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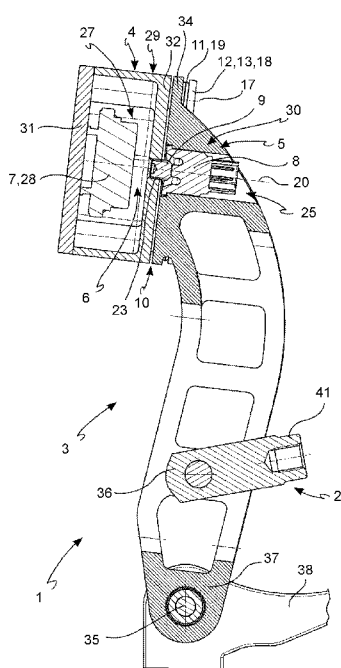


FIG. 6

(57) Abstract: A braking system (1), comprising a braking feel simulator device (2) and a brake pedal (3) operatively connected to the braking feel simulator device (2), wherein the braking system (1) comprises at least a first body (4) and a second body (5), mechanically connected to each other so that the actuating force applied by the driver to the brake pedal (3) is transferred between the first body (4) and the second body (5), wherein the braking system (1) comprises a signaling and detection system (6) comprising a haptic feedback actuator (7), a sensor (8), and a transmission element (9) configured to transmit the haptic feedback generated by the haptic feedback actuator (7) to the sensor (8) and/or to transfer the actuating force applied by the driver to the brake pedal (3) between the first body (4) and the second body (5), wherein the haptic feedback actuator (7) and the transmission element (9) are positioned at the first body (4), while the sensor (8) is positioned at the second body (5), wherein the transmission element (9) leads from the first body (4) and is positioned to abut against the sensor (8) so as to define a clearance (10) between the first body (4) and the second body (5), wherein the braking system (1) comprises connecting means (12) to connect the first body (4) to the second body (5), wherein the braking system (1) comprises damping means (11), positioned interposed between the first body (4) and the second body (5) and configured to damp movements or vibrations transmissible, through the connecting means (12), between the first body (4) and the second body (5).



Braking system

[0001] Field of the invention

[0002] The present invention relates to a braking system of the Brake-By-Wire ("BBW") type of vehicles with two or more wheels actuatable by a driver by means of a brake pedal or lever.

[0003] Background art

[0004] In braking systems of the BBW type, there is a decoupling between force and displacement applied on the brake pedal or lever by the driver and the resulting braking force which is applied by the calipers to the vehicle wheels.

[0005] In BBW braking systems, the force and displacement applied by the driver to 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 BBW braking systems with a braking feel simulator device connected to the brake pedal or lever and configured to simulate the feel and stiffness of a brake pedal or lever of conventional hydraulic braking systems, and thus emulate the "stiffness curve" thereof.

[0007] "Stiffness curve" refers to 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] Driving safety and comfort are strictly dependent on the stiffness of the brake pedal or lever, implemented by the braking feel simulation devices.

[0009] Braking feel simulator devices comprising a master cylinder connected to the brake pedal are known.

[0010] The master cylinder comprises a float, which is moved by the driver's mechanical action on the brake pedal and has the function of pressurizing the hydraulic fluid.

[0011] The hydraulic fluid is contained in a reservoir fluidically connected to the master cylinder by means of a hydraulic connection.

[0012] Moreover, the master cylinder is fluidically connected by means of a further hydraulic connection to an absorber, which is a device generally provided with a plurality of elastic elements arranged in series and in parallel, configured to apply an elastic reaction force against a brake pedal actuation.

[0013] In known BBW braking systems, the decoupling between the force applied to

the brake pedal by the driver and the braking force which is applied by the calipers to the wheels of the vehicle generates difficulties in returning haptic signals and feedback to the driver, such as the brake pedal shaking of a conventional braking system which is triggered when the ABS system intervenes.

[0014] Moreover, both BBW and conventional hydraulic braking systems do not allow transmitting special alerts or warning signals related to the braking system itself to the driver, such as a parking brake engagement or disengagement warning.

