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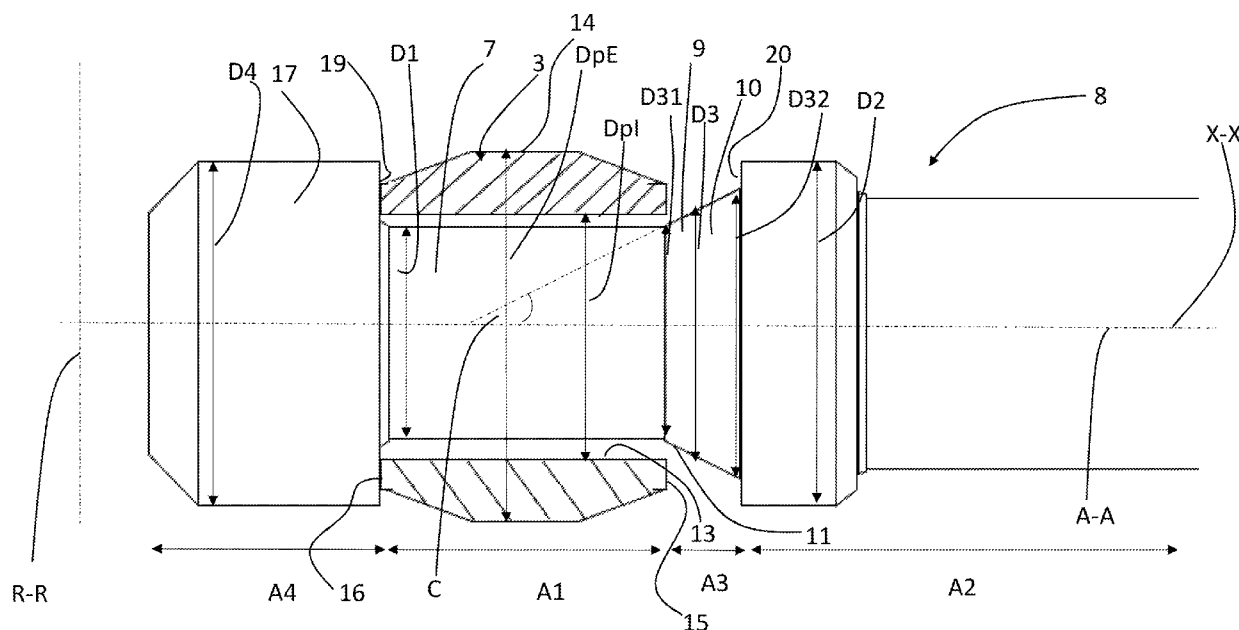


FIG.2b

(57) Abstract: One aspect of the present invention relates to a brake pad pin and axially constraining elastic element assembly (1), wherein said assembly (1) comprises a brake pad supporting pin (2) comprising a pin body (4), which extends along a pin axis (X-X) between a head end (5) and a tip end (6), wherein said pin body (4) comprises in succession along said axial direction (A-A) towards said tip end (6) at least one pin first portion (7) having at least one pin first portion diameter (D1), and a pin second portion (8) having at least one pin second portion diameter (D2), wherein said at least one pin second portion diameter (D2) is greater than said at least one pin second portion diameter (D1); and wherein said assembly (1) comprises an elastic element (3) arranged on said pin body (4) at least at said pin first portion (7), wherein said elastic element (3) has at least one elastic element inner diameter (Dpi) and at least one elastic element outer diameter (DpE), wherein said at least one elastic element outer diameter (DpE) is either greater than or equal to

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said at least pin second portion diameter (D2), and wherein said at least one elastic element inner diameter (Dpi) is smaller than said at least one pin second portion diameter (D2), wherein said pin body (4) comprises a pin third portion (9) arranged between said pin first portion (7) and said pin second portion (8), wherein said pin third portion (9) has at least one pin third stretch (10) having at least one pin third diameter (D3), which is greater than said at least one elastic element inner diameter (Dpi), wherein said elastic element (3) comprises an elastic element inner profile (13) facing towards said pin body (4), wherein said pin head third portion (9) comprises a head portion third profile (11) which connects said pin first portion (5) and said pin second portion (6), wherein, when said pin head third portion (9) is biased towards said elastic element (3) or vice versa, said pin third portion profile (11) is wedged at least partially into said elastic element inner profile (13) so that said pin third portion stretch (7) biases at least said elastic element (3) at least in a radial direction (R-R) outwards with a biasing force (F).

BRAKE PAD PIN AND AXIALLY CONSTRAINING ELASTIC ELEMENT ASSEMBLY
AND INTERACTION METHOD

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DESCRIPTION

[0001]. Field of the invention

[0002]. The present invention relates to brake pad supporting pin and axially constraining elastic element assembly, as well as a brake caliper and an interaction method for a pad supporting pin and an axially constraining elastic element.

[0003]. Background art

[0004]. In a disc brake of known type, the brake caliper is generally arranged to straddle a brake disc mounted on the hub of a vehicle wheel. The brake caliper usually comprises a caliper body which accommodates the brake pads and actuators to push the pads against the disc to achieve the braking action on the vehicle.

[0005]. In some known disc brake types, the pads are supported by supporting pins accommodated in specific caliper body housings made in the caliper body, wherein each supporting pin crosses through corresponding holes made in the backing plate for the friction material of each brake pad. Such supporting pins have a longitudinal extension axis, a pin head, and a pin tip arranged on opposite ends of the extension axis.

[0006]. The supporting pins are coupled with clearance relative to the respective caliper body housing and consequently elastic elements are used to axially constrain the pins to the caliper body housings.

[0007]. In some cases, such elements are pre-assembled coaxially to the pin in a pin housing. The pin housing, in which the elastic element is accommodated, provides an axially extending, usually cylindrical, end wall, axially delimited by a first abutment wall and a second abutment wall, wherein the abutment walls are substantially transverse to the bottom wall unless flared machining connectors are provided.

[0008]. Such elastic elements are usually expanding elastic elements and have a larger radial dimension than the radial dimension of the first and second abutment walls in a resting condition. In this manner, when the supporting pin provided with the expanding elastic element is assembled to the caliper body, the expanding elastic element is radially compressed by the walls of the caliper body housing in the direction of the supporting pin, and the expanding elastic element is constrained by friction to the caliper body housing. As a result, the expanding elastic element provides an axial constraint aimed at preventing the pin from falling out of its housing.

[0009]. The expanding elastic element is inserted by sliding inside the caliper body housing, e.g., under the thrust action of the abutment wall distal to the pin tip. Once the expanding elastic element is positioned inside the caliper body housing, the elastic element forms an axial constraint relative to the pin thereby preventing the movements of the pin in the extraction direction until the action in the axial direction applied by the abutment wall proximal to the pin tip of the pin housing exceeds the static friction force between the elastic element and the caliper body, allowing the sliding of the elastic element relative to the caliper body and, consequently,

allowing the pin to exit from its housing.

[0010]. For example, document **EP1425520** by the applicant, shows a brake pad supporting pin coupled to a barrel-shaped expanding elastic element.

[0011]. The shape of the supporting pins and the respective expanding elastic elements is such to satisfy the need to guarantee an easy assembly of a brake caliper assembly, as well as a simple replacement of the brake pads, e.g., during maintenance, and at the same time to satisfy the need to guarantee an axially constrained coupling between the supporting pins and the caliper body during vehicle use, withstanding the operating biases. In other words, the shape of the supporting pins and the respective expanding elastic elements is such that the pin can only be inserted into and extracted from the caliper body by applying an extraction effort approximately equal in magnitude to the insertion effort overcoming the same limit sliding load, given by the force applied by the elastic element in the direction normal to the wall of the caliper body housing, in other words by the pre-compression force of the elastic element due to insertion into the caliper body housing, multiplied by the friction coefficient between the two surfaces.

[0012]. Although such pins meet such requirements with good margins of stability within the normal operating conditions of the vehicle, it has been found that under extreme operating conditions, the biases acting on the supporting pins of known type may be such to disengage the supporting pin from its housing, generating effects of noise in the system.

[0013]. Therefore, the need is strongly felt in the industry to devise a supporting pin and elastic element assembly which can stably maintain its position or rather can resist extraction even in very severe operating situations, and which at the same time makes it possible to satisfy the conflicting need of devising a supporting pin and elastic element assembly which can be easily inserted into the caliper body during the brake system assembly and maintenance.

[0014]. Therefore, the problem underlying the present invention is to provide a supporting pin and elastic element assembly, a brake caliper, and a method of interaction of a pad supporting pin and axially constraining elastic element assembly, which have structural and functional features to satisfy the aforesaid requirements and, at the same time, solve the drawbacks mentioned with reference to the prior art and satisfy the aforesaid felt needs.

[0015]. Solution

[0016]. It is an object of the present invention to provide a pad supporting pin and axially constraining elastic element assembly, as well as a brake caliper comprising said assembly and an interaction method for a pad supporting pin and an axially constraining elastic element, which allow a stable coupling between the supporting pin and the respective housing seat also in extreme biasing conditions and at the same time allow easy maintenance and assembly.

[0017]. This and other objects and advantages are achieved by a brake pad supporting pin and axially constraining elastic element assembly according to claim 1, as well as a brake caliper according to claim 9 and an interaction method for a pad supporting pin and an

elastic element according to claim 10.

[0018]. Some advantageous embodiments are the object of the dependent claims.

[0019]. The analysis of this solution shows that the suggested solution achieves an increase in the extraction sliding limit force of an elastic axially constraining element which must be overcome to extract a brake pad supporting pin from a caliper body.

[0020]. Furthermore, the suggested solution makes it possible to increase the sliding limit force of the axially constraining elastic element as the axial force acting on the pad supporting pin in the extraction direction increases.

[0021]. Additionally, the suggested solutions make it possible to keep unchanged the insertion sliding limit force of an axially constraining elastic element which must be overcome to insert the pad supporting pin and the respective elastic constraining element into the caliper body.

[0022]. Even further, by virtue of the suggested solutions, it is possible to reduce or avoid the accidental removal of brake pad supporting pins from the caliper body due to an unexpected increase of biasing on the pin.

[0023]. Even further, by virtue of the suggested solutions, it is possible to guarantee resistance to the sliding of a supporting pin increased by a value depending on the tapering angle, defined in design step according to the application requirements, of a portion of tapered pin wedged in the elastic element compared to the use of brake pad supporting pin and axially constraining elastic element

assemblies of known type.

[0024]. Even further, by virtue of the suggested solutions, it is possible to supply brake pad supporting pin and axially constraining elastic element assemblies customized according to guiding requirements.

[0025]. Figure

[0026]. Further features and advantages of the pad supporting pin and axially constraining elastic element assembly, the brake caliper, and the method by way of non-limiting examples, with reference to the accompanying drawings, in which:

[0027]. - figures 1a and 1b show an axonometric view of a pad supporting pin assembly and axially constraining elastic element according to the present invention;

[0028]. - figures 2a and 2b show an enlarged detail of figures 1a and 1b respectively, in a partially sectioned view along a plane passing through the pin axis X-X, in which the shape of the pin portion and the elastic element fitted on it is shown in detail;

[0029]. - figures 3a and 3b show further embodiments of the assembly of figure 2b according to the present invention;

[0030]. - figure 4 shows a partially exploded axonometric view of a brake caliper according to the present invention comprising a caliper body and at least one assembly according to the present invention;

[0031]. - figures 5a and 5b show in a section plan view of the brake caliper of figure 4 on a horizontal plane parallel to the axes X-X of the two assemblies according to the present invention of figure 4, an insertion sequence of at least one assembly according to the present

invention into the caliper body;

[0032]. - figure 6 shows an enlarged detail of the section plan view of figure 5b, when said pin and elastic element assembly is housed in the caliper body, in particular, the pin head is shown housed in the corresponding housing of the caliper body in which the elastic element creates an axial constraint which limits the sliding of said pin outside the caliper body;

[0033]. - figure 7 shows a section plan view of the brake caliper of figure 5b, a detail of the assembly housed in the caliper body according to a further embodiment;

[0034]. - figure 8 shows a section plan view of the brake caliper of figure 5b, a detail of the assembly housed in the caliper body according to a further embodiment, in which the profile of the pin third portion is stepped and the inner profile of the elastic element is shaped so that the profile of the pin third portion wedges into the inner profile of the elastic element;

[0035]. - figure 9 shows a section plan view of the brake caliper of figure 5b, a detail of the assembly housed in the caliper body according to a further embodiment, in which the profile of the pin third portion is shaped and the inner profile of the elastic element is shaped so that the profile of the pin third portion wedges into the inner profile of the elastic element;

[0036]. - figure 10 shows a section plan view of an enlarged detail of a pin and elastic element assembly according to the prior art inserted into a caliper body housing.

