole (26) having a lower opening and an upper opening, said first valve comprising an upper end and a lower end,
characterized in that
 said first valve abuts the lower opening of said through hole (26) by its upper end and the upper opening of said moving piston (3) by its lower end.

2. A vibration pump as claimed in claim 1, comprising a pump body (1) with a communication conduit (21) extending between a suction port (22) and a discharge port (23), a fluid flowing in said communication conduit (21) from said suction port (22) to said discharge port (23),
 a coil (4) axially extending along said communication conduit (22) to generate a magnetic field for translating a moving piston (3), which moving piston (3) is slidably and sealingly received in said communication conduit (21) and which moving piston (3) has a passage (30) for fluid that extends from a lower mouth (31) located proximate to said suction port (22) to an upper mouth (32),
 a first valve seat (24) and a first closure member (33) cooperating with said valve seat (24) being provided at said upper mouth (32), which first closure member (33) is mounted in such a manner as to be movable between a position in which it interferes with said valve seat (24) thereby closing the passage (30), i.e. a so-called valve closing position, and a position in which said first closure member (33) does not interfere with said valve seat (24), whereby the passage (30) is open, i.e. a so-called valve opening position, lower elastic means (13) and upper elastic means (14) being provided between said moving piston (3) and a lower stationary abutment wall (11) and an upper stationary abutment wall (12) respectively, for axially pushing said moving piston (3) toward ejection from the communication conduit (22),
 in such a manner that, when the coil is energized (4), the moving piston (3) is drawn into the communication conduit (22) by the magnetic flux, against the action of the elastic pushing means (13, 14), whereas when the coil is de-energized the moving piston (3) is pushed by said elastic means (13) toward ejection from the communication conduit (22), said moving piston (3) being connected with drive members for transferring the motion thereof to the first closure member (33), which members include an elastic element (34), and the first closure member (3) having a side exposed to the inflowing fluid pressure,
 said first valve seat (24) communicating with a second valve seat (25) via a through hole (26), which second valve seat being located at said discharge port (23) and a second closure member (35) being provided, which cooperates with said second valve seat (25), which second closure member (35) is mounted in such a manner as to be movable between a position in which it interferes with said second valve seat (25) thereby closing the through hole (26), i.e. a so-called valve closing position, and a position in which said second closure member (35) does not interfere with said second valve seat (25), whereby the through hole (26) is open, i.e. a so-called valve opening position,
 the first closure member (33) consisting of a circular

body having a flat top end (331), such that, when the coil (4) is de-energized, said flat top end (331) abuts proximate to the inlet of said through hole (26).

3. A vibration pump as claimed in claim 2, wherein said first closure member (33) has a bottom end with coupling means for attachment to said elastic element (34), which coupling means consist of a hook element (332) engaging in a corresponding loop (341) of the elastic element (34).
4. A vibration pump as claimed in claim 2, wherein said first closure member (33) has a bottom end consisting of an elongate member (335) extending toward said lower mouth (31), which elongate member has a through hole oriented perpendicular to the longitudinal axis of said pump body (1), which through hole engages in a corresponding loop (341) of the elastic element (34).
5. A pump as claimed in one or more of the preceding claims, wherein said elastic element (34) has a first part (342) consisting of an elongate member, which elongate member engages with said first closure member (33), said first part (342) being connected to a second part (343) consisting of a plurality of metal turns.
6. A vibration pump as claimed in one or more of the preceding claims, wherein said second closure member (35) has a side exposed to pressure of the fluid that comes out of said first valve seat (24), an elastic element (38) being interposed between said second closure member (35) and said discharge port (23), whose compression/extension opens/closes the second valve seat (25) respectively, said second closure member (35) also having an element (351) that extends toward said first closure member (33), such that, when said moving piston (3) is in its limit stop position, said element (351) abuts said flat top end (331) of said first closure member (33).
7. A vibration pump as claimed in one or more of the preceding claims, wherein said moving piston (3) consists of a hollow cylindrical body in which said passage (30) extends from a lower mouth (31) to an upper mouth (32), said hollow cylindrical body consisting of a lower part (36) proximate to said lower mouth (31) and a radially narrower portion (37) proximate to said upper mouth (32), said lower part (36) being made of a ferromagnetic material, such as iron or the like, coated with a plastic material.
8. A vibration pump as claimed in one or more of the preceding claims, wherein said coil (4) is housed in an outer casing (41), said outer casing (41) being

coaxial with said pump body (1) and encircling the outer surface of said pump body (1), the ends of said coil (4) being connected to a power source via a diode and a thermal protection device, which diode and which thermal protection device are both housed in said outer casing (41).

9. A vibration pump as claimed in one or more of the preceding claims, wherein said outer casing (41) is formed of a metal tubular cylindrical body, which tubular cylindrical body accommodates said coil (4) within the thickness of its side walls.
10. A vibration pump as claimed in one or more of the preceding claims, wherein a flow sensor (5) axially extends along said discharge port (23), and consists of a coil (51) that encircles said discharge port (23), for sensing the movement of said moving piston (3).
11. A vibration pump as claimed in one or more of the preceding claims, wherein said pump body (1) is composed of two parts, i.e. a first part (15) cooperating with a second part (16), with said second part (16) having a lower annular band (161) designed for insertion into an upper circular ring (151) of said first part (15), said circular ring (151) and said annular band (161) having at least one hole (152, 162) each, such that, when they are fitted one into the other, the hole on the circular ring (151) is coincident with the hole on the annular band (161), at least one element (17) being provided, which at least partially encircles said circular ring (151) and has an engagement tooth (171) to be fitted into the holes (152, 162) for locking said first part (15) in position to said second part (16).
12. A vibration pump as claimed in claim 11, wherein said first part (15) comprises said suction port (22) and said communication conduit (21), whereas said second part comprises said discharge port (23), the first valve seat (24) and the second valve seat (25), said first part (15) and said second part (16) being made of plastic.
13. A vibration pump as claimed in claim 11, wherein said first part (15) is received in said outer casing (41) of the coil (4) and said first part (15) has at least one lateral tab (153) cooperating with a corresponding housing seat on a support element of said outer casing (41).
14. A vibration pump as claimed in claim 1, wherein at least two bushings (8) are interposed between said pump body (1) and said coil (4), said at least two bushings (8) being spaced by a ring (81) made of an elastic material.

