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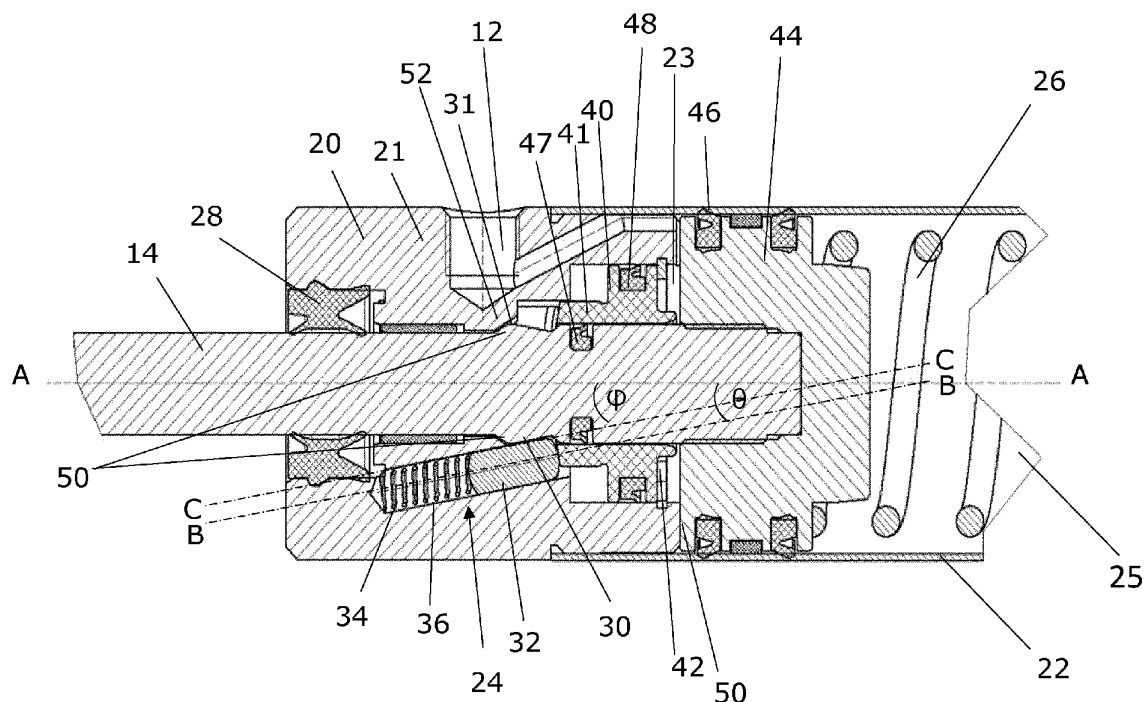
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(54) PISTON-CYLINDER ASSEMBLY WITH LOCKING UNIT

(57) A piston assembly (10) with an automatic locking mechanism is provided comprising a piston housing (20), piston rod (14) with a centreline (AA), at least one collar (40), and a lock (24). The at least one collar (40) is slidably disposed on the piston rod (14) to actuate the lock (24). The lock (24) is configured to engage the at least one conical surface (30) in a piston locked state. The lock

(24) is also configured to be spaced apart from the at least one conical surface (30) in a piston unlocked state. The at least one collar (40) is arranged to abut the lock (24) and to move the lock (24) from the piston locked state to the piston unlocked state when fluid pressure is applied to the at least one collar (40).

**Figure 2****EP 3 978 766 A1**

Description

TECHNICAL FIELD

5 **[0001]** The present disclosure relates to a piston cylinder lock. Particularly, but not exclusively, the disclosure relates to locking piston cylinders. Aspects of the invention relate to a piston assembly with an automatic locking mechanism, and to a method of actuating a piston assembly.

BACKGROUND

10 **[0002]** Piston locks are used in a variety of applications where locking a piston in an extended or retracted position is required. Actuating a piston without a lock in the same position for an extended time (minutes, hours or days) requires permanent pneumatic, hydraulic or fluid pressure. Locking a piston in a fixed extended, retracted or partially extended position negates the need for a permanent pneumatic, hydraulic or fluid pressure to be provided to a piston.

15 **[0003]** Known piston cylinder lock arrangements are disposed in or on a piston housing and prevent the piston rod from moving when the piston cylinder lock is locked. Known piston cylinder locks can employ bolts which interact with a groove on the piston rod to prevent the rod from moving. In use bolts may shear, or otherwise become damaged, due to excessive pulling or pushing forces that the piston rod is subjected to. Shearing of the lock's bolts can compromise the effectiveness of the lock causing it to become weakened or breaking the lock.

20 **[0004]** The present invention aims to overcome at least one or more of the limitations identified above.

SUMMARY OF THE INVENTION

25 **[0005]** Aspects and embodiments of the invention provide a piston assembly, a method of actuating a piston, a method of locking a piston and a method of locking a piston as claimed in the appended claims.

[0006] A first aspect of the present invention relates to a piston assembly with an automatic locking mechanism comprising:

- 30 a. a piston housing;
b. a piston rod with a centreline;
c. at least one collar;
d. at least one lock with a centreline;

35 wherein the piston rod has at least one conical surface;
the piston housing containing the at least one lock;
the at least one collar being moveably disposed in the piston housing;
wherein the centreline of the at least one lock is at an angle from the centreline of the piston rod;
wherein the at least one lock is configured to engage the at least one conical surface in a piston locked state,
40 and the at least one lock is configured to be spaced apart from the at least one conical surface in a piston unlocked state; and wherein the at least one collar is arranged to abut the at least one lock and to move the at least one lock from the piston locked state to the piston unlocked state when fluid pressure is applied to the collar.

[0007] The piston assembly locks and engages the at least one conical surface of the rod when the component is locked. This angle between the lock and the at least one conical surface of the rod gives mechanical engagement
45 between the lock and piston rod stopping the piston from moving.

[0008] Advantageously the lock being disposed at an angle allows for good engagement between the lock and the piston rod.

[0009] Disposing the lock at an angle to the piston rod reduces the potential for shearing of the lock.

50 **[0010]** Advantageously pushing on the end of the piston rod would cause greater engagement between the lock and the at least one conical surface.

[0011] The piston assembly preferably further comprises a biasing means the biasing means being connected to the piston rod and wherein the biasing means is adapted to return the piston assembly to the piston locked state when the fluid pressure applied to the at least one collar is released.

55 **[0012]** The biasing means automatically returns the piston to the locked position when fluid pressure is removed from the piston assembly. Advantageously this reduces the need for pneumatic pressure to be applied to return the piston to a piston locked state. Further, if pneumatic pressure is interrupted the piston assembly will return automatically to the piston locked state.

[0013] Preferably the at least one conical surface of the rod is at an angle (φ) from the centreline of the piston rod.

[0014] Advantageously having the at least one conical surface at an angle to the centreline of the piston rod gives better engagement between the at least one conical surface and the lock.

[0015] Preferably the angle (θ) and angle (φ) are approximately the same. The angles being the same allows for good interaction between the at least one conical surface and the lock.

[0016] Preferably wherein the angles (θ , φ) are both between 1-45 degrees, preferably the angles (θ , φ) are both between 5-30 degrees, more preferably the angles (θ , φ) are both between 7-15 degrees, more preferably still the angles (θ , φ) are both between 8-12 degrees, and most preferably the angles (θ , φ) are both 10 degrees.

[0017] The at least one conical surface angle and lock angle being approximately the same ensures good agreement between the lock and the at least one conical surface. The angle of the lock and conical surface ensures arrangement of the lock, conical surface and collar within the piston housing.

[0018] Preferably the at least one lock comprises a pin and a biasing means.

[0019] The pin and biasing means can be made of standard components which advantageously can be exchanged if worn down over time or serviced in use.

[0020] Preferably the at least one lock is located in the piston housing radially outwards from the piston rod centreline in at least one bore. The bore may be vented. The bore may be a blind bore.

[0021] The bore is open on the side facing the centreline AA. The use of a bore allows for a compact arrangement of the locks in the piston housing.

[0022] Preferably the piston assembly has a plurality of locks.

[0023] Advantageously providing a plurality of locks reduces the load on an individual lock by uniformly distributing the load across all the locks.

[0024] Preferably the number of locks is uneven and preferably three or five or seven. An uneven number of locks gives good centring of the piston rod. An uneven number of locks gives better alignment of the piston rod than an even number of locks.

[0025] Preferably the locks are disposed equidistantly around the circumference of the piston housing. The equidistant arrangement of the locks and spring loaded pins help to keep the piston rod aligned along the centreline. The pins all being circumferentially disposed around the housing at an angle help to maintain the centring.

[0026] Preferably the piston housing comprises a piston cap and a piston casing, wherein the piston cap and piston casing are separable; and wherein the piston housing comprises at least one pilot fluid port disposed in the piston cap or piston cover, wherein the at least one pilot fluid port is fluidly connected to the at least one collar and wherein the at least one pilot fluid port is adapted to supply pressurised fluid.

[0027] The housing is made up of two separate components, cap and cover, that are joined together. Separable components allows the assembly to be made in two parts then joined together, separable components allows for ease of manufacture. Further, separable components allow for the housing to be disassembled during maintenance of the piston.

[0028] Preferably the piston rod is adapted to move under the effect of the pressurised fluid when the piston assembly is in the piston unlocked state.

[0029] The piston rod and piston head are actuated by the pilot fluid when the piston assembly is unlocked. The piston head is arranged in the piston housing such that the pilot fluid acts on a surface facing the collar.

[0030] Preferably wherein the piston rod and the at least one conical surface are separate components.

[0031] The rod and conical surface can be manufactured separately to different manufacturing standards. For example higher tolerances for the conical surface to ensure good fit with the pin, or they could be made of dissimilar materials and/or alloys or, undergo different post-solidification heat treatments/surface hardening methods. The conical surface can be made of a hardened material to prevent excessive abrasion/wear. Making the conical surface out of a hardened material reduces the wear on the conical surface in use.

[0032] In a further embodiment a second pilot fluid supply orifice may be provided. Preferably the pilot fluid supply orifice is located in the cap or cover of the housing. The pilot fluid supply orifice is fluidly connected to the collar. Supplying a pilot fluid through the pilot fluid supply orifice advantageously allows the at least one collar to move from a first position to a second position. In this embodiment the biasing means may be provided by fluid pressure provided by the first or second pilot fluid supply orifices. Advantageously the fluid pressure provided by the first or second pilot fluid supply orifices into a chamber of the assembly will cause the assembly to return to an unactuated position.

[0033] In a further embodiment the at least one collar is not fluidly connected to the at least one pilot fluid supply orifice. This provides the advantage of actuating the lock and piston rod individually. The lock may only be actuated for a short duration of time rather than constantly.

[0034] Preferably the piston disc may not have through holes. Advantageously the at least one collar is not connected to the chamber of the assembly.

[0035] Preferably the piston rod is actuated by supplying pressurised fluid through the at least pilot fluid supply orifice, and the at least one collar and lock are separately actuated using pressurised fluid supplied through the second pilot fluid supply orifice.

[0036] In a further embodiment the biasing means may bias the piston rod into the retracted position.

[0037] In a further embodiment the piston assembly may be provided with at least one or more vent ports in the housing suitable for venting pressurised fluid from the internal volumes of the piston assembly. For example, the at least one vent port may be located in the piston cap or piston cover.

[0038] Preferably the at least one vent port may be disposed in the piston cap. Venting the fluid pressure in the piston cap causes a decrease in pressure in the chamber and allows for greater control of the piston assembly. Advantageously venting can be controlled to provide pneumatic cushioning when the piston is actuated.

[0039] Preferably the piston assembly can be provided with a further pilot fluid supply orifice in the piston cover.

[0040] Preferably the piston assembly is a double acting piston.