[0037]. Description of some preferred embodiments

[0038]. According to a general embodiment, a brake pad pin and elastic axially constraining element assembly 1 is indicated by reference numeral 1 as a whole.

[0039]. Said assembly 1 comprises a brake pad supporting pin 2 and an elastic element 3.

[0040]. Said brake pad supporting pin 2 comprises a pin body 4 which extends along a pin axis X-X between a head end 5 and a tip end 6.

[0041]. Said pin axis X-X defines an axial direction A-A, either coincident with or parallel to said pin axis X-X, and a radial direction R-R transverse to said axial direction A-A.

[0042]. Said pin body 4 comprises in sequence along said axial direction A-A towards said tip end 6 at least one pin first portion 7 having at least one pin first portion diameter D1, and a pin second portion 8 having at least one pin second portion diameter D2.

[0043]. According to an embodiment, said at least one pin second portion diameter D2 is greater than said at least one pin first portion diameter D1.

[0044]. Said elastic element 3 is arranged on said pin body 4 at least at said pin first portion 7.

[0045]. Said elastic element 3 has at least one elastic element inner diameter DpI and at least one elastic element outer diameter DpE.

[0046]. Said at least one elastic element outer diameter DpE is either greater than or equal to said at least one pin second portion diameter D2.

[0047]. According to an embodiment, said at least one elastic element inner portion DpI is smaller than said at least one pin second portion diameter D2.

[0048]. Said pin body 4 comprises a pin third portion 9 arranged between said pin first portion 7 and said pin second portion 8.

[0049]. Said pin third portion 9 has at least one pin third stretch 10 having at least one pin third diameter D3 which is greater than said at least one elastic element inner diameter DpI.

[0050]. Said elastic element 3 comprises an elastic element inner profile 13 facing towards said pin body 4.

[0051]. Said pin head third portion 9 comprises a head third portion profile 11 which connects said pin first portion 5 and said pin second portion 6.

[0052]. When said pin head third portion 9 is biased towards said elastic element 3 or vice versa, said pin third portion profile 11 is wedged at least partially into said elastic element inner profile 13 so that said pin third portion stretch 10 biases said elastic element 3 at least in a radial direction R-R outwards with a biasing force F.

[0053]. The elastic element 3 is deformable towards and away from the pin axis X-X between at least one compressed configuration, in which the elastic element is compressed by a containing surface, e.g., a housing made in a caliper body, and at least one resting configuration, in which the elastic element is, e.g., outside the caliper body. In this description, the elastic element outer diameter DpE is considered to be larger than each pin second portion diameter D2 in both the compressed and resting configurations. Instead, it is

considered that the elastic element inner diameter D_{pI} is smaller than said pin second portion diameter D_2 at least in the compressed configuration. Similarly, the elastic element inner diameter D_{pI} is considered to be less than at least one third portion diameter D_3 of the at least one third portion stretch 10 at least in the compressed configuration.

[0054]. According to an embodiment, said at least one elastic element outer diameter D_{pE} is the greater outer diameter of said elastic element 3.

[0055]. According to an embodiment, said at least one elastic element inner diameter D_{pI} is the smaller inner diameter of said elastic element 3.

[0056]. According to an embodiment, said elastic element outer diameter D_{pE} measured in at least one elastic element section traverse to axial direction A-A, is either greater than or equal to the pin second portion diameter D_2 measured in each pin second portion section traverse to pin axis X-X.

[0057]. According to an embodiment, said elastic element inner profile 13 and said pin third portion profile 11 are mutually shaped so that said biasing force F increases when said pin head second portion 8 and said elastic element 3 approach each other.

[0058]. According to an embodiment, said elastic element inner profile 13 has an elastic element constant inner diameter equal to said at least one elastic element inner diameter D_{pI} .

[0059]. According to an embodiment, said elastic element inner profile 13 increases radially between an elastic element minimum

diameter equal to said at least one elastic element inner diameter D_{pI} to an elastic element maximum inner diameter at least towards said pin second portion 8.

[0060]. According to an embodiment, said pin third portion profile 11 at least at said pin third portion stretch 10 increases radially in the direction of said pin second portion 8 between a pin third portion minimum diameter D_{31} and a pin third portion maximum diameter D_{32} .

[0061]. According to an embodiment, said elastic element inner diameter D_{pI} is comprised between said pin third portion minimum diameter D_{31} and said pin third portion maximum diameter D_{32} such that said pin third portion stretch 10 is wedged biasing said elastic element 3 in a radially increasing direction.

[0062]. According to an embodiment, said pin third portion profile 11 increases radially in the direction of said pin second portion 8 in a linear manner. In other words, said pin third portion profile 11 forms a truncated cone surface in space.

[0063]. According to an embodiment, said pin third portion profile 11 increases radially in the direction of said pin second portion 8 in a curvilinear manner. In other words, said pin third portion profile 11 forms a paraboloid surface in space.

[0064]. According to an embodiment, said pin third portion profile 11 increases radially in the direction of said pin second portion 8 in a radial manner. In other words, said pin third portion profile 11 forms a flared surface in space.

[0065]. According to an embodiment, said pin third portion profile

11 radially increases in the direction of said pin second portion 8 connecting said pin first portion 7 and said pin second portion 8 between said pin third portion minimum diameter D31 and said pin third portion maximum diameter D32.

[0066]. According to an embodiment, said pin second portion diameter D31 is equal to said at least one pin first portion diameter D1.

[0067]. According to an embodiment, said pin third portion maximum diameter D32 is either smaller than or equal to said pin second portion diameter D2.

[0068]. According to an embodiment, said pin third portion minimum diameter D31 is either smaller than or equal to said elastic element constant inner diameter.

[0069]. According to an embodiment, said pin third portion 9 is a tapered pin portion which increases radially in the direction of said pin second portion 8 between said pin third portion minimum diameter D31 and said pin third portion maximum diameter D32 at a tapering angle C relative to said pin axis X-X.

[0070]. According to an embodiment, said tapering angle C is smaller than 45 degrees.

[0071]. According to an embodiment, said tapering angle C is comprised between 5 and 35 degrees.

[0072]. According to an embodiment, said tapering angle C is comprised between 12 and 26 degrees.

[0073]. According to an embodiment, said tapering angle is smaller than 60 degrees.

[0074]. According to an embodiment, said elastic element 3 comprises

an elastic element outer profile 14 facing outwards in the radial direction.

[0075]. According to an embodiment, said elastic element outer profile 14 increases radially between an elastic element maximum diameter equal to said at least one elastic element outer diameter D_{pE} to an elastic element minimum inner diameter at least towards said pin second portion 8.

[0076]. According to an embodiment, said elastic element outer profile 14 decreases radially between said elastic element maximum outer diameter equal to said at least one elastic element outer diameter D_{pE} , and said elastic element minimum inner diameter towards said head end, facing in the opposite direction relative to said pin second portion 8.

[0077]. According to an embodiment, said elastic element 3 has an elastic element longitudinal extension along said axial direction A-A.

[0078]. According to an embodiment, said pin first portion 7 has a pin first portion longitudinal extension along said axial direction A-A.

[0079]. According to an embodiment, said pin second portion 8 has a pin second portion longitudinal extension along said axial direction A-A.

[0080]. According to an embodiment, said pin third portion 9 comprises a pin third portion longitudinal extension along said axial direction A-A.

[0081]. According to an embodiment, said elastic element inner

diameter D_{pI} measured in at least said elastic element first section 3 transverse to said pin axis X-X along the elastic element longitudinal extension is either smaller than or equal to said pin third portion diameter D_3 measured in at least a first section of said pin third portion 7 transverse to said pin axis X-X along the pin third portion longitudinal extension.

[0082]. According to an embodiment, said elastic element inner diameter D_{pI} measured in at least said elastic element second section 3 transverse to said pin axis X-X along the elastic element longitudinal extension is either greater than or equal to said pin third portion diameter D_3 measured in at least a second section of said pin third portion 7 transverse to said pin axis X-X along the elastic element longitudinal extension.

[0083]. According to an embodiment, said second section transversal to said pin axis X-X of said elastic element 3 is in an advanced position relative to said first section transversal to said pin axis X-X of said elastic element 3 in the direction of said pin second portion 8.

[0084]. According to an embodiment, said first section of said pin third portion 7 transversal to said pin axis X-X is in an advanced position in the direction of said pin second portion 8 relative to said second section of said pin third portion 9 transverse to said pin axis X-X.

[0085]. According to an embodiment, said pin third portion 9 is substantially a pin shoulder having a constant diameter equal to said pin third portion diameter D_3 .

[0086]. According to an embodiment, said pin portion third profile 11 is connected with a step to said pin first portion 7 and said second portion 8.

[0087]. According to an embodiment, said elastic element inner profile 13 increases radially between an elastic element minimum diameter equal to said at least one elastic element inner diameter D_{pI} to a maximum elastic element inner diameter at least towards said pin second portion 8 with a tapering angle C .

[0088]. According to an embodiment, said pin third portion diameter D_3 is comprised between said elastic element maximum inner diameter and said elastic element minimum inner diameter so that said pin third portion stretch 10 is wedged biasing said elastic element 3 in a radially increasing direction.

[0089]. According to an embodiment, said elastic element 3 comprises an elastic element outer profile 14 facing outwards in the radial direction. Said elastic element outer profile 14 has a constant diameter equal to said at least one elastic element outer diameter D_{pE} .

[0090]. According to an embodiment, said pin body 4 comprises a pin head 17 having a pin head diameter D_4 .

[0091]. According to an embodiment, said pin head 17 is connected to said pin first portion 7.

[0092]. According to an embodiment, said pin head diameter D_4 is larger than said elastic element inner diameter D_{pI} .

[0093]. According to an embodiment, said pin head 17 defines a pin first radial wall 19 facing in the direction of said tip end 6 and

configured to axially abut with said elastic element 3.

[0094]. According to an embodiment, said first radial wall 19 extends radially between a radially inner edge having a diameter equal to said pin first portion diameter D1 to a radially outer edge having a diameter equal to said pin head diameter D4.

[0095]. According to an embodiment, said pin body 4 comprises a pin tip 18 connected to said pin second portion 8 and has a tapered shape in the direction of said tip end 6.

[0096]. According to an embodiment, said pin second portion 8 comprises at least one pin abutment wall 21 facing towards said tip end 6 configured to abut against a caliper body portion.

[0097]. According to an embodiment, said pin second portion 8 comprises a pin stem which has a stem diameter smaller than a pin second portion maximum diameter D2.

[0098]. According to an embodiment, said pin second portion defines a pin radial second wall 20 facing in the direction of said head end 5 configured axially abut against said elastic element 3.

[0099]. According to an embodiment, said pin radial second wall 20 extends in a radial direction from a radially inner edge, preferably having a diameter equal to said pin third portion maximum diameter D32, to a radially outer edge having a diameter equal to said pin second portion diameter D2.

[00100]. According to an embodiment, said elastic element 3 comprises an elastic element first radial wall 15 configured to abut against at least one corresponding pin abutment wall, preferably said pin radial first wall 19.

[00101]. According to an embodiment, said elastic element first radial wall 15 faces in the direction of said pin second portion 8.

[00102]. According to an embodiment, said elastic element radial first wall 15 extends between a radially inner edge having a diameter equal to said elastic element inner diameter D_{pI} and a radially outer edge having a diameter equal to said elastic element outer diameter D_{pE} .

[00103]. According to an embodiment, said elastic element radial first wall 15 is perpendicular to said axial direction A-A.

[00104]. According to an embodiment, said elastic element comprises an elastic element second abutment wall 16 configured to abut against with at least one corresponding pin abutment wall, preferably said pin radial second wall 20.

[00105]. According to an embodiment, said elastic element radial second wall 16 faces in a direction opposite to said pin second portion 8.

[00106]. According to an embodiment, said elastic element radial second wall 16 extends between a radially inner edge having a diameter equal to said elastic element inner diameter D_{pI} to a radially outer edge having a diameter equal to said elastic element outer diameter D_{pE} .

[00107]. According to an embodiment, said elastic element second radial wall 16 is perpendicular to said axial direction A- A.

[00108]. According to an embodiment, said elastic element 3 has an annular and/or tubular shape.

[00109]. According to an embodiment, said elastic element comprises

an elastic element through opening 22 parallel to said axial direction A-A.

[00110]. According to an embodiment, said elastic element axial extension A_p is smaller than said pin head first portion axial extension A_1 .