[0015] The inventors are aware of braking feel simulator devices which comprise means configured to provide and transmit haptic signals and feedback, in particular vibrations, to the driver, such as the trembling of the brake pedal of a conventional braking system which is triggered when the ABS intervenes.

[0016] The inventors are also aware of braking feel simulator devices provided with sensors configured to detect various parameters related to the braking system, such as the braking system actuation force applied by the driver to the brake pedal or lever, or the vibrations transmitted by the haptic signal transmission and feedback means.

[0017] A critical issue of such braking systems known to the inventors is in ensuring a correct sensor measurement of the parameters related to the braking system, such as the braking force applied by the driver and the vibrations transmitted by the haptic signal and feedback transmission means.

[0018] The criticality of ensuring a correct measurement of parameters by the sensor is even more apparent when the vehicle is subjected to vibrations or particular movements, e.g., due to road surface conditions, which have the potential to distort the parameter readings by the sensor.

[0019] A further criticality of the braking systems known to the inventors is in the attempt to reduce the size and bulk of the integration of the sensors and the haptic signal and feedback transmission means.

[0020] Solution

[0021] It is the object of the present invention to provide a braking system, of the BBW type, such as to obviate at least some of the drawbacks of the prior art.

[0022] It is a particular object of the present invention to provide a braking system configured to return and transmit haptic signals and feedback to the driver, such as the shaking of the brake pedal of a conventional braking system which is triggered when the ABS intervenes or an engagement or disengagement alert of the parking brake.

[0023] It is a further particular object of the present invention to provide a braking system configured to detect parameters related to the braking system actuation, such as

the braking system actuation force applied by the driver to the brake pedal or lever, or the vibrations transmitted by the haptic signal transmission and feedback means.

[0024] It is a further particular object of the present invention to provide an improved braking system capable of ensuring a correct reading of parameters related to braking system actuation, such as the braking system actuation force applied by the driver to the brake pedal or lever, or the vibrations transmitted by the haptic signal transmission and feedback means, even under conditions of vibration or special vehicle movement, e.g., due to the vehicle passing over potholes or ditches in the road surface.

[0025] It is a further particular object of the present invention to provide a more compact braking system.

[0026] These and other objects are achieved by a braking system according to claim 1.

[0027] The dependent claims relate to preferred and advantageous embodiments of the present invention.

[0028] Figures

[0029] In order to better understand the invention and appreciate the advantages thereof, some non-limiting exemplary embodiments thereof will be described below with reference to the accompanying drawings, in which:

[0030] – figure 1 is a front perspective view of a component of a braking system according to an embodiment of the invention;

[0031] – figure 2 is a rear perspective view of the component shown in figure 1;

[0032] – figure 3 is a side view of a component of a braking system according to an embodiment of the invention;

[0033] – figure 4 is a front view of the component in figure 3;

[0034] – figure 5 is a rear view of the component shown in figure 3;

[0035] – figure 6 is a longitudinal section view of a component of a braking system according to an embodiment of the invention;

[0036] – figure 7 is a detail view of the longitudinal section shown in figure 6;

[0037] – figure 8 is a longitudinal section view of the component shown in figure 6;

[0038] – figure 9 is a detail view of the longitudinal section shown in figure 8;

[0039] – figure 10 is an exploded view of the component of a braking system shown in figure 6;

[0040] – figure 11 diagrammatically shows a braking system, according to an embodiment of the invention;

[0041] – figure 12 diagrammatically shows a braking system, according to a further embodiment of the invention;

[0042] – figure 13 diagrammatically shows a braking system, according to a further embodiment of the invention;

[0043] – figure 14 diagrammatically shows a braking system, according to a further embodiment of the invention;

[0044] – figure 15 is a front perspective view of a component of a braking system according to an embodiment of the invention;

[0045] – figure 16 is a front perspective view of a component of a braking system according to an embodiment of the invention;

[0046] – figure 17 is a front perspective view of a connecting system according to an embodiment of the invention.

[0047] Description of some preferred embodiments

[0048] The present invention relates to a braking system of the Brake-By-Wire ("BBW") type of vehicles with two or more wheels actuatable by a driver by means of a brake pedal or lever. Therefore, in the present description, the term "brake pedal" means indistinctly both a brake pedal for motor vehicles and the like and a brake lever for motorcycles, mopeds, and the like, unless otherwise specified. Moreover, "electrically connected" and "electrically connected" means a connection for the transmission of electric power and/or electric signals.