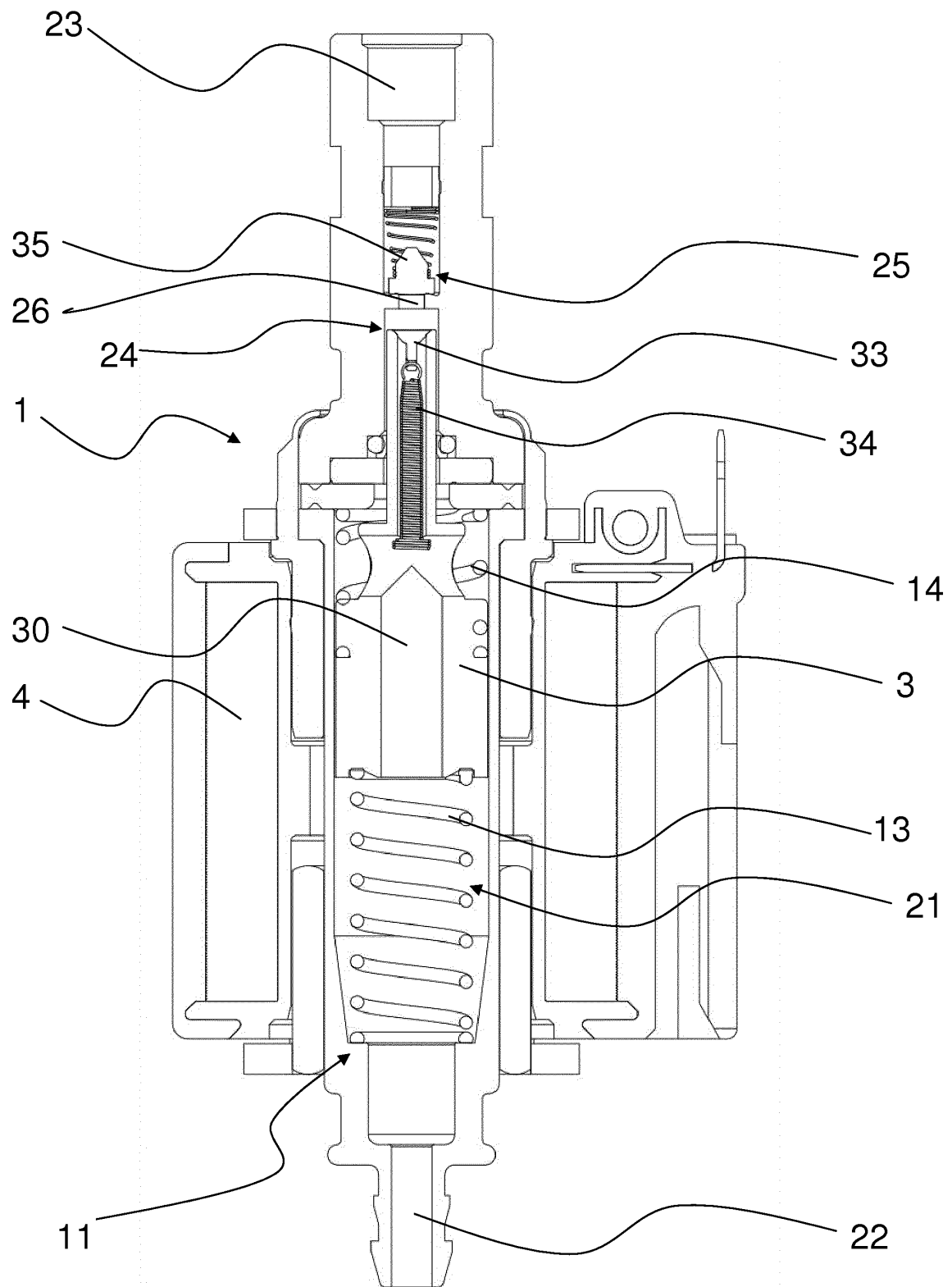


Fig. 1

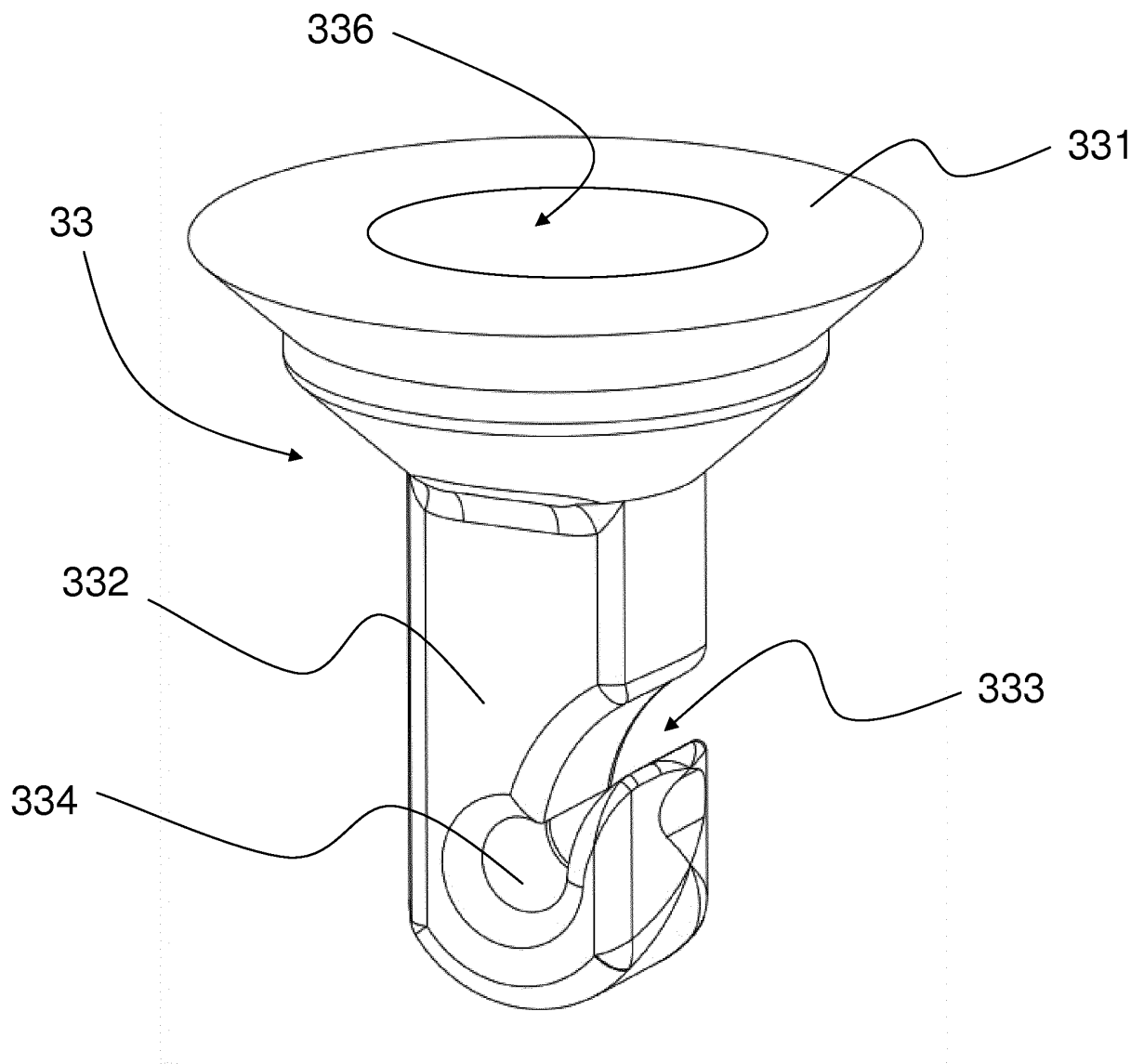


Fig. 2a

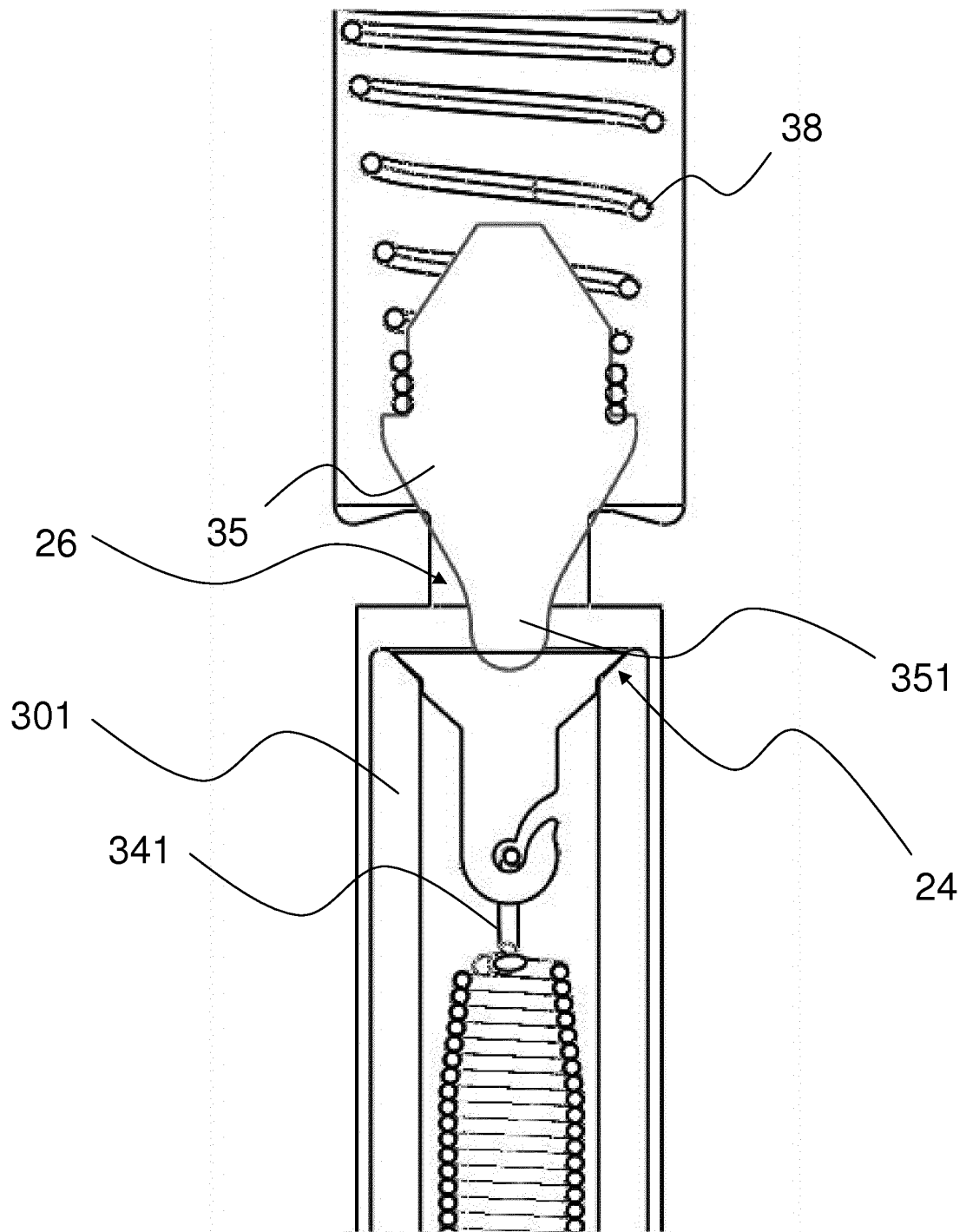


Fig. 2b

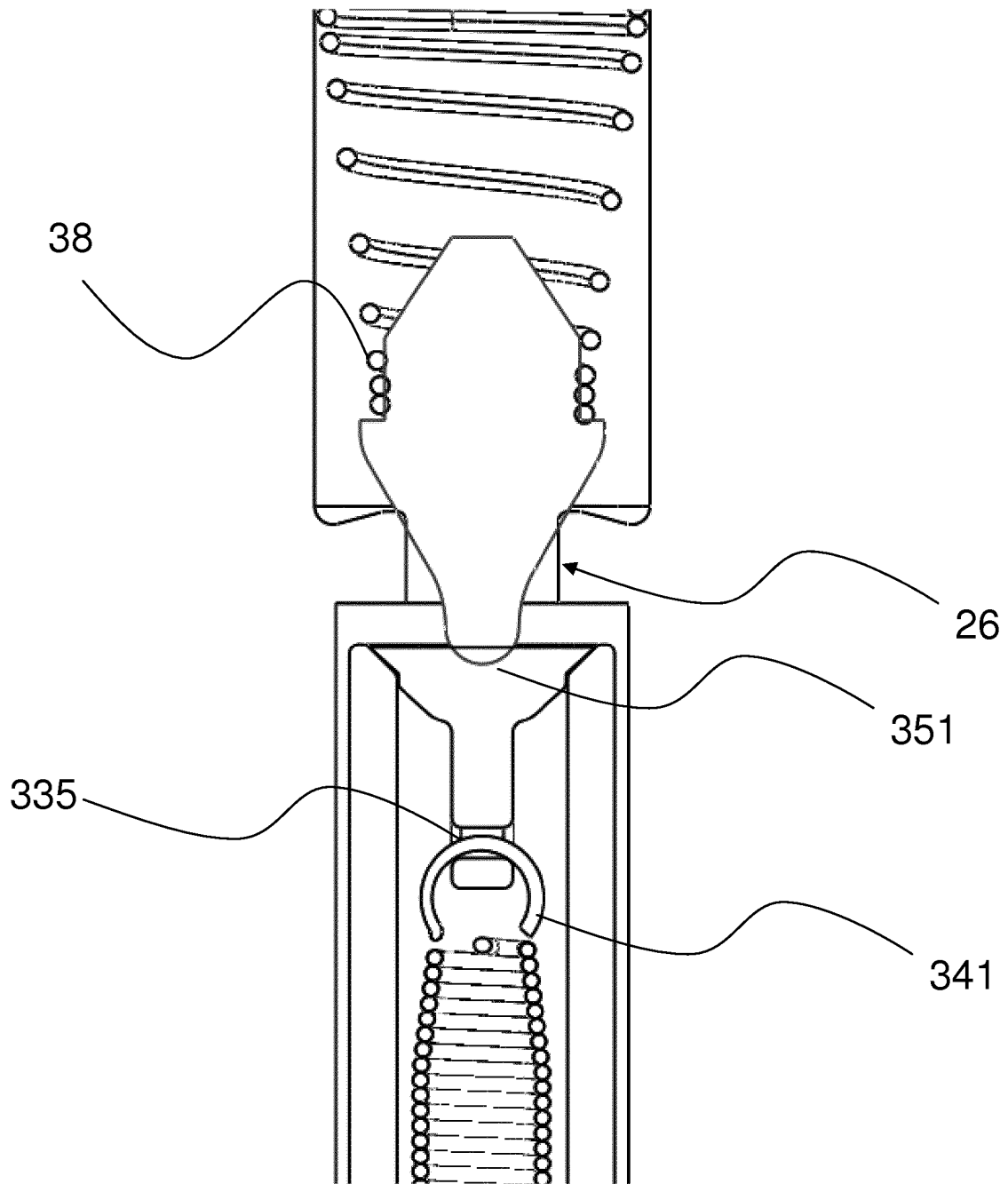