[00111]. According to an embodiment, said pin head third portion axial extension A_3 is equal to at least $1/6$ of the elastic element axial extension A_p .

[00112]. According to an embodiment, said pin third portion 9 is shaped so that, when said pin second portion 8 and said elastic element 3 approach each other, said pin third portion 7 biases said elastic element 3 with a pin biasing force F having an axial force component F_a and a radial pin force component F_r , wherein said radial pin force component F_r increases according to the tapering angle C .

[00113]. According to an embodiment, as an axial biasing force applied to said pin 2 increases, said pin third portion 9 biases said elastic element 3 with said increased pin biasing force F , wherein said radial component of pin force F_r increases.

[00114]. Advantageously, by virtue of the shape of the pin head third portion 9 having a pin third portion profile 11 configured to wedge the elastic element 3, when said pin head second portion 8 and said elastic element 3 approach each other, the pin third head portion 9 allows biasing the elastic element 3 deforming it in the radial direction R-R away from said pin axis X-X. As a consequence, when said elastic element 3 is pre-compressed in the radial direction R-R in the direction of said pin axis X-X, said pin third portion 9 makes it

possible to increase the compression of said elastic element 3 and consequently the sliding limit effort to be overcome to extract the pin from the respective caliper body housing.

[00115]. According to an embodiment, said pin first portion 7 and said second pin portion 8 are cylindrical pin portions.

[00116]. According to an embodiment, said pin third portion 9 is a tapered pin portion. According to an embodiment, said tapered pin portion is truncated-cone-shaped or curvilinear.

[00117]. According to an embodiment, said pin second portion 8, said pin third portion 9, and said pin first portion 7 are mutually connected with respective pin connection portions. The respective connection portions may have connection angles or connection radii to connect the different pin head portions.

[00118]. According to an embodiment, said elastic element inner profile 13 defines an elastic element first sliding wall and said elastic element outer profile defines an elastic element second sliding wall.

[00119]. According to an embodiment, said elastic element first sliding wall is configured to slide at least partially on said pin third portion 9. Said elastic element second sliding wall is adapted to slide on a containing wall, e.g., a wall of a caliper body housing 28, and is adapted to abut against said caliper body housing wall 32 to form a friction constraint to prevent said pin 2 from exiting from the caliper body 28.

[00120]. According to an embodiment, said elastic element 3 is shaped like an upside-down barrel.

[00121]. According to an embodiment, said elastic element 3 is "barrel"-shaped.

[00122]. According to an embodiment, said pin 2 is axisymmetric. According to an embodiment, said pin 2 is centrally symmetric.

[00123]. According to an embodiment, said elastic element 3 is axisymmetric, unless an axial opening 22 is present. According to an embodiment, said pin 2 is centrally symmetric unless an axial opening 22 is present.

[00124]. According to an embodiment, when said elastic element 3 and said pin second portion 8 approach each other, the pin third portion 9 comes into contact with said first sliding wall and by virtue of the provision of said tapered or stepped sliding wall, the elastic element compresses and the second sliding wall forms a second sliding wall contact of greater magnitude with a retaining wall, e.g., a cylindrical wall of caliper body first housing 31, and consequently increases the maximum sliding limit which must be exceeded to extract said pin 2 from a caliper body 28.

[00125]. The present invention further relates to a maintenance kit comprising at least one assembly 1 as previously described, and at least one brake pad 23a, 23b. Each brake pad 23a, 23b has a backing plate 24 connected to a friction material 25, wherein each backing plate 24 comprises at least one plate through hole 26 for housing said brake pad supporting pin 2.

[00126]. The present invention further relates to a brake caliper 27 comprising a caliper body 28 and at least one assembly 1, as described above.

[00127]. Said caliper body 28 comprises a first elongated element 34 and a second elongated element 35, wherein said first elongated element 34 comprises at least a caliper body first housing 29 and said second elongated element 35 comprises at least a caliper body second housing 30, wherein said first caliper body first housing 29 and said caliper body second housing 30 each have a housing axis G-G parallel to and coincident with said pin axis X-X, wherein said caliper body first housing 29 comprises at least one first housing first portion 31, said caliper body first housing 29 having a prevalent longitudinal extension and having a caliper body first housing diameter D_p , and said caliper body second housing 30 having a prevalent longitudinal extension and having a caliper body second housing diameter D_s , wherein said pin second portion 8 is at least partially housed, e.g., with said stem 12, in said caliper body first housing 30 and said pin first portion 7 is housed with clearance in said caliper body first housing 29, wherein said elastic element 3 is housed in said pin body first housing portion 31.

[00128]. Said elastic element outer diameter D_{pE} is either greater than or equal to said first housing diameter D_p to make an axial constraint opposing an extraction in an axial direction A-A of said supporting pin 2 from the caliper body 28.

[00129]. According to an embodiment, said elastic element outer diameter D_{pE} measured in at least one section of said elastic element 3 transverse to said pin axis X-X along its longitudinal extent is either greater than or equal to said first housing diameter D_p measured in at least one section transverse to said housing axis G-G of said

first housing first portion 31 along its longitudinal extent to form an axial constraint which opposes an extraction in axial direction A-A of said supporting pin 2 from the caliper body 28.

[00130]. According to an embodiment, said caliper body first housing 29 comprises a first caliper body housing cylindrical wall 31.

[00131]. According to an embodiment, said caliper body first housing 29 comprises a first caliper body housing abutment wall 33.

[00132]. According to an embodiment, said caliper body second housing 30 comprises a caliper body second housing cylindrical wall 32.

[00133]. According to an embodiment, said caliper body second housing 30 comprises a caliper body second housing abutment wall.

[00134]. According to an embodiment, said caliper body first housing cylindrical wall 31 has a caliper body first housing radius r_1 .

[00135]. According to an embodiment, said caliper body first housing abutment wall 33 is a circular crown and said pin second portion 8 has a pin abutment wall 21 configured to abut against said circular-crown-shaped caliper body first housing abutment wall 33.

[00136]. According to an embodiment, said pin second portion diameter D_2 is either smaller than or equal to said caliper body first housing cylindrical wall diameter D_p . According to an embodiment, said elastic element outer diameter D_{pE} is not smaller than said caliper body first housing cylindrical wall diameter D_p so that said elastic element 3 is pre-compressed against said caliper body first housing cylindrical wall 31 forming said axial friction constraint.

[00137]. According to an embodiment, said caliper body first housing cylindrical wall 31 has a caliper body first housing cylindrical wall

axial extension a1 along said housing axis G-G.

[00138]. According to an embodiment, said caliper body first housing cylindrical wall axial extension a1 is not smaller than the pin first portion axial extension A1 and pin third portion axial extension A3.

[00139]. The present invention further relates to a disc brake assembly for a vehicle, comprising a brake disc connected to a hub of a wheel of the vehicle, and a brake caliper 27 as previously described, in which said caliper body 28 is arranged to straddle the brake disc.

[00140]. The present invention further relates to an interaction method between a pad supporting pin and an axially constraining elastic element, comprising the steps of

a- providing a pin assembly according to any one of the claims from 1 to 8,

b- approaching said pin second portion 8 to said elastic 3, or vice versa,

c- during step b, wedging at least partially said pin third portion profile 11 into said elastic element inner profile 13 so that said pin third portion stretch 10 biases said elastic element 3 at least in a radial direction R-R outwards with a biasing force F.

[00141]. According to an embodiment, said step b provides a sub-step b1 of approaching for a first stretch said pin second portion 8 to said elastic element 3 until said elastic element 3 goes into contact with said pin third portion 9, preferably with said pin third portion stretch 10.

[00142]. According to an embodiment, said step b provides a step b2 of approaching for a second stretch said pin second portion 8 to said

elastic element 3 until said elastic element 3 goes into abutment with a radial wall of said pin second portion 8.

[00143]. According to an embodiment, during said step b2, said step c provides wedging said pin third portion 9 into said elastic element 3, or wedging said pin third portion profile (11) into said internal profile of elastic element (13), so that said biasing force F gradually increases as said elastic element 3 and said pin second portion 8 approach each other.

[00144]. According to an embodiment, said method provides at the same time as step a, step z of providing a caliper body 28 of a brake caliper 27 as previously described, and, before said step b, said method provides step x of inserting said assembly 1 into the caliper body housings 29, 30 to position said elastic element 3, preferably by sliding, within the first caliper body housing 29 in a compressed configuration against a retaining wall of first caliper body housing, e.g., said caliper body first housing first portion cylindrical wall.

[00145]. According to an embodiment, said steps b, c, b1, and b2 are performed with said elastic element 3 pre-compressed against a containing wall to form an axial constraint for said supporting pin 2.

[00146]. According to an embodiment, said containing wall is a caliper body first housing wall of a first housing made in a caliper body, preferably it is a caliper body first housing cylindrical wall 31.

LIST OF REFERENCES

- 1 brake pad pin and axially constraining elastic element assembly
- 2 supporting pin
- 3 elastic element
- 4 pin body
- 5 5 head end
- 6 tip end
- 7 pin first portion
- 8 pin second portion
- 9 pin third portion
- 10 10 pin third portion stretch
- 11 third portion profile
- 12 pin stem
- 13 elastic element inner profile
- 14 elastic element outer profile
- 15 15 elastic element first radial wall
- 16 elastic element second radial wall
- 17 pin head
- 18 pin tip
- 19 pin radial first wall
- 20 20 pin radial second wall
- 21 pin abutment wall
- 22 elastic element through opening
- 23a, brake pad
- 23b brake pad
- 25 24 backing plate
- 25 friction material
- 26 plate through hole
- 27 brake caliper
- 28 caliper body
- 30 29 caliper body first housing
- 30 caliper body second housing
- 31 caliper body first housing cylindrical wall

	32	caliper body second housing cylindrical wall
	33	caliper body first housing circular crown abutment wall
	34	caliper body elongated first element
	35	caliper body elongated second element
5	X-X	pin axis
	A-A	axial direction
	R-R	radial direction
	G-G	caliper body housing axis
	A1	pin first portion axial extension
10	A2	pin second portion axial extension
	A3	pin third portion axial extension
	A4	fourth pin portion axial extension
	Ap	elastic element axial extension
	D1	diameter or pin first portion maximum diameter
15	D2	diameter or pin second portion maximum diameter
	D3	pin third portion diameter
	D4	diameter or pin head maximum diameter
	D31	head third portion minimum diameter
	D32	head third portion maximum diameter
20	DpI	inner diameter or elastic element minimum inner diameter
	DpE	outer diameter or elastic element maximum outer diameter
	r1	caliper body first housing cylindrical wall radius
	a1	caliper body first housing cylindrical wall axial extension
	Dp	caliper body first housing diameter
25	Ds	caliper body second housing diameter

CLAIMS

1. A brake pad pin and axially constraining elastic element assembly (1),

wherein said assembly (1) comprises:

- 5 - a brake pad supporting pin (2) comprising a pin body (4) which extends along a pin axis (X-X) between a head end (5) and a tip end (6),

wherein said pin axis (X-X) defines an axial direction (A-A), either coincident with or parallel to said pin axis (X-X), and a radial direction (R-R) transverse to said axial direction (A-A),

wherein said pin body (4) comprises in succession along said axial direction (A-A) towards said tip end (6) at least one pin first portion (7) having at least one pin first portion diameter (D1), and a pin second portion (8) having at least one pin second portion diameter (D2);

and wherein said assembly (1) comprises:

- an elastic element (3) arranged on said pin body (4) at least at said pin first portion (7),

wherein said elastic element (3) has at least one elastic element inner diameter (DpI) and at least one elastic element outer diameter (DpE),

wherein said at least one elastic element outer diameter (DpE) is either greater than or equal to said at least one pin second portion diameter (D2),

25 **characterized in that**

said pin body (4) comprises a pin third portion (9) arranged between

said pin first portion (7) and said pin second portion (8), wherein said pin third portion (9) has at least one pin third stretch (10) having at least one pin third diameter (D3) which is greater than said at least one elastic element inner diameter (DpI),

5 wherein said elastic element (3) comprises an elastic element inner profile (13) facing towards said pin body (4),

wherein said pin head third portion (9) comprises a head portion third profile (11) which connects said pin first portion (5) and said pin second portion (6),

10 wherein, when said pin head third portion (9) is biased towards said elastic element (3), or vice versa, said pin third portion profile (11) is wedged at least partially into said elastic element inner profile (13)

so that said pin third portion stretch (10) biases said elastic element

15 (3) at least in a radial direction (R-R) outwards with a biasing force (F).

