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(71) Applicant: **BREMBO S.P.A.** [IT/IT]; Via Brembo, 25, I-24035 Curno, BERGAMO (IT).

(72) Inventors: **TRUFFELLO, Martina**; c/o BREMBO S.P.A., Via Brembo, 25, I-24035 Curno, BERGAMO (IT). **GALIZZI, Valerio**; c/o BREMBO S.P.A., Via Brembo, 25, I-24035 Curno, BERGAMO (IT).

(74) Agent: **SIGNORI, Ludovico** et al.; c/o JACOBACCI & PARTNERS S.p.A., Via Senato, 8, I-20121 MILANO (IT).

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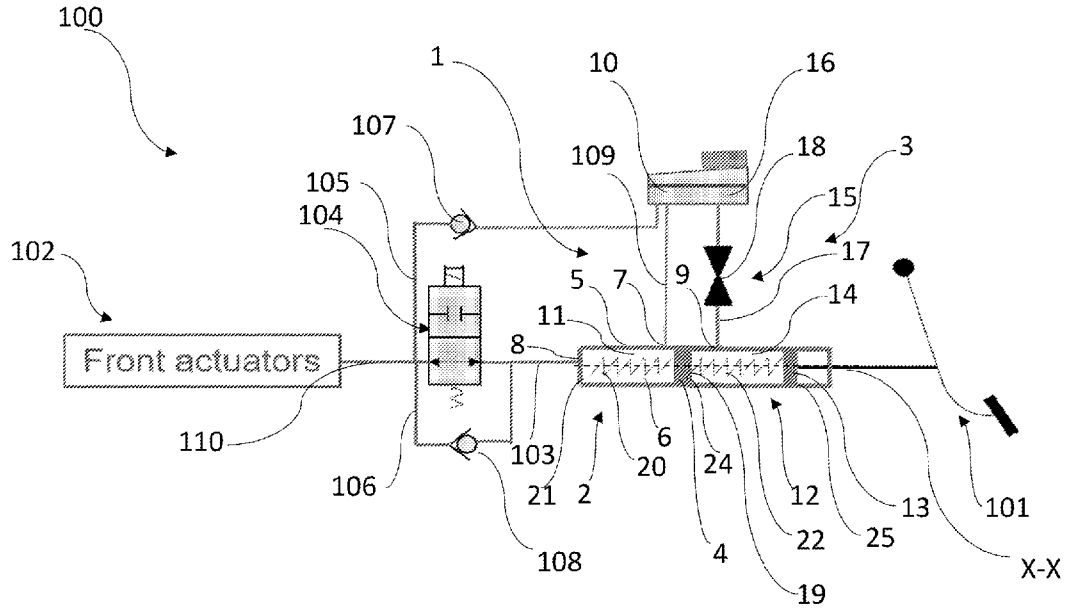

FIG. 2

(57) Abstract: The present invention relates to a brake master cylinder and pedal simulator assembly (1) for a braking system (100) of the brake-by-wire type, said assembly (1) being configured to be connected to a brake pedal or lever (101), said assembly (1) comprising : - a brake master cylinder (2), wherein the brake master cylinder (2) comprises at least one float (4) and a cylinder (5), wherein the cylinder (5) defines a cavity or housing compartment 6) adapted to contain a working fluid, wherein the at least one float (4) is movable in the cavity (6) at least by the actuation of the brake pedal (101), wherein the cylinder (5) delimits a feeding port (7) configured to connect the cavity (6) to at least one reservoir (10) adapted to contain a working fluid supply; wherein the cylinder (5) defines an outlet port (8) configured to fluidly connect the cavity (6) to at least one braking device (102), for example through a primary branch (103) along which an electrically actuatable on-off valve (104) is arranged to fluidly connect the brake master cylinder (2) to

WO 2024/252318 A1

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the at least one braking device (102) in a selective manner, wherein the float (4) is configured to move forward over an idle float stroke XI shutting the feeding port (7) and defining a pressure chamber (11) in said cavity (6) with said cylinder (5), wherein the assembly (1) further comprises - a braking feel simulator device (3) comprising at least one absorber (12), wherein the absorber (12) is configured to apply a reaction force on the brake pedal (101) against an actuation of the brake pedal (101, wherein the at least one absorber (12) is integrated into said brake master cylinder (2), wherein the absorber (12) is adapted to be connected to the brake pedal (101), wherein the absorber (12) is interposed between said float (4) and said brake pedal (101), wherein, against the actuation of the brake pedal (3), the absorber (12) is configured to bias the float (4) moving forward over at least said idle float stroke XI in said cylinder (5) until it pressurizes the working fluid in said pressure chamber (11), and the braking feel simulator device (3) is configured to dampen the actuation of the brake pedal (101) keeping the working fluid in said pressure chamber (11) pressurized.

"Brake master cylinder and pedal simulator assembly, braking system, method of actuating a braking system"

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DESCRIPTION

[0001]. Field of the invention

[0002]. The present invention relates to a brake master cylinder and pedal simulator assembly, as well as to a Brake-By-Wire ("BBW") type braking system, as well as to a method of actuating the braking system.

[0003]. Background art

[0004]. In BBW-type braking systems of vehicles with two or more wheels actuatable by a driver by means of a brake pedal or lever, the force and displacement imparted to the brake pedal or lever by the driver are decoupled from the resulting braking force, which is applied by at least one braking device to the respective wheel of the vehicle.

[0005]. In BBW braking systems, the force and displacement imparted by the driver on the brake pedal or lever are transduced into an electrical signal, which is processed by a control unit to control the actuation of the braking system calipers.

[0006]. Accordingly, it is known to equip the BBW braking systems with a braking feel simulator device connected to the brake pedal or lever and configured to simulate the feeling and stiffness of a brake pedal or lever of conventional hydraulic braking systems, and thus emulate the "stiffness curve" thereof.

[0007]. "Stiffness curve" means the relationship between the displacement of the brake pedal or lever along its stroke and the respective reaction force applied by the simulator device on the brake pedal or lever, and thus by the brake pedal or lever on the driver.

[0008]. In BBW braking systems, it is further known to provide a brake master cylinder connected to the brake pedal or lever, where the brake master cylinder is hydraulically connected to the braking feel simulator device through a first branch along which a first electrically actuatable on-off valve of the normally closed type is arranged, and where the brake master cylinder is also hydraulically connected to at least one braking device associated with a wheel of the vehicle through a second branch along which a second electrically actuatable on-off valve of the normally open type is arranged. Therefore, in a by-wire configuration, the first on-off valve is open and the second on-off valve is closed, and by detecting the position of the brake pedal or lever, it is possible to actuate the at least one braking device through motor means.

[0009]. In the BBW braking systems, the brake pedal or lever usually acts on a movable float in a cavity of a cylinder of the brake master cylinder in fluid connection with a reservoir containing a working fluid, where the float, by moving forward, once the fluid connection with the fluid reservoir is interrupted, in a by-wire configuration, acts on the fluid which passing through the first branch acts, in turn, on an absorber of the braking feel

simulator device arranged downstream of the brake master cylinder so as to simulate the braking feeling on the pedal. Solutions of this type are known, for example, from document **EP3630559** to the Applicant.

[0010]. Known-type solutions involve arranging the absorber downstream of the brake master cylinder, making two separate fluid chambers, a brake master cylinder pressure chamber and an absorber simulator chamber, adapted to receive fluid from the pressure chamber through a connection branch.

[0011]. In some solutions of the known type, the absorber and brake master cylinder are made into a single brake master cylinder and pedal simulator assembly, arranging the brake master cylinder and the absorber connected through a first branch either mutually in-line or in a transvers position.

[0012]. However, such known simulator assemblies have large dimensions which make them difficult to install inside the passenger compartment of the vehicle, in which there is less space available, in both the hanging brake pedal configuration and the grounded brake pedal configuration. Due to the large axial and/or transverse dimensions, the known simulator devices are generally installed in the engine compartment of the vehicle, under the hood.

[0013]. Additionally, the manufacturing of such assemblies is very complex given the high number of components and housing chambers which have to withstand high pressures and form very labor-intensive and difficult-to-make structures, increasing machine costs and

processing times, and thus making such systems difficult for mass production.

[0014]. Even further, in addition to the complex manufacturing, such assemblies, given the high number of components, are very time-consuming during the steps of assembly and end-of-line testing (EOL verification) once assembled.

[0015]. Moreover, in such assemblies, the absorber does not apply any counteracting force on the pedal actuation until the float of the brake master cylinder moves forward under the bias of the brake pedal or lever over an idle stroke thus fluidly isolating the pressure chamber of the brake master cylinder from the working fluid reservoir, thus adversely affecting the braking and driving feeling perceived by the driver.

[0016]. Therefore, the need is felt in the industry for compact and space-saving brake master cylinder and pedal simulator assemblies, which also are less structurally complex than those known.

[0017]. Moreover, the need is felt in the industry to manufacture brake master cylinder and pedal simulator assemblies which comprise a smaller number of components than before, and involve fewer and simplified mechanical machining of the housings, assembly, and end-of-line testing steps.

[0018]. Additionally, the need is felt in the industry to make very efficient and sensitive brake master cylinder and pedal simulator assemblies, which allow withstanding the forward movement

of the brake pedal over the entire pedal stroke, reducing as much as possible if not eliminating any idle stroke of the brake pedal.

[0019]. Solution

[0020]. The present invention aims to provide a brake master cylinder and pedal simulator assembly, as well as a Brake-By-Wire ("BBW") type braking system, as well as a method of actuating the braking system which allow obviating at least some of the drawbacks highlighted in the prior art.

[0021]. These and other purposes are achieved by a brake master cylinder and pedal simulator assembly, a braking system provided with such an assembly, and a method of actuating the braking system according to the independent claims.

[0022]. Some advantageous embodiments are the subject of the dependent claims.

[0023]. By virtue of the suggested solutions, it is possible to provide a more compact brake master cylinder and pedal simulator assembly adapted to be installable inside the vehicle passenger compartment, in both the hanging brake pedal configuration and the grounded brake pedal configuration.

[0024]. By virtue of the suggested solutions, it is possible to provide a brake master cylinder and pedal simulator assembly, the absorber being integrated into the brake master cylinder.

[0025]. By virtue of the suggested solutions, it is possible to provide a brake master cylinder and pedal simulator assembly and a braking system comprising the brake master cylinder and pedal

simulator assembly, with a small number of components by avoiding a connection branch or duct between the brake master cylinder and the absorber from being constructed or used.

[0026]. By virtue of the suggested solutions, it is possible to provide a braking system comprising the brake master cylinder and pedal simulator assembly, with a small number of components by limiting the minimum number of electrically actuatable on-off valves to a single on-off valve.

[0027]. By virtue of the suggested solutions, it is possible to provide a brake master cylinder and pedal simulator assembly and a braking system, which have low costs, lower maintenance requirements, lower machining complexity, simplified assembly, as well as simplified end-of-line testing.