[0049] Braking system 1

[0050] With reference to the figures, a braking feel simulator device is generally indicated by reference numeral 1.

[0051] In particular, the braking system 1 is a braking system of the "BBW" type.

[0052] The braking system 1 comprises a braking feel simulator device 2.

[0053] Moreover, the braking system 1 comprises a brake pedal 3 operatively connected to the braking feel simulator device 2.

[0054] The braking system 1 is configured so that an actuation of the brake pedal 3 by a driver, in particular an actuation force applied by the driver on the brake pedal 3, corresponds to a reaction force applied by the braking feel simulator device 2 to the brake pedal 3 as opposed to an actuation of the brake pedal 3.

[0055] The braking system 1 comprises at least a first body 4 and a second body 5.

[0056] The first body 4 and a second body 5 are mechanically connected to each other so that the actuating force applied by the driver to the brake pedal 3 is transferred

from the first body 4 towards the second body 5, or vice versa from the second body 5 towards the first body 4.

[0057] According to an aspect of the invention, the braking system 1 comprises a signaling and detection system 6.

[0058] The signaling and detection system 6 comprises a haptic feedback actuator 7.

[0059] The haptic feedback actuator 7 is configured to transmit haptic feedback to the brake pedal 3. The haptic feedback actuator 7 can thus transmit haptic feedback, e.g., a vibration, to the driver.

[0060] Haptic feedback actuator 7 also means a "tactile feedback actuator".

[0061] The signaling and detection system 6 further comprises a sensor 8.

[0062] The sensor 8 is configured to detect parameters related to the braking system 1.

[0063] The parameters related to the braking system 1 detectable by the sensor 8 comprise the actuating force applied by the driver to the brake pedal 3 and the haptic feedback transmitted from the haptic feedback actuator 7 to the brake pedal 3.

[0064] The signaling and detection system 6 further comprises a transmission element 9.

[0065] The transmission element 9 is configured to transmit the haptic feedback generated by the haptic feedback actuator 7 to the sensor 8.

[0066] Alternatively or additionally, the transmission element 9 is configured to transfer the actuating force applied by the driver on the brake pedal 3 between the first body 4 and the second body 5.

[0067] The haptic feedback actuator 7 and the transmission element 9 are positioned at the first body 4.

[0068] Instead, the sensor 8 is located at the second body 5.

[0069] The transmission element 9 leads from the first housing 4 and is positioned abutting against the sensor 8. The transmission element 9 thus defines a clearance 10 between the first body 4 and the second body 5.

[0070] The braking system 1 further comprises connecting means 12.

[0071] The connecting means 12 are configured to connect the first body 4 to the second body 5.

[0072] Moreover, the braking system 1 comprises damping means 11.

[0073] The damping means 11 are positioned to be interposed between the first body 4 and the second body 5.

[0074] Moreover, the damping means 11 are configured to damp movements or vibrations transmissible, through the connecting means 12, between the first body 4 and the second body 5.

[0075] Advantageously, the braking system 1 thus configured allows returning haptic signals and feedback, such as the shaking or vibration, which is triggered when the ABS system intervenes, to the driver by transmitting appropriate haptic feedback from the haptic feedback actuator 7 to the brake pedal 3. Moreover, the braking system 1 thus configured allows transmitting particular alerts or warning signals relating to the braking system 1 itself, such as an electronic parking brake ("EPB") engagement or disengagement alert or an electronic stability control ("ESC") activation or deactivation alert, or a vehicle ignition key on and off alert, or a malfunction alert of the braking system 1, or a regenerative braking activation or deactivation alert to the brake pedal 3, and thus to the driver. Moreover, the braking system 1 allows transmitting an insufficient or excessively light braking force alert to the brake pedal 3, and thus an indication to the driver to increase the braking force, e.g., under the conditions in which the vehicle is approaching other vehicles and the current braking force is not sufficient to avoid a collision.

