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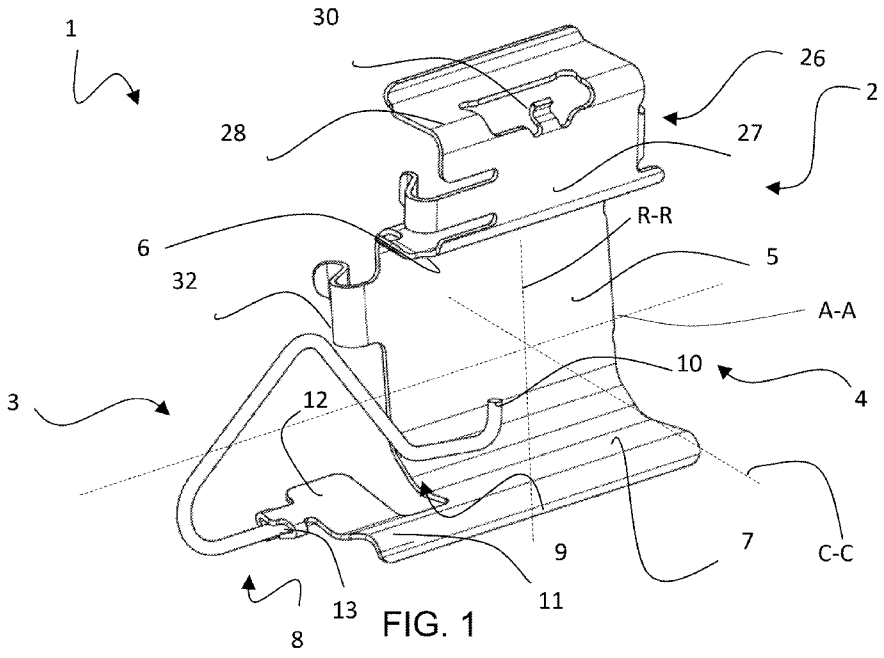

FIG. 1

(57) Abstract: A pad-holding and pad return spring assembly (1) for a disc brake assembly (100), said assembly (1) comprising at least one pad- holding spring (2) and pad return spring (3), wherein said pad-holding spring and said pad return spring are made as separate pieces and are operatively connected, wherein said pad-holding spring comprises at least one C-shaped section (4), wherein said C-section is adapted to be inserted into a recess (106) of said support (101) and is adapted to accommodate the guiding ear (111) of a brake pad (103), wherein said brake pad return spring comprises an anchoring portion (8) operatively connected to said C-shaped section, and a spring return arm (9) operatively connected to said anchoring portion and having a spring return arm end configured to engage said brake pad.

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[Continued on next page]

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"Pad-holding and pad return spring assembly, pad assembly, disc brake assembly"

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DESCRIPTION

[0001]. Field of the invention

[0002]. The present invention relates to a brake caliper spring assembly capable of biasing a brake pad in axial, circumferential, and radial directions to reduce vibration and move the pad away from the brake disc when braking is completed to eliminate or reduce residual torque between the friction material and the brake disc.

[0003]. Background art

[0004]. Disc brake spring assemblies configured to elastically hold and affect at least one brake pad in a brake caliper are known.

[0005]. In particular, the documents **US20180223928, US 9677629, US8869950,** and **CN207989608U** show spring assemblies having a pad-holding spring operatively connected to a pad return spring.

[0006]. Usually, the pad-holding springs hold the pads inside their housings in the brake caliper without limiting their movement in the axial direction to reduce vibrations.

[0007]. The pad return spring instead biases the pads away from the brake disc to reduce or eliminate a residual braking torque (residual torque) due to undesired contacts between the pads and the brake disc with the brake deactivated.

[0008]. Some known solutions include spring assemblies in which the pad-holding spring is made in one piece with the pad return

spring. Such springs are made from a single piece of shaped and bent sheet metal and thus for each different field of application of the disc brake it is necessary to make different types of springs. Such solutions are particularly disadvantageous in terms of production costs, as a specific spring assembly is required for each different disc brake application.

[0009]. Other well-known solutions comprise spring assemblies in which the pad-holding spring and pad return spring are made starting from separate shaped and bent pieces of sheet metal, and are assembled afterward. In this manner, the pad return springs can be customized according to the application requirements of the braking system. However, the use of axial disc springs, particularly in high-performance brake applications, raises issues of space and weight gain that negatively affect the performance of the vehicle on which the brake is mounted.

[0010]. Furthermore, it has been found that in some known solutions, at least a portion of the pad return spring slides on a respective portion of the pad-holding spring in the movements of approaching the brake pad to the disc and/or in the movements of moving the brake pad away from the disc. Such a sliding generates friction and consequently has a negative effect on braking efficiency, on the service life of the axial spring, on the reliability of the axial spring, and in particular it can induce a movement of the pad away from the decelerated disc, resulting in uneven wear of the brake pad.

[0011]. Therefore, a need arises for new spring assemblies, pad

assemblies, and brake caliper assemblies which can simultaneously offer, during the step of braking, in particular efficient performance in reducing, or even suppressing, any residual torque at the end of braking, as well as vibration and noise minimization properties and at the same time allow a high adaptability and ease of modification to be used in various fields of application and desired performance of disc brakes without affecting time and costs in the step of designing and manufacturing.

[0012]. Therefore, the problem underlying the present invention is to devise a spring assembly, a pad assembly, and a brake caliper assembly, which have structural and functional features such to satisfy the aforementioned requirements and, at the same time, solve the drawbacks mentioned with reference to the prior art and satisfy the aforesaid felt needs.

[0013]. Solution

[0014]. It is an object of the present invention to provide a pad-holding spring and a pad return spring assembly, as well as a brake pad assembly, a floating disc brake assembly, which makes it possible to reduce if not eliminate residual torque once a braking action is completed.

[0015]. These and other purposes and advantages are achieved with a pad-holding spring and a pad return spring assembly according to claim **1**, as well as a brake pad assembly according to claim **9**, and a floating disc brake assembly according to claim **12**.

[0016]. Some advantageous embodiments are the object of the dependent claims.

[0017]. The analysis of this solution showed that the suggested solution achieves a higher residual torque reduction between the brake pad and brake disc than the solutions of the prior art, thus a reduction in uneven brake pad wear events and in particular a reduction in maintenance events.

[0018]. Furthermore, the suggested solution maintains a very high braking efficiency if not even improved, e.g., the efficiency is greatly improved by virtue of the absence of frictional contact between the pad return spring and the pad-holding spring.

[0019]. Additionally, the suggested solutions make it possible to increase the service life of the pad-holding spring and pad return spring assembly compared to known solutions and to drastically reduce maintenance interventions.

[0020]. Even further, by virtue of the proposed solutions, it is possible to guarantee simple spring assembly solutions according to the desired braking performance, maintaining a uniform pad-holding spring for various applications and modifying the pad return spring according to the applications. In particular, it is possible to supply different diameters of pad return springs according to the required applications in an extremely simple manner.

[0021]. Even further, by virtue of the suggested solutions, it is possible to avoid modifying the layout of the disc brake assembly on which the pad return spring and pad-holding spring assembly is mounted.

[0022]. Even further, by virtue of the suggested solutions, by preloading the pad return spring in the radial direction, it is

possible to increase the stability of contact between the pad return spring and the brake pad, while avoiding sliding with friction between the pad return spring and the pad-holding spring on which the pad slides, and at the same time maximizing the axial force which pushes the pad away from the brake disc.

[0023]. Even further, by virtue of the suggested solutions, by virtue of the portion of the pad-holding spring to which the pad return spring is connected, it is possible to guarantee, in conditions of advanced pad wear, an additional contribution to the axial force which moves the pad away from the brake disc.

[0024]. Figures

[0025]. Further features and advantages of the spring assembly, the pad assembly, and the disc brake assembly will be apparent from the following description of its preferred embodiments, given by way of non-limiting examples, with reference to the accompanying figures, in which:

[0026]. - figure 1 is an axonometric view of a pad-holding spring and pad return spring assembly according to the present invention;

[0027]. - figure 2 shows in a partial section side view of a disc brake assembly according to the present invention comprising a support, at least one brake pad, a floating caliper, a brake disc, and an assembly in figure 1 connected to said support and said brake pad;

[0028]. - figure 3 is an axonometric view of the assembly of figure 1 comprising a pad-holding spring connected to the support of the disc brake assembly and a pad return spring;

[0029]. - figure 4 shows an enlargement of the pad return spring in figure 3;

[0030]. - figure 5 shows an axonometric view of the assembly of figure 3, in which the pad-holding spring is interposed between the support of the disc brake assembly and a brake pad;

[0031]. - figure 6 shows an axonometric view of an embodiment of a brake pad connectable to an assembly according to the present invention;

[0032]. - figure 7 shows in a section view of a disc brake assembly according to the present invention in which the pad return spring is connected to the brake pad of figure 6;

[0033]. - figure 8 shows an axonometric view of a further embodiment of a brake pad connectable to an assembly according to the present invention;

[0034]. - figure 9 shows a section view of a disc brake assembly according to the present invention in which the pad return spring is connected to the brake pad of figure 8;

[0035]. - figure 10 shows an axonometric view of a further embodiment of a pad-holding spring and pad return spring assembly, according to the present invention.