[0041] Preferably the chamber and a further chamber located on the other side of the piston head are pneumatically separated. Pressurised fluid can be supplied from either pilot fluid supply port to actuate the piston assembly when it is in a piston unlocked state.

[0042] In any of the above embodiments one or more locks may be provided at alternative ends or positions of the shaft with one or more conical surfaces to lock the piston in a retracted or extended position.

[0043] Preferably a first and second lock is provided with a first and second conical surface and a first and second collar. Advantageously such an arrangement allows the first lock to lock the assembly in an extended position, and the second lock provided to maintain the piston rod in a retracted position. Such an arrangement provides greater control and positioning of the lock in more than one locked position. For example, if the piston assembly is either locked in an extended or retracted position for extended lengths of time providing two locks reduces energy use by continuous actuation in either the extended or retracted position.

[0044] In any of the above embodiments the at least one collar can be replaced by a piston that is used to depress the spring loaded pin. The piston can be actuated using fluid supplied by pilot fluid orifice, or the piston can be actuated using a separate pilot fluid supply orifice.

[0045] Preferably a number of pistons can be provided equal to the number of locks.

[0046] In a further embodiment the invention relates to a double acting piston assembly with two automatic locking mechanisms comprising:

- a. a piston housing;
- b. a piston rod with a centreline;
- c. a first collar and a second collar;
- d. a first at least one lock with a first centreline and a second at least one lock with a second centreline;

wherein the piston rod has a first conical surface and a second conical surface;

the first conical surface being spaced apart from the second conical surface;

the piston housing containing the first lock at a first end of the piston housing and second lock at a second end of the piston housing;

the first collar being moveably disposed in the piston housing at the first end of the piston housing;

the second collar being moveably disposed in the piston housing at the second end of the piston housing;

the first centreline of the first at least one lock is at an angle from the centreline of the piston rod;

the second centreline of the second at least one lock is at an angle from the centreline of the piston rod;

wherein the first at least one lock is configured to engage the first conical surface in a first piston locked state, and the first at least one lock is configured to be spaced apart from the first conical surface in a first piston unlocked state; wherein the first collar is arranged to abut the first at least one lock and to move the first at least one lock from the first piston locked state to the first piston unlocked state when fluid pressure is applied to the first collar;

wherein the second at least one lock is configured to engage the second conical surface in a second piston locked state, and the second at least one lock is configured to be spaced apart from the second conical surface in a second piston unlocked state; and wherein the second collar is arranged to abut the second at least one lock and to move the second at least one lock from the second piston locked state to the piston unlocked state when fluid pressure is applied to the second collar.

[0047] In a further embodiment the piston assembly or lock may be a kit of parts, wherein the parts comprise any of the components in the previous embodiments. The kit of parts may further consist of one or more tools to fit, remove, clean, or otherwise maintain the components.

[0048] A second aspect of the invention relates to a method of actuating a piston assembly with an automatic locking mechanism comprising:

- a. a piston housing;

- b. a piston rod;
- c. at least one collar;
- d. at least one lock;

wherein the piston rod has at least one conical surface;
the piston housing containing the at least one lock;
the at least one collar being moveably disposed in the piston housing;
wherein the centreline of the at least one lock is at an angle from the centreline of the piston rod;
wherein the at least one lock is configured to engage the at least one conical surface in a piston locked state,
and the at least one lock is configured to be spaced apart from the at least one conical surface in a piston
unlocked state; and wherein the at least one collar is arranged to abut the at least one lock and to move the at
least one lock from the piston locked state to the piston unlocked state when fluid pressure is applied to the at
least one collar; and the steps of:

- e. supplying a pressurised fluid to the piston assembly;
- f. the pressurised fluid actuating the piston rod.

[0049] Advantageously the pilot fluid source can come from a plant source.

[0050] The piston assembly can be actuated to different degrees dependent up on the pressure of the pneumatic fluid.

[0051] A method of unlocking a piston assembly that is actuated as described above, wherein the method comprises the further steps of:

- a. moving the at least one collar to actuate the lock;
- b. disengaging the at least one lock from the at least one conical surface;
- c. unlocking the piston assembly.

[0052] Advantageously the method of actuating the piston using a pilot fluid requires only one pilot source of pilot fluid to unlock the at least one lock and actuate the piston rod.

[0053] A method of locking a piston assembly that is actuated as described above, wherein the method further comprises the steps of:

- a. stopping the supply of the pressurised fluid;
- b. engaging the at least one lock and the conical surface;
- c. locking the piston assembly.

BRIEF DESCRIPTION OF THE DRAWINGS

[0054] One or more embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a piston assembly with a piston lock according to an embodiment of the invention.
Figure 2 is a section view of the piston assembly of Figure 1 with the piston lock in a locked position.
Figure 3 is a section view of the piston assembly of Figure 1 with the piston lock in an unlocked position.
Figure 4 is a section view of the piston assembly of Figure 1 with the piston lock in the unlocked and the piston rod is in a partially retracted position.
Figure 5 is a section view of the piston assembly of Figure 1 with the piston lock in the unlocked and the piston rod is in a further partially retracted position.
Figure 6 is an isometric view of the piston assembly of Figure 1 with the piston lock in the locked position.
Figure 7 is a section view of the piston assembly of Figure 1 with the piston lock in a locked position.
Figures 8a, 8b, 8c and 8d show alternative views of a double acting piston with a piston lock according to a second aspect of the invention.
Figure 9 is a section view of the piston assembly of Figure 8a with the piston rod retracted and locked in place.
Figure 10 is a section view of the piston of Figure 8a with the piston rod extended and locked in place.
Figure 11 is a section view of the piston of Figure 8a with the piston rod extended and the piston lock in an unlocked position.
Figure 12 is a section view of the piston of Figure 8a with the piston rod partially retracted and the piston lock in an unlocked position.
Figure 13 is a section view of the piston of Figure 8a with the piston rod further partially retracted and the piston

lock in an unlocked position.

Figure 14 is a section view of the piston of Figure 8a with the piston rod retracting and returning to a fully extended and locked state.

5 DETAILED DESCRIPTION

[0055] Figure 1 shows an isometric view of a piston assembly 10 with an automatic locking mechanism with: a piston rod 14; a piston housing 20 comprising a cap 21 and a cover 22; at least one lock 24; and at least one pilot fluid supply orifice 12 (also known as the pilot fluid supply port 12).

10 **[0056]** The piston cap 21 and cover 22 are two separate components which are fixed together using known means to form the piston housing 20.

[0057] The piston housing 20 contains the lock 24. The lock is contained in the piston cap 21.

[0058] The piston cap 21 defines an internal chamber (or volume or space) 23.

[0059] The piston cover 22 defines an internal chamber (or volume or space) 25.

15 **[0060]** The piston rod 14 is a cylindrical rod which is slidably received within the housing 20. In alternative embodiments the piston rod 14 may be a shape other than circular in cross-section, for example, the piston rod may be made of a hexagonal bar.

[0061] The at least one pilot fluid supply orifice 12 is located in the piston cap 21. The orifice 12 is suitably sized to connect, using known means, to a supply of pressurised fluid (e.g. hydraulic, pneumatic, compressed air, other or other suitable pilot fluid). The orifice 12 is fluidly connected to the internal chamber 23 of the piston housing 20, this will be described in more detail below with reference to Figure 2. The pilot fluid supply orifice 12 is advantageously able to actuate both the at least one lock 24 and the piston rod 14.

[0062] In the embodiment shown in Figure 1, a connector 16 is disposed on the piston rod 14 at one end. The connector 16 is fixed to the piston rod 14 in a known manner. The connector 16 has a through hole (or an aperture) suitably sized to receive a bolt or other fixing arrangement of a tool, apparatus or device. The connector 16 can be used to attach tools or other items to the piston rod 14. In alternative embodiments the piston rod 14 may attach directly to tools using a suitable fitting known in the art, or may comprise other suitable attaching arrangements known in the art.

[0063] In the embodiment shown in Figure 1, a connector 18 is disposed on one end of the piston housing 20 on the piston cover 22 facing away from the connector 18. The connector 18 is connected to the piston cover 22 in a known manner. The connector 18 has a through hole or an aperture suitably sized to receive a bolt or other fixing arrangement to fix the piston assembly 10. In alternative embodiments the connector 18 could be located on the piston cover 22. In alternative embodiments the connector 18 may be any suitable attachment arrangement known in the art.

[0064] The piston housing 20 has a bearing 28 (or guide) which guides the piston rod 14. The bearing is disposed in the piston cap 21 around the piston rod. The bearing 28 helps to guide the piston rod 14 when it extends and retracts. 35 The bearing 28 may be a plane bearing or roller bearing, or another suitable type of bearing known in the art.

[0065] With reference to Figures 2, 6 and 7 the piston assembly 10 and at least one locking mechanism 24 will be described in more detail.

[0066] The piston assembly 10 with an automatic locking mechanism comprises: the piston housing 20; the piston rod 14, the piston rod 14 having a centreline AA and at least one conical surface 30; a biasing means 26; at least one collar 40; the at least one lock 24, the at least one lock 24 having a centreline BB; and an angle θ .

[0067] The at least one conical surface 30, biasing means 26, collar and at least one lock 24 are located within the piston housing 20.

[0068] The central axis or centreline AA is along the major length of the piston assembly 10 and the piston rod 14. The centreline AA is approximately located on the point of radial symmetry of the piston rod 14. The piston rod 14 moves along the centreline AA when the piston assembly 10 is unlocked and the piston rod 14 is actuated.

[0069] The lock 24 is located in the housing 20, specifically in the piston cap 21. In alternative embodiments the lock 24 can be located in the piston cover 22.

[0070] The lock 24 comprises a pin 32, a spring 34 and a bore 36. The bore 36 has an axis BB located along its centreline. The combination of pin 32 and spring 34 are alternatively known as a spring loaded pin 32. The spring loaded pin 32 is located in the bore 36 so that the spring 34 is at the located at the blind end of the bore 36 and the pin 32 is located at the open end of the bore 36.

[0071] The open end of the bore 36 faces the piston head 44. In alternative embodiments the bore 36 may face away from the piston head 44 as shown in Figure 6. The bore 36 may be a blind bore.

[0072] The bore 36 is radially offset from the centreline AA. The bore centreline BB is disposed at the angle θ to the centreline AA of the piston rod 14.

[0073] The locking mechanism of the piston assembly 10 comprises five locks 24 spaced approximately equidistantly around the piston rod 14 in the piston cap 21, as shown in Figure 7. In alternative embodiments the number of locks may be at least one, or two, or three, or four, or six, or seven, or eight, or nine, or any number greater than nine.

[0074] An odd number of locks 24 disposed around the piston rod 14 aid in aligning the piston rod 14 in the piston housing 22. The odd number of locks 24 help to guide the piston rod 14 and retain its alignment when the piston rod 14 is actuated in use.

[0075] The centreline BB of the bore 36 is the same as the axis or centreline of the spring loaded pin 32. The centreline BB of the bore 36 is the centreline of the lock 24 and spring loaded pin 32. In alternative embodiments the central axis or centreline of the spring loaded pin 32 and bore 36 may be different.

[0076] The spring 34 of the spring loaded pin 32 is biased to an extended state. Depressing the pin 32 causes the spring 34 to compress. The movement of the spring loaded pin 32 is approximately along the centreline BB.

[0077] The piston rod 14 has a piston head 44 disposed on one end of the piston rod 14 such that the piston rod 14 extends away from the piston head 44. The piston head 44 is disposed within the piston housing 20. The piston head 44 fluidly separates the piston cap 21 chamber 23 and the piston cover 22 chamber 25. The piston head 44 has one or more O-rings 46 disposed around the piston head.

[0078] As shown in Figure 1 the piston head abuts a wall of the piston cap 21 when the piston assembly is in the locked position. The piston head 44 is connected to the piston rod 14 by a known means, such as an interference fit, spline, screw, welding, or other suitable arrangement.