[0028]. Figures

[0029]. Further features and advantages of brake master cylinder and pedal simulator assembly, braking system provided with such an assembly, and actuation method will become apparent from the following description of preferred embodiments thereof, given by way of non-limiting indication, with reference to the accompanying drawings, in which:

[0030]. - figure 1 shows a diagrammatic depiction of a braking system according to the prior art, comprising a braking feel simulator device arranged downstream of a brake master cylinder connectable to a brake pedal or lever, where the brake master cylinder is connected to the braking feel simulator device through a

first branch along which a first on-off valve is arranged, and where the brake master cylinder is connected to at least one braking device through a second branch along which a second on-off valve is arranged;

[0031]. - figure 2 shows a diagrammatic depiction of a braking system comprising a braking feel simulator device, according to an embodiment of the invention, where the braking feel simulator device is partially integrated into the brake master cylinder;

[0032]. - figure 3 shows a diagrammatic depiction of the brake master cylinder and pedal simulator assembly, according to an embodiment of the invention, in a resting configuration, not biased by the actuation of the brake pedal or lever;

[0033]. - figure 4 shows a diagrammatic depiction of the brake master cylinder and pedal simulator assembly, according to an embodiment of the invention, in an active configuration, where against the actuation of the brake pedal or lever, the absorber resisted the forward movement of the pedal and biased the brake master cylinder float forward by pressurizing the working fluid in the pressure chamber, where a further actuation of the brake pedal or lever corresponds to a damping of the forward movement of the pedal or lever without displacements of the brake master cylinder float and keeping the working fluid in the pressure chamber pressurized

[0034]. - figure 5A shows a perspective view, according to a first direction of view, of a brake master cylinder and pedal simulator

assembly according to the present invention;

[0035]. - figure 5B shows a perspective view, according to a second direction of view, of the brake master cylinder and pedal simulator assembly in figure 5A;

[0036]. - figure 6 shows a side view in a section taken along a plane passing through the extension direction of the brake master cylinder and pedal simulator assembly in figures 5A and 5B, in which the absorber and the brake master cylinder float are visible in series, where the float and the at least one absorber thrust piston are in the respective resting positions;

[0037]. - figure 7 shows the brake master cylinder and pedal simulator assembly in figure 6, where the float and the at least one thrust piston of the absorber are moved forward under an action on the brake pedal over the same stroke, until the float has pressurized the working fluid in the pressure chamber fluidly isolated from the at least one reservoir, in addition it can be seen that the at least one thrust piston comprises a first thrust piston and a second thrust piston and an elastic element, a coil spring, interposed between the two pistons, where between the resting position and the idle stroke position, the first piston and the second piston move integrally while maintaining the same mutual distance D1 therebetween and maintaining the same distance D2 between the second thrust piston and the float;

[0038]. - figure 8 shows the brake master cylinder and pedal simulator assembly in figures 6 and 7, where following a further

thrust action on the pedal with respect to the configuration in figure 7, the float remains in the same position as in figure 7, keeping the working fluid pressurized and fluidly isolated from the absorber chamber and the at least one reservoir, where the at least one thrust piston is moved forward against the elastic action of at least one elastic absorber element and/or the at least one elastic thrust piston element, as well as against the hydraulic damping action of the working fluid flow from the absorber chamber to the at least one reservoir, in addition it can be seen that the first thrust piston and the second thrust piston are in a maximally compact position with the elastic element interposed therebetween maximally compressed, thus minimizing the distance D1 between the first thrust piston and the second thrust piston;

[0039]. - figure 9 shows the brake master cylinder and pedal simulator assembly in figures 6, 7, and 8, in which following a further thrust action on the pedal with respect to the configuration in figure 8, the float remains in the same position as in figure 7, keeping the working fluid pressurized and fluidly isolated from the absorber chamber and the at least one reservoir, where the at least one thrust piston is moved forward against the elastic action of at least one elastic absorber element, as well as against the hydraulic damping action of the working fluid flow from the absorber chamber to the at least one reservoir, in addition it can be seen that the first thrust piston and the second thrust piston are in the maximally compact position with the elastic element interposed

therebetween in a maximally compressed configuration, thus minimizing the distance D1 between the two pistons, and are in the maximum forward position, with the at least one elastic absorber element in a maximally compressed configuration, thus minimizing the distance D2 between the second thrust piston and the float;

[0040]. - figure 10 shows an exploded perspective view of the brake master cylinder and pedal simulator assembly in figures 5A to 9, where the reservoir has been omitted, in which the float, the elastic return element of the float, the at least one thrust piston comprising the first thrust piston and the second thrust piston with the elastic thrust piston element interposed therebetween, as well as the first elastic absorber element and the second elastic absorber element which are interposed between the second thrust piston and the bottom of the float, as well as the master cylinder body in one piece, which defines the cylinder in which the pressure chamber and the absorber chamber are defined, in which the float and the at least one thrust piston are fluid-tightly housed, are visible.

[0041]. Description of some preferred embodiments

[0042]. According to a general embodiment, a brake master cylinder and pedal simulator assembly for a braking system 100 of the brake-by-wire type is indicated by reference numeral 1.

[0043]. Said assembly 1 is configured to be connected to a brake pedal or lever 101. Brake pedal or lever means a hand-operated device adapted to actuate the assembly 1.

[0044]. Said assembly 1 comprises a brake master cylinder 2 and a brake simulator device 3, which comprises at least one absorber 12. The at least one absorber 12 is configured to apply a reaction force on the brake pedal 101 against an actuation of the brake pedal 101.

[0045]. The brake master cylinder 2 comprises at least one float 4 and one cylinder or master cylinder body 5. The cylinder 5 defines a cavity or housing compartment 6 adapted to contain a working fluid. In an embodiment, the cylinder 5 defines the cavity 6 with its peripheral walls, such as a cylinder side wall and two opposite cylinder bottom walls. In an embodiment, the cavity 6 extends along a thrust direction X-X, which is rectilinear direction defining an axis about which the cylinder side wall parallelly extends.

[0046]. The at least one float 4 is movable in the cavity 6 at least by the actuation of the brake pedal 101.

[0047]. The cylinder 5 delimits a feeding port 7 configured to connect the cavity 6 to at least one reservoir 10 adapted to contain a working fluid supply. In an embodiment, the cylinder side wall delimits the feeding port 7. In an embodiment, the feeding port 7 defines a port axis which is perpendicular to the thrust direction X-X. In an embodiment, the assembly 1 comprises a feeding branch or duct adapted to fluidly connect the feeding port 7 and the reservoir 10.

[0048]. The cylinder 5 defines an outlet port 8 configured to fluidly connect the cavity 6 to at least one braking device 102. In an embodiment, the cylinder side wall delimits the outlet port 8,

e.g., on the same side as or on a side diametrically opposite to the feeding port 7. In an embodiment, the outlet port 8 defines an axis perpendicular to the thrust direction X-X. In an embodiment, the cylinder bottom wall 5, faced by the float 4, delimits the outlet port 8. In an embodiment, the outlet port 8 defines an axis parallel to the thrust direction X-X.

[0049]. The cylinder 5 defines, with said float 4, a pressure chamber 11 in said cavity 6. The pressure chamber 11 being in fluid communication with said outlet port 8.

[0050]. In an embodiment, the outlet port 8 is fluidly connected to the braking device 102 though a primary branch or duct 103 along which an electrically actuatable on-off valve 104 is arranged to fluidly connect the brake master cylinder 2 to the at least one braking device 102 in a selective manner. The on-off valve 104 is electrically actuatable, preferably of the normally open type, where in a by-wire condition, the on-off valve is electrically powered and in the closed configuration, and in a blackout condition, the on-off valve is not powered and in the open configuration.

[0051]. The float 4 is configured to move forward in the cavity 6 over an idle float stroke X1 until the feeding port 7 is shut, fluidly isolating the pressure chamber 11 from the feeding port 7 so as to pressurize the working fluid in the pressure chamber 11.

[0052]. Advantageously, the at least one absorber 12 is integrated into said brake master cylinder 2. The absorber 12 is adapted to be connected to the brake pedal or brake lever 101, e.g., by means of a

connection rod 35.

[0053]. Advantageously, the absorber 12 is interposed between said float 4 and said brake pedal 101.

[0054]. Against the actuation of the brake pedal 3, the absorber 12 is configured to bias the float 4 moving forward over at least said idle float stroke X1 in said cylinder 5 until it pressurizes the working fluid in said pressure chamber 11.

[0055]. Against the actuation of the brake pedal 3, the braking feel simulator device 3 is configured to dampen the actuation of the brake pedal 101 keeping the working fluid in said pressure chamber 11 pressurized.

[0056]. By virtue of the provision of the absorber integrated into the brake master cylinder, it is possible to directly connect the absorber to the brake pedal 3, so that a reaction force on the pedal can be provided immediately, without providing idle strokes with no reaction force for a pedal actuation. Additionally, by virtue of the provision of the absorber interposed between the pedal and the float, it is possible to immediately actuate a forward movement of the float while simultaneously damping and withstanding the forward movement of the pedal.

[0057]. By virtue of the provision of the absorber integrated into the brake master cylinder, t is possible to use the brake master cylinder as a housing for the absorber, without the need to provide two different chambers, one for the absorber and a separate one for the brake master cylinder float connected by a hydraulic duct or

branch. As a result, it is possible to make a single cavity in the cylinder 5, adapted to house both the float and the absorber, thus simplifying the mechanical machining of the body of the assembly 1. For example, the cylinder body 5 can form an assembly body to be molded or forged, from which material can be removed to obtain the finished assembly.

[0058]. In an embodiment, the braking feel simulator device 3 is configured to contain the working fluid with fluid continuity inside the absorber 12 and the at least one reservoir 10 or a simulator reservoir 16.

[0059]. In an embodiment, the absorber 12 is integrated into said brake master cylinder 2 upstream of said float 4.

[0060]. In an embodiment, the absorber 12 is configured so that, once the float 4 is biased forward over at least said idle float stroke X1 in said cylinder 5 pressurizing the working fluid in said pressure chamber 11, the actuation of the brake pedal 101 corresponds to a pressurization of the hydraulic fluid contained in the absorber 12, which conveys a flow of hydraulic fluid from the absorber 12 to the at least one reservoir 10 or the simulator reservoir 16.

[0061]. In an embodiment, the absorber 12 comprises a thrust piston 13 arranged in said cavity 6. In an embodiment, the thrust piston 13 is adapted to be connected to the brake pedal 101.

[0062]. In an embodiment, a simulator chamber 14 adapted to contain said working fluid is defined in said cavity 6, between said

thrust piston 13 and said float 4.

[0063]. In an embodiment, the thrust piston 13 is movable in said cavity 6 and is adapted to bias the working fluid contained in said simulator chamber 14. In an embodiment, the thrust piston 13 is connected to the connection rod 35 by means of an attachment element 36. For example, the attachment element 36 is a ball joint adapted to clamp a ball-shaped or ball-like end of the connection rod 35. In an embodiment, a portion of the connection rod 35 is protected by a dust cap.

[0064]. In an embodiment, the cylinder 5 defines a simulator port 9 to fluidly connect the simulator chamber 14 to the at least one reservoir 10 or a simulator reservoir 16. In an embodiment, the at least one reservoir 10 comprises the simulator reservoir 16, forming a common reservoir for the pressure chamber and the simulator chamber. According to an embodiment, the simulator port 9 defines an axis perpendicular to the thrust direction X-X. According to an embodiment, the simulator port 9 is parallel to the feeding port 7. In an embodiment, the simulator port 9 and the feeding port 7 are the same port and/or are coincident.