Fig. 2c

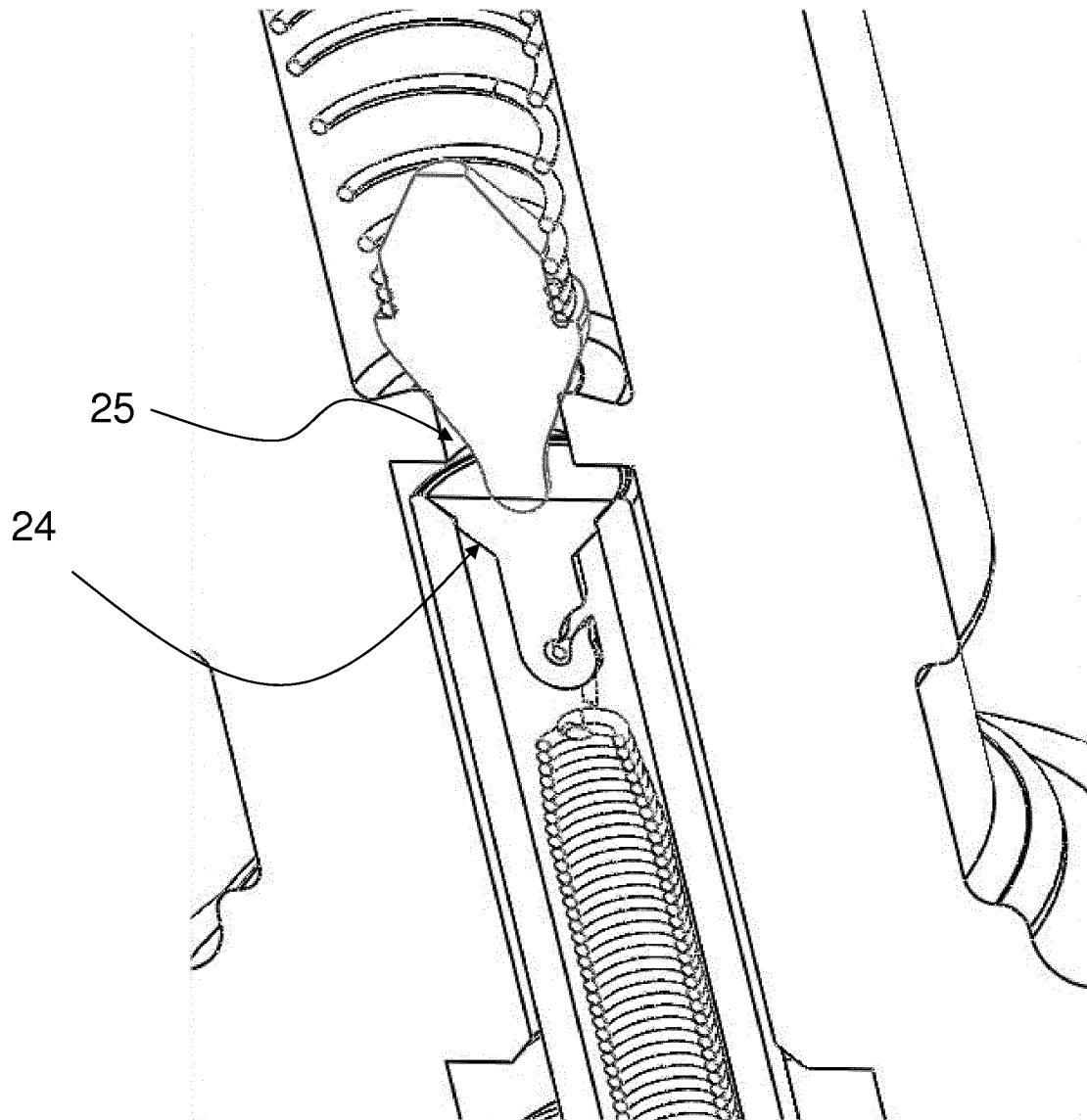


Fig. 2d

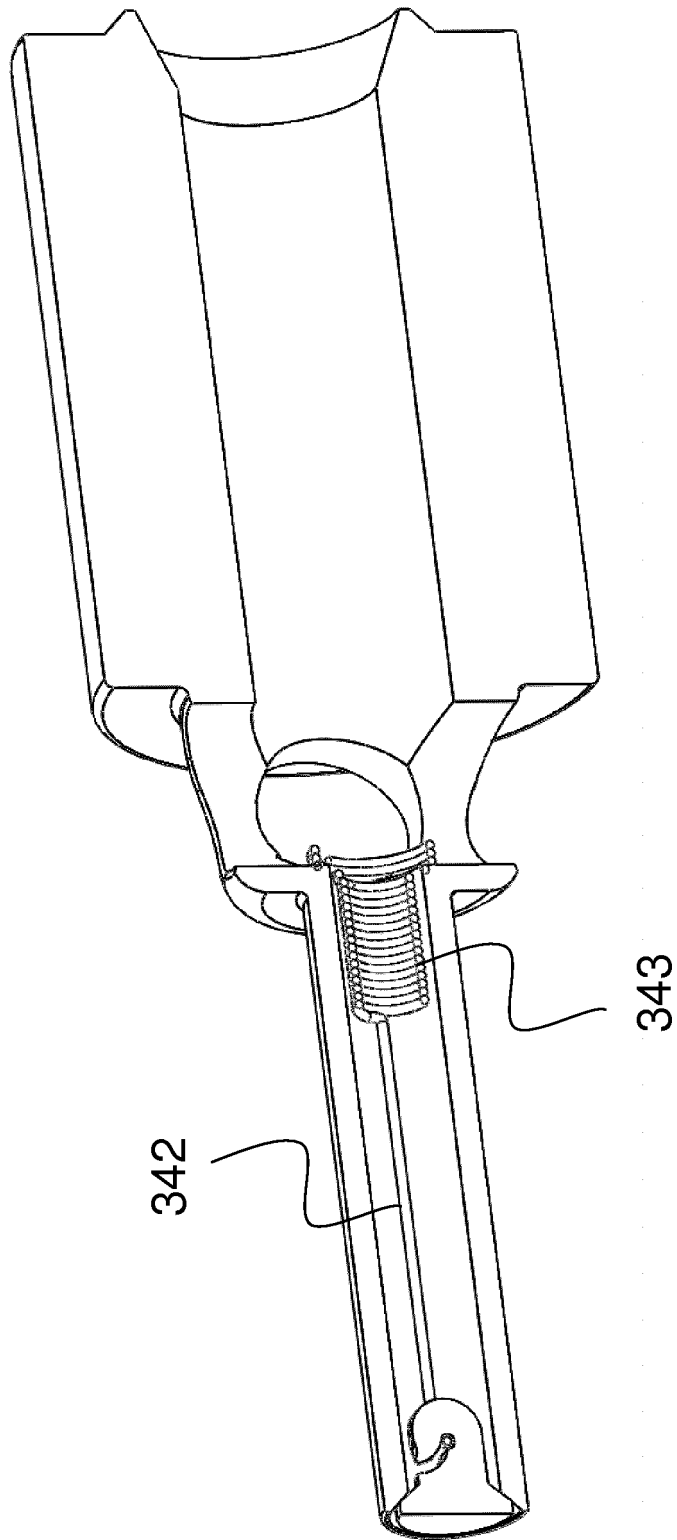
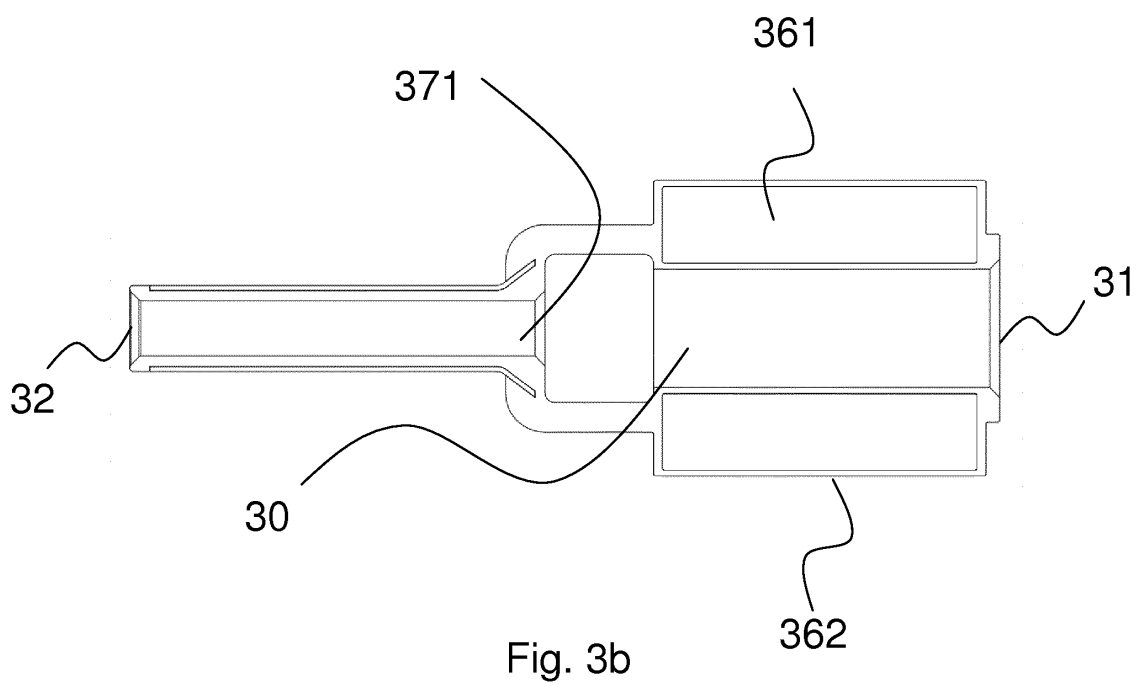
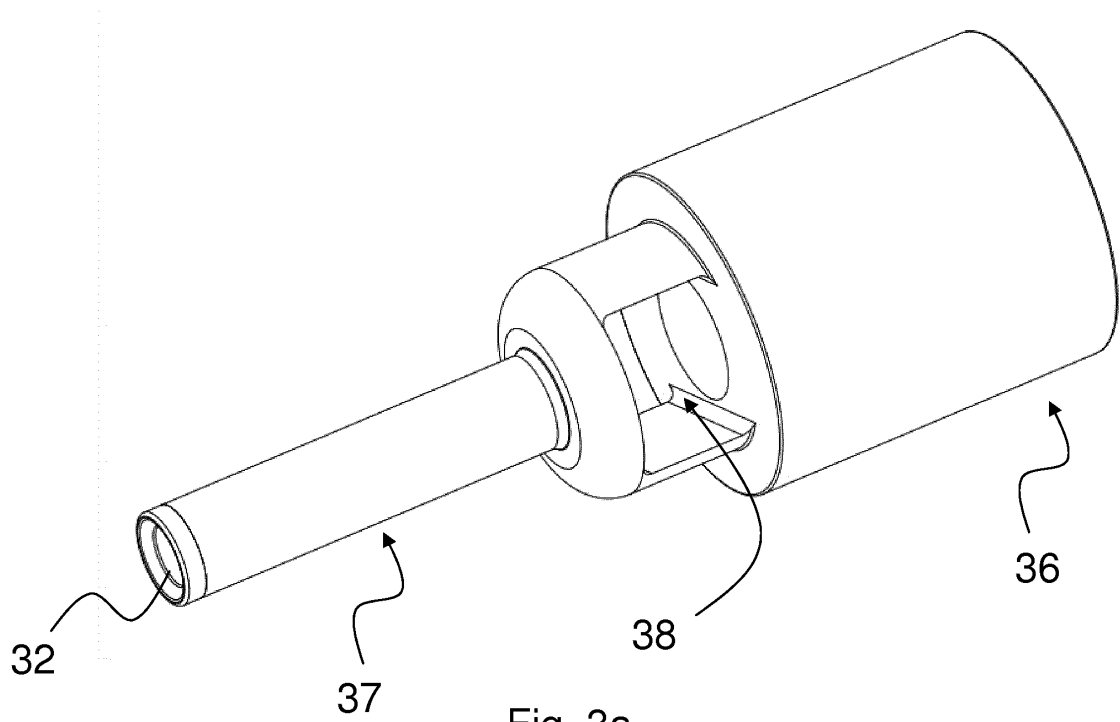