2. An assembly (1) according to the preceding claim, wherein said elastic element inner profile (13) and said pin third portion profile

20 (11) are mutually shaped so that said biasing force (F) increases when said pin head second portion (8) and said elastic element (3) approach each other, and/or wherein

wherein said at least one pin second portion diameter (D2) is greater than said at least one pin first portion diameter (D1), and wherein

25 said at least one elastic element inner diameter (DpI) is smaller than said at least one pin second portion diameter (D2), and/or wherein

said elastic element (3) has an elastic element longitudinal extension along said axial direction (A-A),

said pin third portion (9) comprises a pin third portion longitudinal extension along said axial direction (A-A),

5 wherein said elastic element inner diameter (DpI) measured in at least one elastic element first section (3) transversal to said pin axis (X-X) along the elastic element longitudinal extension is either smaller than or equal to said pin third portion diameter (D3) measured in at least one pin third portion first section (7) transversal to
10 said pin axis (X-X) along the longitudinal extension of said pin third portion, and wherein said elastic element inner diameter (DpI) measured in at least one elastic element second section (3) transverse to said pin axis (X-X) along the elastic element longitudinal extension is either greater than or equal to said pin third portion
15 diameter (D3) measured in at least one said pin third portion second section (7) transverse to said pin axis (X-X) along the elastic element longitudinal extension,

wherein

- said second section transversal to said pin axis (X-X) of said
20 elastic element (3) is in an advanced position relative to said first section transversal to said pin axis (X-X) of said elastic element (3) in the direction of said pin second portion (8),
and said first section of said pin third portion (7) transversal to said pin axis (X-X) is in an advanced position in the direction of
25 said pin second portion (8) relative to said second section of said

pin third portion (9) transverse to said pin axis (X-X).

3. An assembly (1) according to claim 1, wherein said pin third portion profile (11) at least at said pin third portion stretch (10) radially
5 increases in the direction of said pin second portion (8) between a pin third portion minimum diameter (D31) and a pin third portion maximum diameter (D32), wherein said elastic element inner diameter (DpI) is comprised between said pin third portion minimum diameter (D31) and said pin third portion maximum diameter (D32), so that said
10 pin third portion stretch (10) is wedged biasing said elastic element (3) in a radial direction.

4. An assembly (1) according to the preceding claim, wherein said elastic element inner profile (13) has an elastic element constant
15 inner diameter equal to said at least one elastic element inner diameter (DpI), or wherein said elastic element inner profile (13) radially increases from an elastic element minimum diameter equal to said at least one elastic element inner diameter (DpI) to an elastic element maximum inner diameter at least towards said pin second
20 portion (8),

and/or wherein said pin third portion profile (11) radially increases in the direction of said pin second portion (8) in a linear manner or a curvilinear/spoked manner, and/or wherein
said pin third portion profile (11) radially increases in the
25 direction of said pin second portion (8) connecting said pin first

portion (7) and said pin second portion (8) between said pin third portion minimum diameter (D31) and said pin third portion maximum diameter (D32), and/or wherein

said pin third portion minimum diameter (D31) is equal to said pin

5 first portion diameter (D1), and/or wherein

said pin third portion maximum diameter (D32) is either smaller than

or equal to said pin second portion diameter (D2), and/or wherein said

pin third portion minimum diameter (D31) is either smaller than or

equal to said elastic element constant inner diameter, and/or wherein

10 said pin third portion (9) is a tapered pin portion radially increasing

in the direction of said pin second portion (8) between said pin third

portion minimum diameter (D31) and said pin third portion maximum

diameter (D32) with a tapering angle (C), and/or wherein

said elastic element (3) comprises an elastic element outer profile

15 (14) facing outwards in a radial direction (R-R), wherein said elastic

element outer profile (14) decreases radially between an elastic

element maximum outer diameter equal to said at least one elastic

element outer diameter (DpE), to an elastic element minimum inner

diameter at least towards said pin second portion (8).

20

5. An assembly (1) according to claim 1, wherein, said pin third

portion (9) is substantially a pin shoulder having a constant diameter

equal to said pin third portion diameter (D3), wherein said pin third

portion profile (11) connects as a step to said pin first portion (7)

25 and said pin second portion (8), wherein said elastic element inner

profile (13) increases radially between an elastic element minimum diameter equal to said at least one elastic element inner diameter (DpI) and an elastic element maximum inner diameter at least towards said pin second portion (8) with a tapering angle (C), wherein said pin third portion diameter (D3) is comprised between said elastic element maximum inner diameter and said elastic element minimum inner diameter, so that said pin third portion stretch (10) is wedged biasing said elastic element (3) in an increasing manner in a radial direction.

6. An assembly (1) according to the preceding claim, wherein said elastic element (3) comprises an elastic element outer profile (14) facing outwards in a radial direction (R-R), wherein said elastic element outer profile (14) has a constant diameter equal to said at least one elastic element outer diameter (DpE).

7. An assembly (1) according to any one of the preceding claims, wherein:

said pin body (4) comprises a pin head (17) having a pin head diameter (D4), wherein said pin head (17) is connected to said pin first portion (7), wherein said pin head diameter (D4) is greater than said elastic element inner diameter (DpI), wherein said pin head (17) defines a first radial pin wall (19) facing the direction of said tip end (6) and configured to abut axially against said elastic element (3), wherein said first radial wall (19) extends radially between a radially inner edge having a diameter equal to said pin first portion

diameter (D1) and a radially outer edge having a diameter equal to said pin head diameter (D4) and/or wherein
said pin body (4) comprises a pin tip (18) connected to said pin second portion (8) and has a tapered conformation in the direction of
5 said tip end (6), and/or wherein
said pin second portion (8) comprises at least one pin abutment wall (21) facing towards said tip end (6) configured to abut with a caliper body portion, and/or wherein
said pin second portion defines a pin radial second wall (20) facing
10 in the direction of said head end (5) configured to abut axially said elastic element (3), wherein said pin radial second wall (20) extends in a radial direction from a radially inner edge, preferably having a diameter equal to said pin third portion maximum diameter (D32), to a radially outer edge having a diameter equal to said pin second portion
15 diameter (D2).

8. An assembly (1) according to any one of the preceding claims, wherein said elastic element (3) comprises an elastic element first radial wall (15) configured to abut with at least one corresponding
20 pin abutment wall, wherein said elastic element first radial wall (15) faces towards said pin second portion (8), wherein said elastic element first radial wall (15) extends between a radially inner edge having a diameter equal to said elastic element inner diameter (DpI) and a radially outer edge having a diameter equal to said elastic
25 member outer diameter (DpE), and/or wherein said elastic member

comprises an elastic element first abutment wall (15) configured to abut with at least one corresponding pin abutment wall, wherein said elastic element second radial wall (16) faces in a direction opposite to said pin second portion (8), wherein said elastic element first radial wall (15) extends between a radially inner edge having a diameter equal to said elastic element inner diameter (D_{pI}) and a radially outer edge having a diameter equal to said elastic element outer diameter (D_{pE}),

and/or wherein said elastic element (3) has annular and/or tubular, and/or wherein said elastic element comprises an elastic element through opening (22) parallel to said axial direction (A-A), and/or wherein said pin head third portion axial extension (A_3) is at least $1/6$ of the elastic element axial extension (A_p).

9. A brake caliper (27) comprising at least a caliper body (28) and at least one assembly (1) according to one of claims from 1 to 8; wherein said caliper body comprises a first elongated element (34) and a second elongated element (35), wherein said first elongated element (34) comprises at least one caliper body first housing (29) and said second elongated element (35) comprises at least one caliper body second housing (30), wherein said caliper body first housing (29) and said caliper body second housing (30) each have a housing axis (G-G) parallel to and coincident with said pin axis (X-X), wherein said caliper body first housing (29) comprises at least one first housing first portion (31), said caliper body first housing (29)

having prevalent longitudinal extension and having a caliper body first housing diameter (Dp), and said caliper body second housing (30) having prevalent longitudinal extension and having a caliper body second housing diameter (Ds), wherein said pin second portion (8) is
5 at least partially housed in said caliper body first housing (29) and said pin first portion (7) is housed with clearance in said caliper body first housing (29), wherein said elastic element (3) is housed in said pin body first housing portion (31),.

wherein said elastic element outer diameter (DpE) is either greater
10 than or equal to said first housing diameter (Dp) to make an axial constraint opposing an extraction in an axial direction (A-A) of said support pin (2) from the caliper body (28).

10. An interaction method between a pad support pin and an elastic
15 retaining element, comprising the steps of
a- providing a pin assembly according to any one of claims from 1 to 8,
b- approaching said pin second portion (8) to said elastic element (3), or vice versa,
c- during step b, wedging at least partially said pin third portion profile (11) into said elastic element inner profile (13) so that said
20 pin third portion stretch (10) biases said elastic element (3) at least in a radial direction (R-R) outwards with a biasing force (F).