[0065]. In an embodiment, the at least one reservoir 10 is distinct and fluidly isolated from said simulator reservoir. In an embodiment, said at least one reservoir 10 and/or said simulator reservoir 16 are made in one piece with or as a separate piece from said cylinder. In an embodiment, the reservoir 10 and the simulator reservoir 16 are the same reservoir.

[0066]. In an embodiment, said the braking feel simulator device 3 comprises hydraulic resistance means 15. The hydraulic resistance means 15 are arranged between the simulator port 9 and the at least one reservoir 10 or the simulator reservoir 16.

[0067]. The hydraulic resistance means 15 are configured to control a fluid flow from the simulator chamber 14 to the at least one reservoir 10 or the simulator reservoir 16 to dampen the actuation of the brake pedal 101 at least when the float 4 is moved forward over said idle float stroke X1 by pressurizing the working fluid in said pressure chamber 11.

[0068]. In an embodiment, the thrust piston 13 comprises in series a first thrust piston 26, at least one elastic thrust piston element 30, and a second thrust piston 27. In an embodiment, the at least one elastic thrust piston element 30 is configured to absorb a thrust on the brake pedal or lever 103, providing a resisting and/or damping action on a forward movement of the brake pedal.

[0069]. According to an embodiment, the thrust piston 13 is movable in said cavity 6 over an idle piston stroke X2 simultaneously with the float 4 until the float 4 is moved forward over said idle float stroke X1 by pressurizing the fluid in said pressure chamber 11. According to an embodiment, the thrust piston 13 is movable in said cavity 6 over a piston idle stroke X2, against the elastic action of an elastic simulator element which opposes a forward movement of the piston, providing a resisting and/or damping action on a forward movement of the brake pedal. In an embodiment,

the first thrust piston and the second thrust piston are movable in said cavity 6 each over an idle piston stroke X2 simultaneously with the float 4 until the float 4 is moved forward over said idle float stroke X1 by pressurizing the fluid in said pressure chamber 11.

[0070]. In an embodiment, the thrust piston 13 is movable in said cavity 6 by keeping a distance between said thrust piston 13 and said float 4 and/or a volume of said simulator chamber 14 constant, until the float 4 is moved forward over said idle float stroke X1 by pressurizing the fluid in said pressure chamber 11. In an embodiment, the first thrust piston and the second thrust piston are movable in said cavity 6 keeping a distance between each thrust piston and said float 4 constant.

[0071]. In an embodiment, once the float 4 is moved forward over said idle float stroke X1 by pressurizing the fluid in said pressure chamber 11, the thrust piston 13 is movable in said cavity 6 by conveying the fluid from the simulator chamber 14 towards the at least one reservoir 10 or the simulator reservoir 16 through the hydraulic resistance means 15 and/or through the feeding port 7. In an embodiment, the reservoir comprises an engagement portion configured to be sealingly coupled to a reservoir connection seat made on the cylinder 5. The reservoir connection seat is in fluid connection with the supply port 7.

[0072]. In an embodiment, once the float 4 is moved forward over said idle float stroke X1 by pressurizing the fluid in said pressure chamber 11, the thrust piston 13 is movable in said cavity 6 by

reducing the distance between said thrust piston 13 and said float 4 and/or the volume of said simulator chamber 14.

[0073]. In an embodiment, the first float 4 is movable along a thrust direction X-X along which the cavity 5 extends between a float resting position and at least one float operating position. In an embodiment, in the float resting position, the float 4 abuts against a shoulder 19 connected to said cylinder 5 in said cavity 6. The shoulder can be made in one piece with cylinder 5, preferably with the side wall of the cylinder. The shoulder 19 can be a separate piece from the cylinder 5 and connectable thereto to form a retainer portion for the float. In an embodiment, in the at least one float operating position, the float 4 fluidly isolates the pressure chamber 11 and the reservoir 10 by pressurizing the working fluid in the pressure chamber 11. In an embodiment, the shoulder 19 connects a first cavity portion to a second cavity portion, where the float 4 is movably housed in the second cavity portion, and where the thrust piston is movably housed in the first cavity portion and is configured to move forward at least partially into the second cavity portion. The first cavity portion has a smaller diameter than the second cavity portion.

[0074]. In an embodiment, the brake master cylinder 2 comprises an elastic float element 20 arranged inside said cavity 6 between a cylinder seat or a cylinder bottom wall 21 of said cylinder 5 and said float 4 so as to constantly bias the float 4 to the float resting position.

[0075]. In an embodiment, the brake master cylinder 2 comprises a pressure chamber plug 33 configured to fluid-tightly close the pressure chamber 11 by connecting to an open end of the cylinder 5 with an interposed plug gasket or O-ring 34. In an embodiment, the pressure chamber plug 33 comprises the cylinder bottom wall 21. In an embodiment, the cylinder bottom wall 21 delimits an annular cylinder seat 48 configured to house and axially abuts against an end of the elastic float element 20. In an embodiment, the float 4 delimits an annular float biasing seat 46 configured to house and axially abut against the other end of the elastic float element 20.

[0076]. In an embodiment, the thrust piston 13 is movable along a thrust direction X-X, along which the cavity 5 extends, between an absorber resting position and at least one absorber operating position. In an embodiment, in the absorber resting position, the thrust piston 13 abuts against a retainer 25 either connected to or made in one piece with said cylinder 5 inside said cavity 6. For example, the retainer 25 can be a cylinder bottom wall 5 made in one piece with the cylinder side wall or it can be a plug made as a separate piece from the cylinder side wall and adapted to close the cylinder cavity on the side where the pedal connects to the absorber 12. In an embodiment, in the at least one absorber operating position, the thrust piston 13 approaches said simulator port 9 and/or said feeding port 7.

[0077]. In an embodiment, in no absorber operating position, the

piston 13 can reach the simulator port 9 to obstruct it.

[0078]. In an embodiment, in at least one absorber operating position, the piston 13 obstructs the simulator port 9 fluidly isolating the simulator chamber from the at least one reservoir.

[0079]. In an embodiment, the absorber 12 comprises at least one elastic absorber element 22.

[0080]. In an embodiment, the absorber 12 comprises a plurality of elastic absorber elements positioned in series and/or in parallel.

[0081]. Each or at least one absorber element 22 of said plurality of elastic absorber elements is arranged inside said cavity 6 between an elastic element seat 23 connected to said cylinder 5 or made on said cylinder 5 and said thrust piston 13, or between a float bottom 24 of said float 4 and said thrust piston 13, so as to constantly bias the thrust piston 13 towards the absorber resting position by elastically opposing a forward movement of the thrust piston 12 into the cavity 5.

[0082]. In an embodiment, the at least one elastic thrust piston element 30 is interposed between a thrust wall 39 of the first thrust piston 26 and a second piston bottom 42 of the second thrust piston 27 so as to elastically oppose an approach between the first thrust piston 26 and the second thrust piston 27. In an embodiment, the at least one elastic thrust piston element 30 is a coil spring. In an embodiment, the first thrust piston 26 comprises a first piston bottom 38 configured to be connected to the brake pedal or

lever 101. In an embodiment, the thrust piston 13 is fluid-tightly movable within the cavity 6, e.g., by means of a thrust piston gasket or O-ring 31 connected to a respective annular seat made in the inner wall of the cylinder 5. In an embodiment, the first thrust piston 26 is fluid-tightly movable inside the cavity 6, thus avoiding the working fluid from passing from the absorber chamber to the brake pedal or lever.

[0083]. In an embodiment, the at least one elastic absorber element 22 comprises a first elastic absorber element 28 and a second elastic absorber element 29. In an embodiment, the first elastic absorber element 28 and the second elastic absorber element 29 are arranged in series. In an embodiment, the first elastic absorber element 28 and the second elastic absorber element 29 are arranged in parallel. In an embodiment, the first elastic absorber element 28 and the second elastic absorber element 29 are concentric coil springs. In an embodiment, at least one of the first elastic absorber element 28 and the second elastic absorber element 29 is configured to constantly bias the thrust piston 13 towards the absorber resting position by opposing a forward movement of the thrust piston 13 into the cavity 6. In an embodiment, at least one of the first elastic absorber element 28 and the second elastic absorber element 29 is configured to constantly bias the second thrust piston 27 towards the first thrust piston 26 and towards the absorber resting position by opposing a forward movement of the

first thrust piston 12 and the second thrust piston into the cavity 5.

[0084]. In an embodiment, the first thrust piston 26 comprises a thrust cup portion 37 which has the thrust wall 39 of the first thrust piston 26 as the bottom. In an embodiment, the thrust cup portion 37 is configured to at least partially house the second thrust piston 27 in a movable manner avoiding a fluid tightness. In an embodiment, the thrust cup portion 37 is configured to contain the working fluid delimiting the simulator chamber 14. In an embodiment, the first thrust piston 26 comprises a groove 53 adapted to accommodate a positioning pin 54 removably connected to the cylinder 5. In an embodiment, the groove forms a guide configured to slide on the positioning pin 54.

[0085]. In an embodiment, the second thrust piston 27 comprises a flange 40 and a central body 50. In an embodiment, the flange 40 is configured to abut against the first elastic absorber element 28. In an embodiment, the flange 40 is connected to the central body 50 forming a first shoulder 43 configured to abut against the first elastic absorber element 28. In an embodiment, the central body 50 is configured to abut against the second elastic absorber element 29. In an embodiment, the central body 50 defines a second shoulder 44 configured to abut against the second elastic absorber element 29. In an embodiment, the central body 50 has an elongated shape, e.g., cylindrical, and is coaxial with the first elastic absorber 28

and the second elastic absorber element 29. In an embodiment, the second thrust piston 27 further comprises a guide shaft 41. In an embodiment, the central body 50 is connected to the guide shaft 41 forming the second shoulder 44. In an embodiment, the guide shaft 41 is coaxial with the first elastic absorber element 28 and the second elastic absorber element 29. In an embodiment, the flange 40 has peripheral discharges to facilitate the passage of fluid when the first piston and second piston move relatively to each other. In an embodiment, the flange and the central body have a T-shaped section.

[0086]. In an embodiment, the float 4 delimits an outer annular float biasing seat 45 on the side of or at the float bottom 24, configured to house and abut against an end of the first elastic absorber element 28. In an embodiment, the float 4 delimits a central float seat 47, e.g., cylindrical, on the side of or at a float bottom 24, configured to house the guide shaft 41 in a movable manner. In an embodiment, the float 4 comprises a partition 49 configured to radially divide the outer annular seat 45 from the central float seat 47. In an embodiment, the partition 49 defines with an end thereof an abutment seat for one end of the second elastic absorber element 29.

[0087]. In an embodiment, the braking feel simulator device 3 comprises a simulator branch or duct 17 adapted to fluidly connect the absorber 12 and the at least one reservoir 10 or a simulator reservoir 16. In an embodiment, the simulator branch 17 has no

selective opening/closing valves for the fluid passage. In an embodiment, the simulator branch or duct 17 and the supply branch are one and the same branch and/or are coincident.

[0088]. According to an embodiment, the braking feel simulator device 3 comprises a feeding branch 109, configured to connect the feeding port 7 to the reservoir 10.