Fig. 2e



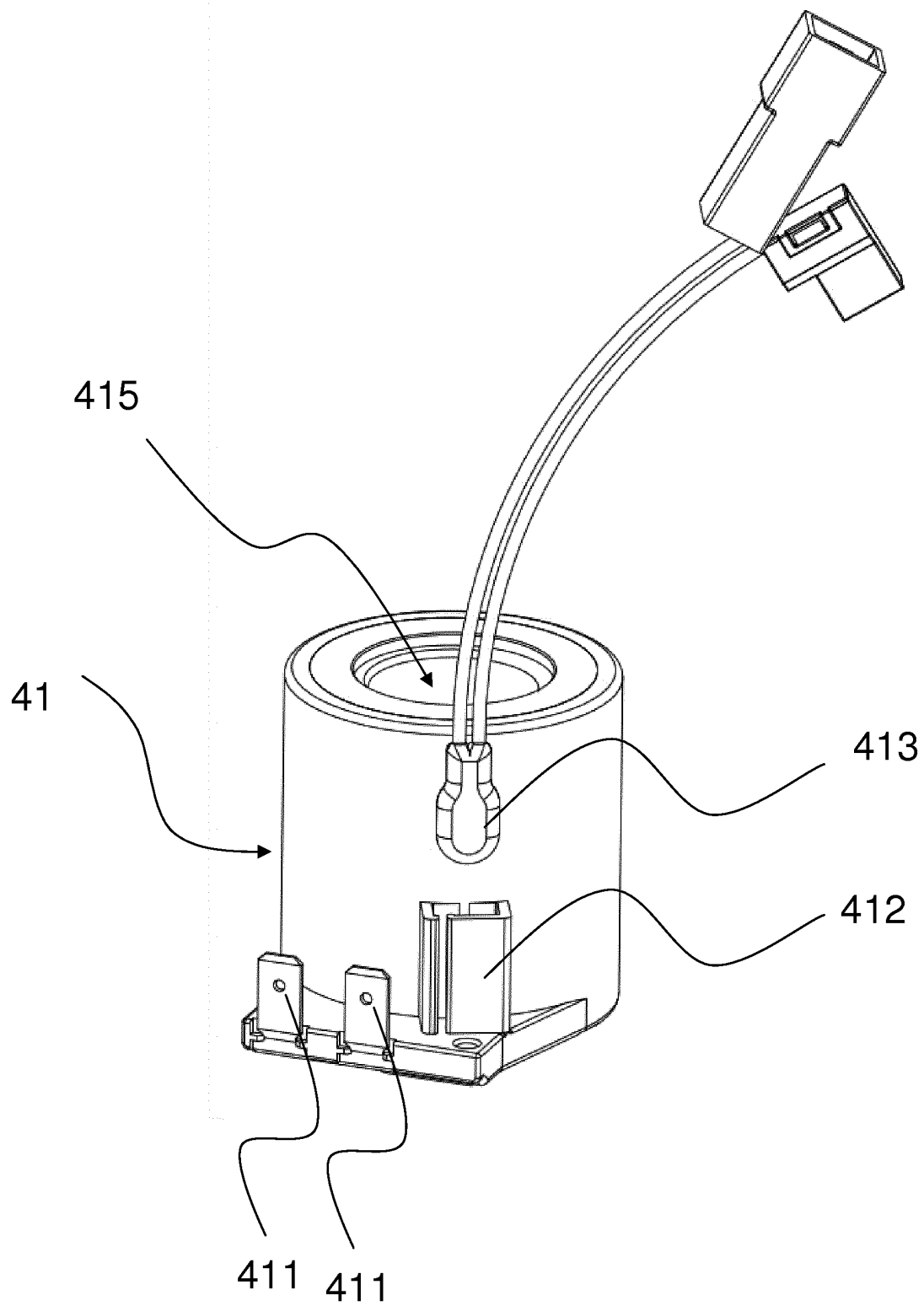


Fig. 4a

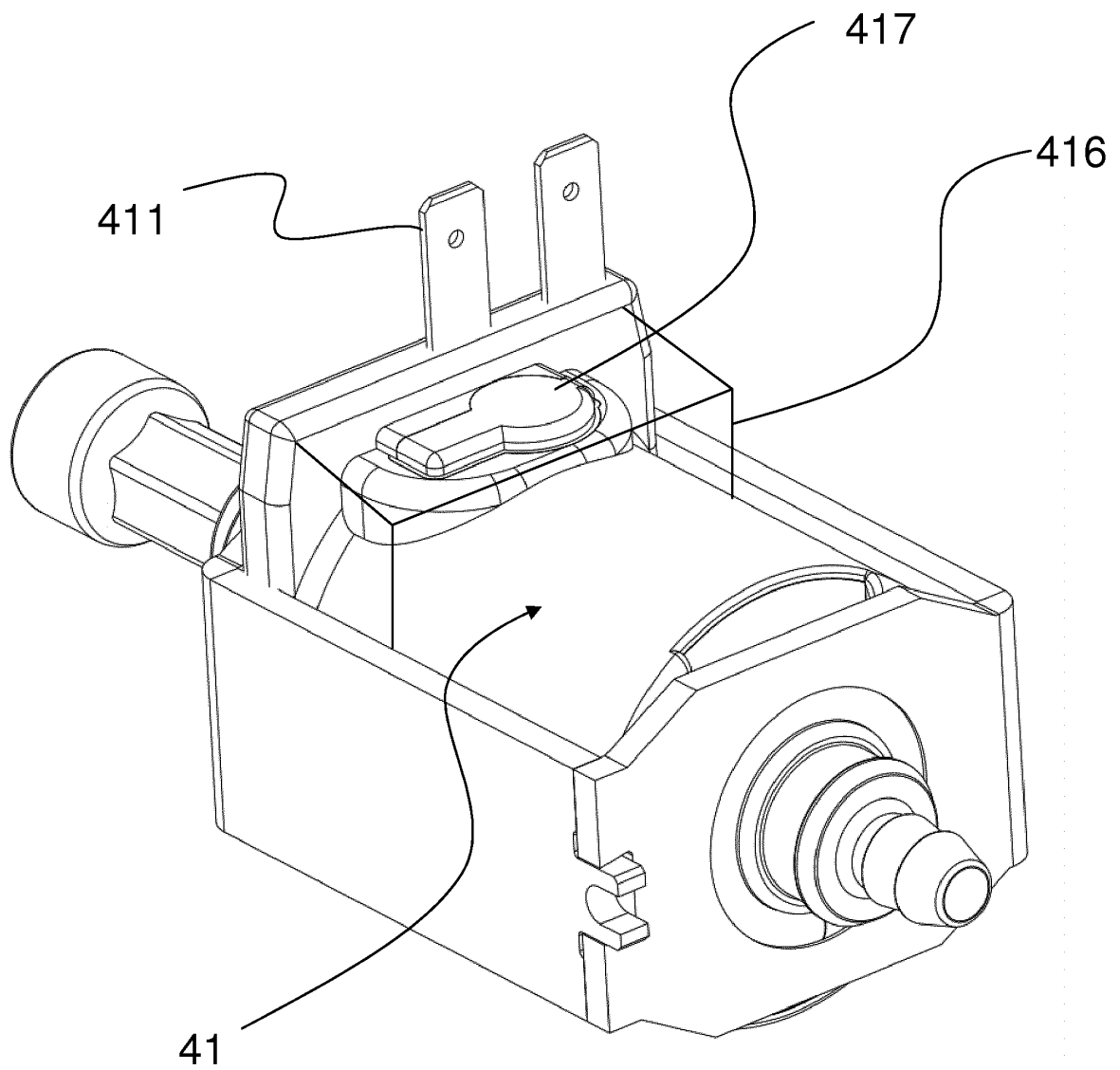


Fig. 4b

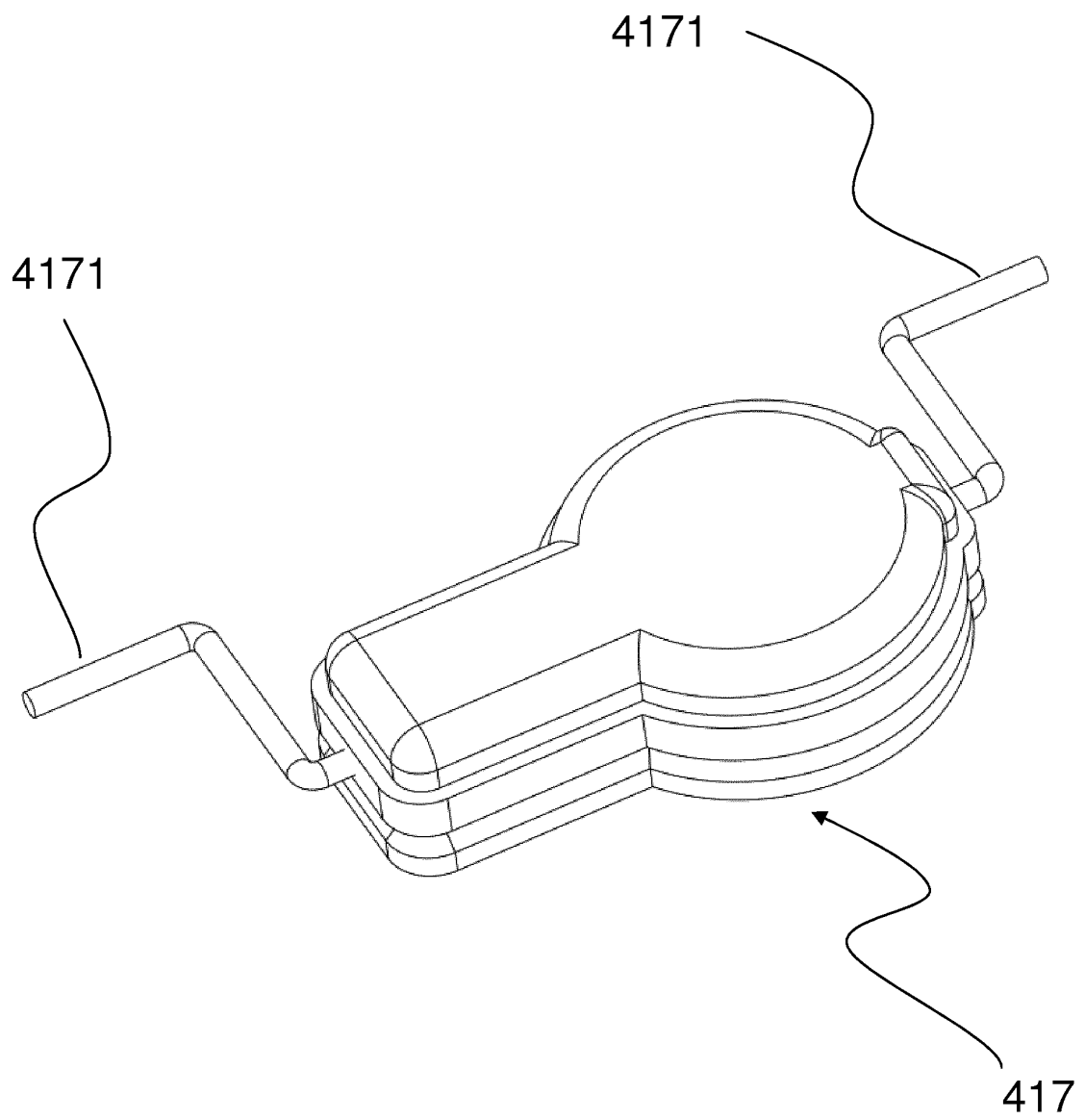