[0036]. Description of some preferred embodiments

[0037]. According to a general embodiment, a pad-holding spring and pad return spring assembly 1 for a disc brake assembly 100 is provided.

[0038]. Said assembly 1 defines an axial direction A-A, a radial direction R-R perpendicular to said axial direction A-A, and a

circumferential or circumferential direction C-C perpendicular to both said axial direction A-A and said radial direction R-R.

[0039]. According to an embodiment, said axial direction A-A is parallel to a rotational axis of brake disc 102 of a disc brake assembly 100.

[0040]. Said assembly 1 comprises at least one pad-holding spring 2 and at least one pad-return spring 3, made of different semi-finished products and operatively connected afterward.

[0041]. Said pad-holding spring 2 is configured to be arranged between at least one guiding ear 111 of a brake pad 103 of the disc brake assembly 100 and a support 101 of the disc brake assembly 100 to bias said brake pad 101 in radial direction R-R and circumferential direction C-C.

[0042]. Said pad return spring 3 is configured to bias said brake pad 101 in the axial direction A-A away from a disc 102 of the disc brake assembly 100.

[0043]. Said pad-holding spring 2 has a prevailing development in radial R-R and circumferential C-C.

[0044]. Said pad-holding spring 2 comprises at least one C-shaped section 4. Said C-shaped section 4 comprises a central portion 5, an upper portion 6, and a lower portion 7. The central surface 5 extends substantially in the radial direction R-R. The upper portion 6 and the lower portion 7 which extend substantially in the circumferential direction C-C extending from two opposite ends of the central portion 5.

[0045]. Said C-shaped section 4 is adapted to be inserted into a recess 106 of said support 101 and is adapted to accommodate said guiding ear 111.

[0046]. Said pad return spring 3 has a prevailing development in axial direction A-A and radial direction R-R and comprises an anchoring portion 8 and an elastic return arm 9.

[0047]. Said anchoring portion 8 is operatively connected to said C-shaped section 4 which extends from said C-shaped section 4 in axial direction A-A with a first orientation opposite to said disc 102.

[0048]. Said elastic return arm 9 is operatively connected to said anchoring portion 8 and has an elastic return arm terminal end 10.

[0049]. Said elastic return arm 9 extends from said anchoring portion 8 along an elastic return arm longitudinal direction oriented in a prevalently axial direction A-A with a second orientation concordant with said disc 102, opposite to said first direction.

[0050]. Said elastic return arm end 10 is configured to engage said brake pad 103.

[0051]. Said elastic return arm 9 is elastically movable in an axial direction A-A between at least one advanced position towards said disc 102, protracted along said second direction, and a resting position retracted with opposite orientation.

[0052]. Said spring return pad 3 is made from at least one wire. Said wire is bent, i.e., said pad return spring 3 is shaped so that

each position of said spring return arm 9, during normal operation, said spring return arm 9 is spaced from any portion of said pad-holding spring 2 and from said anchoring portion 8 of said pad return spring 3.

[0053]. Within this description, said first direction and said second direction mean two opposite axial direction directions A-A. For example, the C-shaped section is bounded axially by a first edge and a second edge, where the first edge is facing in the axial direction A-A in agreement with the first direction and said second edge vice versa. For the sake of ease of understanding, even when referring to assembly 1 only, second direction means the direction directed toward a brake disc and first direction means the opposite direction.

[0054]. According to an embodiment, in each position of said spring return arm 9, during its normal operation, said spring return arm 9 is spaced in the radial direction R-R from said lower portion 7 of said C-shaped section 4.

[0055]. According to an embodiment, in each position of said spring return arm 9, during its normal operation, said spring return arm 9 is spaced in the circumferential direction C-C from said upper portion 6 of said C-shaped section 4.

[0056]. Advantageously, by virtue of the provision of a guaranteed minimum distance between the elastic return arm 9 of the pad return spring 3 and any portion of the pad-holding spring 2 on which the brake pad 103 may slide in advancement and retraction, any contact between the pad return spring 3 and the pad-holding spring 2 can be

avoided, and therefore, by avoiding the occurrence of sliding events with friction, it is possible to maximize the force along the axial direction A-A with which the pad return spring 3 biases the brake pad away from the brake disc 102.

[0057]. With further advantage, the provision of a pad return spring made of wire, makes it possible to maximize the stiffness of the pad return spring, maximize the force exerted in the axial direction A-A, and at the same maximum force applied in the axial direction A-A it is possible to reduce the overall dimensions and weight of the assembly 1 compared to solutions in which the pad return spring is made of shaped and bent plate.

[0058]. According to an embodiment, the central portion 5 extends along said radial direction R-R to affect said pad 103 in the circumferential direction C-C.

[0059]. According to an embodiment, the upper portion 6 extends into in circumferential direction C-C, to bias said pad 103 in radial direction R-R.

[0060]. According to an embodiment, the lower portion 7 extends in circumferential direction C-C to bias said pad 103 in radial direction R-R.

[0061]. According to an embodiment, said pad return spring 3 is preloaded in a radial direction R-R so that in each position of said spring return arm 8, during its normal operation, said spring return arm 9 is free to slide in an axial direction A-A without interfering with each portion of said pad-holding spring 2 and with said anchoring portion 8.

[0062]. According to an embodiment, said elastic return arm end 10 has a contact wall which is configured to constantly come into contact with at least one pad edge 110 of a side edge of pad 107.

[0063]. According to an embodiment, said contact wall is facing in a radial direction R-R towards said upper portion 6 of said C-shaped section 4 of said pad-holding spring 2 and in an axial direction A-A in said first direction opposite to said disc 102.

[0064]. According to an embodiment, said pad return spring 3 is preloaded in a radial direction R-R so that in each position of said spring return arm 8, during its normal operation, said spring return arm 9 is constantly in contact with said brake pad 103.

[0065]. According to an embodiment, said elastic return arm end 10 is hook-shaped.

[0066]. According to an embodiment, said pad-holding spring 2 comprises a first cantilevered portion 11 operatively connected to said lower portion 7. Said first cantilevered portion 11 extends cantilevered in axial direction A-A in said first direction, opposite to said brake disc 102.

[0067]. According to a first embodiment, said pad-holding spring 2 comprises a second cantilevered portion 12 operatively connected to said first cantilevered portion 11, which extends in a circumferential direction C-C, wherein said anchoring portion 8 of said pad-holding spring 2 is fixed to said second cantilevered portion 12.

[0068]. According to an embodiment, said second cantilevered portion 12 extends in a circumferential direction C-C towards said

central portion 5 of said C-shaped section 4.

[0069]. According to an embodiment, said second cantilevered portion 12 is elastically movable in a radial direction R-R between a resting position and at least one raised position in direction of said upper portion 6 of said pad-holding spring 2 so that when said spring return arm 9 is biased in an axial direction A-A beyond a threshold limitation in the approaching direction to said brake disc 102, said second cantilevered portion 12 moves from said resting position in a radial direction R-R towards said upper portion 6 of said C-shaped section 4. In this manner, an additional axial direction A-A reaction force can be provided.

[0070]. According to an embodiment, such first cantilevered portion 11 is substantially coplanar to said lower portion 6 of said C-shaped section 4, wherein said second cantilevered portion 12 is arranged at a lower position in the radial direction R-R than said lower portion 6 of said C-shaped section 4.

[0071]. According to an embodiment, said first cantilevered portion 11 is connected to said second cantilevered portion 12 by an inclined portion in a radial and circumferential direction.

[0072]. According to an embodiment, said first cantilevered portion 11 and said second cantilevered portion 12 form an L.

[0073]. According to an embodiment, said second cantilevered portion 12 has an engagement wall 13 facing in a radial direction R-R on the opposite side from said upper portion of said C-shaped section 4.

[0074]. According to an embodiment, said anchoring portion 8 of

said pad return spring 3 is anchored to said engagement wall 13 of said pad-holding spring 2.

[0075]. According to an embodiment, said anchoring portion 8 is arranged below said second cantilevered portion 12 in a radial direction, i.e., in a direction opposite to said upper portion 6.

[0076]. According to an embodiment, said second cantilevered portion 12 comprises a coupling member 14 which extends in an axial direction A-A with said first orientation, opposite to said brake disc 102, wherein said coupling member 14 comprises a pair of coupling tabs 15 configured to clamp said anchoring portion 8 of said pad return spring 3.

[0077]. According to an embodiment, said anchoring portion 8 of said pad spring return 3 is either riveted or welded to said second cantilevered portion 12.

[0078]. Advantageously, in the phases of advanced wear of the brake pads, the deformation of said first cantilevered portion 11 and said second cantilevered portion 12 allows the increase in load in the axial direction A-A to be contained.

[0079]. According to an embodiment, said pad-holding spring 2 comprises an L-shaped section 26 operatively connected to said C-shaped section 4 seamlessly and configured to engage said pad-holding spring to a support 102.