[0089]. In an embodiment, the braking feel simulator device 3 comprises a calibrated orifice 18, e.g., arranged along the simulator branch 17 or along the feeding branch, interposed between the at least one reservoir 10 or the simulator reservoir 16 and the absorber 12. In an embodiment, said hydraulic resistance means 15 comprise a calibrated orifice 18. In an embodiment, the calibrated orifice 18 comprises the feeding port 7 and/or the simulator port 9. In an embodiment, the calibrated orifice 18 is made in the side wall of the cylinder 5. In an embodiment, the calibrated orifice 18 is made as a through hole passing directly through the thickness of the side wall of the cylinder 5. In an embodiment, the feeding branch 109 or simulator branch comprises the calibrated orifice 18.

[0090]. In an embodiment, the calibrated orifice 18 is configured to control a fluid flow from the absorber 12 to the at least one reservoir 10 or the simulator reservoir 16.

[0091]. According to an embodiment, the calibrated orifice 18 forms a section with a diameter between 0.7 mm and 1.5 mm. According to an embodiment, the calibrated orifice 18 has a length of less

than 3.0 mm. According to an embodiment, the simulator branch and/or the calibrated orifice 18 has a length of less than 10.0 mm.

[0092]. In an embodiment, the assembly 1 comprises at least one sensor configured to detect an actuation and/or movement of the float 4 and/or the absorber 13. According to an embodiment, the at least one sensor is a position sensor or a pressure sensor or a force sensor or a combination thereof. According to an embodiment, the at least one sensor is a laser position sensor or an infrared position sensor or an elastomeric sensor or a piezoelectric sensor or a Hall effect sensor or a magnetoresistive sensor or a linear magnetic sensor or a combination thereof. According to an embodiment, the at least one sensor is positioned inside the absorber 13. In an embodiment, the sensor comprises a first sensor portion 51 and a second sensor portion 52. In an embodiment, the first sensor portion 51 is fixedly connected to the thrust piston 13, or to the first thrust piston 26, and the second sensor portion 52 is connected to the cylinder 5, e.g., outside the cavity 6, so as to detect the position of the first sensor portion 51 which is integral in motion with the thrust piston 13, e.g., connected to the first thrust piston 26. In an embodiment, the second sensor portion 52 has an input port for connecting a data transmission cable. According to an embodiment, the second sensor portion is configured to detect the position of the first sensor portion.

[0093]. In an embodiment, the assembly 1 comprises a brake pedal

101 operatively connected to the absorber 13, preferably by means of a mechanical connection so that an actuating force applied by a driver on the brake pedal 101 is mechanically transferred to the absorber 5.

[0094]. The present invention also comprises a braking system of the BBW type generally indicated by reference numeral 100.

[0095]. In an embodiment, the braking system 100 comprises an assembly 1 according to any one of the previously described embodiments, at least one braking device 102, e.g., a hydraulic actuation device for a disc or drum brake, a primary branch 103 for hydraulically connecting the brake master cylinder 2 to the at least one braking device 102, an electrically actuatable on-off valve 104 of the normally open type arranged along said primary branch 103. Under a by-wire condition, the on-off valve 104 is closed. Under an electrical blackout condition, the on-off valve is open allowing a hydraulically direct connection between the assembly 1 and the at least one braking device 102, for example passing through a braking device branch 110.

[0096]. The assembly 1 comprises a processing and control unit operatively connected to said assembly 1 and motor means for actuating said at least one braking device 102. The processing and control unit is programmed so as to actuate the braking device 102 through the motor means as a function of the actuation of the assembly 1 through the brake lever or pedal 101 under a by-wire

operating condition, to said by-wire operating condition.

[0097]. In an embodiment, said assembly 1 comprises said at least one reservoir 10 in fluid connection at least with said pressure chamber 11.

[0098]. In an embodiment, said assembly 1 comprises a charge branch or duct 105, which hydraulically connects the at least one reservoir 10 to the primary branch 103 between the at least one braking device 102 and the on-off valve 104.

[0099]. In an embodiment, a first check valve 107 is arranged along the charge branch 105 and configured to allow a fluid to pass only from the at least one reservoir 10 to the at least one braking device 102.

[00100]. In an embodiment, a discharge branch or duct 106 hydraulically connects the primary branch 103 downstream of the on-off valve 104 to the primary branch 103 upstream of the on-off valve 104.

[00101]. In an embodiment, a second check valve 108 is arranged along the discharge branch 106 and configured to allow a fluid to pass only from the at least one reservoir 10 to the at least one braking device 102 to the brake master cylinder 2.

[00102]. The present invention also relates to a method of actuating a braking system of the brake-by-wire type comprising at least one braking device 102 selectively actuatable, under a blackout condition, by a brake master cylinder by means of a direct

hydraulic connection or, under a by-wire condition, by a processing and control unit operatively connected to motor means and a braking feel simulator device.

[00103]. The method comprises the following steps.

[00104]. Providing an assembly 1 according to any one of the previously described embodiments, connected to a brake pedal 101.

[00105]. According to a mode of operation, actuating said brake pedal 3, and in a by-wire mode:

[00106]. - detecting a position of the brake pedal 101 over time;

[00107]. – against the actuation of the brake pedal 3, biasing, by means of the absorber 12, the float 4 of the brake master cylinder 2 moving forward over at least said idle float stroke X1 in said cylinder 5 until the working fluid in said pressure chamber 11 is pressurized, and

[00108]. - damping the actuation of the brake pedal 101, by means of the braking feel simulator device 3, keeping the working fluid in said pressure chamber 11 pressurized,

[00109]. - actuating the at least one braking device 102 through motor means based on the detected brake pedal position.

[00110]. According to a mode of operation, actuating said brake pedal 3, and in a blackout mode:

[00111]. - against the actuation of the brake pedal 3, biasing, by means of the absorber 12, the float 4 of the brake master cylinder 2 moving forward over at least said idle float stroke X1 in said

cylinder 5 until the working fluid in said pressure chamber 11 is pressurized,

[00112]. - actuating the at least one braking device 102 by biasing, by means of the absorber 12, the float 4 of the brake master cylinder 2, keeping the working fluid in said pressure chamber 11 pressurized.

LIST OF REFERENCE SIGNS

1	brake master cylinder and pedal simulator assembly
2	brake master cylinder
3	braking feel simulator device
4	float
5	cylinder
6	cavity or housing compartment
7	feeding port
8	outlet port
9	simulator port
10	reservoir
11	pressure chamber
12	absorber
13	thrust piston
14	simulator chamber
15	hydraulic resistance means
16	simulator reservoir
17	simulator branch
18	calibrated orifice
19	shoulder
20	elastic float element
21	cylinder bottom wall
22	elastic absorber element
23	elastic element seat
24	float bottom
25	retainer
26	first thrust piston
27	second thrust piston
28	first elastic absorber element
29	second elastic absorber element
30	elastic thrust piston element
31	thrust piston gasket or O-ring
32	float gasket or O-ring
33	pressure chamber plug
34	reservoir gasket or O-ring
35	connection rod or pedal rod
36	attachment element
37	thrust cup portion
38	first thrust piston bottom
39	first thrust piston thrust wall
40	second piston flange

41 second piston guide shaft
42 second piston bottom
43 first shoulder
44 second shoulder
45 annular float biasing seat
46 annular float thrust seat
47 central float seat
48 annular cylinder seat
49 partition
50 central body of second piston
51 first sensor portion
52 second sensor portion
53 groove
54 positioning pin

100 braking system
101 brake pedal or lever
102 braking device
103 primary branch
104 electrically actuatable on-off valve
105 charge branch
106 discharge branch
107 first check valve
108 second check valve
109 feeding branch

X1 idle float stroke
X2 idle piston stroke
X-X thrust direction
D1 distance between pistons
D2 distance between piston and float

CLAIMS

1. A brake master cylinder and pedal simulator assembly (1) for a braking system (100) of the brake-by-wire type, said assembly (1) being configured to be connected to a brake pedal or lever (101), said assembly (1) comprising:

- a brake master cylinder (2), wherein the brake master cylinder (2) comprises at least one float (4) and a cylinder (5), wherein the cylinder (5) defines a cavity or housing compartment (6) adapted to contain a working fluid, wherein the at least one float (4) is movable in the cavity (6) at least by an actuation of the brake pedal (101), wherein the cylinder (5) delimits a feeding port (7) configured to connect the cavity (6) to at least one reservoir (10) adapted to contain a working fluid supply; wherein the cylinder (5) defines an outlet port (8) configured to fluidly connect the cavity (6) to at least one braking device (102), for example through a primary branch (103) along which an electrically actuatable on-off valve (104) is arranged to fluidly connect the brake master cylinder (2) to the at least one braking device (102) in a selective manner, wherein the cylinder (5) with the float (4) defines a pressure chamber (11) in the cavity (6), wherein the float (4) is configured to move forward over an idle float stroke (X1) shutting the feeding port (7), fluidly isolating the pressure chamber (11) from the feeding port (7) so as to pressurize the working fluid in the pressure chamber (11),

wherein the assembly (1) further comprises

- a braking feel simulator device (3) comprising at least one absorber (12), wherein the absorber (12) is configured to apply a reaction force on the brake pedal (101) against an actuation of the brake pedal (101),

characterized in that

the at least one absorber (12) is integrated into said brake master cylinder (2), wherein the absorber (12) is adapted to be connected to the brake pedal (101), wherein the absorber (12) is interposed between said float (4) and said brake pedal (101),

wherein, against the actuation of the brake pedal (3), the absorber (12) is configured to bias the float (4) moving forward over at least said idle float stroke (X1) in said cylinder (5) until it pressurizes the working fluid in said pressure chamber (11), and

the braking feel simulator device (3) is configured to dampen the actuation of the brake pedal (101) keeping the working fluid in said pressure chamber (11) pressurized.

2. An assembly according to the preceding claim,

wherein the braking feel simulator device (3) is configured to contain the working fluid with fluid continuity inside the absorber (12) and the at least one reservoir (10) or a simulator reservoir (16),

wherein the absorber (12) is integrated into said brake master cylinder (2) upstream of said float (4),

wherein the absorber (12) is configured so that, once the float (4) moving forward over at least said idle float stroke (X1) in said cylinder (5) is biased by pressurizing the working fluid in said pressure chamber (11), the actuation of the brake pedal (101) corresponds to a pressurization of the hydraulic fluid contained in the absorber (12), which conveys a flow of hydraulic fluid from the absorber (12) towards the at least one reservoir (10) or the simulator reservoir (16).

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

the absorber (12) comprises a thrust piston (13) arranged in said cavity (6) defined by the cylinder (5), wherein the thrust piston (13) is adapted to be connected to the brake pedal (101),

wherein in said cavity (6), between said thrust piston (13) and said float (4), a simulator chamber (14) adapted to contain said working fluid is defined,

wherein the thrust piston (13) is movable in said cavity (6) and is adapted to bias the working fluid contained in said simulator chamber (14)

wherein the cylinder (5) defines a simulator port (9) to fluidly connect the simulator chamber (14) to the at least one reservoir (10) or a simulator reservoir (16),

wherein the braking feel simulator device (3) comprises hydraulic

resistance means (15),

wherein the hydraulic resistance means (15) are configured to control a fluid flow from the simulator chamber (14) to the at least one reservoir (10) or the simulator reservoir (16) to dampen the actuation of the brake pedal (101) at least when the float (4) is moved forward over said idle float stroke (X1) by pressurizing the working fluid in said pressure chamber (11),

wherein the hydraulic resistance means (15) are arranged between the simulator port (9) and the at least one reservoir (10) or the simulator reservoir (16),

preferably wherein the simulator port (9) coincides with the feeding port (7), and/or wherein the simulator port (9) and the feeding port (7) are the same port.