Fig. 4c

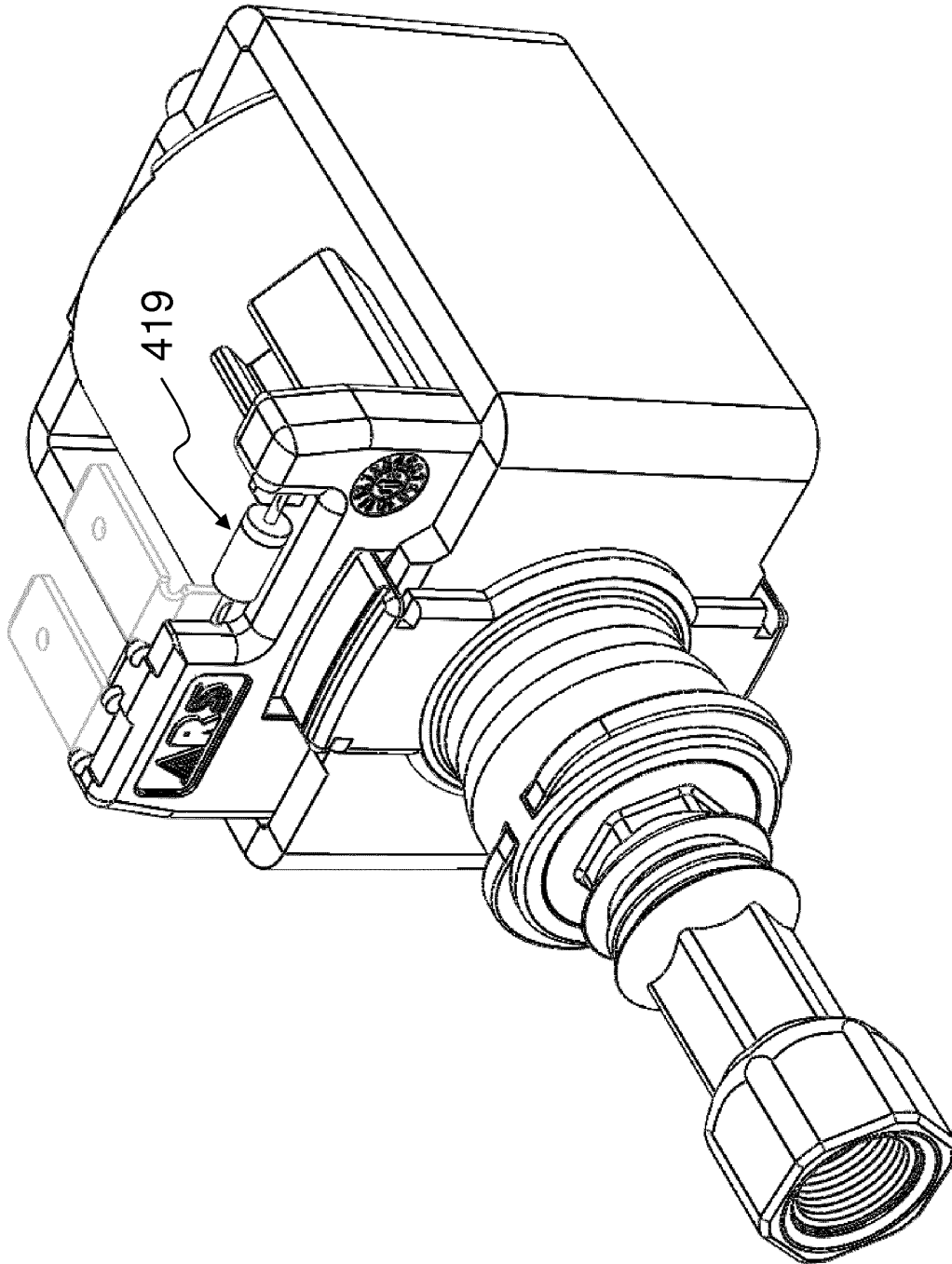


Fig. 4d

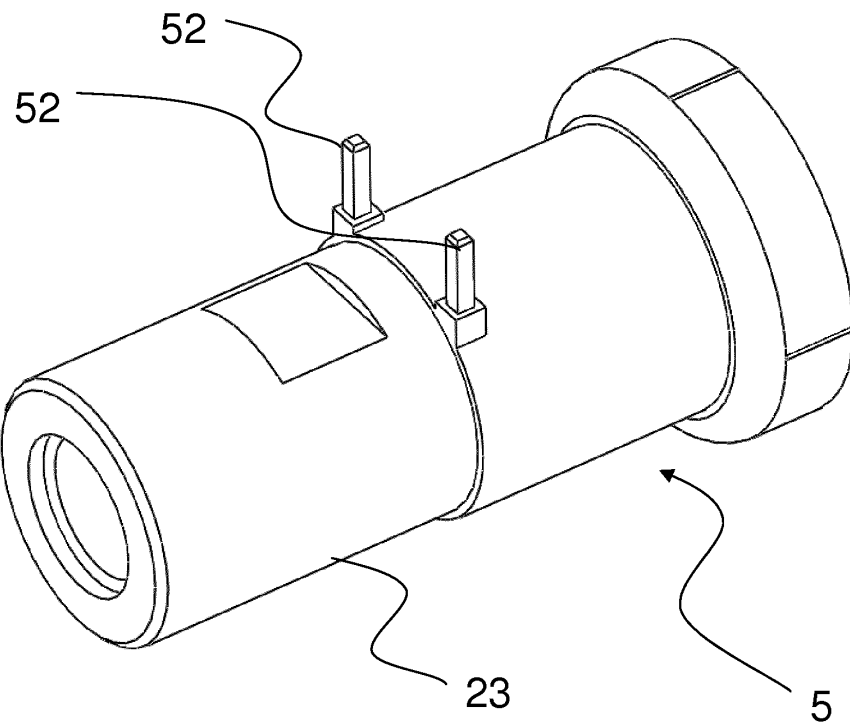


Fig. 5a

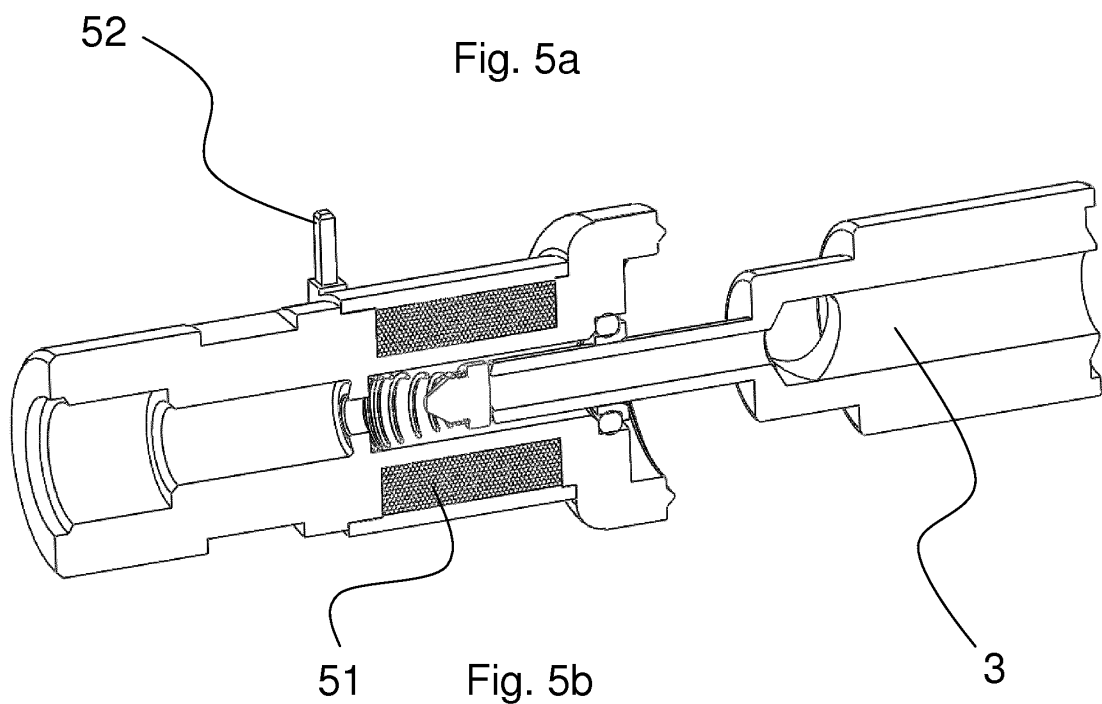