[0076] With further advantage, a braking system 1 thus configured allows detecting parameters related to braking system actuation, such as the braking system actuation force applied by the driver to the brake pedal or lever 3, or the vibrations transmitted by the haptic feedback actuator 7, by means of the sensor 8.

[0077] With further advantage, a braking system 1 thus configured ensures a correct reading of the parameters related to braking system actuation, such as the braking system actuation force applied by the driver to the brake pedal or lever 3, or the vibrations transmitted by the haptic feedback actuator 7, by means of the sensor 8.

[0078] Indeed, the braking system 1 so configured ensures that the actuation force applied by the driver on the brake pedal 3 is transmitted between the first body 4 and the second body 5 through the transmission element 9 and the sensor 8. This ensures a correct reading by the sensor 8 of the actuation force applied by the driver on the brake pedal 3. At the same time, the damping means 11 damp any relative motions between the first body 4 and the second body 5, which would otherwise be transmissible through the connecting means 12, and thus not only through the transmission element 9 and the sensor 8, and which would thus distort the actuation force reading by the sensor 8.

[0079] Similarly, the braking system 1 thus configured ensures that the haptic feedback generated by the haptic feedback actuator 7 is transmitted between the first

body 4 and the second body 5 through the transmission element 9 and the sensor 8. This ensures a correct reading by the sensor 8 of the haptic feedback generated by the haptic feedback actuator 7. At the same time, the damping means 11 damps the transmission of haptic feedback between the first body 4 and the second body 5 by means of the connecting means 12, thus preventing the haptic feedback from also being transferred by means of the connecting means 12, which would distort the reading of the haptic feedback by the sensor 8.

[0080] With further advantage, the braking system 1 thus configured allows integrating a haptic feedback actuator 7 and a respective sensor 8, with reduced overall dimensions.

[0081] According to a preferred embodiment, the first body 4 and the second body 5 are mechanically connected to each other so that the actuation force applied by the driver on the brake pedal 3 is transferred from the first body 4 to the second body 5.

[0082] According to an embodiment, the sensor 8 and the transmission element 9 are positioned facing along a transmission axis 20.

[0083] The forces and vibrations transmitted from the transmission element 9 to the sensor 8 are mainly directed along the transmission axis 20.

[0084] Connecting means 12 and damping means 11

[0085] According to an embodiment, the connecting means 12 are distinct from the transmission element 9.

[0086] According to an embodiment, the damping means 11 are positioned at the connecting means 12.

[0087] According to an embodiment, the connecting means 12 comprise at least one connection screw 13, preferably a plurality of connection screws 13.

[0088] According to an embodiment, the braking system 4 comprises at least one threaded hole 14.

[0089] Moreover, the second body 5 comprises at least one through-hole 15. The through-hole 15 is formed at the threaded hole 14 of the first body 4.

[0090] The connection screw 13 is inserted through a respective through-hole 15 of the second body 5 and is screwed into the respective threaded hole 14 of the first body 4.

[0091] Preferably, the first body 4 and the second body 5 are connected to each other by a plurality of connection screws 13 inserted into respective through-holes 15 of the second body 5 and screwed to respective threaded holes 14 of the first body 4.

[0092] According to an embodiment, the connection screw 13 comprises a threaded stem 16.

[0093] The threaded stem 16 is screwed into the threaded hole 14.

[0094] The threaded stem 16 extends along a screw axis 17. According to an embodiment, the screw axis 17 is parallel to the transmission axis 20.

[0095] According to an embodiment, the connection screw 13 comprises a screw head 18.

[0096] The screw wall 18 extends from the threaded stem 16 in a traverse direction to the screw axis 17.

[0097] The screw head 18 is positioned opposite to the threaded stem 16 with respect to the second body 5.

[0098] According to an embodiment, the damping means 11 are positioned interposed between the screw head 18 and the second body 5.

[0099] Advantageously, such a configuration hinders the transmission of vibrations generated by the haptic feedback actuator 7 from the first body 4 to the second body 5 by means of the connection screw 13. Specifically, the vibrations generated by the haptic feedback actuator 7 are transmitted to the first body 4 and the threaded rod 16 screwed to the first body 4, and therefore to the screw head 18. By means of the damping means 11 interposed between the screw head 18 and the second body 5, the vibrations are damped and not transferred to the second body 5 through the connection screw 13. As a result, such a configuration allows for correct vibration readings by the sensor 8.