[0080]. According to an embodiment, said L-shaped section 26 comprises a first support portion 27 operatively connected perpendicularly to a second support portion 28.

[0081]. According to an embodiment, the first support portion 27

extends perpendicularly from said upper portion 6 of said C-shaped section 4 to make with said upper portion 6 and with said second support portion 28 a U-shaped section having concavity opposite to said C-shaped section 4.

[0082]. According to an embodiment, the central portion 5 of said C-shaped section 4 comprises a first retaining element 29 which extends cantilevered in a circumferential direction C-C outside the concavity of said C-shaped section 4.

[0083]. According to an embodiment, said L-shaped section 26 comprises an opening between said first support portion 27 and said second support portion 28 and said first support portion 27 comprises a second retaining element 30 which extends cantilevered in a circumferential direction C-C in said opening.

[0084]. According to an embodiment, said first support portion 27 comprises a pair of retaining elements which protrude from opposite edges in a circumferential direction C-C within said L-shaped section 26.

[0085]. According to an embodiment, said elastic return arm end longitudinal direction is S-shaped.

[0086]. According to an embodiment, said spring return pad 3 has a convex portion 16 which develops from said anchoring portion 8 along said spring return arm longitudinal direction and a concave portion 17 operatively connected to said convex portion 16, wherein said concave portion 17 has concavity facing towards said upper portion 6 of said C-shaped section 4, and said convex portion 16 has a concavity facing the opposite side, facing at least partially

towards said lower portion 7 of said C-shaped section 4.

[0087]. According to an embodiment, said elastic return arm 9 comprises in succession, starting from said anchoring portion 8 along said elastic return arm longitudinal direction, a first curved section 18, a first rectilinear section 19, a second curved section 20, a second rectilinear section 21, a third curved section 22, a third rectilinear section 23, a fourth curved section 24.

[0088]. According to an embodiment, said spring return pad 3 extends along said longitudinal direction of elastic return arm in a single plane.

[0089]. According to an embodiment, each portion of said return spring 3 extends in a plane orthogonal to said circumferential direction C-C.

[0090]. According to an embodiment, said spring return arm 9 is connected to said anchoring portion 8 with a first connecting radius R1, wherein the extensions of said spring return arm 9 and said anchoring portion 8 form an angle of fewer than 90 degrees.

[0091]. According to an embodiment, said elastic return arm 9 comprises a first rectilinear section 19 connected to a second rectilinear section 21 with a second connecting radius R2, wherein extensions of said first rectilinear section 19 and said second rectilinear section 21 form an angle of not less than 90 degrees.

[0092]. According to an embodiment, wherein said elastic return arm 9 comprises a second rectilinear section 21 connected to a third rectilinear section 23 with a third connecting radius R3, wherein the extensions of said second rectilinear section 21 and said third

rectilinear section 23 form an acute angle.

[0093]. According to an embodiment, said pad return spring 3 is a circular cross-section spring.

[0094]. Advantageously, according to the size of the diameter of the pad return spring 3, and on the first connection radius R1 defined in the design phase, it is possible to make pad return springs 3 adapted to specific fields of braking application which can be operatively connected to a previously described pad-holding spring of standard dimensions for different fields of braking application.

[0095]. According to an embodiment, said assembly comprises two pad return springs 2 as previously described, two pad return springs 3 as previously described, and a bridge-like portion 25 which connects said pad return springs 2 to said pad return springs 3. Wherein each pad-holding spring 2 and each pad return spring 3 work on respective brake pad 3.

[0096]. According to an embodiment, said spring return pad 3 is made with two parallel wires side by side in the circumferential direction C-C.

[0097]. The present invention further relates to a brake pad assembly 100 for a disc brake assembly 100 which comprises at least one assembly 1 as previously described and at least one brake pad 103 to which said assembly 1 is connectible.

[0098]. According to an embodiment, said brake pad 103 comprises friction material 105 and a support plate 104 which supports said friction material 105, wherein said support plate 104 comprises at

least one guiding ear 111 protruding laterally in a circumferential direction C- C.

[0099]. According to an embodiment, said C-shaped section 4 of said pad-holding spring 2 is configured to accommodate said guiding ear 111 to bias said pad 103 in a circumferential direction C-C and a radial direction R-R.

[00100]. According to an embodiment, said elastic return arm terminal end 10 of said pad return spring 3 is configured to engage said guiding ear 111 to bias said pad 103 in a distancing direction away from a brake disc 102.

[00101]. According to an embodiment, said brake pad 103 comprises a first ear side edge 112 which laterally delimits said guiding ear 111 in circumferential direction C-C and radial direction R-R, wherein said ear side edge 112 comprises a pad edge 110.

[00102]. According to an embodiment, when said assembly 1 is connected to said brake pad 103, said pad edge 110 faces said lower portion 7 of said C-shaped section 4 of said pad-holding spring 2 in radial direction R-R and faces said brake disc 102 in the axial direction A-A.

[00103]. According to an embodiment, said side ear edge 112 can is insertable in said C-shaped section 4.

[00104]. According to an embodiment, said ear side edge 112 comprises a circumferential edge portion 116 which extends in a circumferential direction C-C and a radial edge portion 117 which extends in a radial direction R-R.

[00105]. According to an embodiment, said radial edge portion 116

faces said central portion 5 of said C-shaped section 4.

[00106]. According to an embodiment, said circumferential edge portion 117 even comprises said pad edge 110.

[00107]. According to an embodiment, said spring return arm 9 is engaged, or engageable, with said pad edge 110, and movements in the circumferential direction of said spring return arm 9 are limited by the presence of said radial edge portion 116.

[00108]. According to an embodiment, said elastic return arm terminal end 10 is engageable at least to said pad edge 110 to bias said pad 103 in axial direction A-A constantly with the orientation opposite to said friction material 105.

[00109]. According to an embodiment, said guiding ear 111 comprises a guiding ear rear surface 113 which faces the opposite side of said friction material 105 and a first ear front surface 114 which faces the same side of said friction material 105, wherein said first ear front surface 113 comprises a first ear recess 115, wherein said first ear recess 115 comprises said pad edge 110.

[00110]. According to an embodiment, wherein said elastic return arm end 9 can be completely housed in said first ear recess 115 at least when said friction material 105 is completely worn so that said elastic return arm end 9 does not interfere with said brake disc 102.

[00111]. The present invention also relates to a disc brake assembly 100 comprising at least one pad assembly as described above.

[00112]. Said disc brake assembly 100 comprises a support 101 which

can be connected in a fixed manner to a vehicle facing a rotating brake disc, wherein said support comprises at least one brake pad housing pocket, wherein said housing pocket comprises at least one recess 106.

[00113]. Said pad-holding spring is interposed at least between said guide ear 111 and said recess 106.

[00114]. Said disc brake assembly 100 comprises a brake caliper connected in a floating manner to said support, said brake caliper being configured to be arranged straddling said brake disc 102 and to bias said brake pad 103 along said axial direction A-A approaching said brake disc 102 between at least one pad resting position and a pad braking position.

[00115]. Said elastic return arm terminal end 10 of said pad return spring 3 is engaged with said guiding ear 111 to bias it in the distancing direction away from said brake disc 102.

[00116]. Said pad return spring 3 is shaped so that, in each position of said brake pad 103, said elastic return arm 8 is spaced from each portion of said pad return spring 2 and said anchoring portion 7 of said pad return spring 3.

[00117]. According to an embodiment, said disc brake assembly 100 comprises a brake disc 102, wherein said floating caliper is arranged straddling said disc 102, wherein said brake disc (102) comprises a disc axis, wherein said axial direction A-A is parallel to said disc axis.

[00118]. According to an embodiment, said support 101 comprises a support protuberance 108, wherein said L-shaped section 26 is

engaged with said protuberance 108.