Fig. 5b

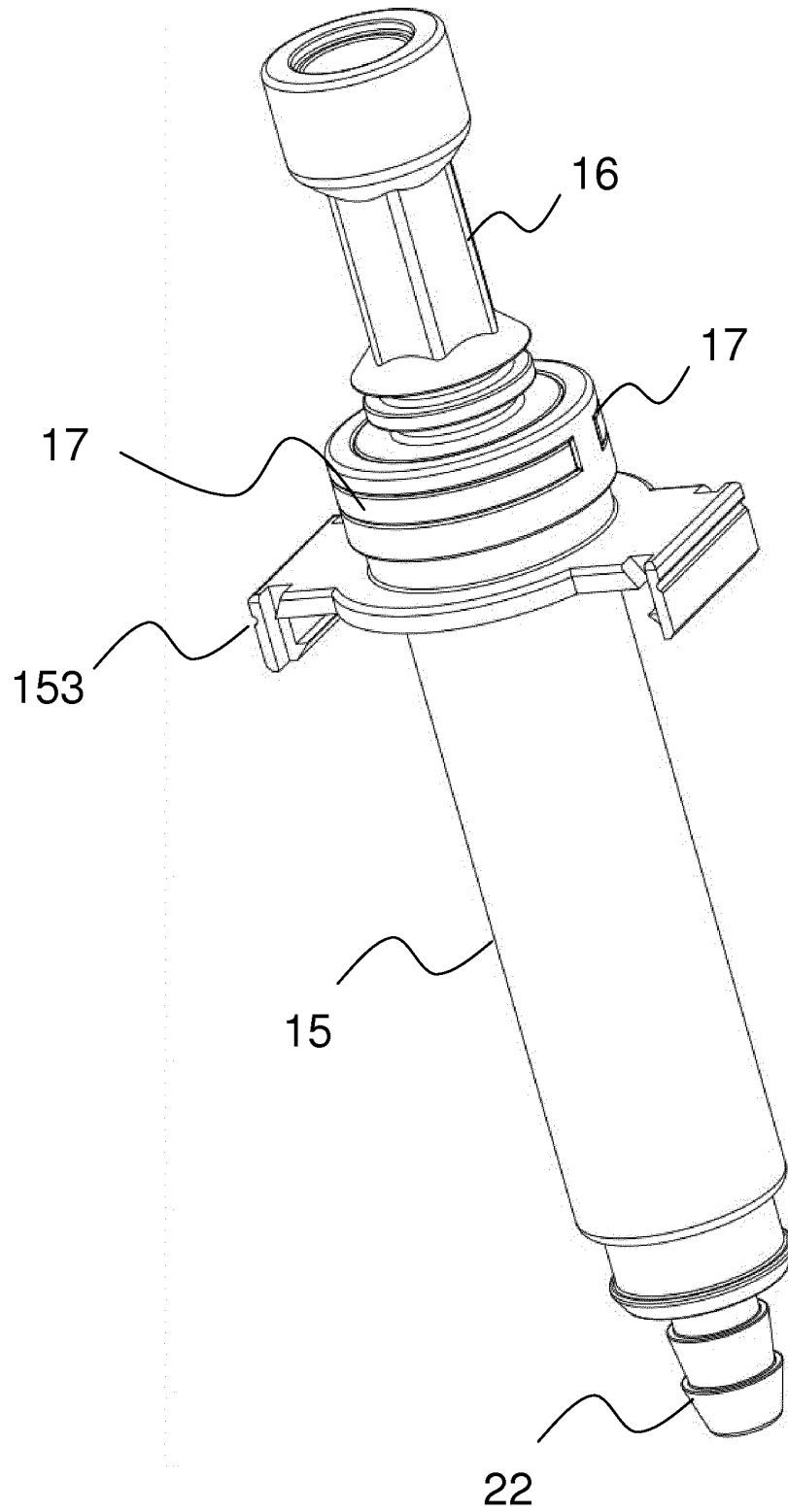


Fig. 6a

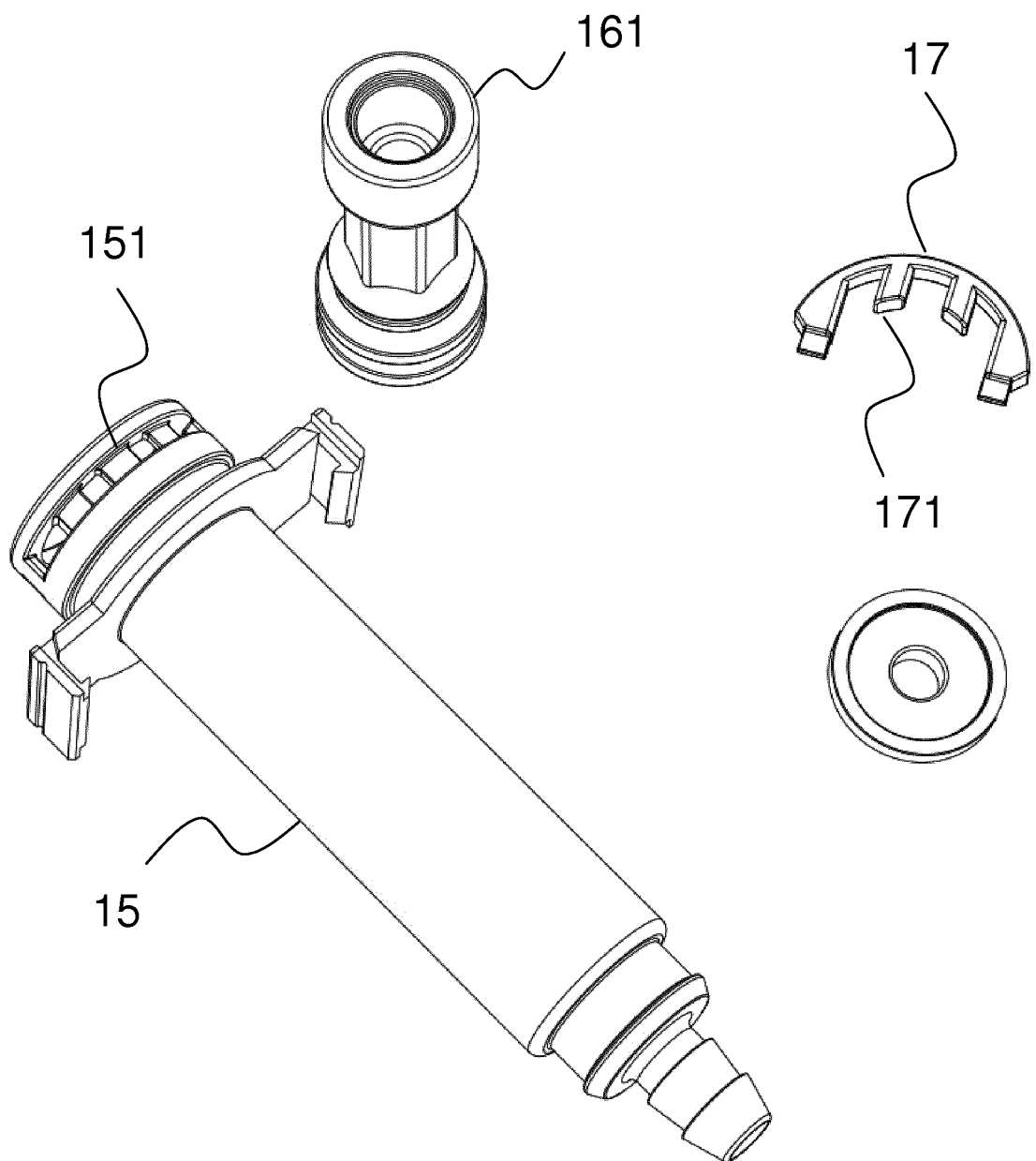


Fig. 6b

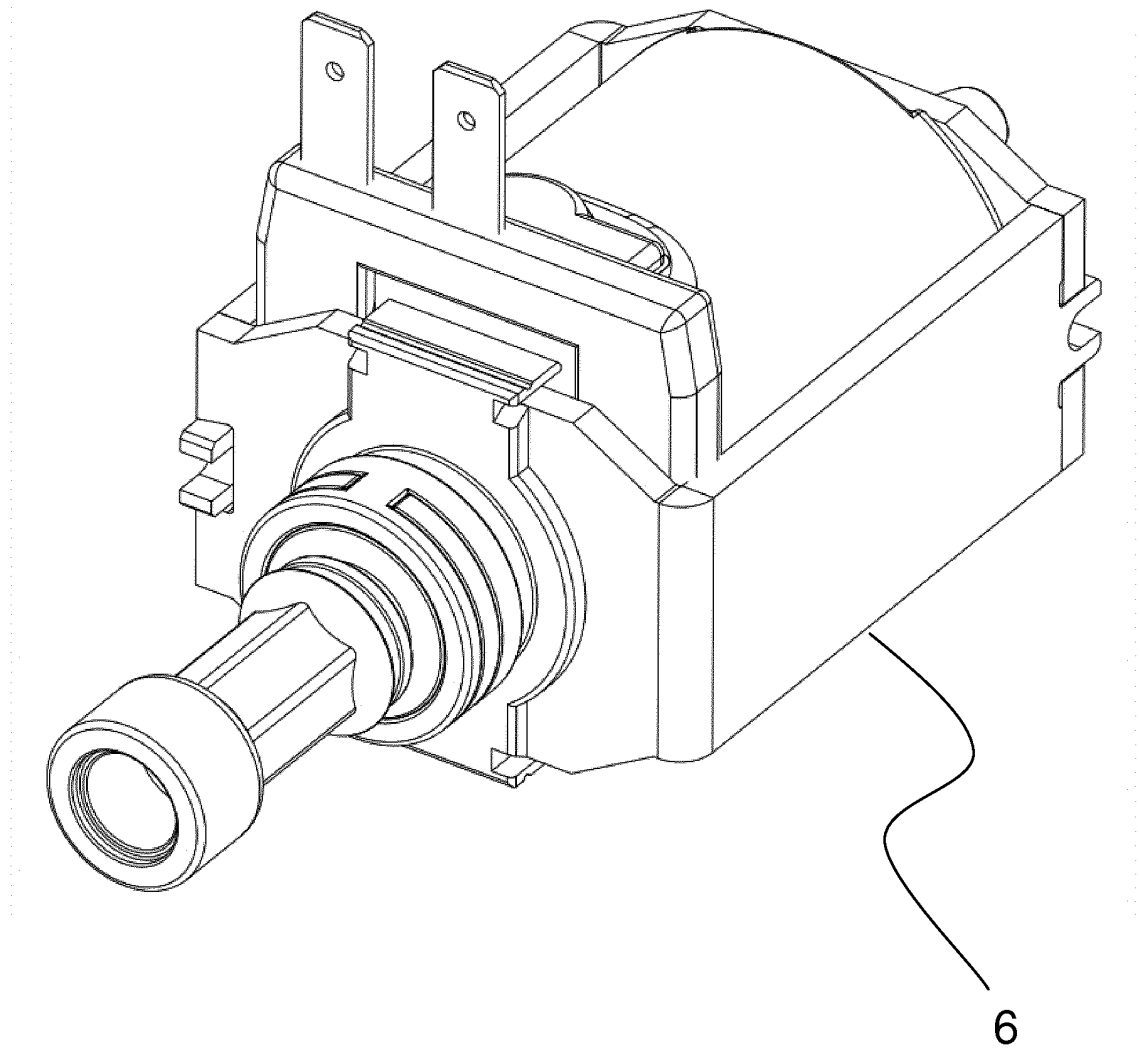