[00100] According to an embodiment, the connection screw 13 comprises a backing wall 21, extended between the screw head 18 and the threaded stem 16.

[00101] The backing wall 21 extends from the threaded stem 16 in a traverse direction to the screw axis 17.

[00102] The backing wall 21 is positioned passing through the through-hole screw 15. Moreover, the backing wall 21 is positioned passing through the clearance 10 between the first body 4 and the second body 5.

[00103] Moreover, the backing wall 21 is positioned abutting against the first body 4.

[00104] The backing wall 21 is not threaded.

[00105] Preferably, the diameter of the backing wall 21 with respect to the screw axis 15 is larger than the diameter of the threaded stem 16 and smaller than the diameter of the screw head 18.

[00106] According to an embodiment, the diameter of the through-hole 15 is larger

than the diameter of the backing wall 21 and smaller than the diameter of the screw head 18. Preferably, the diameter of the through-hole 15 is substantially equal to the diameter of the backing wall 21.

[00107] According to an embodiment, the damping means 11 comprise at least one ring-shaped element made of elastomeric material 19.

[00108] According to an embodiment, the ring-shaped element 19 made of elastomeric material is positioned about the connection screw 13, coaxial to the screw axis 17.

[00109] Preferably, the ring-shaped element 19 made of elastomeric material is positioned against the screw head 18.

[00110] Preferably, the ring-shaped element 19 made of elastomeric material is positioned about the braking system 21, against the screw head 18, coaxial to the screw axis 17.

[00111] According to an embodiment, the connection screw 13 is screwed to the first body 4 so as to pre-compress the respective ring-shaped element 19 made of elastomeric material between the screw head 18 and the second body 5.

[00112] According to an embodiment, the ring-shaped element made of elastomeric material 19 is an O-ring.

[00113] According to an embodiment, the ring-shaped element made of elastomeric material 19 is made of "EPDM" (Ethylene-Propylene Diene Monomer) rubber.

[00114] According to a preferred embodiment, the first body 4 and the second body 5 are connected to each other by four connection screws 13, as described above. Moreover, four respective ring-shaped elements made of elastomeric material 19 are arranged between the first body 4 and the second body 5, as described above.

[00115] Transmission element 9 and sensor 8

[00116] According to an embodiment, the first body 4 comprises at least one threaded seat 22. The threaded seat 22 is preferably coaxial to the transmission axis 20.

[00117] According to an embodiment, the transmission element 9 is a threaded pin.

[00118] The transmission element 9 is positioned screwed to the threaded seat 22.

[00119] Specifically, the transmission element 9 comprises a threaded wall 23, screwed to the threaded seat 22. The threaded wall 23 is coaxial to the transmission axis 20.

[00120] The transmission element 9 is thus connected to the first body 4 and leads from the first body 4. Moreover, the transmission element 9 faces the sensor 8.

[00121] The transmission element 9 thrust positioned also faces the sensor 8 and

extends through the clearance 10 between the first body 4 and the second body 5.

[00122] According to an embodiment, the transmission element 9 comprises a thrust wall 24 configured to transmit to the sensor 8 haptic feedback generated by the haptic feedback actuator 7 and to allow a transfer of the actuating force applied by the driver to the brake pedal 3 between the first body 4 and the second body 5.

[00123] The thrust wall 24 is positioned to abut against the sensor 8.

[00124] According to an embodiment, the thrust wall 24 is substantially planar, extending in a transverse direction to the transmission axis 20.

[00125] According to an embodiment, the sensor 8 is positioned to be connected to the second body 5, facing the transmission element 9.

[00126] According to an embodiment, the second body 5 comprises a sensor seat 25. The sensor seat 25 is preferably coaxial to the transmission axis 20.

[00127] The sensor 8 is housed in the sensor seat 25 of the second body 5, facing the transmission element 9.

[00128] The sensor 8 is thus configured to receive a haptic feedback generated by the haptic feedback actuator 7 from the transmission element 9 and detect the actuation force applied by the driver to the brake pedal 3.