4. An assembly (1) according to the preceding claim,

wherein the thrust piston (13) is movable in said cavity (6) over an idle piston stroke (X2) simultaneously with the float (4) until the float (4) is moved forward over said idle float stroke (X1) by pressurizing the fluid in said pressure chamber (11),

and wherein the thrust piston (13) is movable in said cavity (6) by keeping a distance between said thrust piston (13) and said float (4) and/or a volume of said simulator chamber (14) constant, until the float (4) is moved forward over said idle float stroke (X1) by pressurizing the fluid in said pressure chamber (11).

5. An assembly (1) according to claim 3 or 4,

wherein, once the float (4) is moved forward over said idle float stroke (X1) by pressurizing the fluid in said pressure chamber (11), the thrust piston (13) is movable in said cavity (6) by conveying the fluid from the simulator chamber (14) towards the at least one reservoir (10) or the simulator reservoir (16) through the hydraulic resistance means (15);

and/or wherein, once the float (4) is moved forward over said idle float stroke (X1) by pressurizing the fluid in said pressure chamber (11), the thrust piston (13) is movable in said cavity (6) by reducing the distance between said thrust piston (13) and said float (4) and/or the volume of said simulator chamber (14).

6. An assembly (1) according to any one of the preceding claims,

wherein the float (4) is movable along a thrust direction (X-X) along which the cavity (5) extends between a float resting position, in which the float (4) abuts against a shoulder (19) connected to said cylinder (5) within said cavity (6), and at least one float operating position, in which the float (4) fluidly isolates the pressure chamber (11) and the reservoir (10) by pressurizing the working fluid in the pressure chamber (11); wherein the brake master cylinder (2) comprises an elastic float element (20) arranged within said cavity (6) between a cylinder seat or a cylinder bottom wall

(21) of said cylinder (5) and said float (4) so as to constantly bias the float (4) to the float resting position, preferably wherein the brake master cylinder (2) comprises a pressure chamber plug (33) configured to fluid-tightly close the pressure chamber (11) by connecting to an open end of the cylinder (5) with a plug gasket or O-ring (34) interposed therebetween, wherein the pressure chamber plug (33) comprises the cylinder bottom wall (21), preferably wherein the cylinder bottom wall (21) delimits an annular cylinder seat (48) configured to house and axially abut against one end of the elastic float element (20), preferably wherein the float (4) delimits an annular float thrust seat (46) configured to house and axially abut against the other end of the elastic float element (20).

7. An assembly (1) according to any one of the preceding claims 3 to 6,

wherein the thrust piston (13) is movable along a thrust direction (X-X), along which the cavity (5) extends, between an absorber resting position, in which the thrust piston (13) abuts against a retainer (25) connected to or made in one piece with said cylinder (5) within said cavity (6), and at least one absorber operating position, in which the thrust piston (13) approaches said simulator port (9);

wherein the absorber (12) comprises at least one elastic absorber

element (22) arranged inside said cavity (6) between an elastic element seat (23) connected to said cylinder (5) or made on said cylinder (5) and said thrust piston (13), or between a float bottom (24) of said float (4) and said thrust piston (13), so as to constantly bias the thrust piston (13) towards the absorber resting position by opposing a forward movement of the thrust piston (12) into the cavity (5),

and wherein the thrust piston (13) comprises in series a first thrust piston (26), a second thrust piston (27), and at least one elastic thrust piston element (30) interposed between a thrust wall (39) of the first thrust piston (26) and a second piston bottom (42) of the second thrust piston (27) so as to oppose an approach between the first thrust piston (26) and the second thrust piston (27), wherein the first thrust piston (26) comprises a first piston bottom (38) configured to be connected to the brake pedal or lever (101).

8. An assembly (1) according to the preceding claim, comprising one or more of the following features:

wherein the at least one elastic absorber element (22) comprises a first elastic absorber element (28) and a second elastic absorber element (29), wherein the first elastic absorber element (28) and the second elastic absorber element (29) are arranged in series or wherein the first elastic absorber element (28) and the second elastic absorber element (29) are arranged in parallel, for example

wherein the first elastic absorber element (28) and the second elastic absorber element (29) are concentric coil springs, wherein at least one of the first elastic absorber element (28) and the second elastic absorber element (29) is configured to constantly bias the second thrust piston (27) towards the first thrust piston (26) and towards the absorber resting position by opposing a forward movement of the first thrust piston (12) and the second thrust piston into the cavity (5);

and/or wherein the first thrust piston (26) comprises a thrust cup portion (37) having the thrust wall (39) of the first thrust piston (26) as a bottom, wherein the thrust cup portion (37) is configured to house at least partially the second thrust piston (27) in a movable manner avoiding a fluid tightness, wherein the thrust cup portion (37) is configured to contain the working fluid by delimiting the simulator chamber (14);

and/or wherein the second thrust piston (27) comprises a flange (40) and a central body (50), wherein the flange (40) is connected to the central body (50) forming a first shoulder (43) configured to abut against the first elastic absorber element (28), and wherein the central body (50) defines a second shoulder (44) configured to abut against the second elastic absorber element (28), wherein the central body (50) is coaxial with the first elastic absorber element (28) and the second elastic absorber element (29), preferably wherein the second thrust piston (27) further comprises a guide

shaft (41), wherein the central body (50) is connected to the guide shaft (41) forming the second shoulder (44), wherein the guide shaft (41) is coaxial with the first elastic absorber element (28) and the second elastic absorber element (28).

9. An assembly (1) according to any one of the preceding claims, comprising at least one of the following features:
wherein the braking feel simulator device (3) comprises a simulator branch (17) adapted to fluidly connect the absorber (12) and the at least one reservoir (10) or a simulator reservoir (16),
wherein the braking feel simulator device (3) comprises a calibrated orifice (18) arranged along the simulator branch (17) and interposed between the at least one reservoir (10) or the simulator reservoir (16) and the absorber (12),
the calibrated orifice (18) being configured to control a fluid flow from the absorber (12) to the at least one reservoir (10) or the simulator reservoir (16);
or wherein said hydraulic resistance means (15) comprise a calibrated orifice (18).

10. An assembly (1) according to the preceding claim, comprising at least one of the following features:
wherein the calibrated orifice (18) forms a section of a diameter between 0.7 mm and 1.5 mm,

and/or wherein the calibrated orifice (18) has a length of less than 3.0 mm,
and/or wherein the simulator branch has a length of less than 10.0 mm, and/or wherein the calibrated orifice (18) is made as a port passing directly through the thickness of the side wall of the cylinder (5).

11. An assembly (1) according to any one of the preceding claims, comprising at least one sensor configured to detect an actuation and/or movement of the float (4) and/or the absorber (13),
and wherein, preferably, the at least one sensor is a position sensor or a pressure sensor or a force sensor, or a combination thereof.

12. An assembly (1) according to any one of the preceding claims, wherein the assembly (1) comprises a brake pedal (101) operatively connected to the absorber (13), preferably by means of a mechanical connection so that an actuating force applied by a driver on the brake pedal (101) is mechanically transferred to the absorber (5), and/or wherein said assembly (1) comprises a primary branch (103) connected to the outlet port (8), and an electrically actuatable on-off valve (104), of the normally open type, arranged along said primary branch (102), wherein under a by-wire condition, the on-off valve (104) is closed
and wherein, under an electrical blackout condition, the on-off

valve is open allowing a hydraulically direct connection between the assembly (1) and the at least one braking device (102).

13. A braking system (100) of the brake-by-wire type, comprising

- an assembly (1) according to any one of the preceding claims,
- at least one braking device (102), such as a hydraulic actuation device of a disc or drum brake,
- a primary branch (103) for hydraulically connecting the brake master cylinder (2) to the at least one braking device (102),
- an electrically actuatable on-off valve (104), of the normally open type, arranged along said primary branch (102), wherein under a by-wire condition, the on-off valve (104) is closed

and wherein, under an electrical blackout condition, the on-off valve is open allowing a hydraulically direct connection between the assembly (1) and the at least one braking device (102);

- a processing and control unit operatively connected to said assembly (1) and motor means for actuating said at least one braking device (102),

the processing and control unit being programmed so as to actuate the braking device (102) through the motor means as a function of the actuation of the assembly (1) through the brake lever or pedal (101) under a by-wire operating condition, to said by-wire operating condition.

14. A braking system (100) according to the preceding claim, wherein said assembly (1) comprises said at least one reservoir (10) in fluid connection at least with said pressure chamber (11), wherein said system (100) comprises:

- a charge branch (105), which hydraulically connects the at least one reservoir (10) to the primary branch (103) between the at least one braking device (102) and the on-off valve (104),
- a first check valve (107) arranged along the charge branch (105) and configured to allow a fluid to pass only from the at least one reservoir (10) to the at least one braking device (102),
- a discharge branch (106), which hydraulically connects the primary branch (103) downstream of the on-off valve (104) to the primary branch (103) upstream of the on-off valve (104);
- a second check valve (108) arranged along the discharge branch (106) and configured to allow a fluid to pass only from the at least one reservoir (10) to the at least one braking device (102) to the brake master cylinder (2).

15. A method of actuating a braking system of the brake-by-wire type comprising at least one braking device (102) selectively actuatable, under a blackout condition, by a brake master cylinder by means of a direct hydraulic connection or, under a by-wire condition, by a processing and control unit operatively connected to motor means and a braking feel simulator device, comprising the following steps:

- providing an assembly (1) according to any one of claims 1 to 12,

connected to a brake pedal (101);

- actuating said brake pedal (3), and

in a by-wire mode

- detecting a position of the brake pedal (101) over time,
- against the actuation of the brake pedal (3), biasing, by means of the absorber (12), the float (4) of the brake master cylinder (2) moving forward over at least said idle float stroke (X1) in said cylinder (5) until the working fluid in said pressure chamber (11) is pressurized, and
- damping the actuation of the brake pedal (101), by means of the braking feel simulator device (3), keeping the working fluid in said pressure chamber (11) pressurized,
- actuating the at least one braking device (102) through motor means based on the detected brake pedal position;

or in a blackout mode

- against the actuation of the brake pedal (3), biasing, by means of the absorber (12), the float (4) of the brake master cylinder (2) moving forward over at least said idle float stroke (X1) in said cylinder (5) until the working fluid in said pressure chamber (11) is pressurized,
- actuating the at least one braking device (102) by biasing, by means of the absorber (12), the float (4) of the brake master cylinder (2), keeping the working fluid in said pressure chamber (11) pressurized.