[0079] The piston rod 14 and conical surface 30 of the piston rod 14 will be described here in more detail. The at least one conical surface 30 is located on the piston shaft 14. The at least one conical surface 30 is complementary to the surface of the pin 32. The at least one conical surface 30 is frustoconical. In cross-section (as shown in Figure 2) the surface of the at least one conical surface 30 is described by line CC. Line CC is approximately parallel to the centreline BB of the lock 24.

[0080] The at least one conical surface 30 and line BB is at an angle φ to the centreline AA. The angle φ is approximately parallel to the angle θ of the lock 24.

[0081] The angles (θ , φ) are both between 1-45 degrees, preferably the angles (θ , φ) are both between 5-30 degrees, more preferably the angles (θ , φ) are both between 7-15 degrees, more preferably still the angles (θ , φ) are both between 8-12 degrees, and most preferably the angles (θ , φ) are both 10 degrees.

[0082] When the piston assembly 10 is in a piston locked state (as shown in Figure 2) the pin 32 and conical surface 30 abut. When the piston assembly 10 is in a piston unlocked state the pin 32 and the at least one conical surface 30 do not abut (as will be described in more detail below).

[0083] The piston rod 14 has a piston stop 50. The piston stop 50 is disposed adjacent to the at least one conical surface 30. The piston stop 50 and conical surface 30 meet at ridge 31 shown in Figure 2. The piston stop 50 is frustoconical.

[0084] The piston cap 21 has a wall 52. The wall 52 is complementary to the piston stop 50. The wall 52 prevents the piston rod 14 from extending further out of the housing 20 by abutting the piston stop 50.

[0085] The at least one collar 40 is annular and receives the piston rod 14 through an annular aperture. The annular aperture has a greater diameter than the conical surface 30 of the piston rod 14 (Figure 4 shows the conical surface 30 in the annular aperture). The at least one collar 40 is moveably disposed on the piston rod 14. The at least one collar 40 moves along the centreline AA of the piston assembly 10 between a first position (in Figure 2) and second position (shown in Figure 3).

[0086] The at least one collar 40 has an annular extension 41. The annular extension 41 has an external diameter smaller than main body of the at least one collar 40. The internal diameter of the annular extension is the same as the annular aperture of the at least one collar 40. The extension 41 abuts the end of the pin 32 as shown in Figure 2 and Figure 6.

[0087] Between the at least one collar 40 and the piston head 44 is disposed a piston disc 42. The piston disc 42 is received in the wall of the piston housing 20. The piston disc 42 is annular and slidably receives the piston rod 14. As shown in Figure 1 the at least one collar 40 abuts the piston disc 42 in the first position. The piston disc 42 prevents the at least one collar 40 from moving into the internal space of the piston housing 20 in the piston cover 22.

[0088] The at least one collar 40 has an O-ring 47 disposed around the at least one collar 40 body. The O-ring 47 prevents fluid communication between the lock 24 and the chamber 23 of the assembly.

[0089] The piston disc 42 has a plurality of apertures which fluidly connect the at least one collar 40 to the pilot fluid supply orifice 12.

[0090] The biasing means 26 is connected to the piston rod 14 at the piston head 44. The biasing means 26 may be fixed to the piston head 44, or abut against the head 44. The biasing means 26 is a spring. The biasing means 26 is a coiled spring but may be any known spring or other suitable device known in the art.

[0091] The biasing means 26 is biased to extend the spring 26 into an extended position, as shown in Figure 2, thus extending the piston rod 14. In alternative embodiments the spring can be biased to retract the piston rod 14.

[0092] The unlocking, actuating and locking of the piston assembly 10 will be described here in further details with reference to Figures 2-5.

[0093] In use, a pressurised fluid is supplied to the piston assembly 10 via the pilot fluid supply orifice 12. The fluid supply orifice 12 is fluidly connected to the inner chamber 23 (or volume 23) of the piston housing 20, the at least one

collar 40 and the piston head 44.

[0094] The pressurised fluid acts on the at least one collar 40 moving the at least one collar 40 from the first position shown in Figure 2 to the second position shown in Figure 3 under the force of the pressurised fluid acting on the at least one collar 40.

[0095] As the at least one collar 40 moves under the force of the pressurised fluid to the second position, the at least one collar extension 41 that abuts the pin 32 pushes the pin 32 disengaging it from the at least one conical surface 30 of the piston rod 14. At the same time the at least one collar extension 41 compresses the spring 34 of the lock 24.

[0096] In the second position the lock 24 is disengaged from the at least one conical surface 30 and thus the piston rod 14. In this position the piston assembly 10 is unlocked as shown in Figure 3. The piston rod 14 is able to be actuated when the lock 24 is unlocked.

[0097] To actuate the piston rod 14 fluid pressure is maintained from the pilot fluid source through the pilot fluid supply orifice 12. The fluid pressure in the chamber 23 acts on the piston head 44 on the side connected to the piston rod 14. The fluid pressure forces the piston head 44 to move overcoming the spring force of the biasing means 26. The fluid pressure force acts antiparallel to the spring force of spring 26 along centreline AA. The piston head 44 and piston rod 14 move along the axis AA under the pneumatic pressure force. The piston rod 14 retracts into the piston housing 20 as shown in Figure 4. Figure 4 shows the partial retraction of the piston rod 14 into the piston housing 20. The magnitude of the retraction of the piston rod 14 is dependent upon a number of factors, for example (but not limited to): the spring force of the biasing means 26; the pilot fluid pressure; and the time pilot fluid is supplied to the piston assembly 10.

[0098] During actuation of the piston assembly 10 the lock 24 remains disengaged and unlocked from the at least one conical surface 30. During actuation, as fluid pressure is maintained, the at least one collar 40 remains in the second position and continues to depress the spring 34 and thus the spring loaded pin 32 as shown in Figure 4.

[0099] To lock the piston assembly 10 pilot fluid flow rate is stopped or the pilot fluid pressure is reduced. The piston assembly 10 returning to the piston locked state is shown in Figure 5.

[0100] When the pilot fluid supply is stopped there is no fluid pressure forcing the at least one collar 40 to compress the spring 34 of the spring loaded pin 32. When the fluid pressure is removed the spring 34 and the spring loaded pin 32 return to their unactuated state. The extension of the spring 34 of the at least one lock 24 pushes the at least one collar 40 back to the collar's 40 first position as shown in Figure 5. The at least one collar 40 abuts the piston disc 42.

[0101] The spring 26 then returns to its uncompressed state as there is no force acting to compress the spring 26 as the pneumatic pressure force acting on the piston head 44 is removed. This in turn causes the piston head 44 and piston rod 14 to return to the unactuated position as shown in Figure 2. The spring 26 returning to its uncompressed state pushes the piston rod 14 such that it extends out of the housing 20.

[0102] As the piston rod 14 returns to its extended and locked position (shown in Figures 1 and 2) the at least one conical surface 40 engages with the pin 32. The conical surface depresses the pin 32 and the spring 34 into the bore hole 36. The at least one conical surface 30 and piston rod 14 continues to slide past the spring loaded pin 32 until the ridge 31 of the at least one conical surface 30 is reached, after the ridge 31 (which is the widest point of the at least one conical surface) the spring loaded pin 32 is no longer compressed by the at least one conical surface 30. The spring loaded pin returns to its unactuated position as shown in Figure 2.

[0103] The piston rod 14 is prevented from extending any further by the internal wall 52 of the housing 20 which abuts the ridge of the at least one conical surface 30. The piston head 44 abuts the piston stop 50 shown in Figure 1. The piston stop 50 prevents the piston head 44 and piston rod 14 from extending further out of the housing.

[0104] In this position the piston assembly 10 is locked and cannot move. The piston rod 14 cannot extend further due to the wall 52 and the piston head 44 cannot move due to the piston stop 50. Pushing the piston rod at connector 16 (shown in Figure 1) will cause the spring loaded pin 32 to engage further with the at least one conical surface 30 of the piston rod 14. The at least one conical surface 30 abutting the spring loaded pin 32 prevents the piston rod 14 from retracting.

[0105] In an alternative embodiment a further pilot fluid supply orifice 13 may be provided. The pilot fluid supply orifice is located in the cap 21 or cover 22 of the housing 20. The pilot fluid supply orifice 13 is fluidly connected to the at least one collar 40. Supplying a pilot fluid through the pilot fluid supply orifice 13 causes the at least one collar 40 to move from a first position to a second position. In this embodiment the at least one collar 40 is not fluidly connected to the pilot fluid supply orifice 12. The piston disc 42 may not have holes in it so that the at least one collar 40 is not connected to the chamber 23 of the assembly 10. In this embodiment the piston rod 14 is actuated by supplying pressurised fluid through the pilot fluid supply orifice 12, and the at least one collar 40 and lock 24 are separately actuated using pressurised fluid supplied through the pilot fluid supply orifice 13.

[0106] In alternative embodiments the spring 26 may be located on the other side of the piston head 44 or alternatively the spring may bias the piston rod 14 into the retracted position. Alternatively, no spring 26 may be provided. In such an embodiment the piston rod 14 may return to its unactuated and locked position under its own weight once fluid pressure is removed. Such an embodiment advantageously returns the assembly 10 to the assembly's locked position automatically.

[0107] The pilot fluid supply port 12 may be disposed in the piston cover 22. In alternative embodiments a first pilot fluid supply port 12 and a second fluid supply port may be provided in the housing 20. The first fluid supply port 12 in the piston cap 21 and the second pilot fluid supply port in the cover 22.

[0108] In an alternative embodiment the at least one collar 40 can be replaced by a piston 201 that is used to depress the spring loaded pin 32. The piston can be actuated using fluid supplied by pilot fluid orifice 9, or the piston can be actuated using a separate pilot fluid supply orifice 9. A number of pistons 201 can be provided equal to the number of locks 24. Or, conversely a piston 201 could actuate one or more locks simultaneously, for example a single piston 201 could actuate one, or two, or three, or four, or five, or six, or seven, or eight, or nine, or any plurality of locks 24. Any combination of pistons 201 could be provided to actuate any number of locks 24, for example with a five lock 24 assembly two pistons 201 could be provided, one piston 201 suitable for actuating two locks 24 and the second piston 201 suitable for actuating three locks.

[0109] In a further aspect of the invention, there is provided a double actuating piston 110 in Figures 8-14. Features of the double actuating piston 110 which are common with the piston assembly 10 are prefixed by 100. Features of the piston assembly 110 located on the side of the piston head 144 towards the cap 121 are suffixed 'a', features located on the other side of the piston head 144 towards the piston cover 122 are suffixed 'b'.

[0110] Figures 8a-8d show an alternative view of the double acting piston 110. The double acting piston 110 has two pilot fluid supply orifices a first fluid supply port 112a and a second fluid supply port 112b.

[0111] The piston head 144 has a first conical surface 130a disposed on the side of the head facing the piston cover 122 and a second conical surface 130b disposed on the piston rod 114 in a fashion similar to the embodiment disclosed above.

[0112] The piston assembly has two sets of locks first at least one lock 124a and second at least one lock 124b. The second lock 124b has a number of locks and is disposed in the piston housing 120 in a fashion similar to the embodiment disclosed above. The first lock 124a is similar to the second lock 124b and is in effect a reflection or mirror image of the second lock 124b provided at the opposite end of the piston 110.

[0113] The first lock 124a is disposed in the piston cover 122. The first lock 124a is positioned in the cover 122 to interact with the first conical surface 130a as shown in Figure 9. The first lock 124a is positioned so that the end of the spring loaded pins 132a face towards the piston cap 121 end of the piston 110.

[0114] The first and second locks 124a 124b interact with the first and second conical surfaces 130a 130b in a fashion similar to that disclosed above.