LIST OF REFERENCES

1	Pad-holding and pad return spring assembly
2	pad-holding spring
3	pad return spring
4	C-shaped section
5	central portion
6	upper portion
7	lower portion
8	anchoring portion
9	elastic return arm
10	elastic return arm end
11	first cantilevered portion
12	second cantilevered portion
13	engagement wall
14	coupling member
15	coupling tabs
16	convex portion
17	concave portion
18	first curved stretch
19	first rectilinear stretch
20	second curved stretch
21	second rectilinear stretch
22	third curved stretch
23	third rectilinear stretch
24	fourth curved stretch
25	bridge-like portion
26	L-shaped section
27	first supporting portion
28	second supporting section
29	first retaining element
30	second retaining element

100 disc brake assembly
101 support
102 brake disc
103 brake pad
104 backing plate
105 friction material
106 recess
107 brake pad side edge
108 support protuberance
109 brake caliper
110 pad edge
111 guiding ear
112 ear side edge
113 ear rear surface
114 ear front surface
115 ear recess
116 radial edge portion
117 circumferential edge portion

R1 first connection radius
R2 second connection radius
A-A axial direction
R-R radial direction
C-C circumferential or tangential direction

CLAIMS

1. A pad-holding and pad return spring assembly (1) for a disc brake assembly (100), wherein said assembly (1) defines an axial direction (A-A), a radial direction (R-R) perpendicular to said axial direction (A-A) and a circumferential or tangential direction (C-C) perpendicular to both said axial direction (A-A) and said radial direction (R-R), said assembly (1) comprising:

- at least one pad-holding spring (2) configured to be arranged between at least one guiding ear (111) of a brake pad (103) of the disc brake assembly (100) and a support (101) of the disc brake assembly (100) to bias said brake pad (101) in radial direction (R-R) and circumferential direction (C-C), and
- a pad return spring (3) configured to bias said brake pad (101) in the axial direction (A-A) away from a disc (102) of the disc brake assembly (100),

wherein said pad-holding spring (2) and said pad return spring (3) are made as separate pieces and are operatively connected,

wherein said pad-holding spring (2) has a prevailing development in radial (R-R) and circumferential (C-C) directions and comprises at least:

- a C-shaped section (4) comprising a central portion (5) which develops substantially in a radial direction (R-R) from the radially opposite ends of which an upper portion (6) and a lower portion (7) extend, which portions develop substantially in a circumferential direction (C-C), wherein said C-shaped section (4) is adapted to be inserted in a recess (106) of said support (101) and is adapted to

accommodate said guiding ear (111),

wherein said pad return spring (3) has a prevalent development in the axial (A-A) and radial (R-R) directions and comprises:

- an anchoring portion (8) operatively connected to said C-shaped section (4) which extends from said C-shaped section (4) in axial direction (A-A) with a first orientation opposite to said disc (102), and

- an elastic return arm (9) operatively connected to said anchoring portion (8) and having an elastic return arm terminal end (10) configured to engage said brake pad (103), wherein said elastic return arm (9) develops from said anchoring portion (8) along an elastic return arm longitudinal direction oriented in a prevalently axial direction (A-A) with a second orientation concordant with said disc (102), opposite to said first direction, wherein said elastic return arm (9) is elastically movable in an axial direction (A-A) between at least one advanced position towards said disc (102) and a resting position retracted with opposite orientation,

wherein said pad return spring (3) is made of at least one wire,

wherein said at least one wire is bent so that, in each position of said spring return arm (9), during normal operation, said spring return arm (9) is spaced from any portion of said pad-holding spring (2) and from said anchoring portion (8) of said pad return spring (3).

2. An assembly (1) according to the preceding claim, wherein said pad return spring (3) is preloaded in a radial direction (R-R) so

that in each position of said spring return arm (8), during its normal operation, said spring return arm (9) is free to slide in an axial direction (A-A) without interfering with each portion of said pad-holding spring (2) and with said anchoring portion (8).

3. An assembly (1) according to claim 1, wherein said spring return arm end (10) has a contact wall which is configured to be in constant contact with at least one pad edge (110) of a pad side edge (107), wherein said contact wall is facing in a radial direction (R-R) towards said upper portion (6) of said C-section (4) of said pad spring (2) and in an axial direction (A-A) with said first orientation opposite to said disc (102), and/or wherein said elastic return arm end (10) is hook-shaped.

4. An assembly (1) according to any one of the preceding claims, wherein said pad-holding spring (2) comprises a first cantilevered portion (11) operatively connected to said lower portion (7) extending cantilevered in an axial direction (A-A) with said first orientation, opposite to said brake disc (102), wherein said pad-holding spring (2) comprises a second cantilever portion (12) operatively connected to said first cantilever portion (11) which extends in a circumferential direction (C-C), wherein said anchoring portion (8) of said pad-retention spring (2) is fixed to said second cantilever portion (12).

5. An assembly (1) according to the preceding claim, wherein said second cantilever portion (12) is elastically movable in a radial direction (R-R) between a resting position and at least one raised position in direction of said upper portion (6) of said pad-holding spring (2), so that when said spring return arm (9) is biased in an axial direction (A-A) beyond a threshold limitation in the approaching direction of said brake disc (102), said second cantilever portion (12) moves from said resting position in a radial direction (R-R) towards said upper portion (6) of said C-shaped section (4), and/or wherein said first cantilevered portion (11) is substantially coplanar to said lower portion (6) of said C-shaped section (4), wherein said second cantilevered portion (12) is arranged in a lower position in a radial direction (R-R) relative to said lower portion (6) of said C-shaped section (4), and/or wherein said first cantilevered portion (11) is connected to said second cantilevered portion (12) by an inclined portion in a radial, circumferential direction.

6. An assembly (1) according to claim 4, wherein said second cantilever portion (12) has an engagement wall (13) facing in a radial direction (R-R) from the opposite side relative to said upper portion of said C-shaped section (4), wherein said anchoring portion (8) of said pad return spring (3) is anchored to said engagement wall (13) of said pad return spring (2),

and/or wherein said second cantilever portion (12) comprises a coupling member (14) which extends in an axial direction (A-A) with

said first orientation opposite to said brake disc (102), wherein said coupling member (14) comprises a pair of coupling tabs (15) configured to clamp said anchoring portion (8) of said pad return spring (3),

and/or wherein said anchoring portion (8) of said spring return pad (3) is either riveted or welded to said second cantilever portion (12).

7. An assembly (1) according to any one of the preceding claims, wherein said elastic return arm longitudinal direction has an S-shaped conformation, and/or wherein

said spring return pad (3) has a convex portion (16) which develops from said anchoring portion (8) along said spring return arm longitudinal direction and a concave portion (17) operatively connected to said convex portion (16), wherein said concave portion (17) has concavity facing towards said upper portion (6) of said C-shaped section (4), and said convex portion (16) has a concavity facing the opposite side, facing at least partially towards said lower portion (7) of said C-shaped section (4),

and/or wherein said elastic return arm (9) comprises in succession, starting from said anchoring portion (8) along said elastic return arm longitudinal direction, a first curved section (18), a first rectilinear section (19), a second curved section (20), a second rectilinear section (21), a third curved section (22), a third rectilinear section (23), a fourth curved section (24), and/or wherein

said pad return spring (3) develops along said elastic return arm longitudinal direction on a single plane, and/or wherein each portion of said return spring (3) develops on a plane orthogonal to said circumferential direction (C-C).

8. An assembly (1) according to claim 1, wherein said spring return arm (9) is connected to said anchoring portion (8) with a first connecting radius (R1), wherein the extensions of said spring return arm (9) and said anchoring portion (8) form an angle of less than 90 degrees,

and/or wherein said elastic return arm (9) comprises a first rectilinear section (19) connected to a second rectilinear section (21) with a second connecting radius (R2), wherein extensions of said first rectilinear section (19) and said second rectilinear section (21) form an angle of not less than 90 degrees,

and/or wherein said elastic return arm (9) comprises a second rectilinear section (21) connected to a third rectilinear section (23) with a third connecting radius (R3), wherein the extensions of said second rectilinear section (21) and said third rectilinear section (23) form an acute angle.

9. An assembly (1) according to any one of the preceding claims, comprising two pad-holding springs (2), two pad-return springs (3) and a bridge portion (25) which connects said pad-holding springs (2), and/or wherein said pad-return spring (3) is made with two parallel wires side by side, and/or wherein

- wherein said pad-holding spring (2) comprises an L-shaped section (26) operatively connected to said C-shaped section (4) without interruption, wherein said L-shaped section (26) comprises a first support portion (27) operatively connected perpendicularly to a second support portion (28), wherein said first support portion (27) extends perpendicularly from said upper portion (6) of said C-section (4) to make with said upper portion (6) and with said second support portion (28) a U-shaped section having concavity opposite to said C-shaped section (4), and/or wherein said central portion (5) of said C-shaped section (4) comprises a first retaining element (29) which extends cantilevered in a circumferential direction (C-C) outside the concavity of said C-shaped section (4) and/or wherein said L-shaped section (26) comprises an opening between said first support portion (27) and said second support portion (28), and said first support portion (27) comprises a second retaining member (30) which extends cantilevered in a circumferential direction (C-C) in said opening, and/or wherein said first support portion (27) comprises a pair of retaining elements projecting from opposite edges in a circumferential direction (C-C) within said L-shaped section (26).

10. A brake pad assembly (100) for a disc brake assembly (100) comprising at least one brake pad (103) and at least one assembly (1) according to any one of the preceding claims, wherein said assembly (1) is connectable to said brake pad (101),

wherein said brake pad (103) comprises friction material (105)

and a support plate (104) supporting said friction material (105), wherein said support plate (104) comprises at least one guiding ear (111) protruding laterally in a circumferential direction (C-C),

wherein said C-shaped section (4) of said pad-holding spring (2) is configured to accommodate said guiding ear (111) to bias said pad (103) in a circumferential direction (C-C) and a radial direction (R-R),

wherein said elastic return arm terminal end (10) of said pad return spring (3) is configured to engage said guiding ear (111) to bias said pad (103) in a distancing direction away from a brake disc (102).