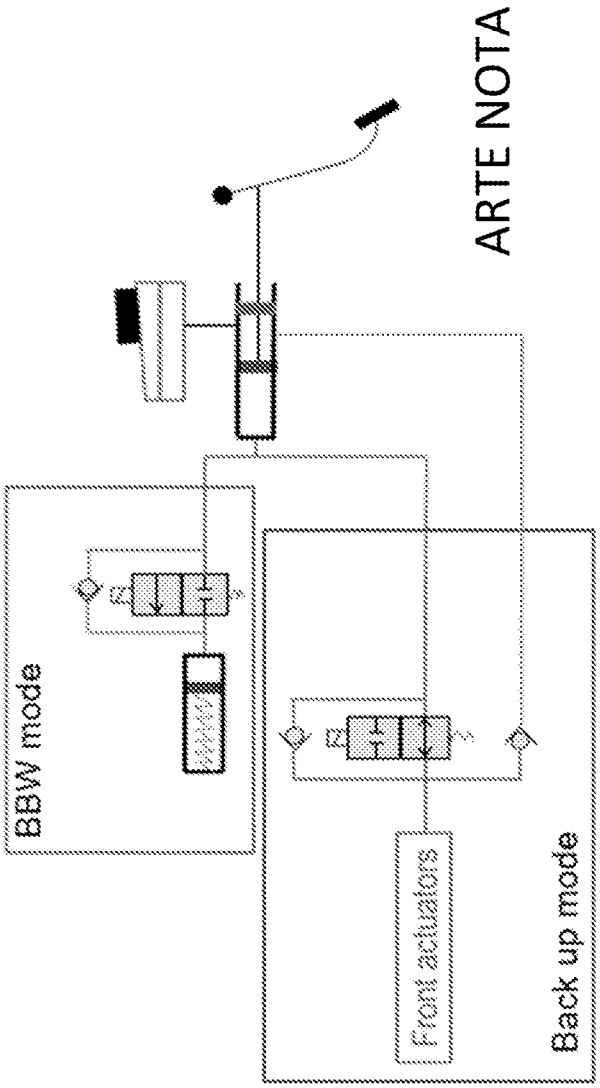

FIG.1

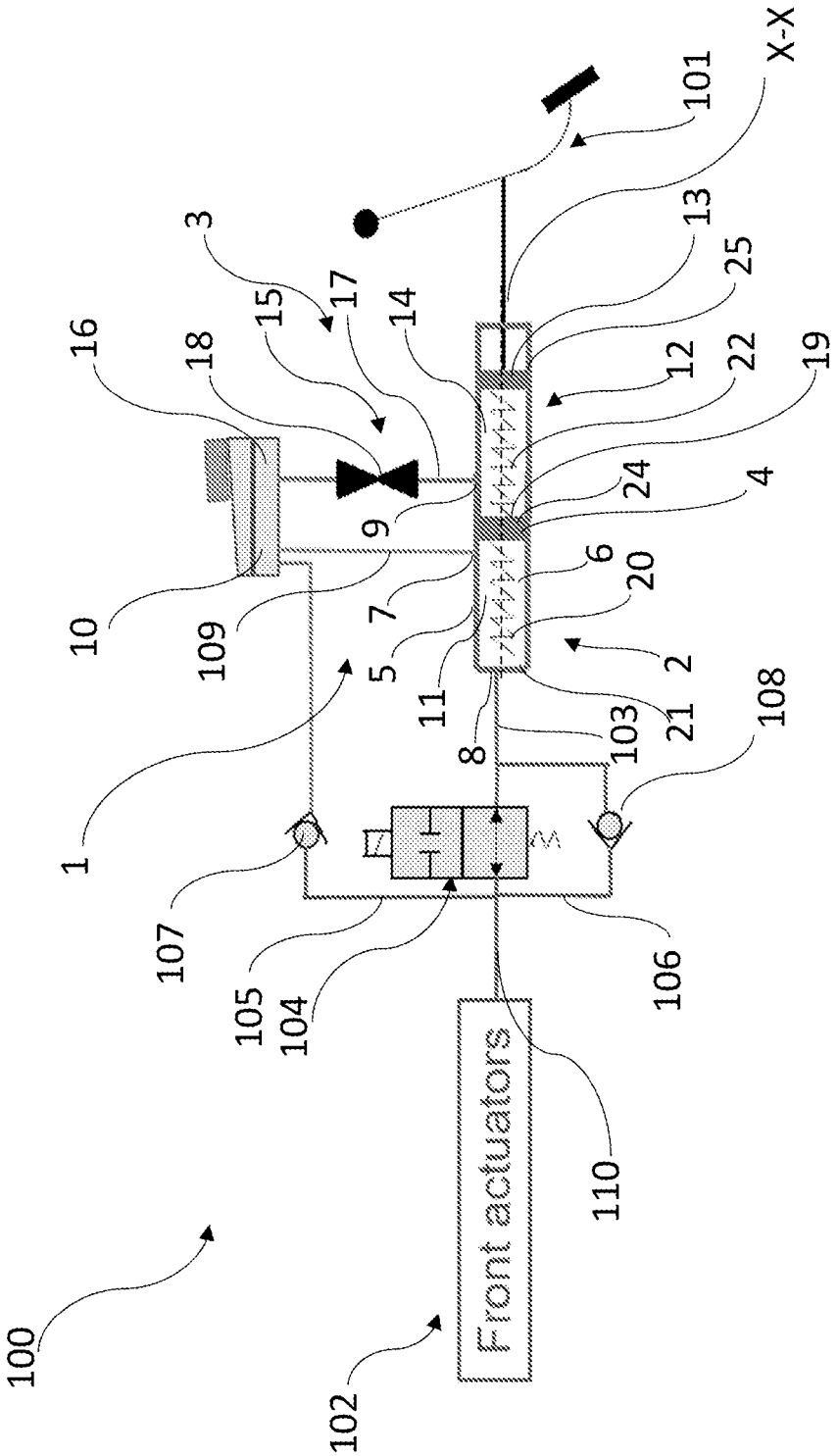
X-X
101
3
15
17
14
13
25
16
18
12
22
19
9
24
4
10
109
6
20
7
5
11
2
8
103
21
108
1
107
105
104
106
Front actuators
110
100
102

FIG. 2

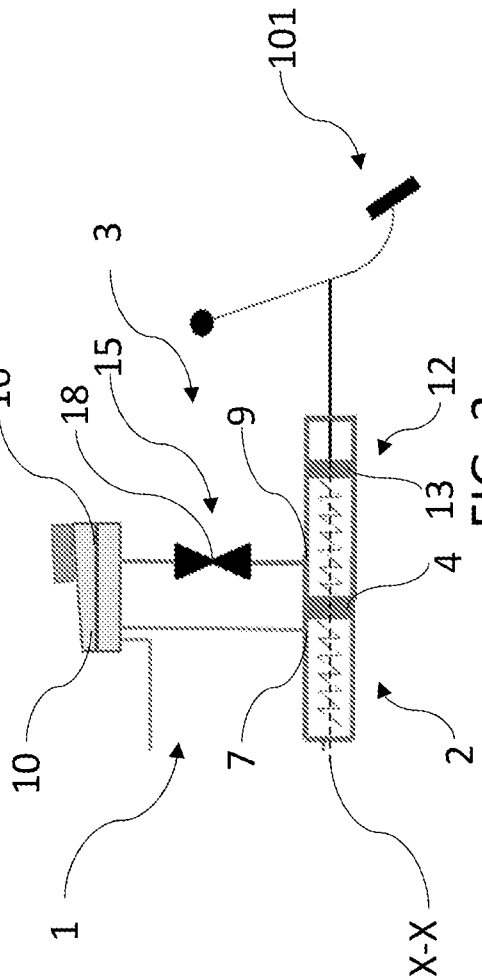
101
3
16
18
15
9
12
13
4
10
7
2
1
X-X

FIG. 3

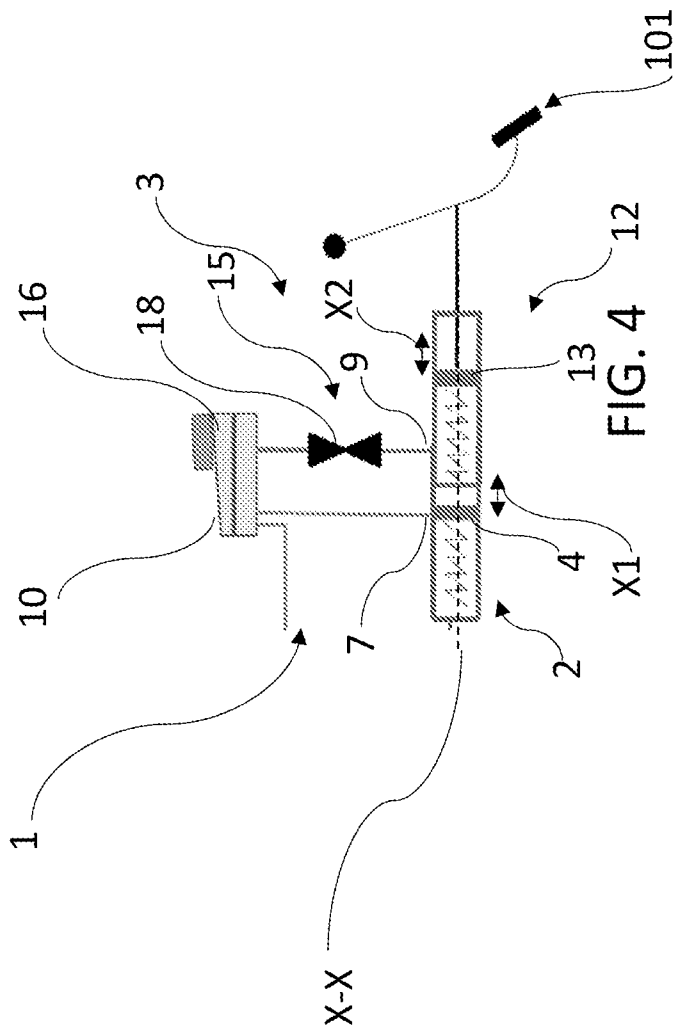
101
3
12
16
18
15
X2
9
13
10
4
X1
7
2
1
X-X