[0115] The first fluid supply port 112a is operationally configured to unlock the first lock 124a by moving a first collar 140a in a manner similar to that disclosed above.

[0116] The second fluid supply port 112b is operationally configured to unlock the first lock 124b by moving a first collar 140b in a manner similar to that disclosed above.

[0117] Figure 9 shows the piston assembly 110 in a fully retracted and locked position. The piston assembly 110 is locked into a retracted position using first lock 124a.

[0118] The operation of the piston assembly 110 will be described with reference to Figures 9-14. The operation of the piston assembly 110 is similar to that described above with reference to Figures 2-6.

[0119] Figure 10 shows the piston assembly 110 in the fully extended and locked position. The second lock 124b is engaging with the second conical surface 130b of the piston rod 114. The interaction between lock 124b and conical surface 130b prevents the lock from retracting.

[0120] In the fully extended position the piston head 144 abuts the housing wall 152b preventing the piston rod 114 from extending further out of the housing 120.

[0121] To unlock the piston assembly 110 pressurised fluid is supplied to lock 124b via fluid supply port 112b. The pressurised fluid acts on the at least one collar 140b moving it from the position shown in Figure 10 to the position in Figure 11. The movement of the at least one collar 140b causes the spring loaded pin 132b (which the at least one collar 140b abuts) to move and disengage from the second conical surface 130b. The piston assembly 110 is now unlocked and the piston rod 114 can move.

[0122] To actuate the piston rod 114 fluid pressure is maintained from the pilot fluid source through the pilot fluid supply orifice 112b. The fluid pressure in the chamber 123 acts on the piston head 144 on the side connected to the piston rod 114. The fluid pressure forces the piston head 144 to move towards the piston cover 122. The piston head 144 and piston rod 114 move along the axis AA under the pneumatic pressure force. The piston rod 114 retracts into the piston housing 120 as shown in Figure 12 and 13. Figure 12 shows the partial retraction of the piston rod 114 into the piston housing 120. Figure 13 shows the further partial retraction of the piston rod 114 into the piston housing 120. The magnitude of the retraction of the piston rod 114 is dependent upon a number of factors, for example (but not limited to): the pilot fluid pressure; and the time pilot fluid is supplied to the piston assembly 110.

[0123] During actuation of the piston assembly 10 the lock 24 remains disengaged and unlocked from the at least one conical surface 30. During actuation, as fluid pressure is maintained, the at least one collar 140a remains in the second position and continues to depress the spring 134a and thus the spring loaded pin 132 as shown in Figure 12 and 13.

[0124] If fluid pressure is maintained through fluid supply port 112b then the piston rod 114 will fully retract and lock in place as the first conical surface 130a engages the lock 124a as shown in Figure 9. In this position the piston 110 is locked in a piston rod 114 fully retracted state. The first lock 124a is engaged in a similar manner as in the description of the embodiment above.

[0125] To move unlock the piston assembly 110 from the fully retracted position and move it back to towards the fully extended position the same process is undertaken, but in this instance supplying pressurised fluid via the fluid supply port 112a. Supplying pressurised fluid through port 112a disengages the first lock 124a from the first conical surface 130a and causes the piston head 144 to move under pneumatic pressure acting on the head 144 causing the piston rod 114 to extend. Figure 14 shows the piston rod 114 in the partially extended position.

[0126] If fluid pressure is maintained through fluid supply port 112a then the piston rod 114 will fully retract and lock in place as the first conical surface 130b engages the lock 124b in a similar fashion as described above. In this position the piston 110 is locked in fully retracted state. The first lock 124a is engaged in a similar manner as in the description of the embodiment above.

Reference:	Description:
θ	Angle between centreline of the piston rod (AA) to centreline of the spring loaded pin (BB)
φ	Angle between the conical surface (CC) and centreline of the piston rod (AA)
AA	Centreline of the piston rod (14)
BB	Centreline of the spring loaded pin (BB)
CC	Line of conical surface
10, 100	Piston
12, 112a, 112b	Pilot fluid supply orifice
13, 113	Further pilot fluid supply orifice
14, 114	Piston rod
16, 116	connector
18, 118	connector
20, 120	Piston housing
21, 121	Cap
22, 122	Piston cover
23, 123	Chamber / volume
24, 124a, 124b	Lock
25, 125	Cover chamber / cover chamber
26, 126	Spring
28, 128	Bearing
30, 130a, 130b	Conical surface
31, 131a, 131b	Ridge
32, 132a, 132b	Spring loaded pin
34, 134a, 134b	Spring
36, 136a, 136b	Bore
40, 140a, 140b	Collar
41, 141a, 141b	extension
42, 142a, 142b	Piston disk
44, 144	Piston head
46, 146	O-ring
47, 147a, 147b	O-ring
48, 148a, 148b	O-ring
50, 150a, 150b	Piston stop
52, 152a, 152b	Wall

Claims

1. A piston assembly (10) with an automatic locking mechanism comprising:

- a piston housing (20);
- a piston rod (14) with a centreline (AA);
- at least one collar (40);
- at least one lock (24) with a centreline (BB);

wherein the piston rod (14) has at least one conical surface (30);
 the piston housing (20) containing the at least one lock (24);
 the at least one collar (40) being moveably disposed in the piston housing (20); wherein the centreline (BB)
 of the at least one lock (24) is at an angle (θ) from the centreline (AA) of the piston rod (14);
 wherein the at least one lock (24) is configured to engage the at least one conical surface (30) in a piston
 locked state, and the at least one lock (24) is configured to be spaced apart from the at least one conical
 surface (30) in a piston unlocked state; and wherein the at least one collar (40) is arranged to abut the at
 least one lock (24) and to move the at least one lock (24) from the piston locked state to the piston unlocked
 state when fluid pressure is applied to the at least one collar (40).

2. The piston assembly (10) of claim 1, wherein the piston assembly (10) further comprises a biasing means (26); the
 biasing means (26) being connected to the piston rod (14); and wherein the biasing means (26) is adapted to return
 the piston assembly (10) to the piston locked state when the fluid pressure applied to the at least one collar (40) is
 released.
3. The piston assembly (10) of claim 1, wherein the at least one conical surface (30) of the piston rod (14) is at an
 angle (φ) from the centreline (AA) of the piston rod (14).
4. The piston assembly (10) of claim 3, wherein the angle (θ) and angle (φ) are approximately the same.
5. The piston assembly (10) of claim 3 or 4, wherein the angles (θ , φ) are both between 1-45 degrees, preferably the
 angles (θ , φ) are both between 5-30 degrees, more preferably the angles (θ , φ) are both between 7-15 degrees,
 more preferably still the angles (θ , φ) are both between 8-12 degrees, and most preferably the angles (θ , φ) are
 both 10 degrees.
6. The piston assembly (10) of claim 1, wherein each of the at least one lock (24) comprises a pin (32) and a biasing
 means (34).
7. The piston assembly (10) of any previous claim, wherein the at least one lock (24) is located in the piston housing
 (20) radially outwards from the piston rod (14) centreline (AA) in at least one bore (36).
8. The piston assembly (10) of claim 1, wherein the at least one lock (24) comprises a plurality of locks (24); and
 preferably wherein the number of plurality of locks (24) is uneven; preferably wherein the plurality of locks (24)
 comprises three locks (24) or five locks (24) or seven locks (24); and more preferably wherein the plurality of locks
 (24) are disposed equidistantly around the circumference of the piston housing (20).
9. The piston assembly (10) of claim 1, wherein the piston housing (20) comprises a piston cap (21) and a piston
 casing (22), wherein the piston cap (21) and piston casing (22) are separable; and wherein the piston housing (20)
 comprises at least one pilot fluid port (12) disposed in the piston cap (21) or piston cover (22), wherein the at least
 one pilot fluid port (12) is fluidly connected to the at least one collar (40) and wherein the at least one pilot fluid port
 (12) is adapted to supply pressurised fluid.
10. The piston assembly (10) of claim 1, wherein the piston rod (14) is adapted to move under the effect of the pressurised
 fluid when the piston assembly (10) is in the unlocked state.
11. The piston assembly (10) of any preceding claim, wherein the piston assembly (10) is a double acting piston assembly.
12. A double acting piston assembly (110) with two automatic locking mechanisms comprising:
 - a piston housing (120);
 - a piston rod (114) with a centreline (AA);
 - a first collar (140a) and a second collar (140b);
 - a first at least one lock (124a) with a first centreline (BB) and a second at least one lock (124b) with a second

centreline (BB);

wherein the piston rod (114) has a first conical surface (130a) and a second conical surface (130b);
 the first conical surface (130a) being spaced apart from the second conical surface (130b);
 the piston housing (120) containing the first lock (124a) at a first end of the piston housing (120) and second
 lock (124b) at a second end of the piston housing (120);
 the first collar (140a) being moveably disposed in the piston housing (120) at the first end of the piston
 housing (120);
 the second collar (140a) being moveably disposed in the piston housing (120) at the second end of the
 piston housing (120);
 the first centreline (BB) of the first at least one lock (124a) is at an angle (θ) from the centreline (AA) of the
 piston rod (114);
 the second centreline (BB) of the second at least one lock (124b) is at an angle (θ) from the centreline (AA)
 of the piston rod (114);
 wherein the first at least one lock (124a) is configured to engage the first conical surface (130a) in a first
 piston locked state, and the first at least one lock (124a) is configured to be spaced apart from the first
 conical surface (130a) in a first piston unlocked state; wherein the first collar (140a) is arranged to abut the
 first at least one lock (124a) and to move the first at least one lock (124a) from the first piston locked state
 to the first piston unlocked state when fluid pressure is applied to the first collar (140a);
 wherein the second at least one lock (124b) is configured to engage the second conical surface (130b) in
 a second piston locked state, and the second at least one lock (124b) is configured to be spaced apart from
 the second conical surface (130b) in a second piston unlocked state; and wherein the second collar (140b)
 is arranged to abut the second at least one lock (124b) and to move the second at least one lock (124b)
 from the second piston locked state to the piston unlocked state when fluid pressure is applied to the second
 collar (140b).

13. A method of actuating a piston assembly (10) with an automatic locking mechanism comprising:

- a piston housing (20);
- a piston rod (14) with a centreline (AA);
- at least one collar (40);
- at least one lock (24) with a centreline (BB);

wherein the piston rod (14) has at least one conical surface (30);
 the piston housing (20) containing the at least one lock (24);
 the at least one collar (40) being moveably disposed in the piston housing (20);
 wherein the centreline (BB) of the at least one lock (24) is at an angle (θ) from the centreline (AA) of the
 piston rod (14);
 wherein the at least one lock (24) is configured to engage the at least one conical surface (30) in a piston
 locked state, and the at least one lock (24) is configured to be spaced apart from the at least one conical
 surface (30) in a piston unlocked state; and wherein the at least one collar (40) is arranged to abut the at
 least one lock (24) and to move the at least one lock (24) from the piston locked state to the piston unlocked
 state when fluid pressure is applied to the at least one collar (40); and the steps of:

- supplying a pressurised fluid to the piston assembly (10); and
- the pressurised fluid actuating the piston rod (14).

14. A method of unlocking a piston assembly (10) of claim 13, wherein the method comprises the further steps of:

- moving the at least one collar (40) to actuate the at least one lock (24);
- disengaging the at least one lock (24) from the at least one conical surface (30); and
- unlocking the piston assembly (10).

15. A method of locking a piston assembly (10) of claim 13, wherein the method further comprises the steps of:

- stopping the supply of the pressurised fluid;
- engaging the at least one lock (24) and the at least one conical surface (30); and locking the piston assembly (10).