11. A pad assembly according to the preceding claim, wherein said brake pad (103) comprises a first ear side edge (112) which laterally delimits said guiding ear (111) in circumferential direction (C-C) and in radial direction (R-R), wherein said ear side edge (112) comprises a pad edge (110),

wherein, when said assembly (1) is connected to said brake pad (103), said pad edge (110) faces in a radial direction (R-R) said lower portion (7) of said C-shaped section (4) of said pad-holding spring (2) and, in axial direction (A-A), faces in the direction of said brake disc (102),

wherein said side ear edge (112) can be inserted in said C-shaped section (4),

and wherein said elastic return arm terminal end (10) is engageable at least to said pad edge (110) to bias said pad (103) in

axial direction (A–A) constantly with the orientation opposite to said friction material (105).

12. A pad assembly (100) according to the preceding claim, wherein said guiding ear (111) comprises a guiding ear rear surface (113) which faces the opposite side of said friction material (105) and a first ear front surface (114) which faces the same side of said friction material (105), wherein said first ear front surface (113) comprises a first ear recess (115), wherein said first ear recess (115) comprises said pad edge (110),
wherein said elastic return arm end (9) is completely accommodated in said first ear recess (115) at least when said friction material (105) is completely worn so that said elastic return arm (9) does not interfere with said brake disc (102) and/or wherein said ear side edge (112) comprises a circumferential edge portion (116) which develops in a circumferential direction (C–C) and a radial edge portion (117) which develops in a radial direction (R–R), wherein said circumferential edge portion (116) comprises said pad edge (110), and wherein said radial edge portion (117) restricts the movements of said elastic return arm in the circumferential direction (C–C).

13. A disc brake assembly (100) comprising
– a support () which can be connected in a fixed manner to a vehicle () facing a rotating brake disc, wherein said support () comprises at least one brake pad housing pocket, wherein said housing pocket

comprises at least one recess (106),

- a pad assembly according to any one of claims 10 to 12, wherein said pad-holding spring () is interposed at least between said guiding ear (111) and said recess (106),

- a brake caliper () connected in floating manner to said support (), said brake caliper being configured to be arranged straddling said brake disc (102) and to bias said brake pad (103) along said axial direction (A-A) approaching said brake disc (102) between at least one pad resting position and a pad braking position,

- wherein said elastic return arm terminal end (10) of said pad return spring (3) is engaged with said guiding ear (111) to bias it in the distancing direction away from said brake disc (102),

wherein said pad return spring (3) is shaped so that, in each position of said brake pad (103), said elastic return arm (8) is spaced from each portion of said pad return spring (2) and from said anchoring portion (7) of said pad return spring (3).

14. A disc brake assembly (100) according to the preceding claim, comprising a brake disc (102), wherein said floating caliper is arranged straddling said disc (102), wherein said brake disc (102) comprises a disc axis, wherein said axial direction (A-A) is parallel to said disc axis, and/or

wherein said support (101) comprises a support protuberance (108), wherein said L-section (26) is engaged with said protuberance (108).