FIG. 4

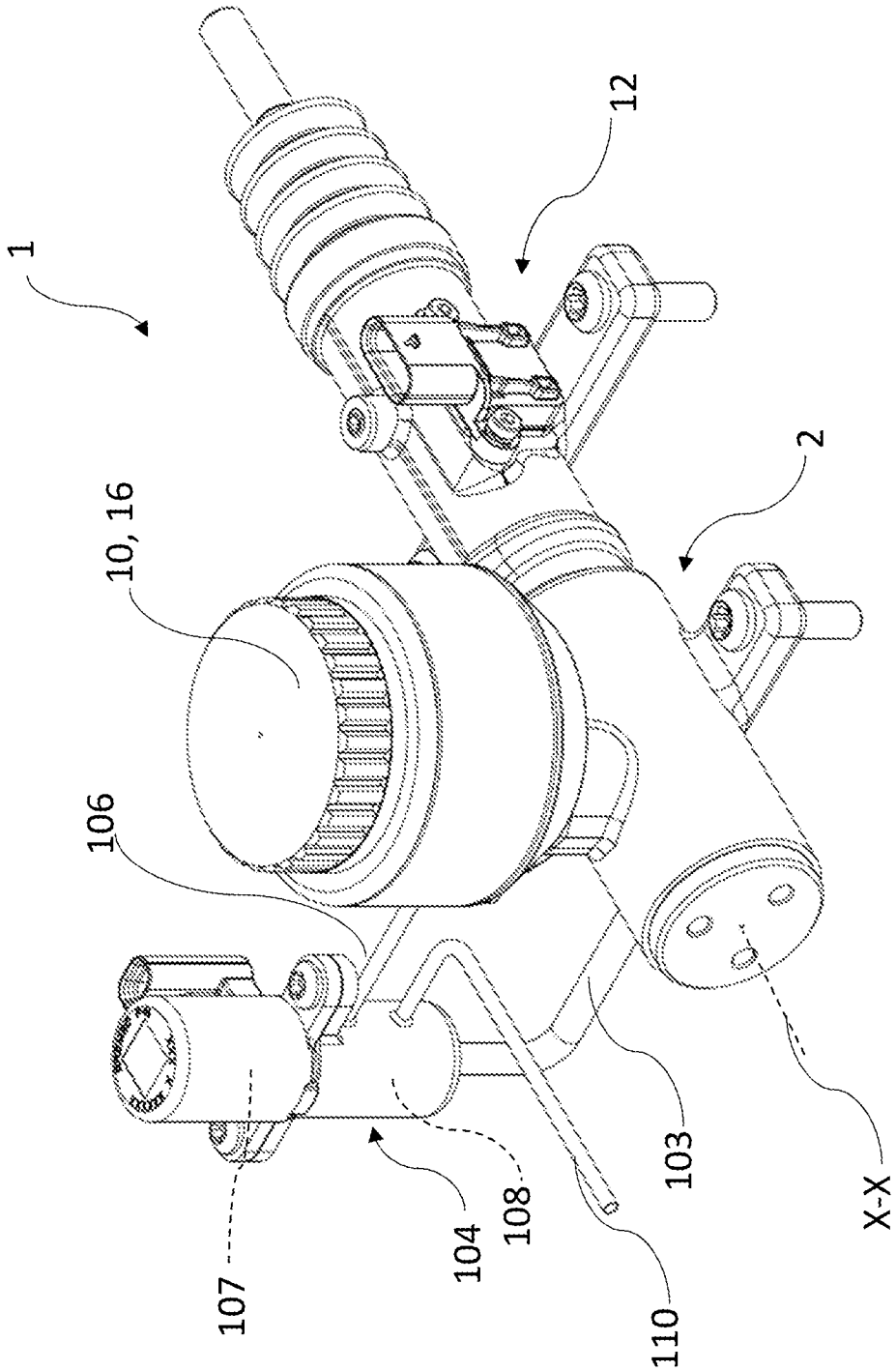

FIG. 5A

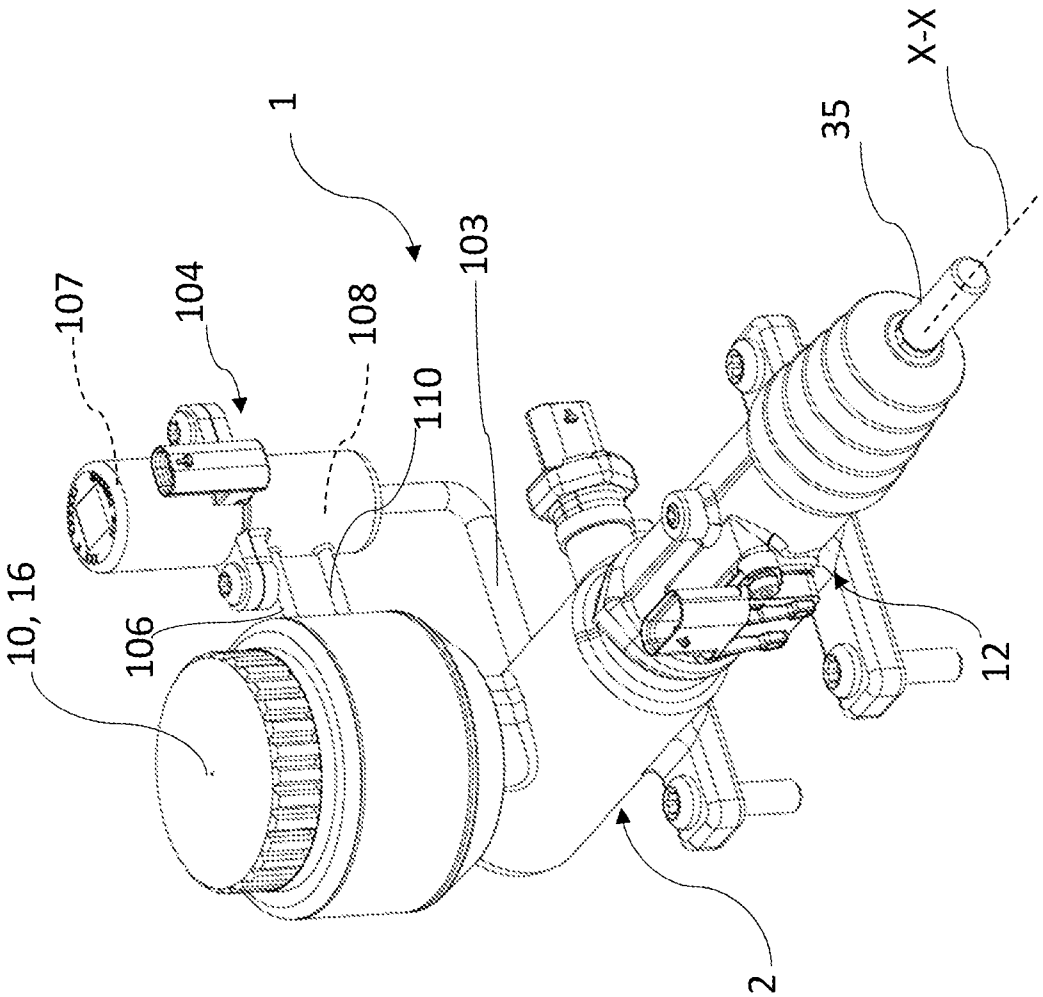

FIG. 5B

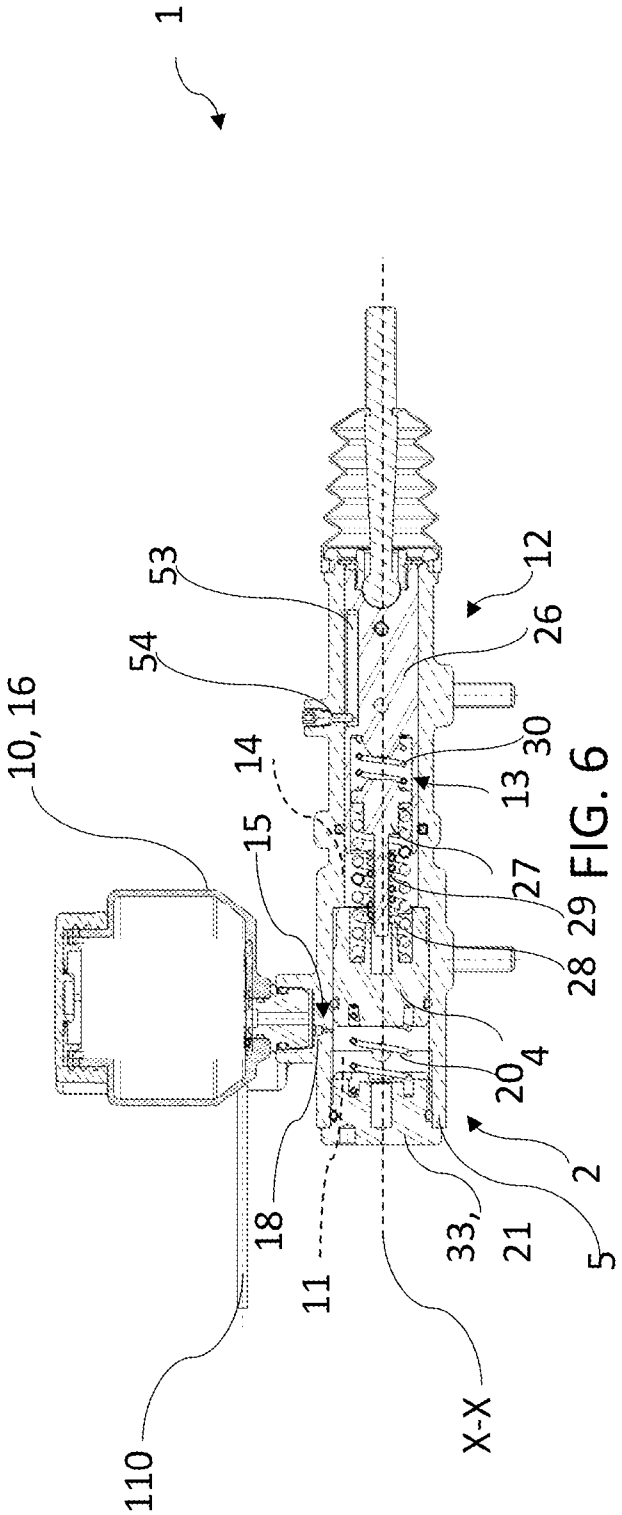
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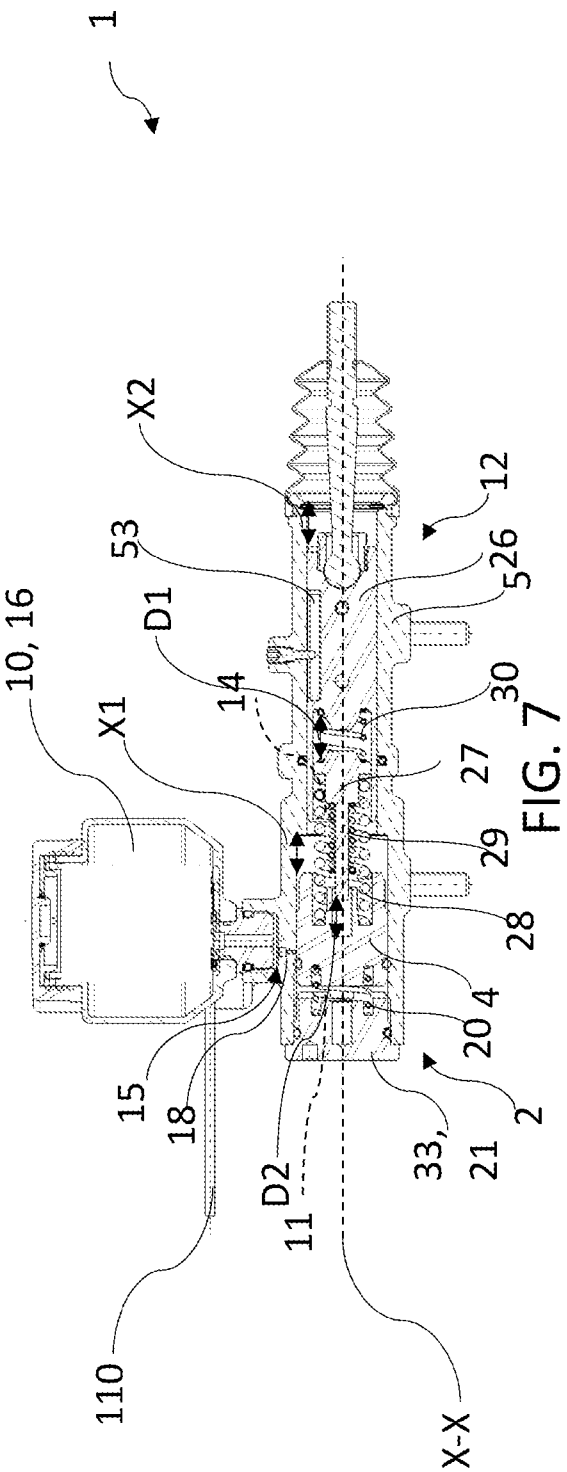
FIG. 6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D2
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FIG. 7