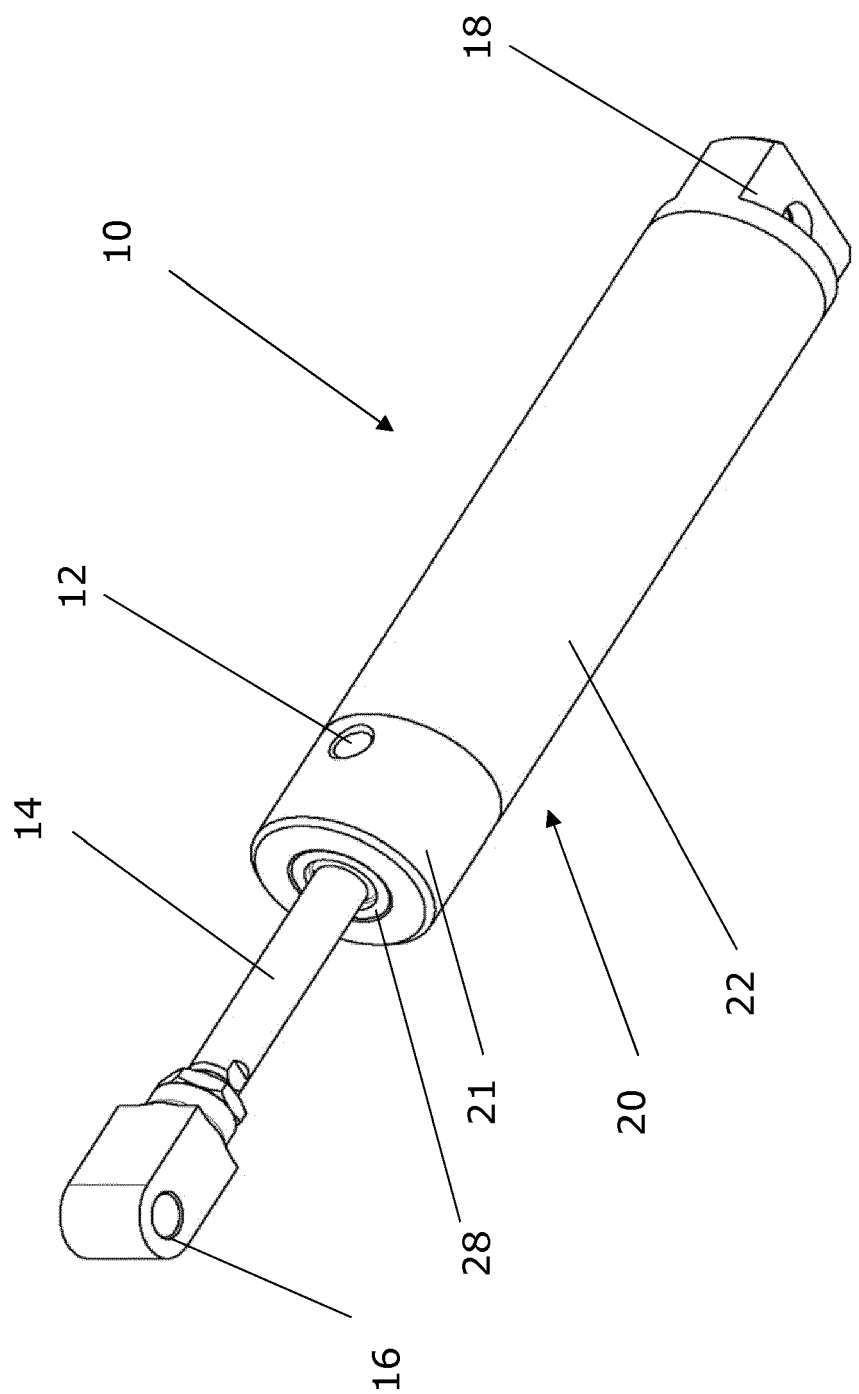
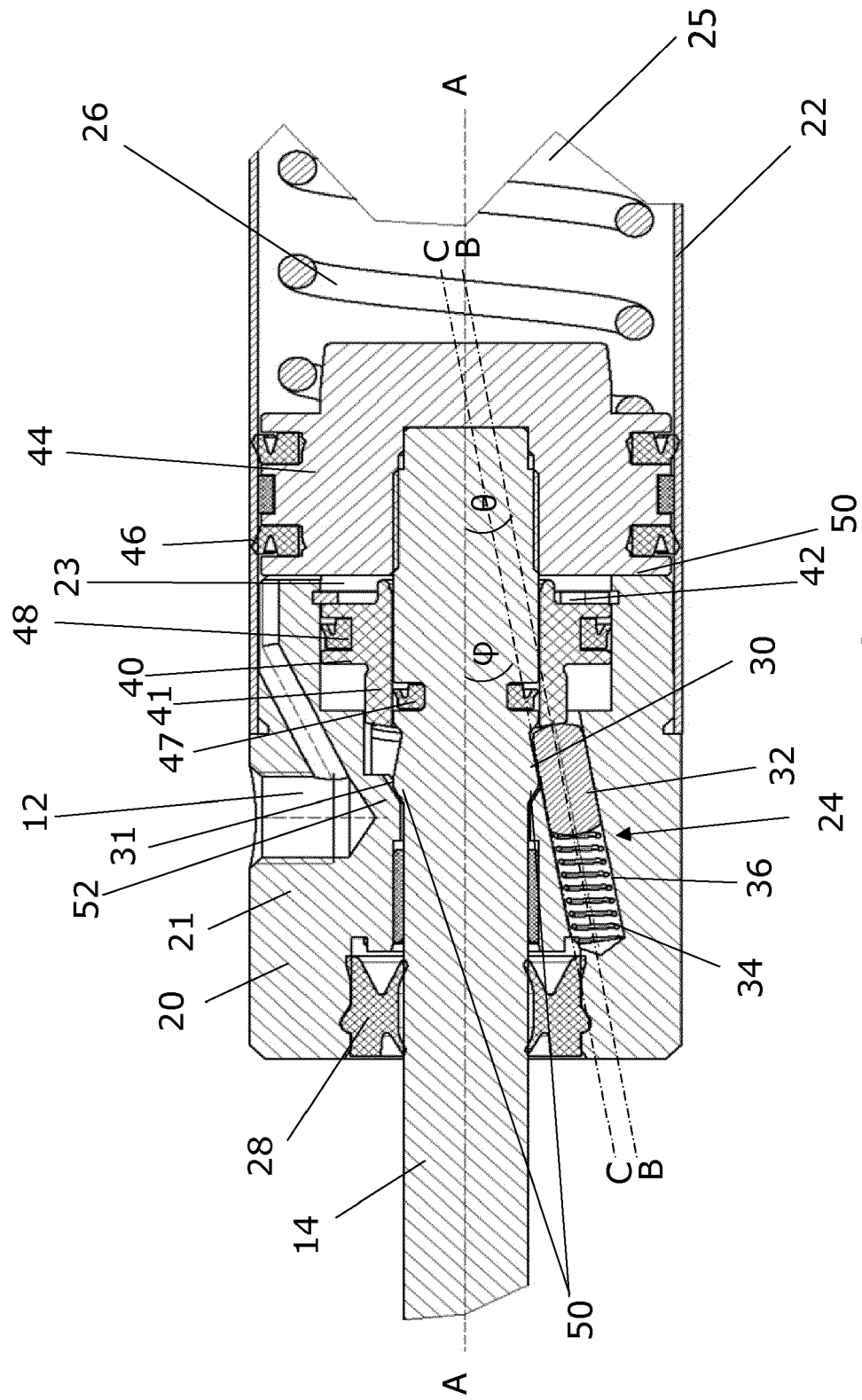