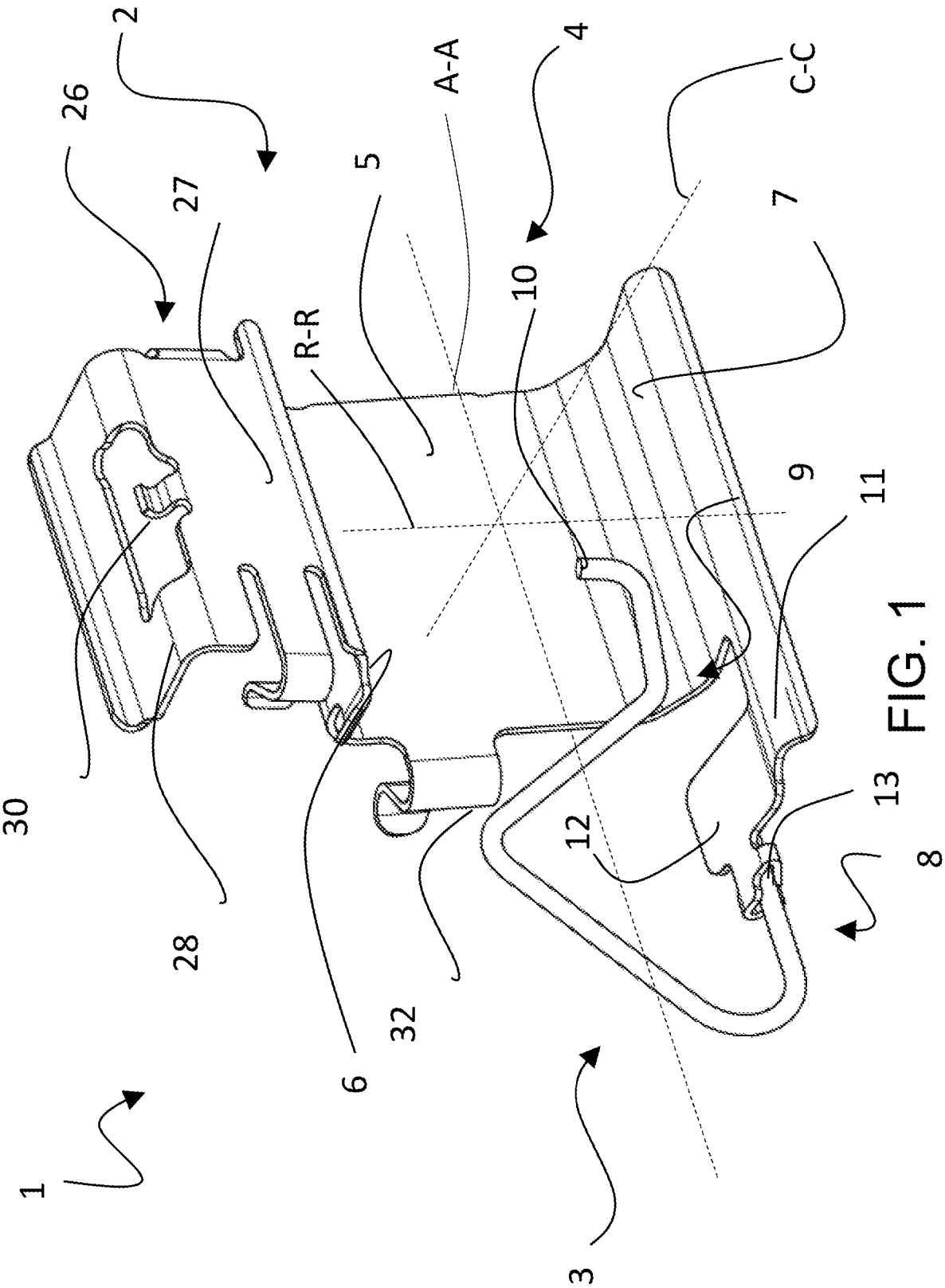

FIG. 1

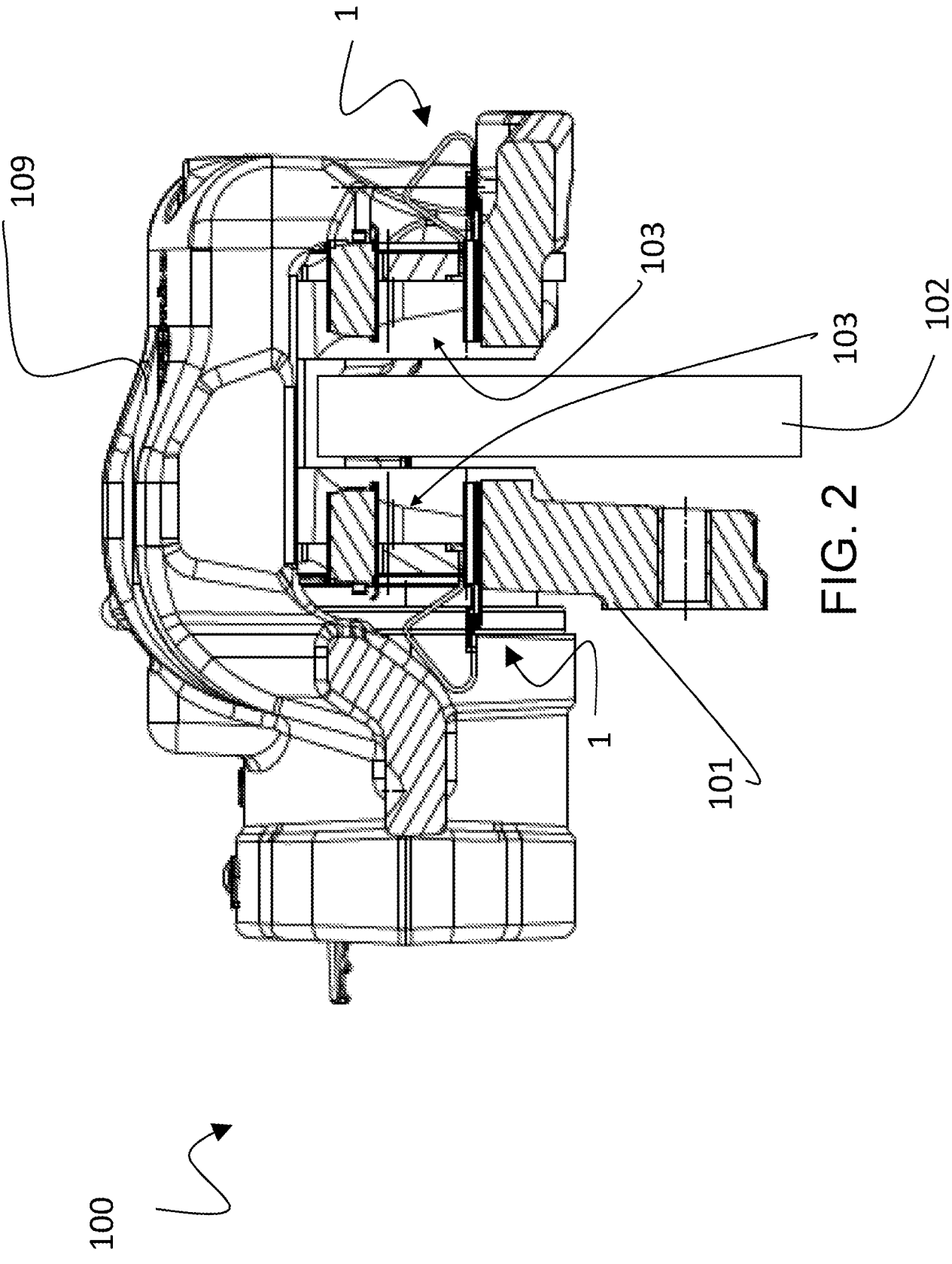

FIG. 2

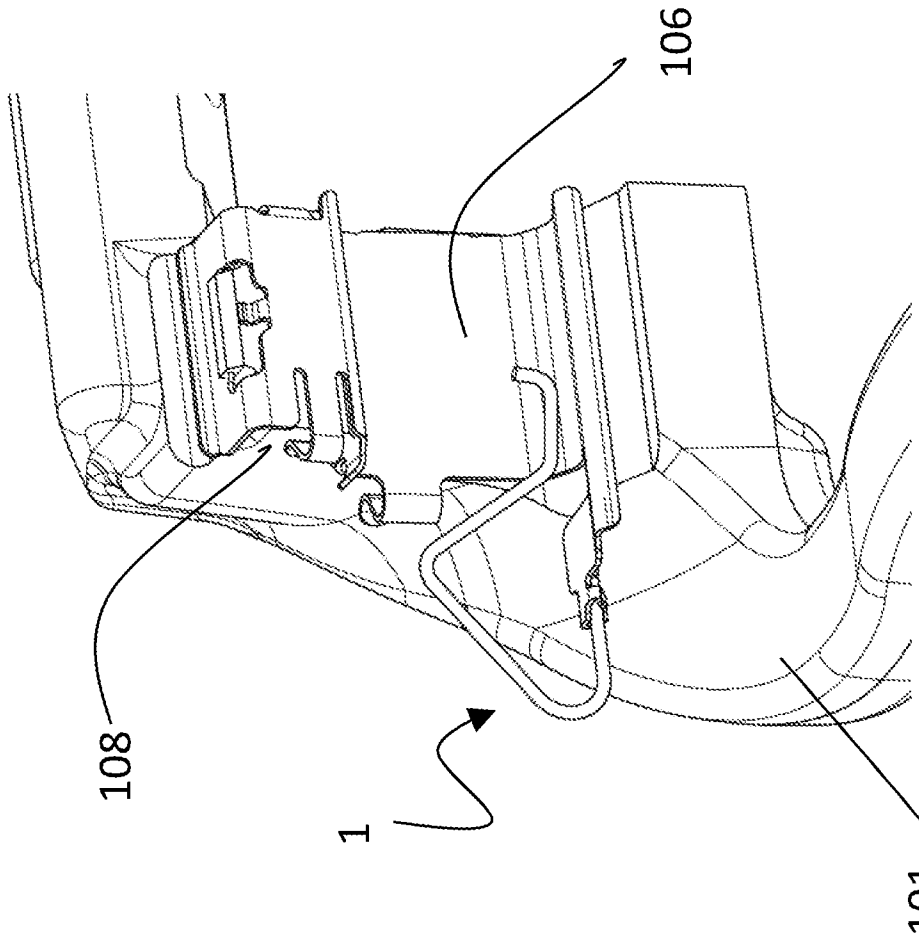

FIG. 3

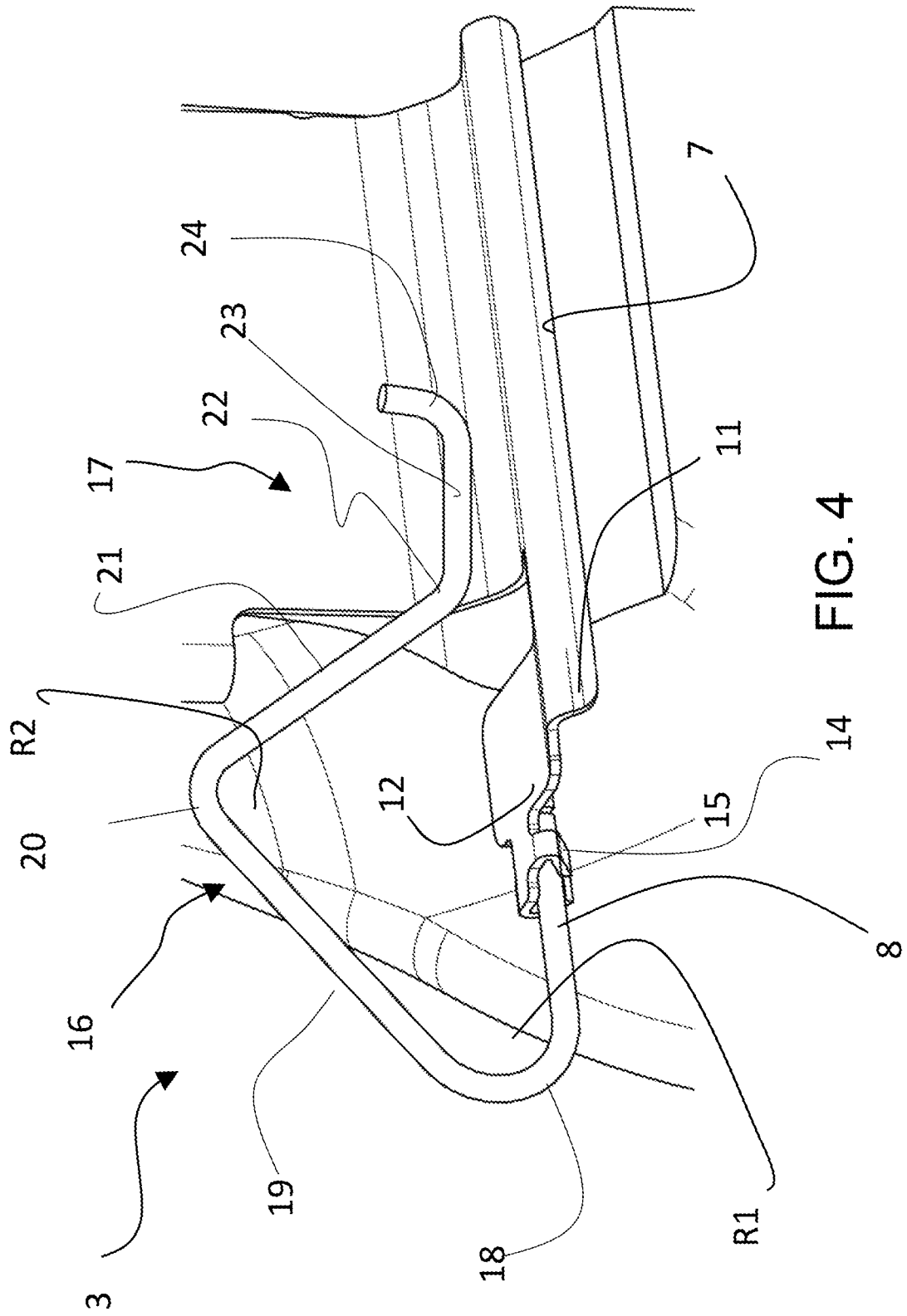

FIG. 4

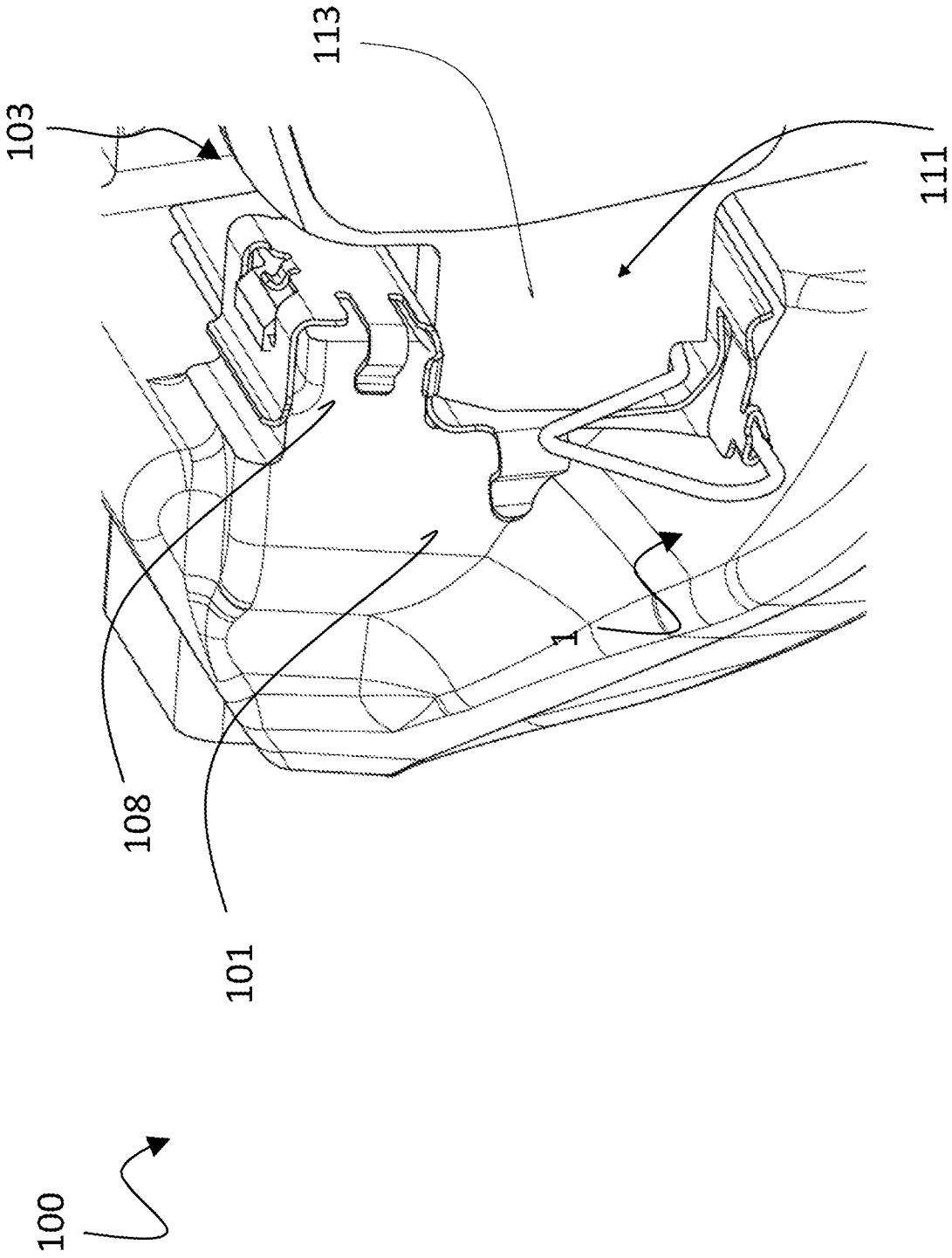

FIG. 5

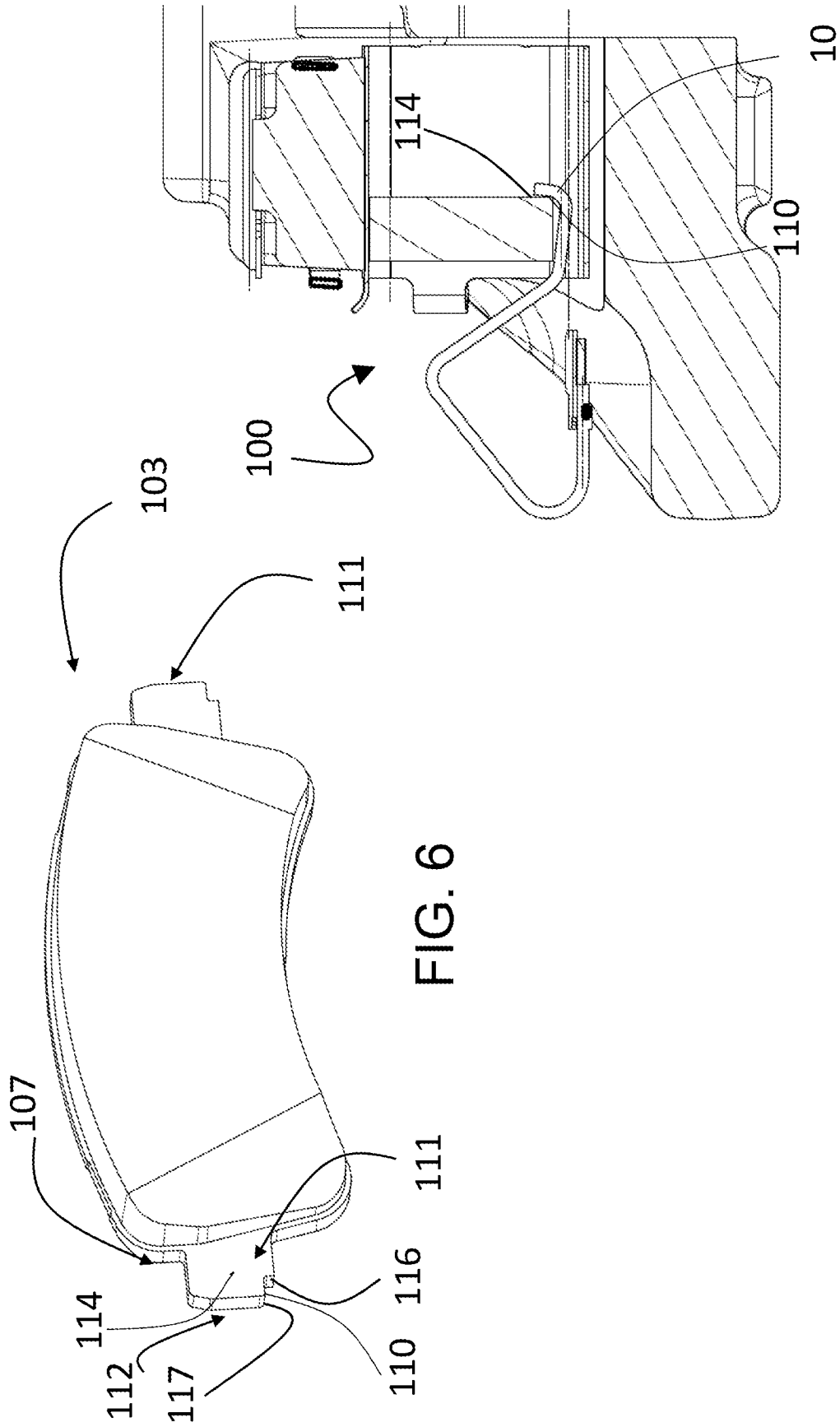

FIG. 6

FIG. 7

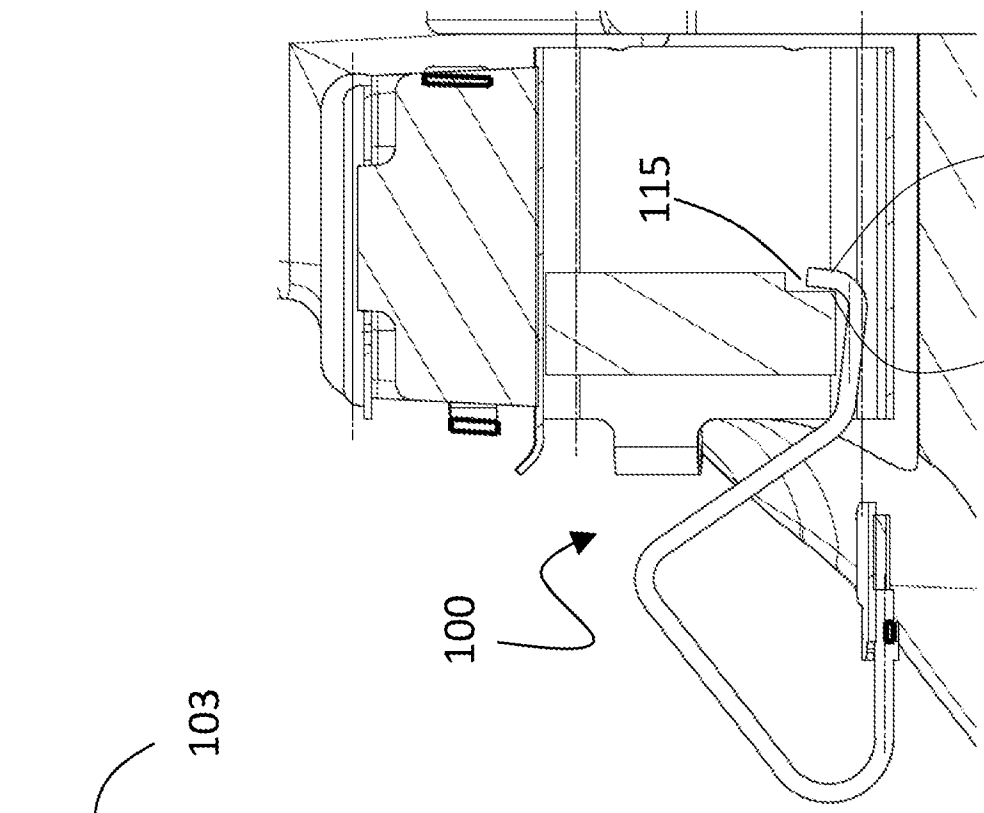

FIG. 9

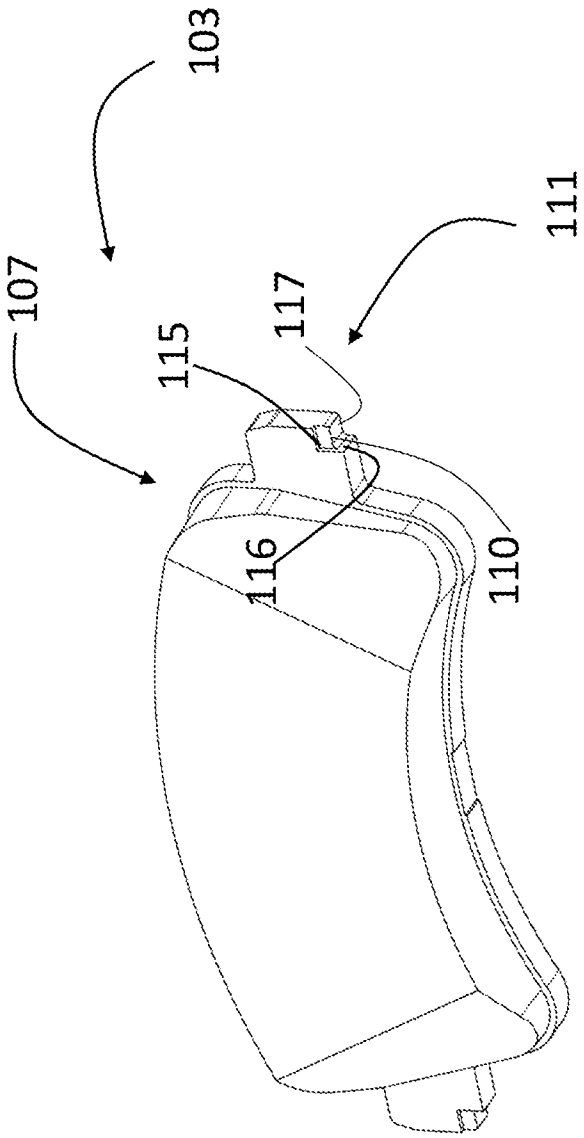

FIG. 8

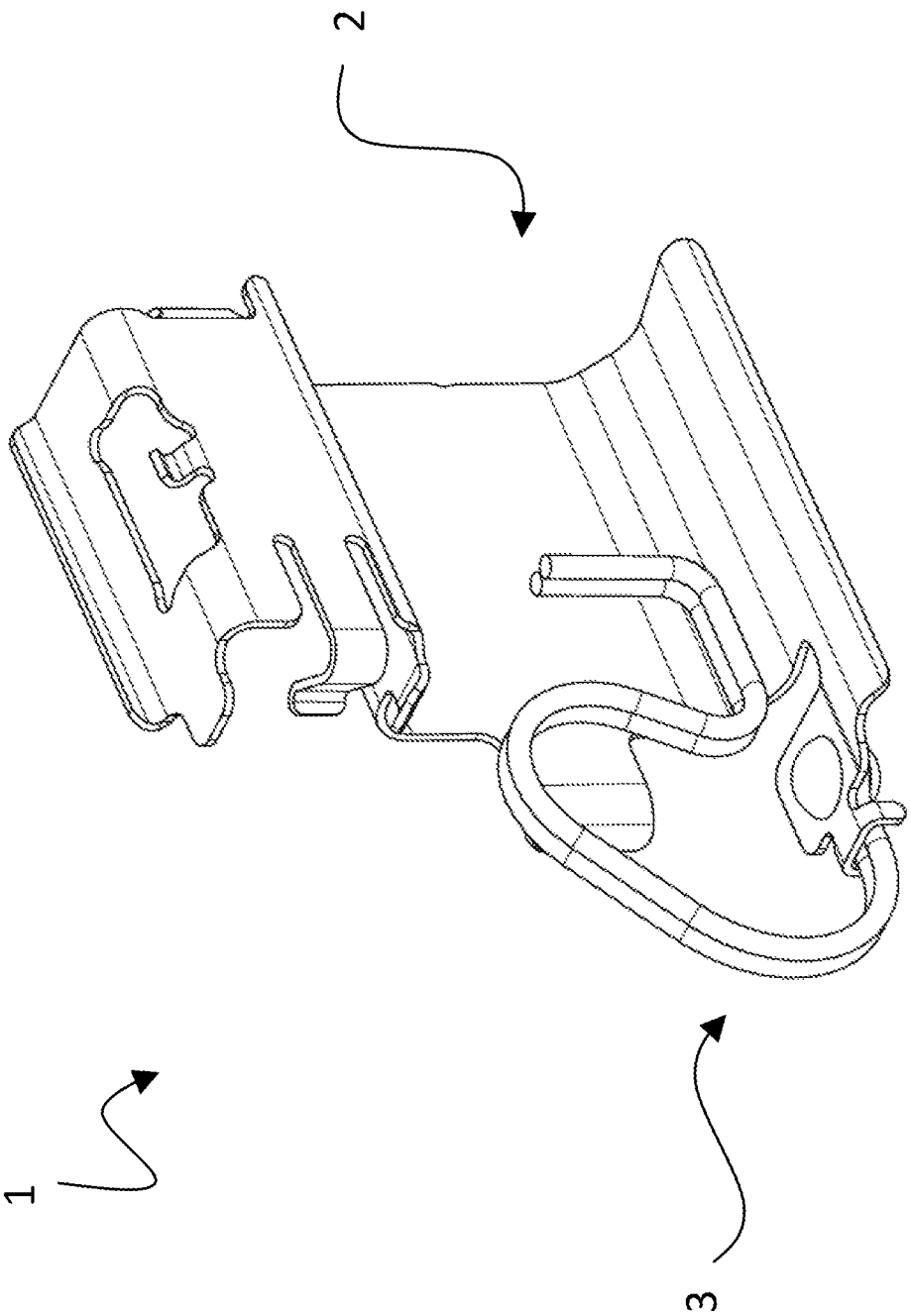

FIG. 10

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2021/060440

A. CLASSIFICATION OF SUBJECT MATTER
INV. F16D65/097 F16D65/04
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, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2013/025981 A1 (MAEHARA TOSHIFUMI [JP] ET AL) 31 January 2013 (2013-01-31) paragraphs [0167] - [0171]; figure 4	1-14
A	GB 2 257 483 A (TOKICO LTD [JP]) 13 January 1993 (1993-01-13) page 5, line 10 - page 6, line 25; figure 1	1-14