[00129] According to an embodiment, the sensor 8 comprises a detection wall 26 abutting against the transmission element 9.

[00130] Preferably, the detection wall 26 extends in the direction parallel to the transmission axis 20 and is positioned against the thrust wall 24 of the transmission element 9.

[00131] According to an embodiment, the detection wall 26 has a convex shape, abutting against the thrust wall 24. Advantageously, such a convex shape facilitates the transfer of forces and vibrations from the transmission element 9 to the sensor 8 and makes the reading of these forces and vibrations by the sensor 8 more accurate.

[00132] According to an embodiment, the sensor 8 is either a position sensor, a pressure sensor, a force sensor, or a combination thereof. According to an embodiment, the sensor 8 is either a laser position sensor, an infrared pressure sensor, an elastomeric sensor, a piezoelectric sensor, a Hall effect sensor, a magnetoresistive sensor, a linear magnetic sensor, a microelectromechanical system ("MEMS"), a fiber optic sensor, a strain gage, a proximity sensor, an eddy current sensor, a sine-cosine differential sensor, a mechanical moment sensor, or a combination thereof.

[00133] Haptic feedback actuator 7

- [00134] The haptic feedback actuator 7 is connected to the first body 4.
- [00135] According to an embodiment, the first body 4 comprises a housing seat 27 inside.
- [00136] The haptic feedback actuator 7 is housed inside the first body 4 in the housing seat 27.
- [00137] According to an embodiment, the haptic feedback actuator 7 is positioned inside the housing seat 27 so as to transmit haptic feedback, in particular vibrations, to the transmission element 9 connected to the first body 4, and in particular screwed to the threaded seat 22.
- [00138] According to an embodiment, the haptic feedback actuator 7 is configured to transmit a vibration transmitted according to one or a plurality of vibration modes, or vibration patterns, to the brake pedal 3 and the transmission element 9.
- [00139] For example, the haptic feedback is emitted according to a clicking vibration, an increasing or decreasing ramp vibration, a pulsed vibration, a continuous intensity vibration, a vibration interspersed with pauses of different durations, continuous intensity vibrations of different durations, vibrations at different vibration frequencies, or vibrations of different vibration intensities. In particular, each vibration mode can correspond to a different signal or alert.
- [00140] Advantageously, a braking system 1 so configured allows transmitting modulated signals or alerts to a driver.
- [00141] According to an embodiment, the haptic feedback actuator 7 is a voice coil 28. Preferably, the haptic feedback actuator 7 is a voice coil 28, preferably of passive type, i.e., electrically powered by an electrical power source external to the voice coil 28. According to an embodiment, the haptic feedback actuator 7 is positioned at comprises a plurality of voice coils 28.
- [00142] The voice coil 28 refers to an electromagnetic device comprising a coil assembly and a magnetic ground in which, by applying an electrical voltage to the haptic feedback actuator 7 through its power supply, the actuator 7 moves in a given direction. By reversing the polarity of the applied voltage, the actuator 7 moves in the opposite direction. The vibration force generated by the actuator 7 is proportional to the current flowing through the coil assembly.
- [00143] According to alternative embodiments, the haptic feedback actuator 7 is a piezoelectric actuator, an eccentric rotating mass ("ERM") motor, a linear resonant actuator ("LRA"), a solenoid actuator, a brushless actuator, a stepper actuator, or a bass shaker actuator.

[00144] Brake pedal 3

[00145] According to an embodiment, the brake pedal 3 is the brake pedal of a motor vehicle.

[00146] The brake pedal 3 comprises a pedal pad 29 fixed to a pedal crank 30.

[00147] The pedal pad 29 is fixed to an end of the pedal crank 30.

[00148] The opposite end of the pedal crank 30 is fixed to a hinge 35 configured to connect the pedal crank 30 to the chassis of a vehicle.

[00149] The brake pedal 3 is operatively connected to the braking feel simulator 2 by means of a mechanical connection device 36. An actuating force applied by a driver on the brake pedal 3 is thus mechanically transferred to the braking feel simulator device 2.

[00150] For example, the mechanical connection device 36 is a hinge mechanism or an articulated connection.