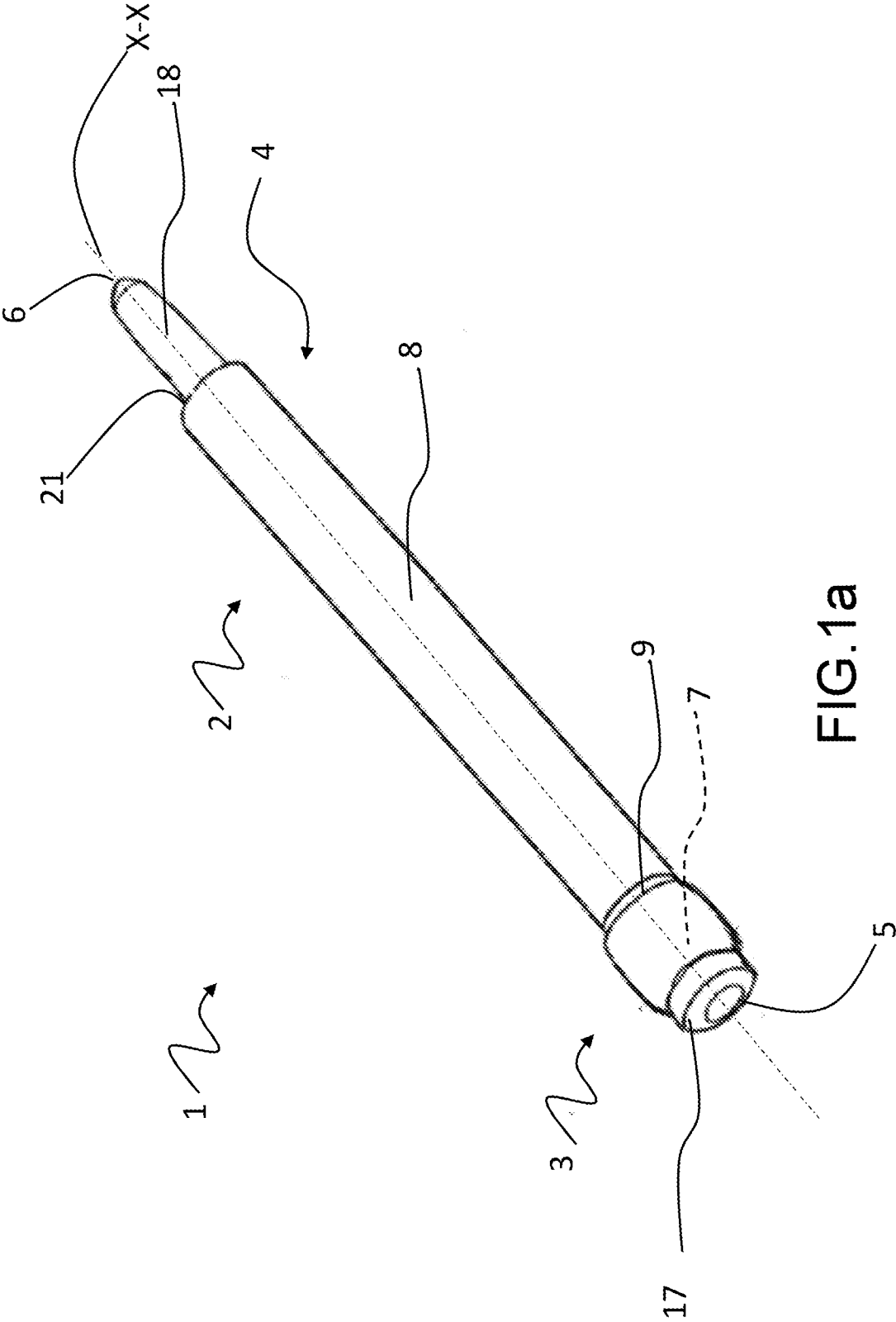
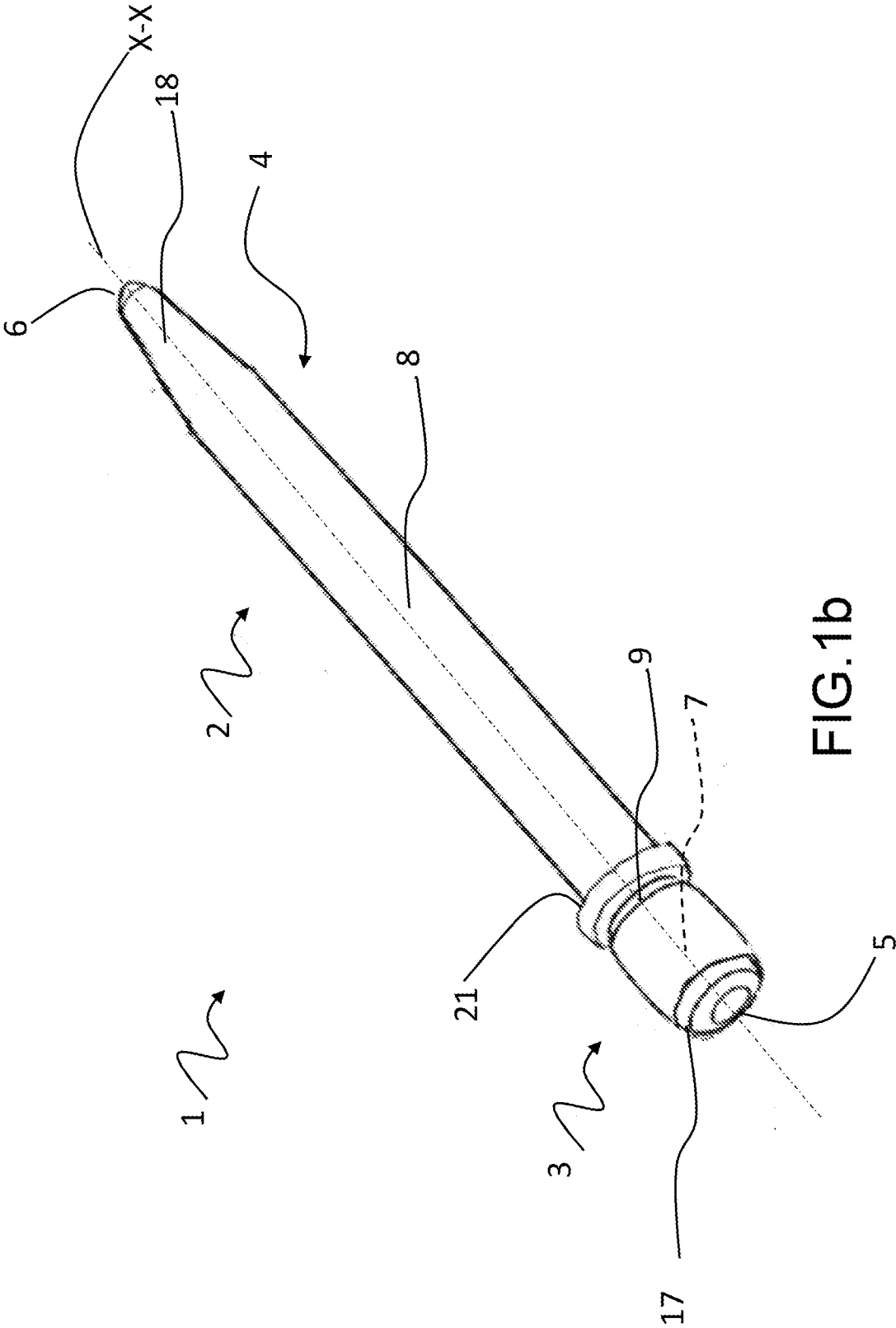
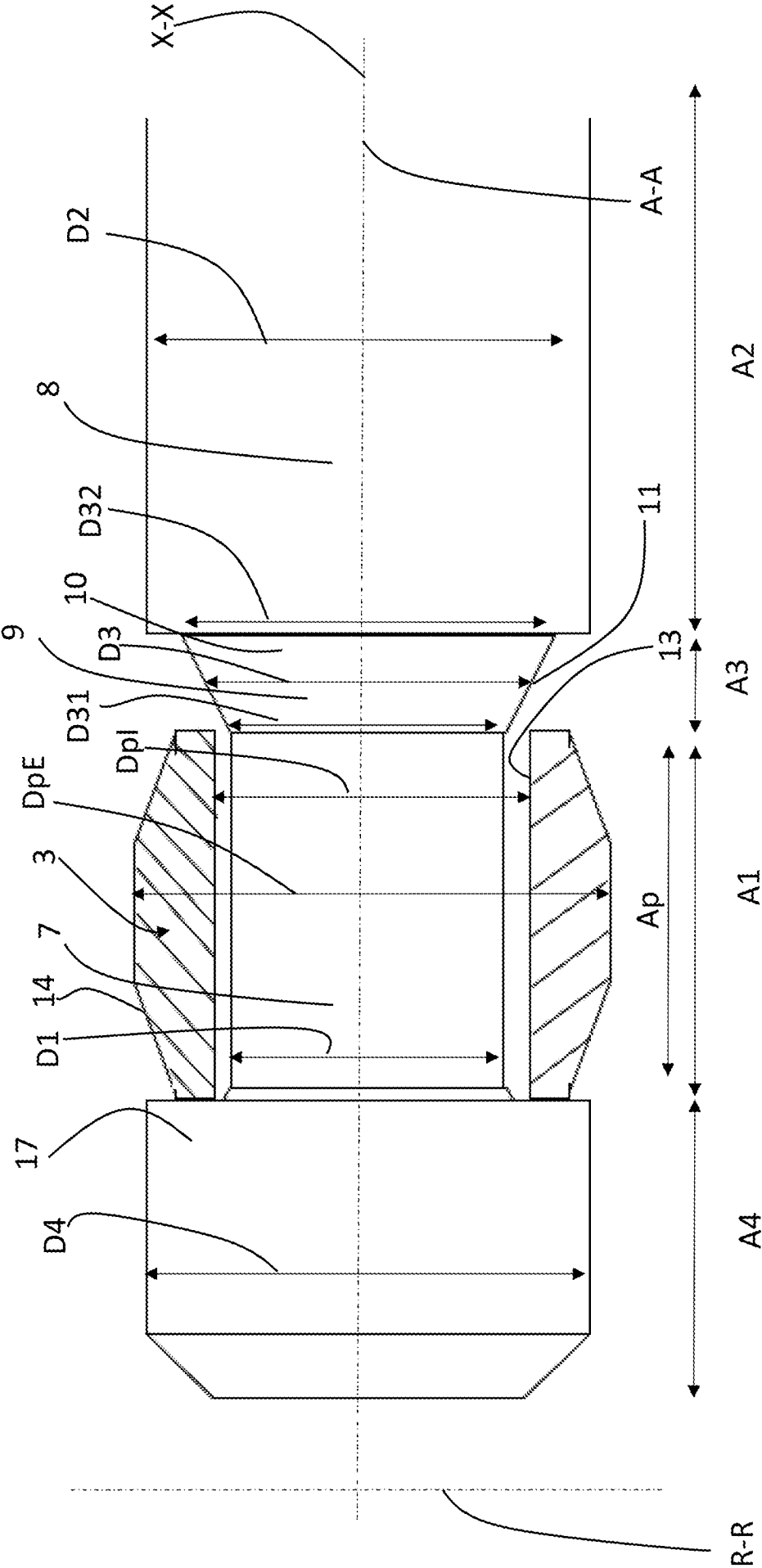