Figure 1



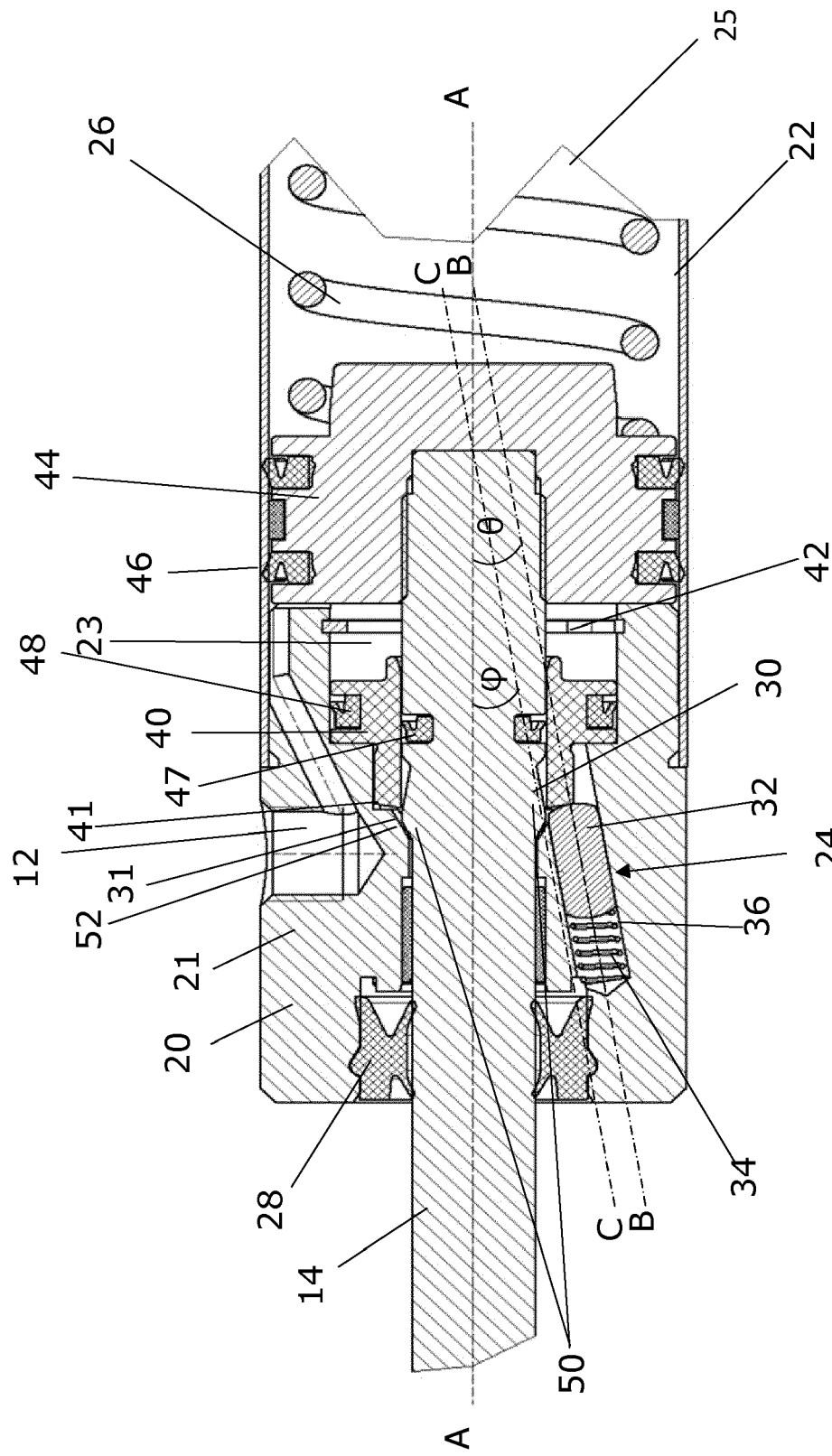


Figure 3

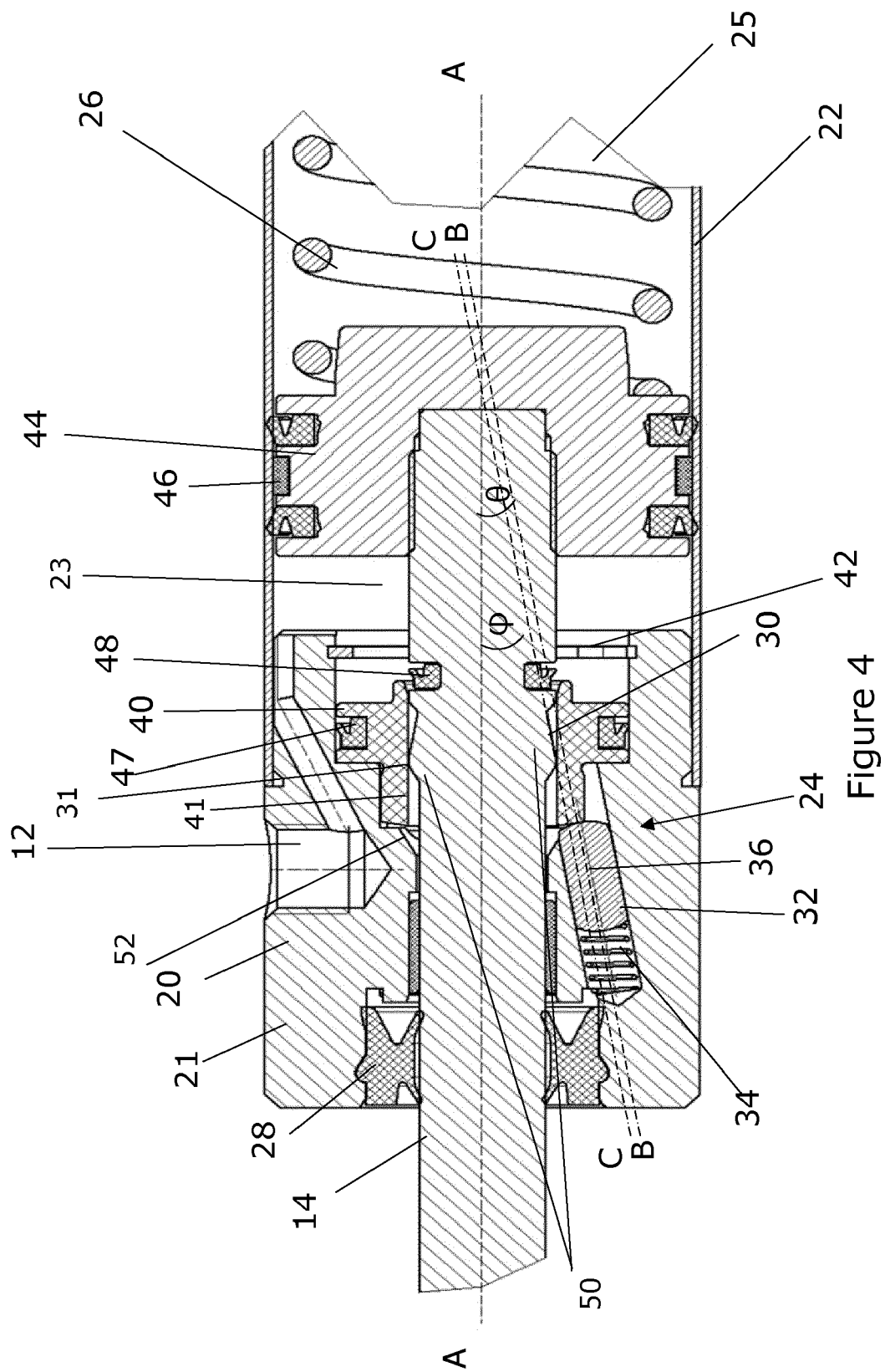


Figure 4

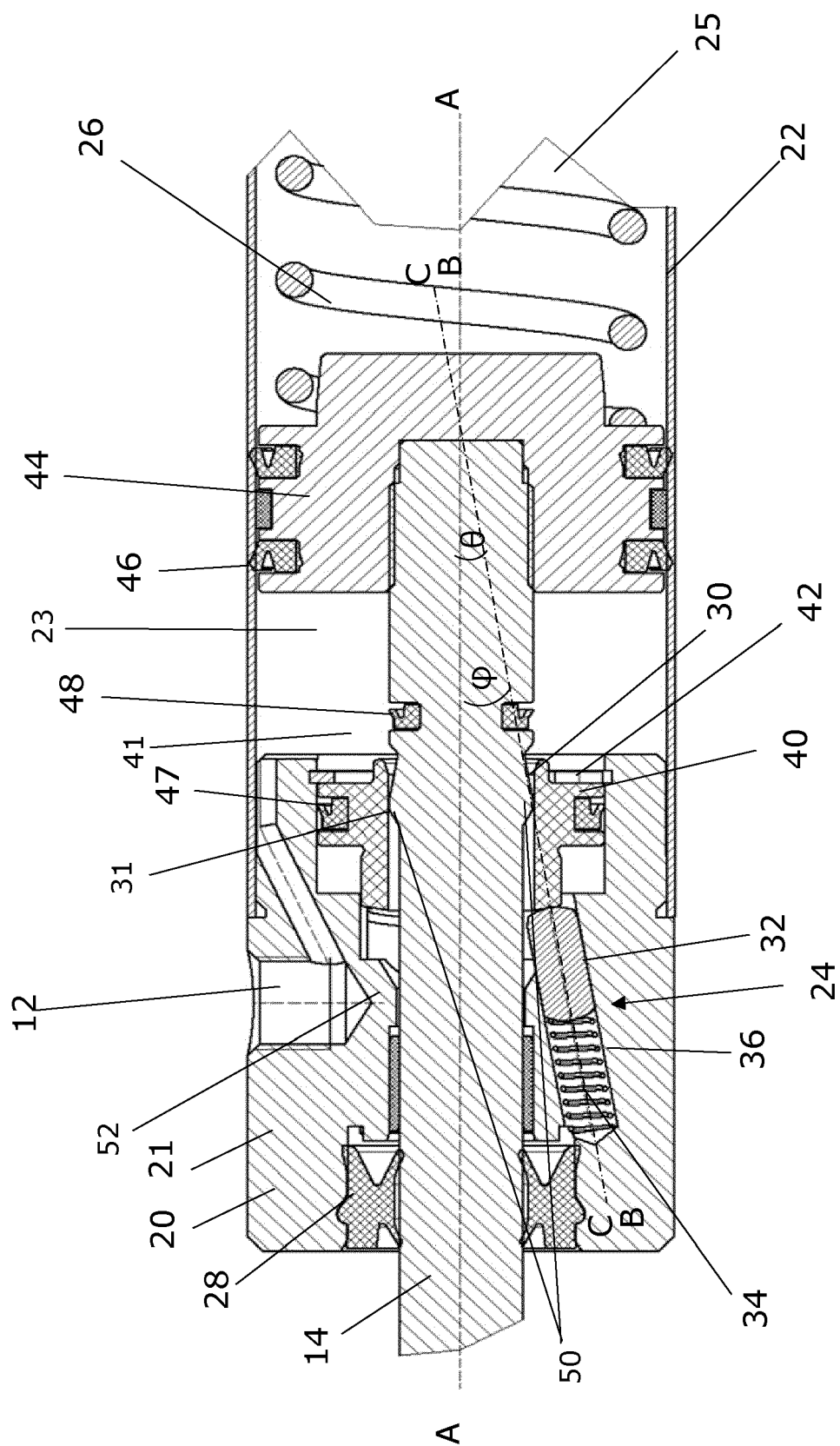


Figure 5

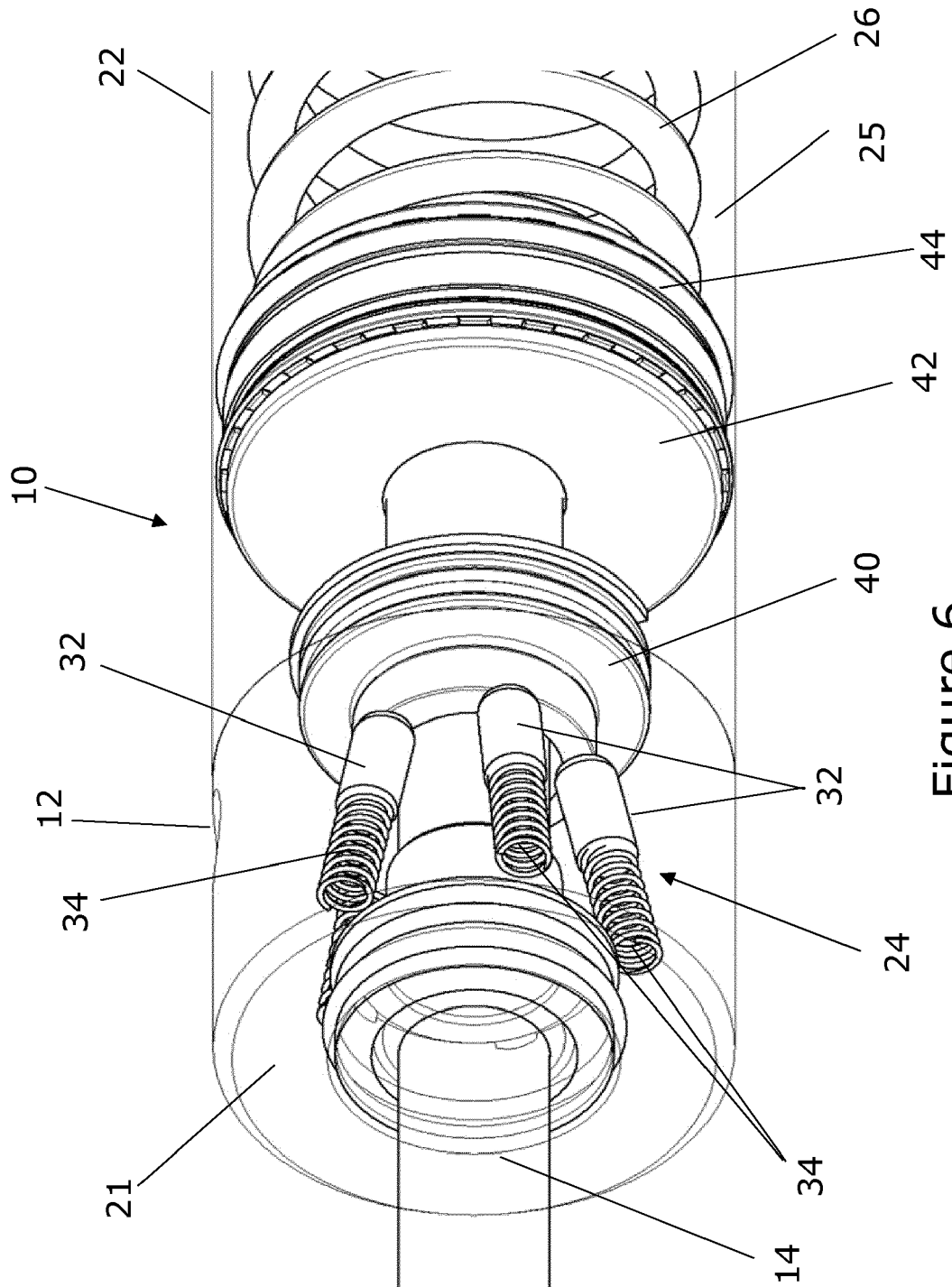


Figure 6

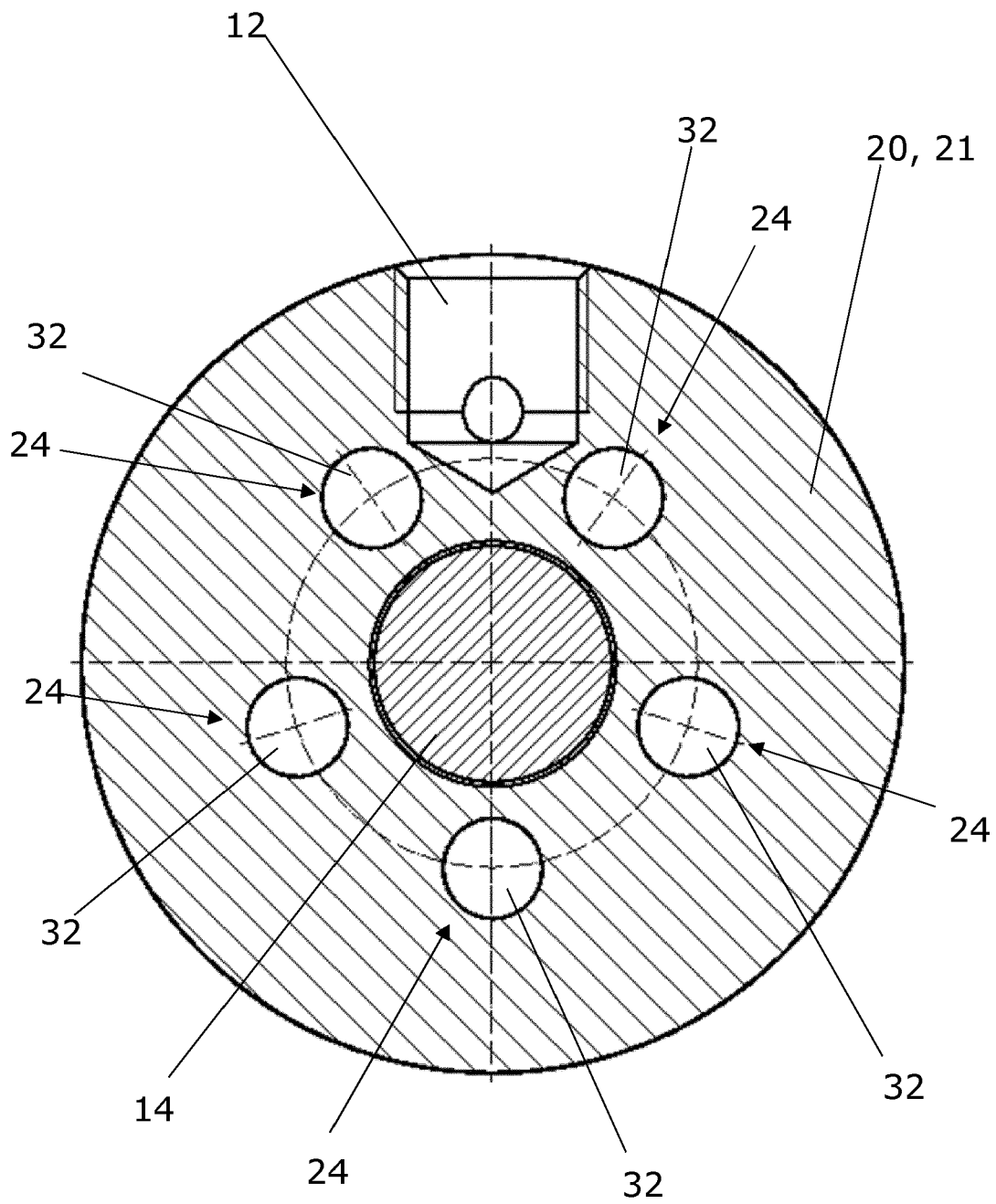


Figure 7

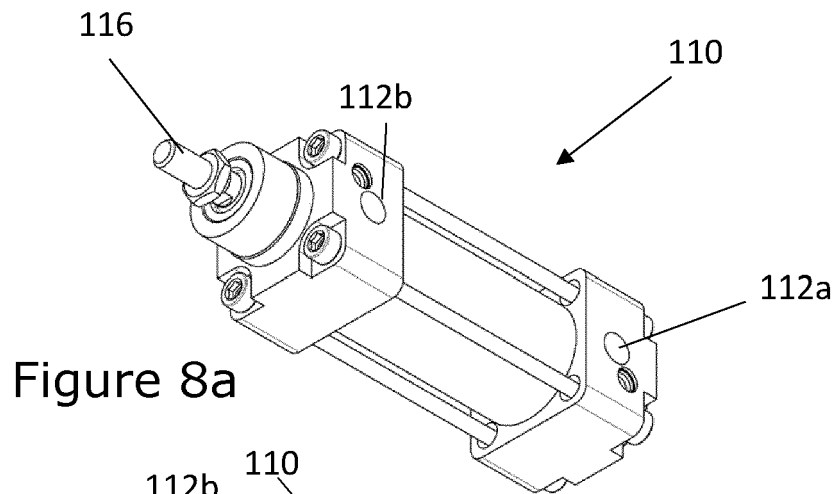


Figure 8a

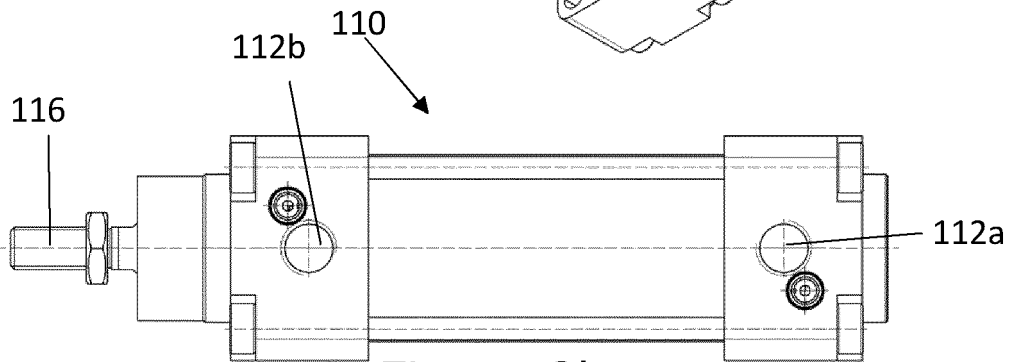