[00151] The connection device 36 is configured to connect the pedal crank 30 to the braking feel simulator device 2 so that an actuation of the brake pedal 3 corresponds to an actuation of the braking feel simulator device 2.

[00152] According to an embodiment, the signaling and detection system 6 is positioned at the brake pedal 3.

[00153] According to an embodiment, the first body 4 corresponds to the pedal pad 29 of the brake pedal 3. Moreover, the second body 5 corresponds to the pedal crank 30 of the brake pedal 3 (**fig. 11**).

[00154] The pedal pad 29 comprises a pressure wall 31 and an opposite fixing wall 32.

[00155] The pressure wall 31 faces the driver and is configured to be pressed by a driver's foot so as to actuate the brake pedal 3.

[00156] Instead, the fixing wall 32 faces towards the pedal crank 30 and is fixed to the pedal crank 30.

[00157] Specifically, the pedal crank 30 comprises a support wall 34 facing the pedal pad 29 and fixed to the pedal pad 29.

[00158] Therefore, the fixing wall 32 of the pedal pad 29 is fixed to the support wall 24 of the pedal crank 30.

[00159] The pressure wall 31 and the fixing wall 32 of the pedal pad 29 together define the housing seat 27 in which the haptic feedback actuator 7, preferably a voice coil 28, is housed.

[00160] According to an embodiment, the haptic feedback actuator 7 is housed inside the housing 27 and is positioned in contact with the pressure wall 31.

[00161] Advantageously, such a configuration facilitates the transmission and perception of haptic feedback by the driver because the haptic feedback is transmitted directly to the pressure wall 31 on which the driver rests his/her foot to control braking.

[00162] According to an embodiment, the pressure wall 31 and the fixing wall 32 are connected to each other by means of a plurality of screws 33. Preferably, the screws 33 are inserted through the pressure wall 31 and are screwed to the fixing wall 32.

[00163] According to an embodiment, the fixing wall 32 is fixed to the pedal crank 30, and in particular to the support wall 34, by means of at least one connection screw 13, preferably a plurality of connection screws 13, as described above.

[00164] Specifically, the fixing wall 32 of the pedal pad 29 and the support wall 34 of the pedal crank 30 face each other and are spaced apart so as to define the clearance 10, as described above.

[00165] Moreover, the damping means 11, e.g., the ring-shaped elements made of elastomeric material 19 described above, are positioned interposed between the support wall 34 of the pedal crank 30 and the screw head 18 of the connection screws 13.

[00166] According to an embodiment, the transmission element 9 is positioned to be fixed to the fixing wall 32 of the pedal pad 29, protruding from the fixing wall 32 and facing the support wall 34 of the pedal crank 30.

[00167] According to an embodiment, the fixing wall 32 comprises a threaded seat 22 in which the transmission element 9 is connected, as described above.

[00168] The sensor 8 is housed in the pedal crank 30.

[00169] According to an embodiment, the support wall 34 of the pedal crank 30 comprises the sensor seat 25 in which the sensor 8 is positioned.

[00170] According to this embodiment, the haptic feedback actuator 7 is configured to transmit haptic feedback, e.g., a vibration, to the pressure wall 31 of the pedal pad 29. The haptic feedback is thus perceivable by the driver acting on the brake pedal 3, and in particular on the pedal pad 29. Moreover, the haptic feedback is transferred from the pressure wall to the fixing wall 32 to which the transmission element 9 is fixed. The transmission element 9 thus transfers the haptic feedback to the sensor 8, and the sensor 8 is thus capable of detecting the haptic feedback and enabling its subsequent processing by an electronic processing unit connected to the sensor 8. The haptic feedback transmitted to fixing wall 32 is further transmitted to the connection screws 13 screwed to the fixing wall 32. The haptic feedback is damped by the damping means 11 at the connection screws 13. The haptic feedback is thus prevented from being transmitted to the pedal crank 30 by means of the connection screws 13, so as to ensure

the correct reading of the haptic feedback by the sensor 8.