FIG.1a





D31

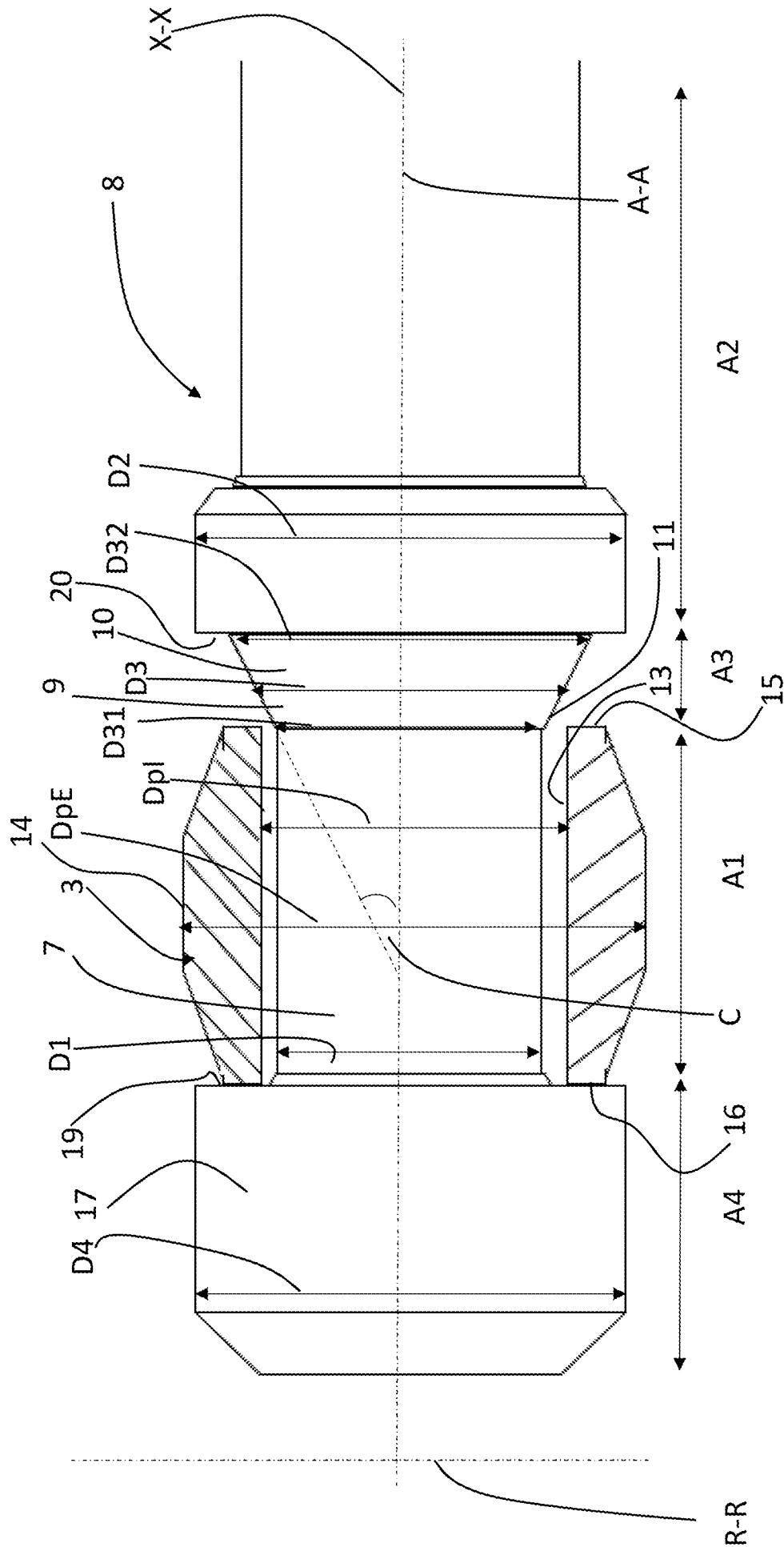


FIG. 2b

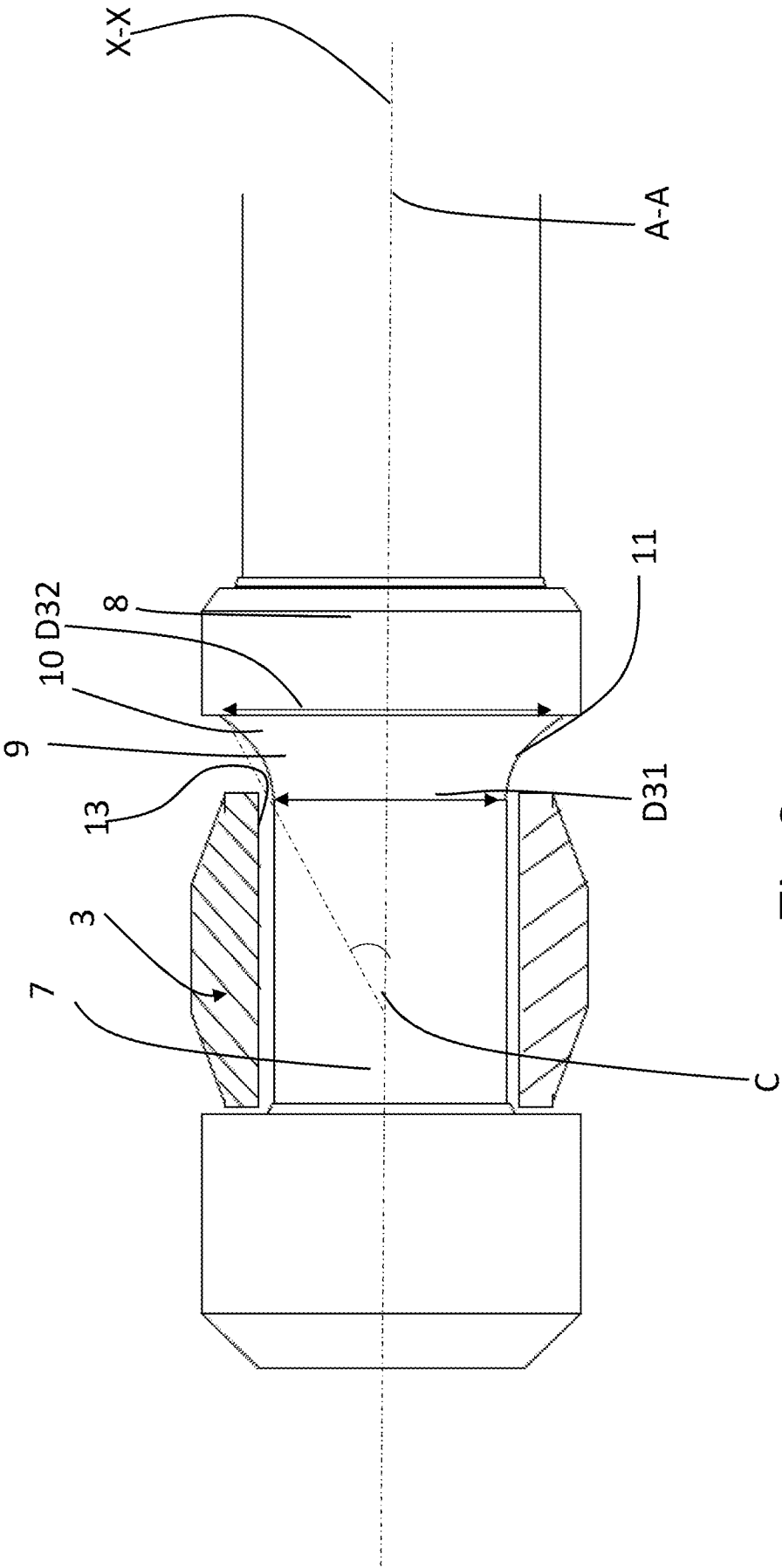


Fig.3a

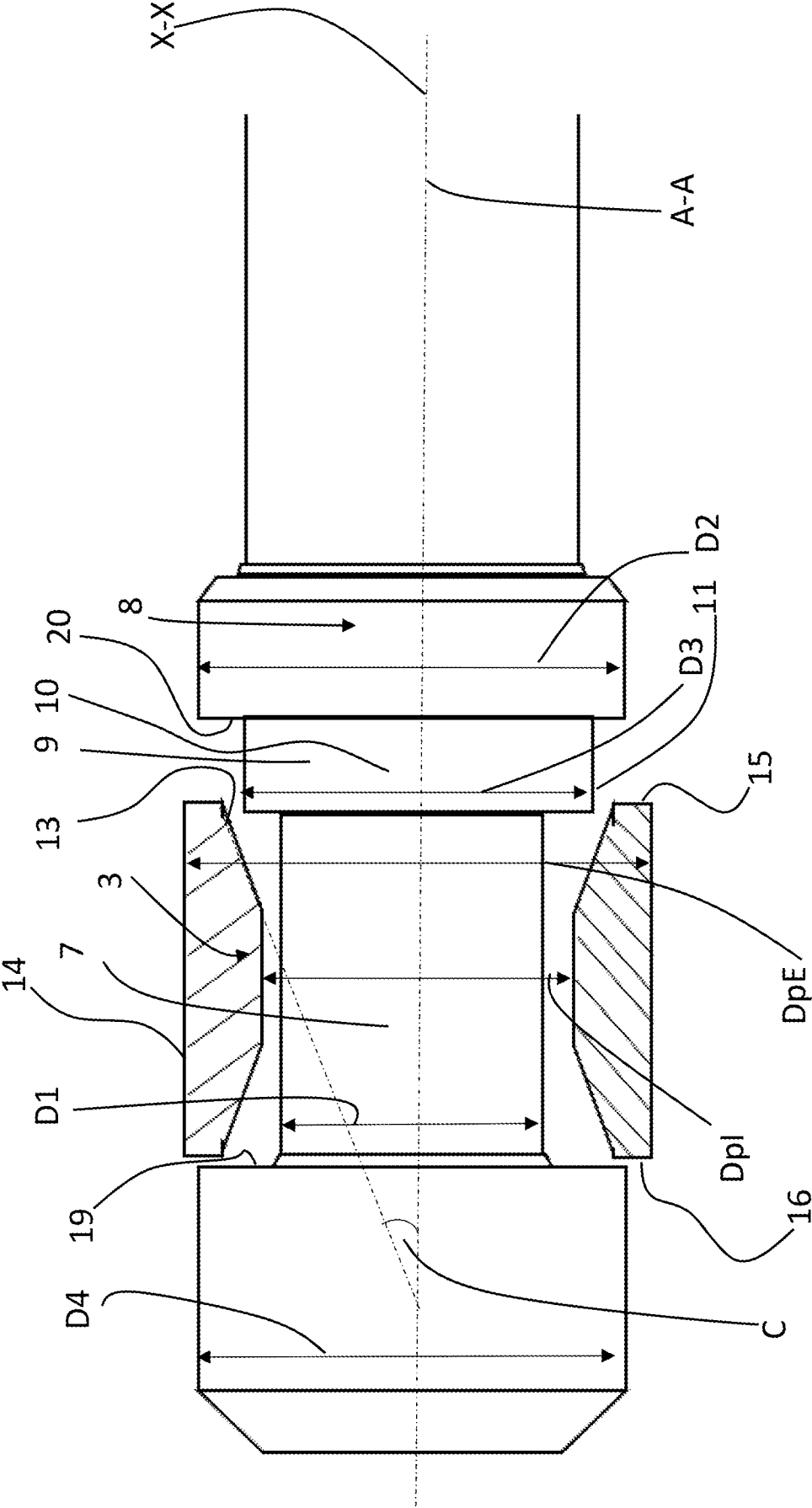


Fig.3b