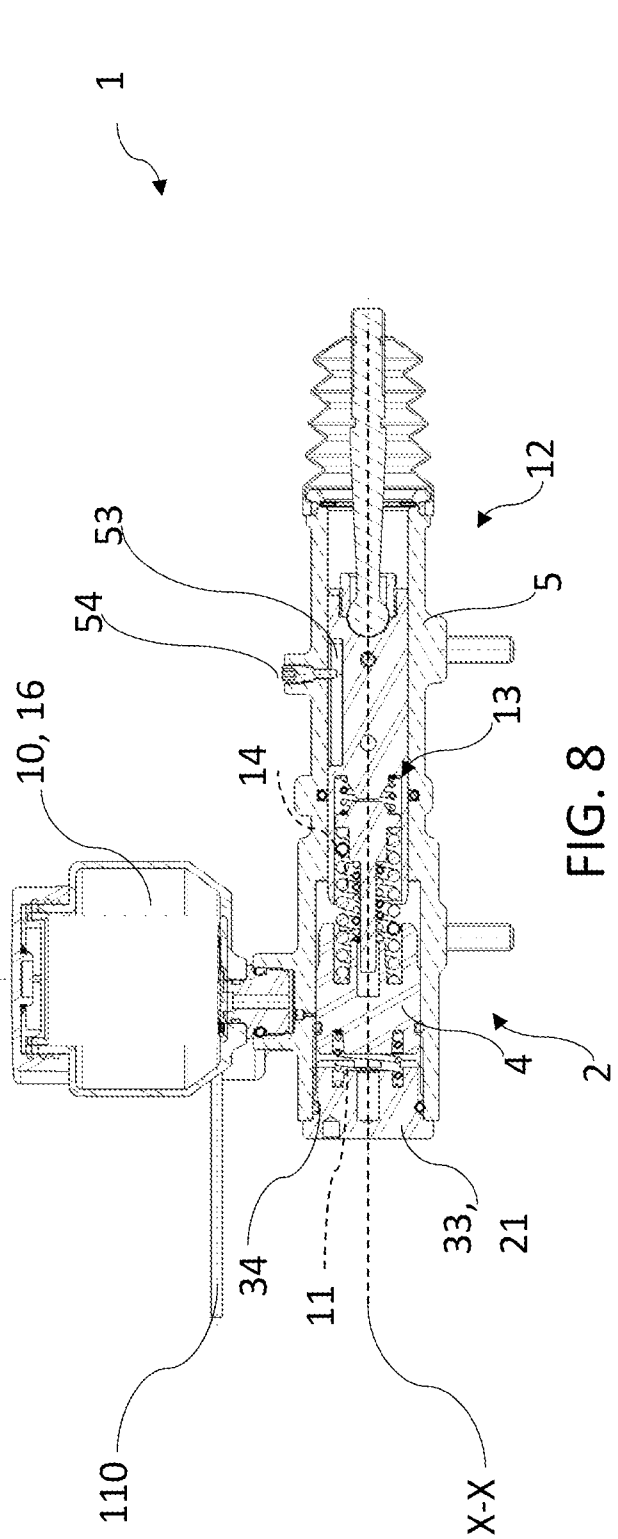
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FIG. 8

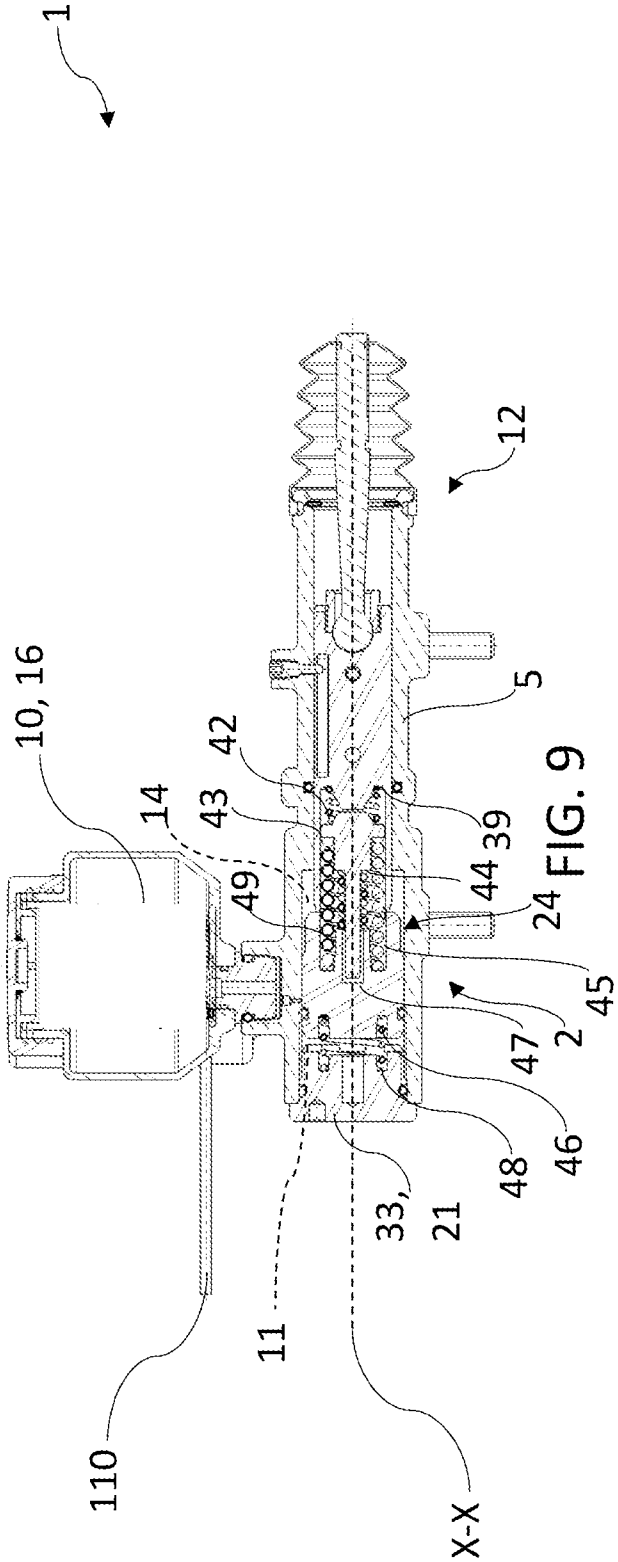
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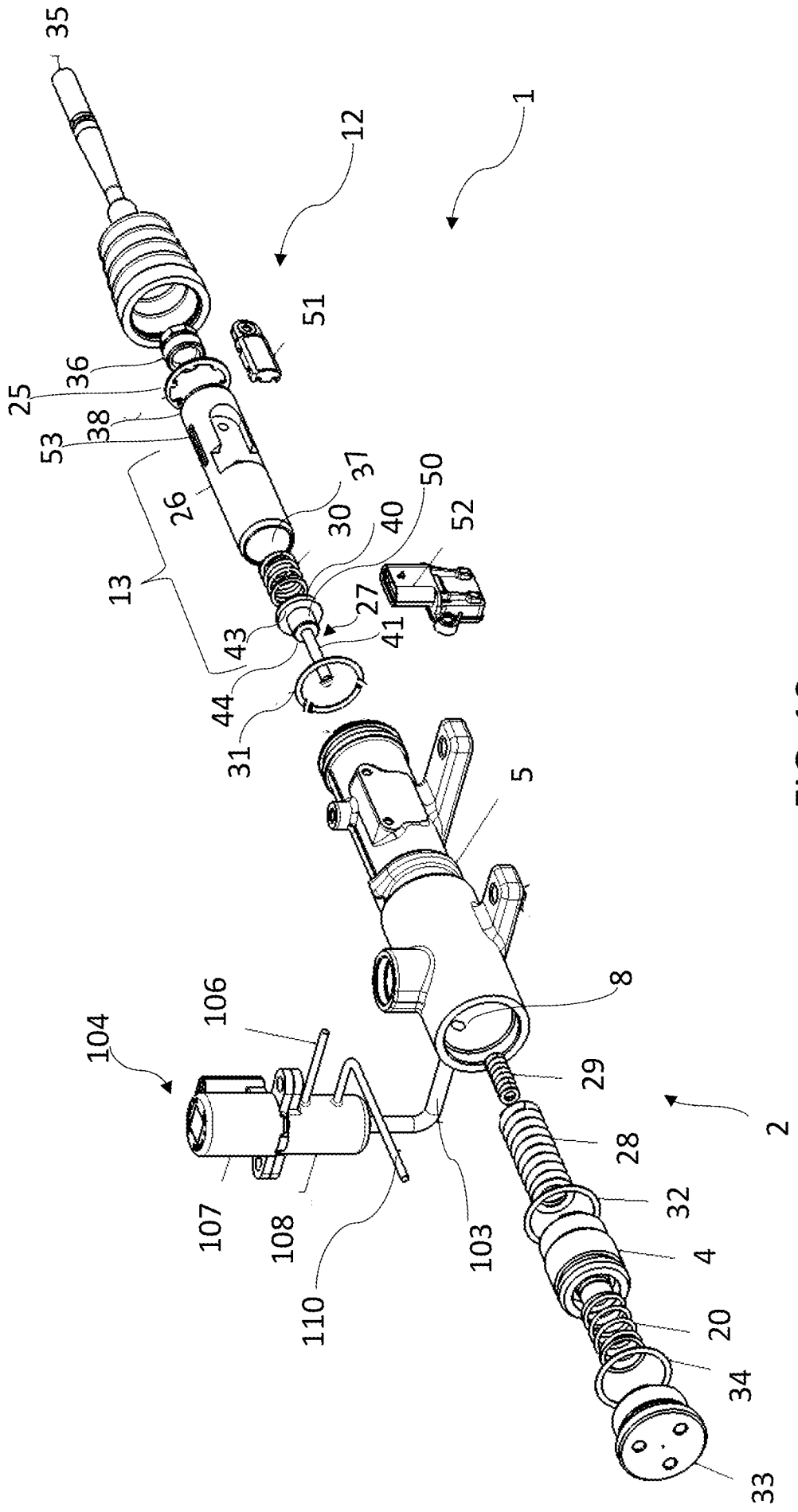
FIG. 9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108
103
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34
33

FIG. 10

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2024/055535

A. CLASSIFICATION OF SUBJECT MATTER
INV. B60T7/04 B60T8/40
ADD. B60T13/68

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)
B60T

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

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

[x] See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 September 2024	24/09/2024

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	Landriscina, V

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INTERNATIONAL SEARCH REPORT

International application No
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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