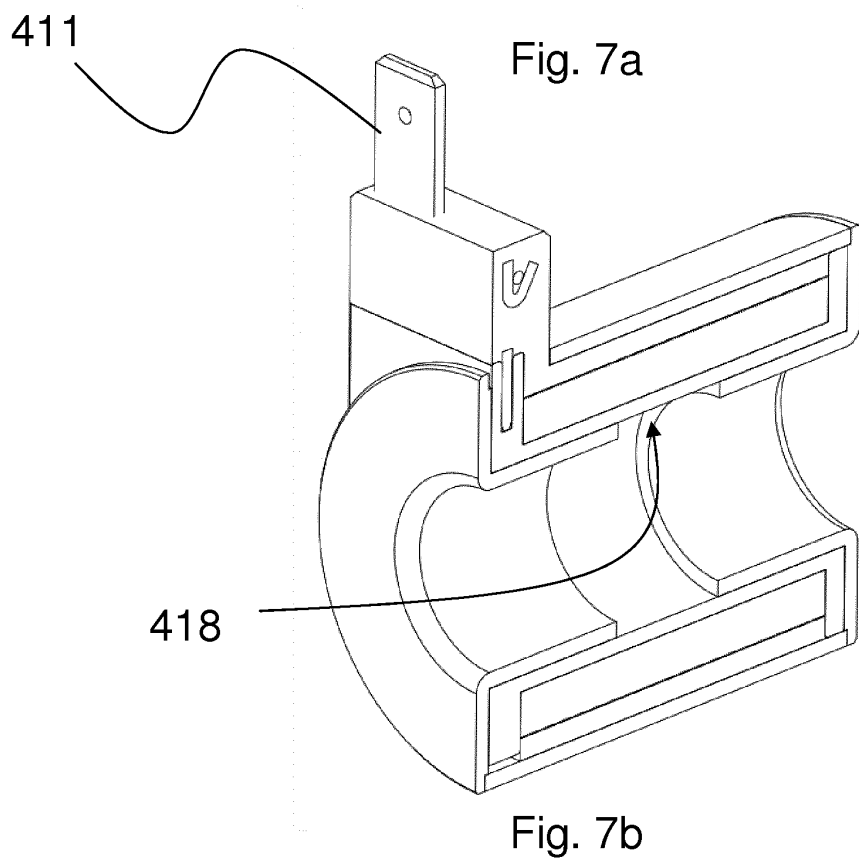
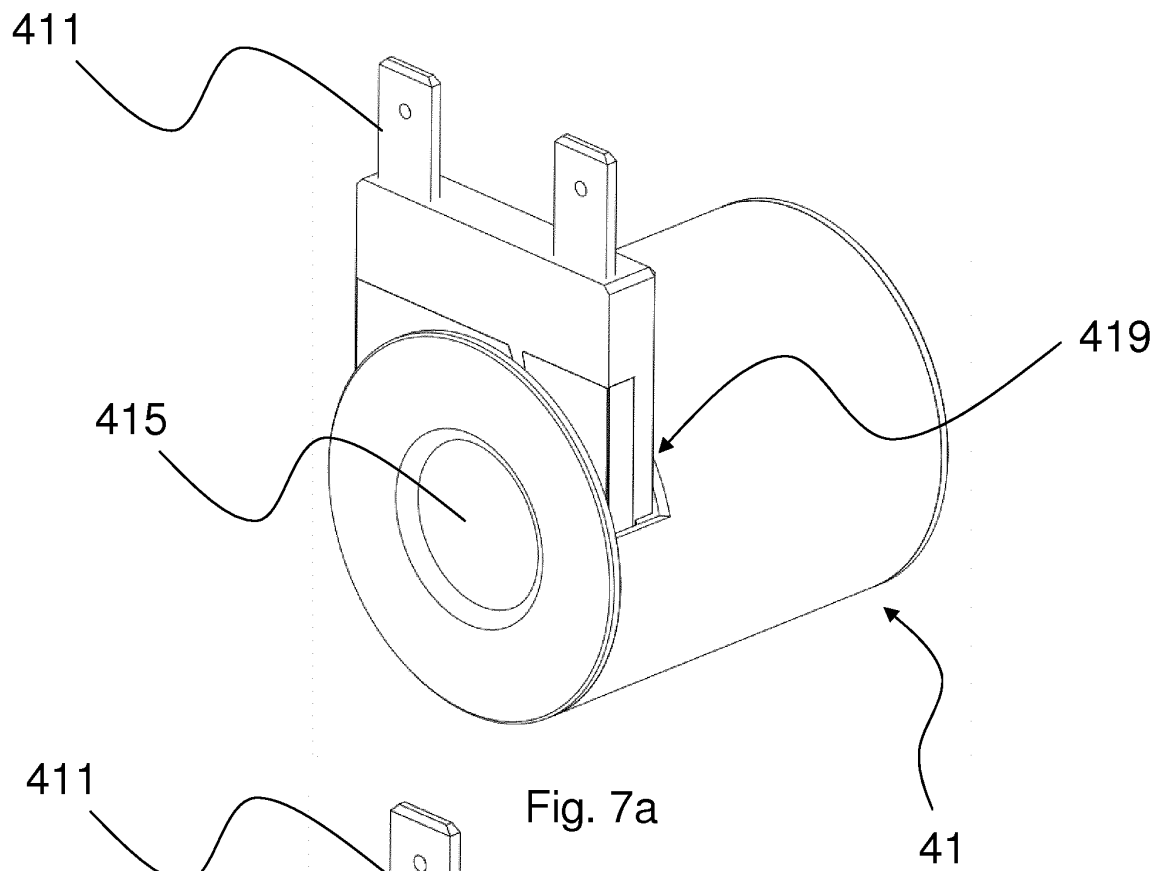
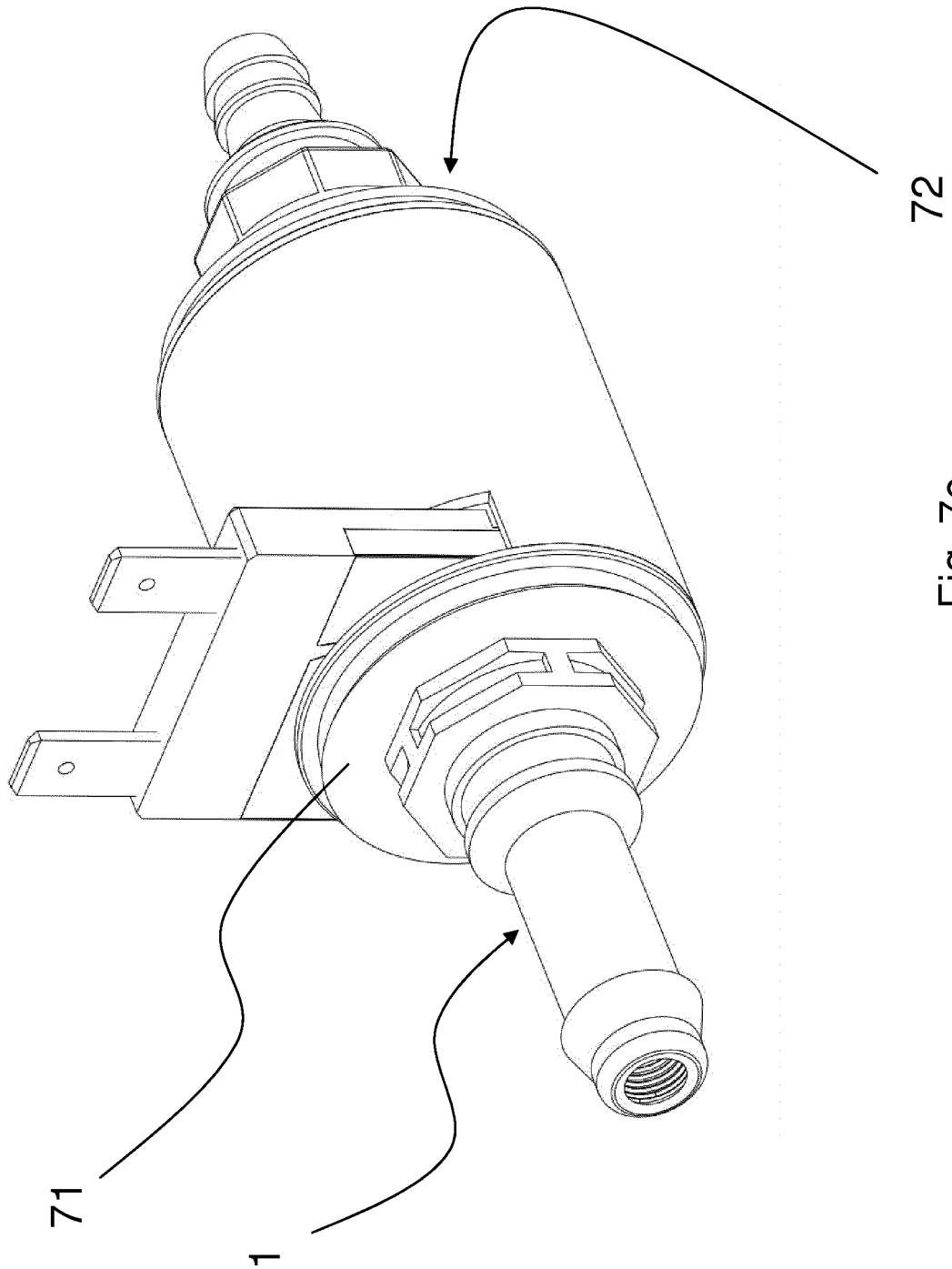
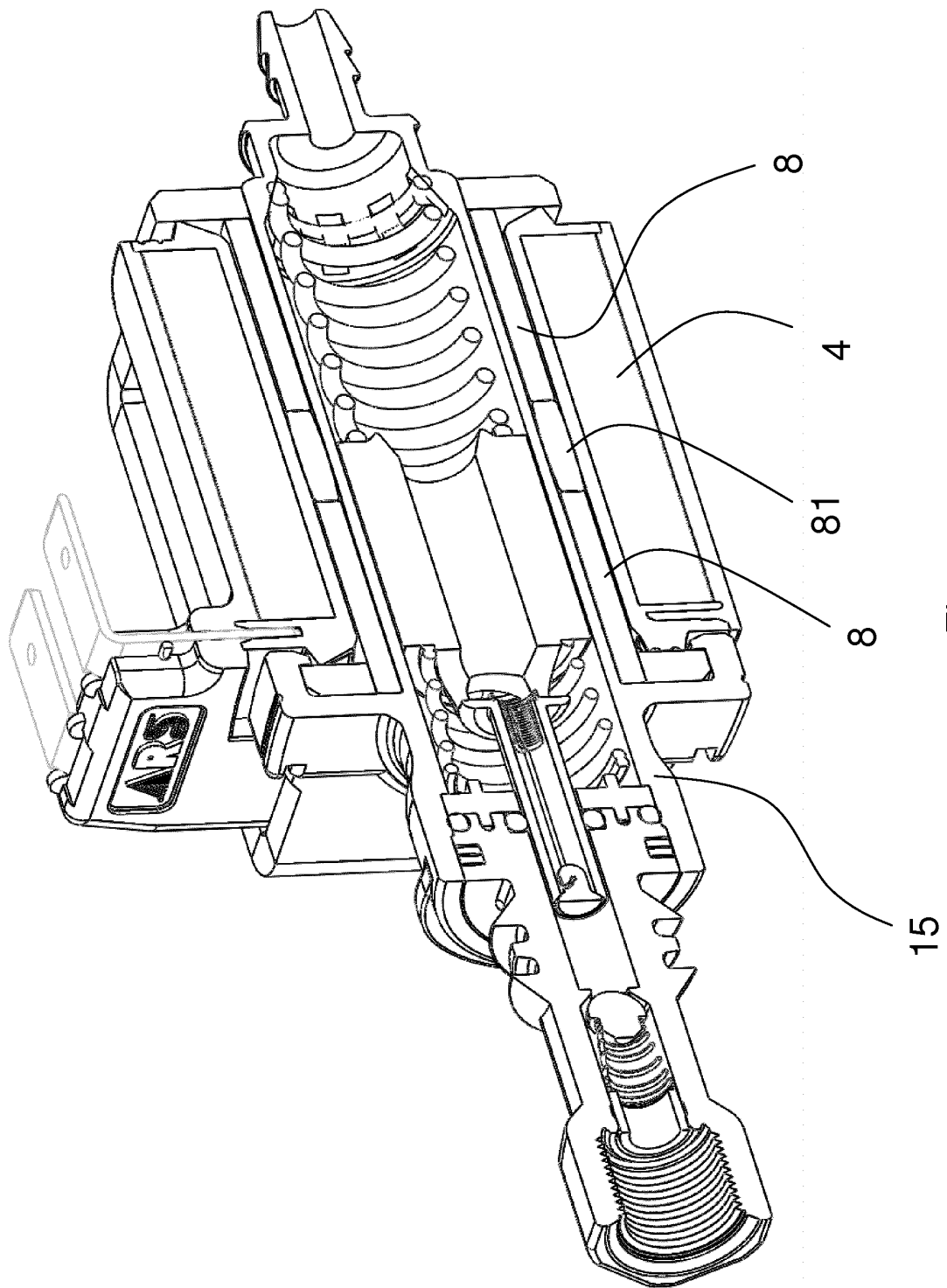