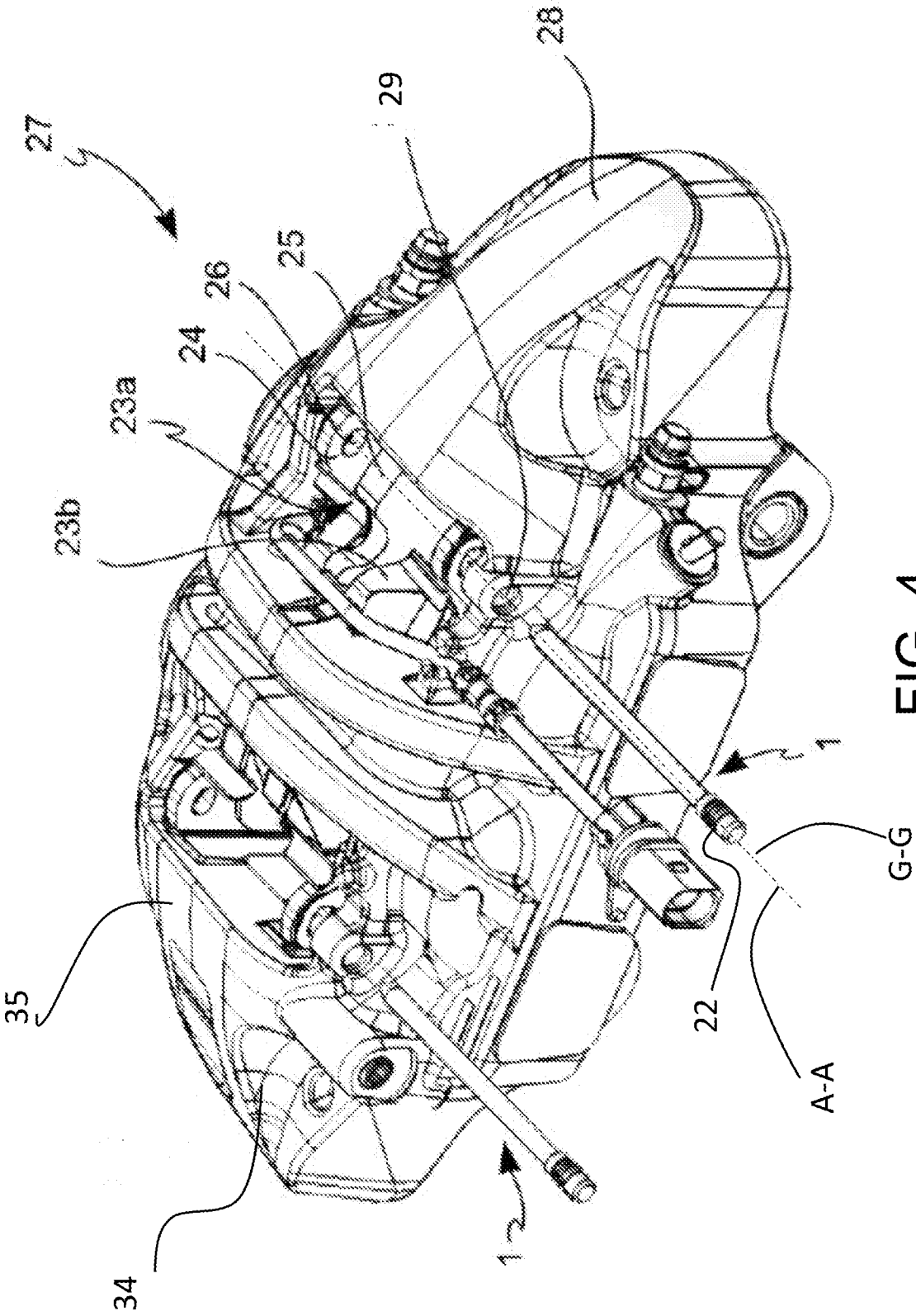
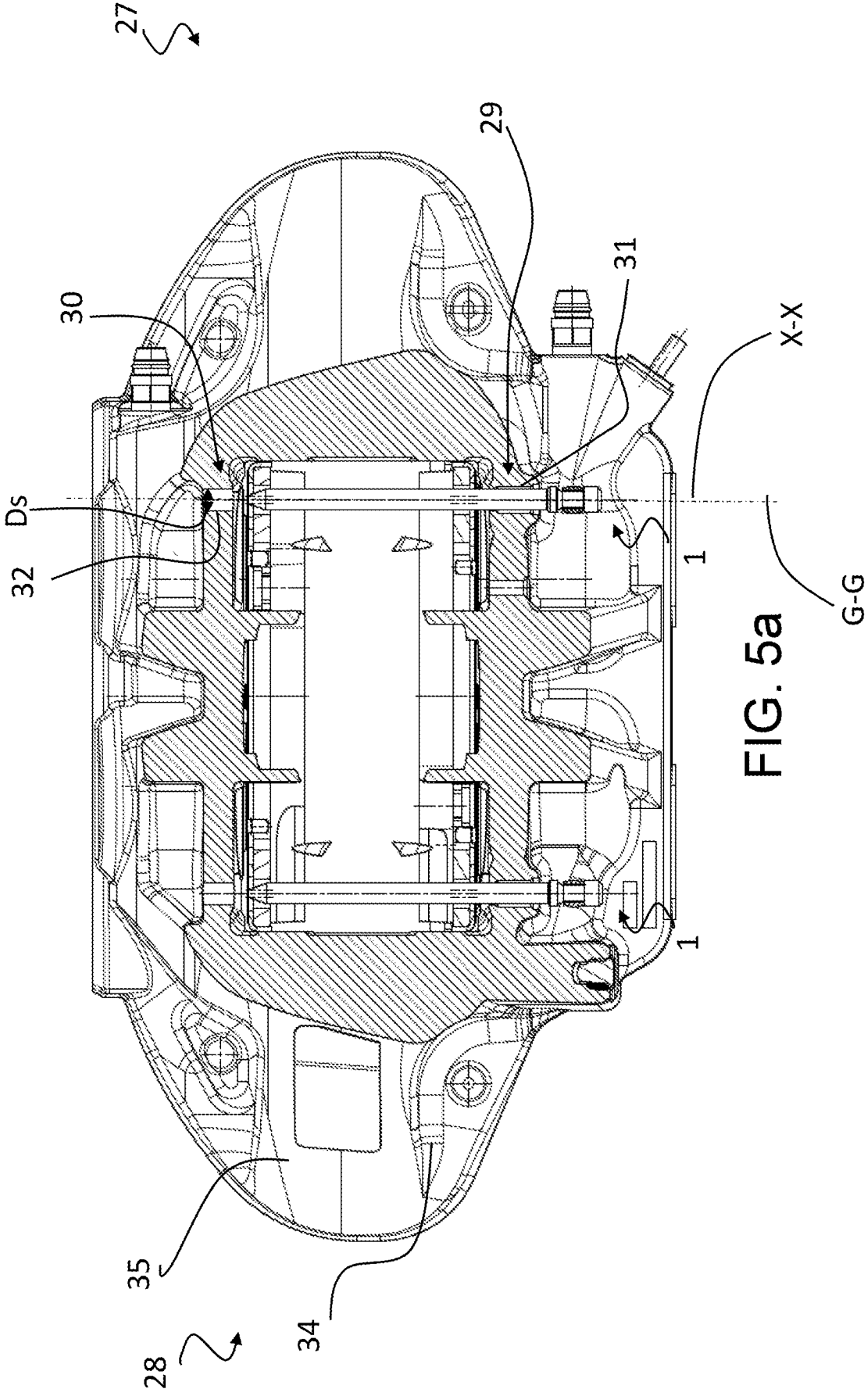
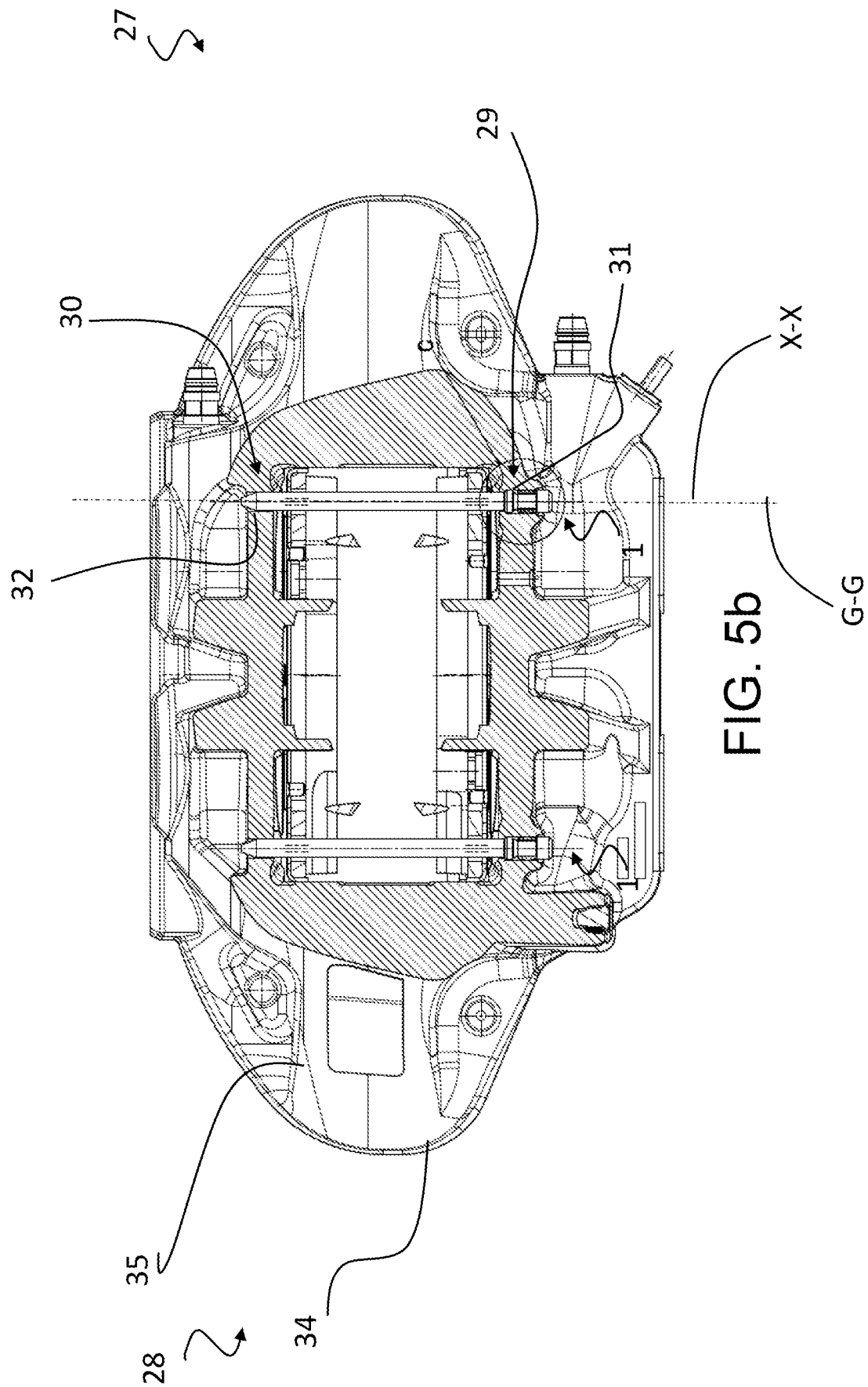
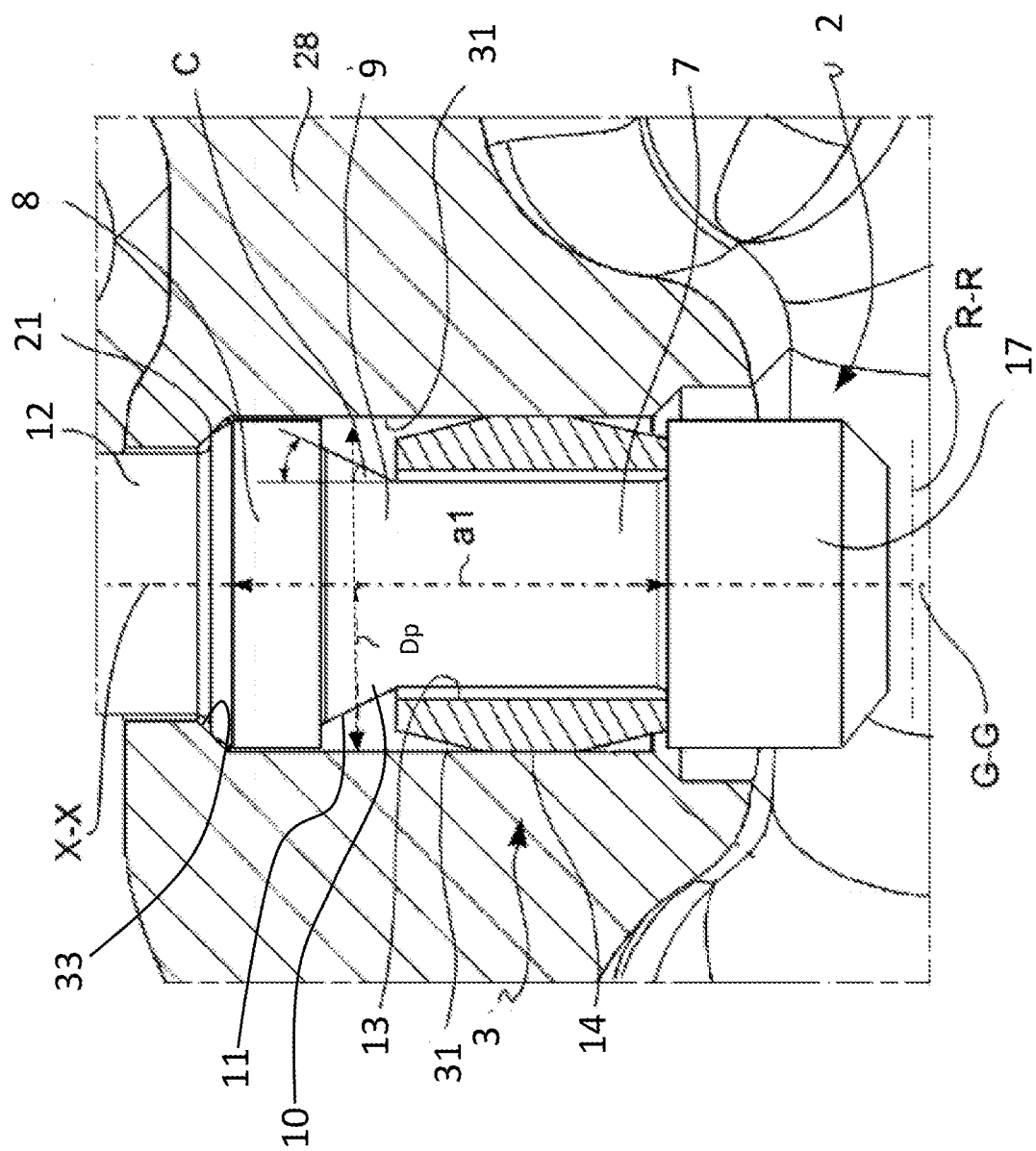