A	DE 10 2015 007523 A1 (LUCAS AUTOMOTIVE GMBH [DE]) 15 December 2016 (2016-12-15) paragraphs [0039] - [0041]; figures 4-6	1-14
A	EP 1 591 689 A1 (AKEBONO CORP [US]) 2 November 2005 (2005-11-02) paragraphs [0030] - [0035]; figures 2,4-7	1-14

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[x] Further documents are listed in the continuation of Box C.

[x] See patent family annex.

* Special categories of cited documents :

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

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"X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 February 2022	24/02/2022

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Christensen, Juan

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2021/060440

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2012/090927 A1 (BACH UWE [DE] ET AL) 19 April 2012 (2012-04-19) paragraph [0013]; figures 2d-3c	1-14

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2021/060440

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2013025981 A1	31-01-2013	CN 102834638 A	19-12-2012
		EP 2557330 A1	13-02-2013
		JP 5292425 B2	18-09-2013
		JP 2012097894 A	24-05-2012
		US 2013025981 A1	31-01-2013
		WO 2011126125 A1	13-10-2011
GB 2257483 A	13-01-1993	GB 2257483 A	13-01-1993
		KR 930000332 A	15-01-1993
		US 5249647 A	05-10-1993
DE 102015007523 A1	15-12-2016	CN 107850151 A	27-03-2018
		DE 102015007523 A1	15-12-2016
		EP 3308050 A1	18-04-2018
		US 2018355932 A1	13-12-2018
		WO 2016198386 A1	15-12-2016
EP 1591689 A1	02-11-2005	CN 1690465 A	02-11-2005
		EP 1591689 A1	02-11-2005
		JP 2005315423 A	10-11-2005
		US 2005236236 A1	27-10-2005
US 2012090927 A1	19-04-2012	CN 102362088 A	22-02-2012
		DE 102009022633 A1	14-10-2010
		EP 2411694 A1	01-02-2012
		KR 20110130512 A	05-12-2011
		US 2012090927 A1	19-04-2012
		WO 2010108830 A1	30-09-2010