Figure 8b

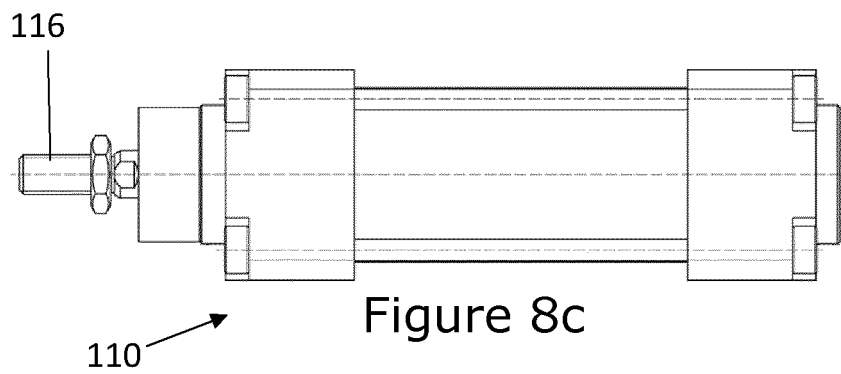


Figure 8c

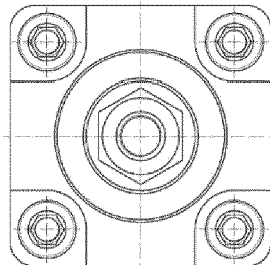


Figure 8d

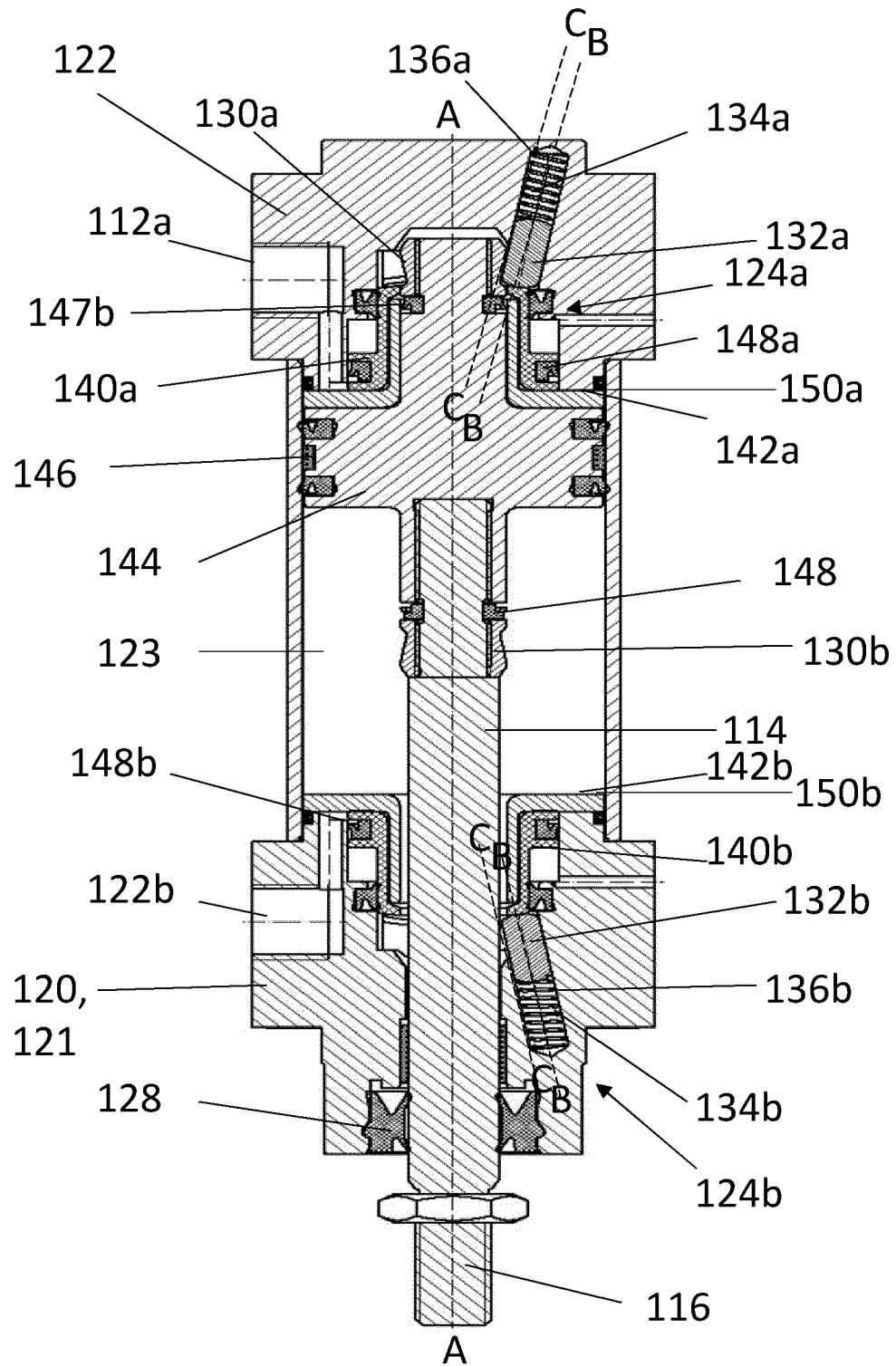


Figure 9

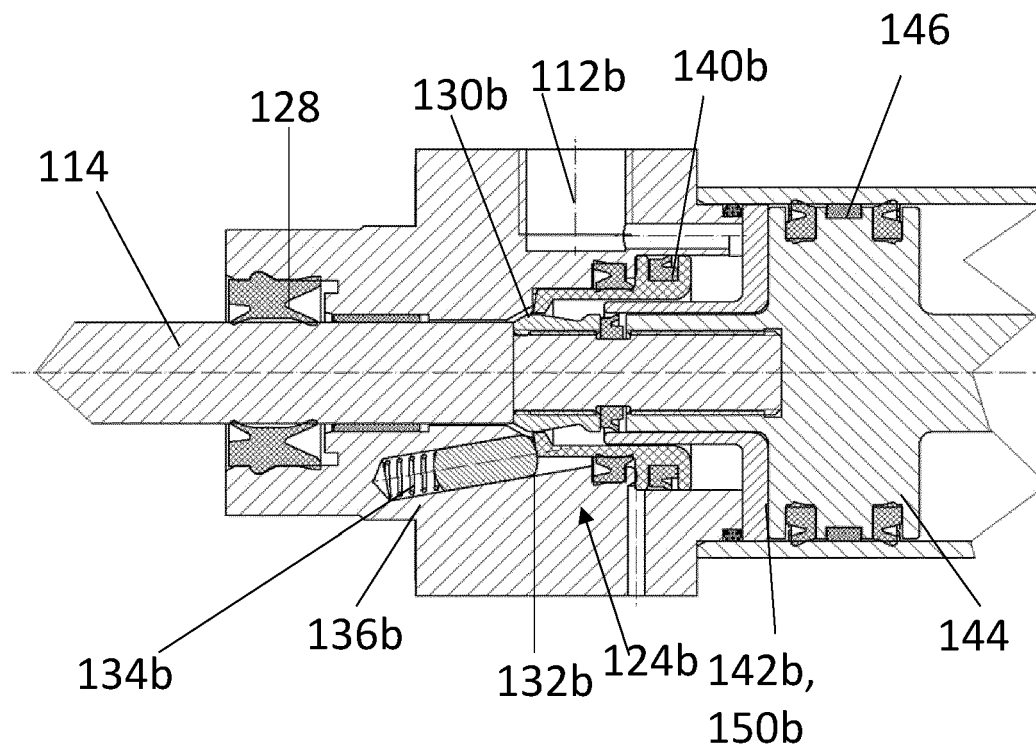
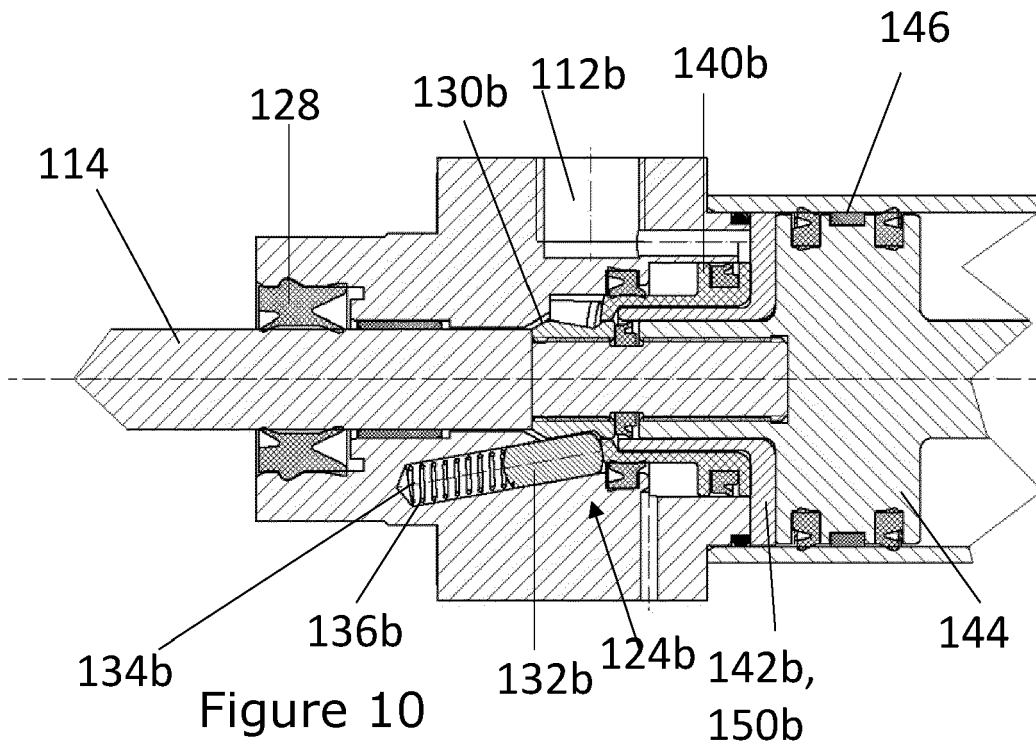
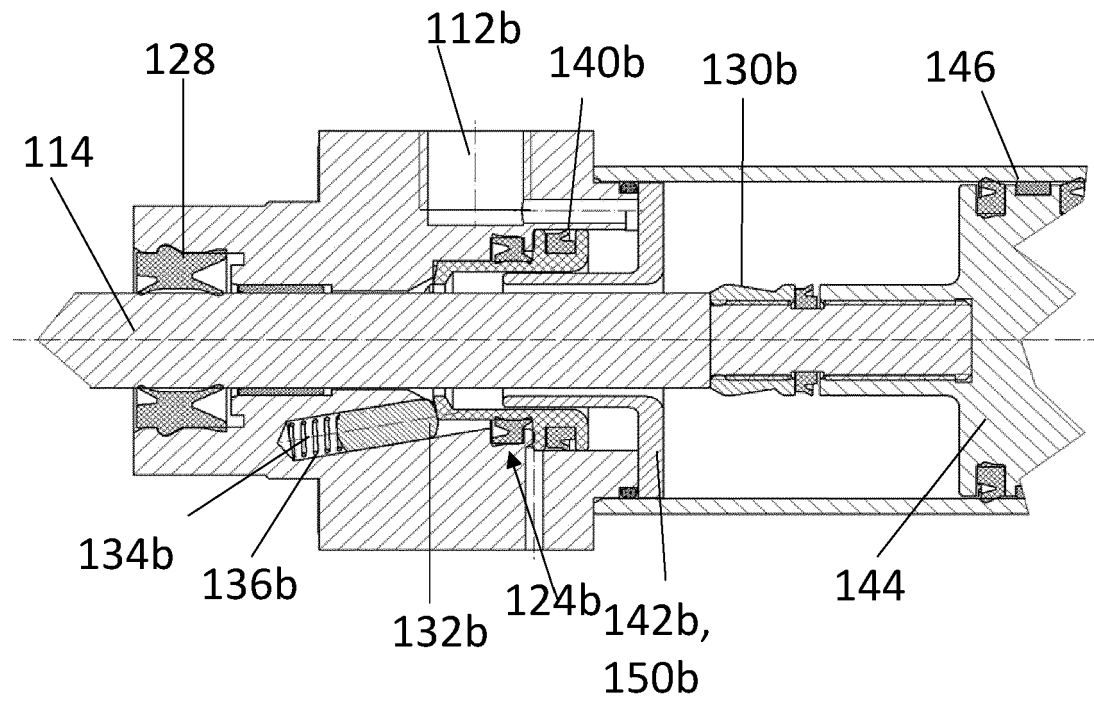
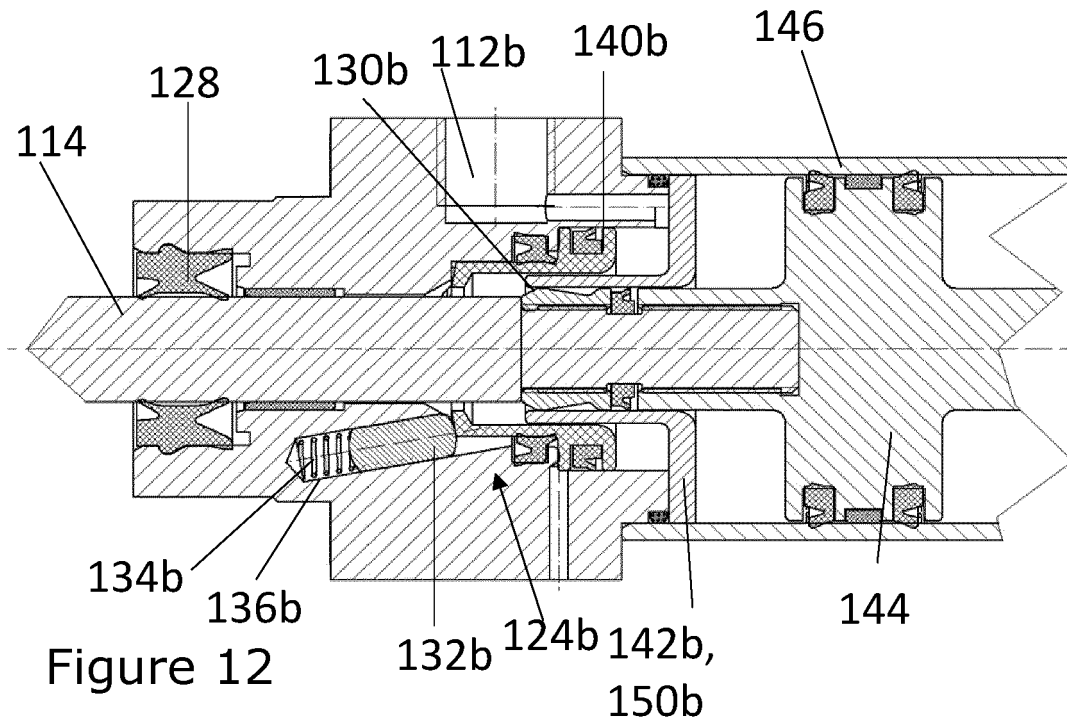


Figure 11



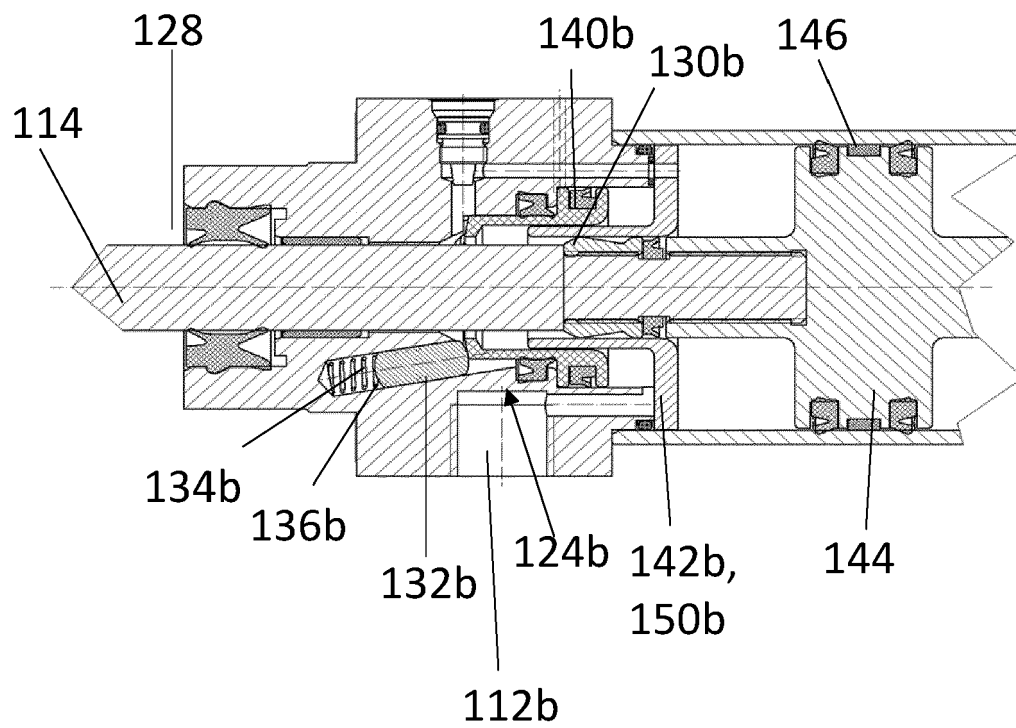


Figure 14



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Application Number

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			F15B
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 18 February 2022	Examiner Toffolo, Olivier
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO.

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