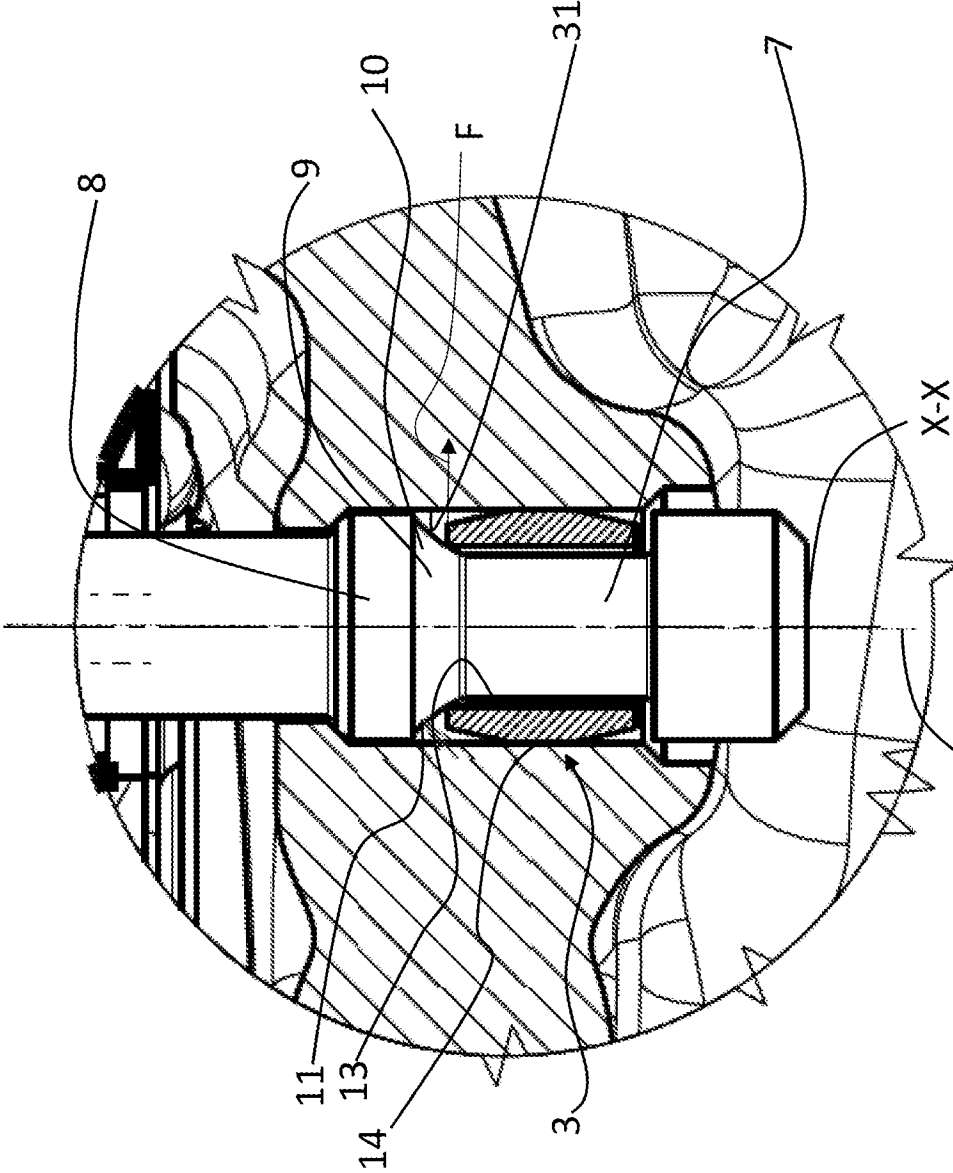
FIG. 4







6
G
L



G-G FIG. 7

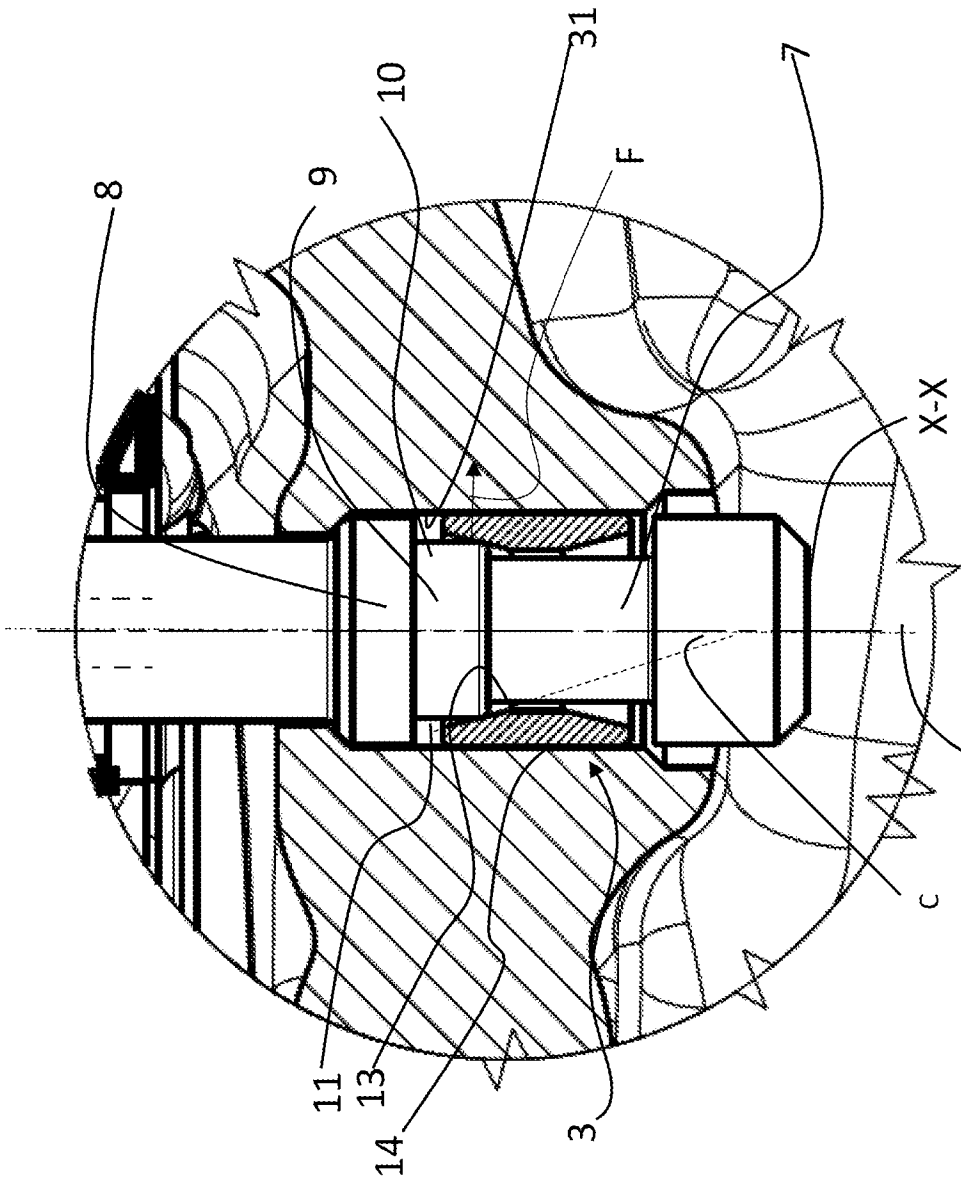


FIG. 8

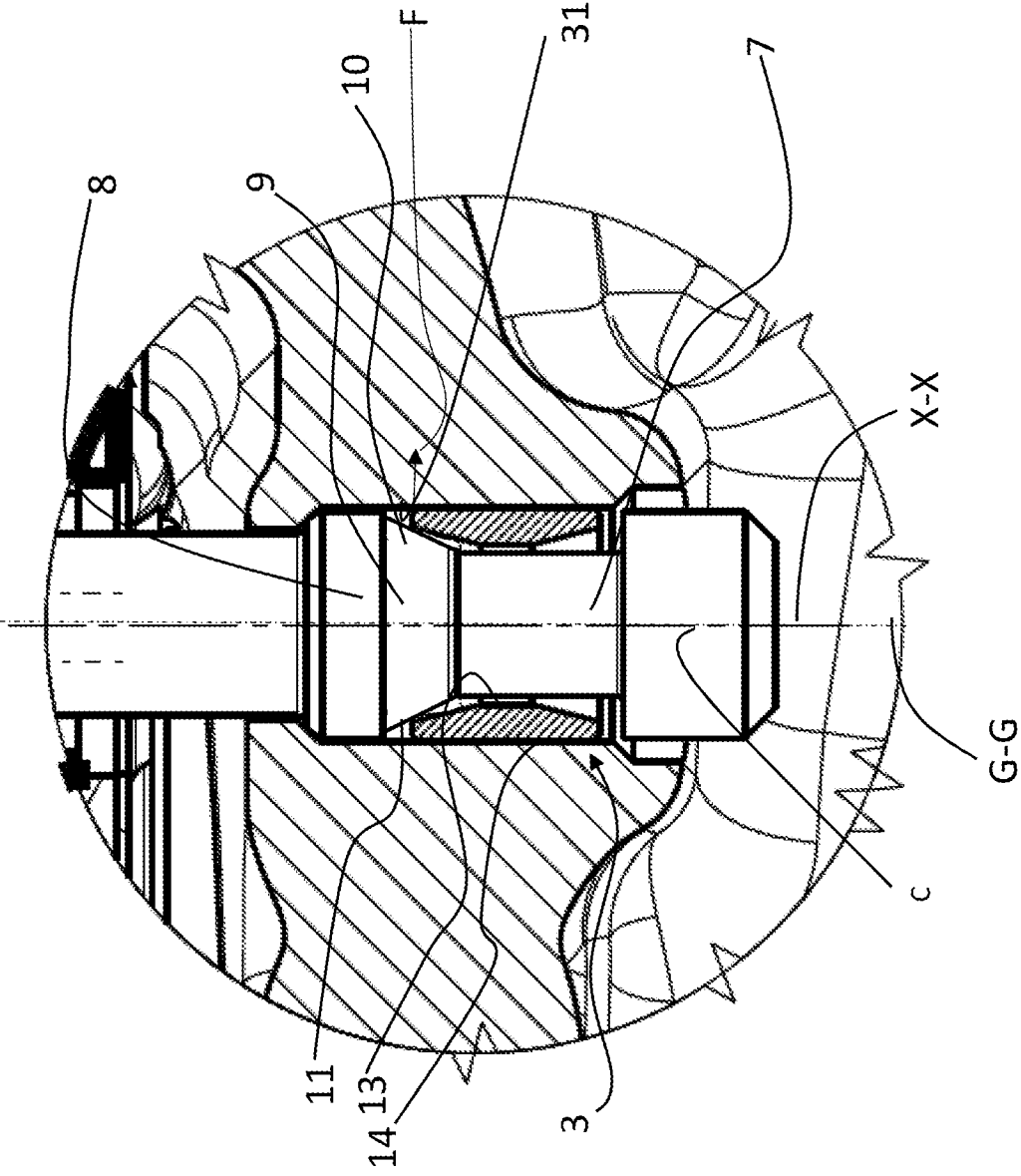
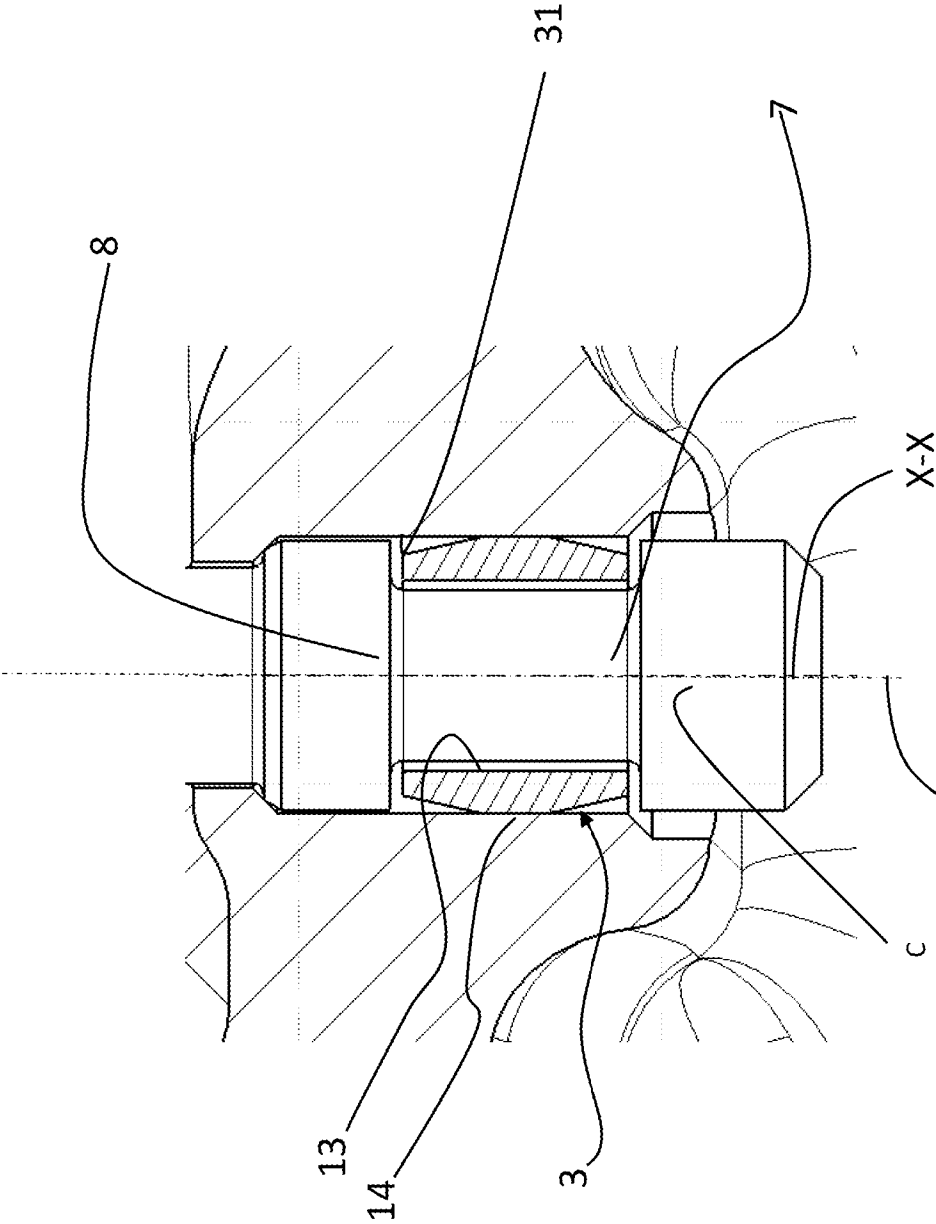


FIG. 9



G-G FIG. 10 PRIOR ART

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2021/060381

A. CLASSIFICATION OF SUBJECT MATTER
INV. F16D55/2265 F16D55/227 F16D65/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F16D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	18 April 1978 (1978-04-18)	
	column 2, line 62 - column 3, line 20;	5
	figures 1, 2, 5	

X	US 4 279 331 A (LUEPERTZ HANS-HENNING)	1-4, 6-10
A	21 July 1981 (1981-07-21)	
	figures 1, 2	5

A	US 4 678 210 A (BALSELLS PETER J [US])	1, 10
	7 July 1987 (1987-07-07)	
	the whole document	

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

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Date of the actual completion of the international search

28 February 2022

Date of mailing of the international search report

11/03/2022

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2021/060381

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