Fig. 6c







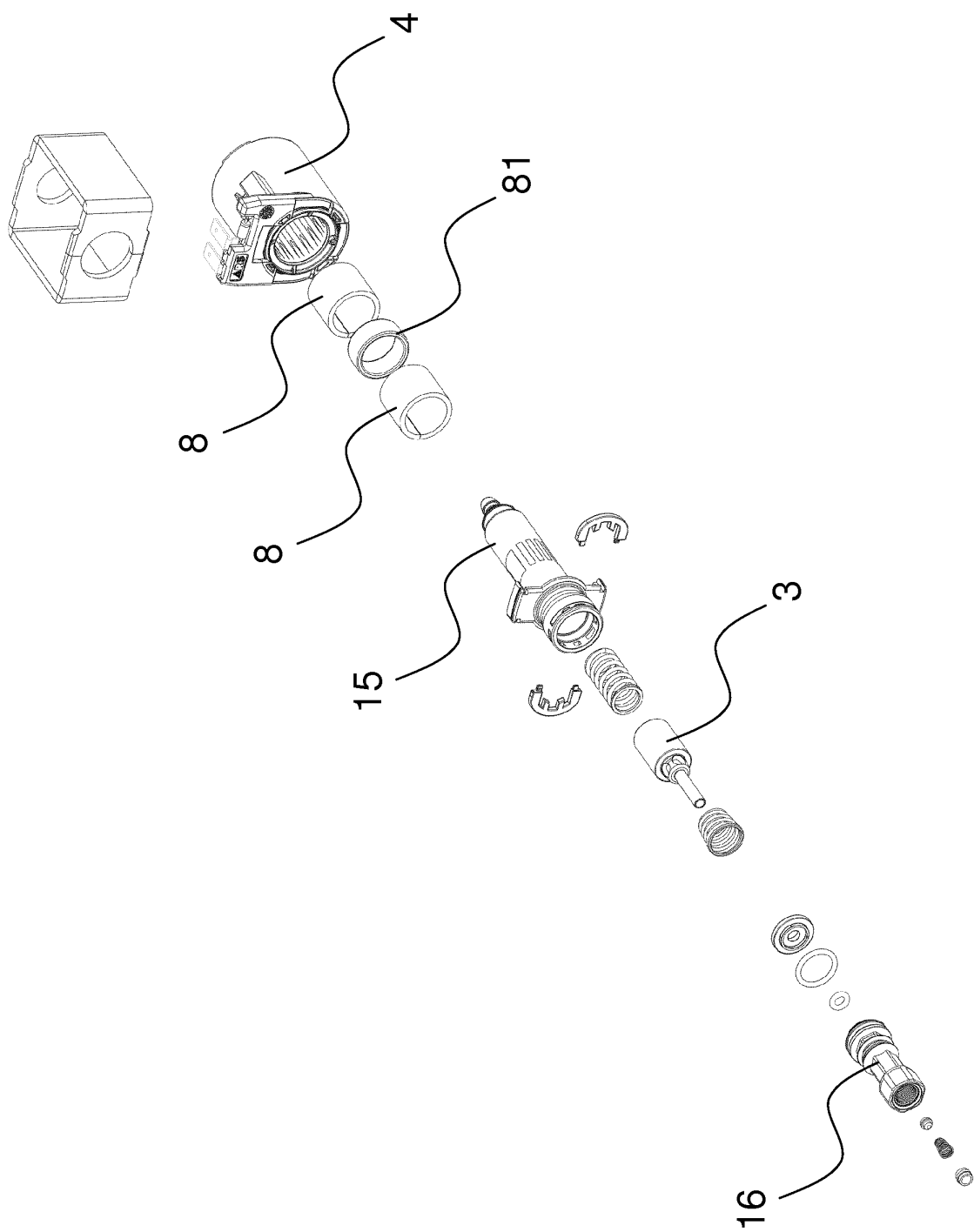


Fig. 8b