[00171] Moreover, the damping means 11 positioned interposed between the pedal pad 29 and the pedal crank 30 allow the transmission of the actuation force, applied by the driver on the pedal pad 29, from the pedal pad 29 to the pedal crank 30 through the transmission element 9. A correct reading by the sensor 8 of the actuating force applied by the driver on the pedal pad 29 is thus ensured.

[00172] With further advantage, such a configuration damps the transfer of vehicle vibrations, e.g., due to road surface, to the signaling and detection system 6. Specifically, the vehicle, and thus the pedal crank 30, will be subject to vibration in the presence of potholes or ditches. These vehicle vibrations are not transmitted to the pedal pad 29, or are transmitted to the pedal pad 29 greatly damped, by the damping means 11. Thus, the vehicle vibrations do not interfere in the reading of the sensor 8 of the vibrations of the haptic feedback actuator 7.

[00173] With further advantage, the positioning of the haptic feedback actuator 7 and sensor 8 inside the brake pedal 3 as described above, guarantees a high transmission of haptic feedback to the driver while providing a direct detection of the actuation force applied by the driver onto the brake pedal 3, in addition to a reduction in the total size of the signaling and detection system 6.

[00174] With further advantage, the braking system 1 thus configured prevents the pedal pad 29 from colliding with the pedal crank 30 when the driver applies the actuation force of the braking system 1 onto the pedal pad 29.

[00175] Alternative embodiments

[00176] According to an embodiment, the signaling and detection system 6 is positioned at the hinge 35 (**fig. 12**).

[00177] The hinge 35 comprises a first hinge body 37 and a second hinge body 38 hinged to each other so as to be mutually rotatable about a hinge axis 39.

[00178] The first hinge body 37 is connected to the pedal crank 30, while the second hinge body 38 is connected to the vehicle chassis.

[00179] According to this embodiment, the first body 4 corresponds to the first hinge body 37. Moreover, the second body 5 corresponds to the second hinge body 38.

[00180] Advantageously, such a configuration of the braking system 1 allows transmitting the haptic feedback, generated by the haptic feedback actuator 7, to the driver by means of the pedal crank 30 connected to the first hinge body 37. At the same time, the haptic feedback 7 is transmitted to the sensor 8 by means of the transmission element 9 in the manner described above and not repeated here to avoid redundancy.

Moreover, the transmission of haptic feedback from the first hinge body 37 to the second hinge body 38 through the connecting means 12, e.g., the connection screws 13, by means of the damping means 11 interposed between the first hinge body 37 and the second hinge body 38, in the manner described above and not repeated here to avoid redundancies, is prevented or otherwise greatly damped. Moreover, such a configuration of braking system 1 allows detecting the actuation force applied by the driver on the brake pedal 3 by means of the relative movement, and subsequent transfer of the actuation force of the brake pedal 3, between the first hinge body 37 and the second hinge body 38.

[00181] According to an embodiment, the signaling and detection system 6 is positioned at the braking feel simulator device 2 (**fig. 13**).

[00182] The braking feel simulator device 2 comprises at least one elastic element 40. The at least one elastic element 40 is configured to apply a reaction force on the brake pedal in response to an actuation of the braking feel simulation device 2. Specifically, the at least one elastic element 40 is configured to apply a reaction force on the brake pedal 3 in response to an actuation of the brake pedal 3 by a driver.

[00183] Moreover, the braking feel simulator device 2 comprises a thrust shaft 41. The thrust shaft 41, configured to be biased against the at least one elastic element 40, in response to an actuation of the brake pedal 3. The at least one elastic element 40 thus applies a counteracting force upon actuation of the brake pedal 3.

[00184] According to this embodiment, the first body 4 corresponds to the thrust shaft 41. Moreover, the second body 5 corresponds to the at least one elastic element 40.

[00185] According to an alternative embodiment, the braking system 4 corresponds to the at least one elastic element 40. Moreover, the second body 5 corresponds to the thrust shaft 41.

[00186] Advantageously, such a configuration 1 of the braking system allows transmitting the haptic feedback, generated by the haptic feedback actuator 7, to the driver by means of the brake pedal 3, and preferably the pedal crank 30, connected to the thrust shaft 41. At the same time, the haptic feedback 7 is transmitted to the sensor 8 by means of the transmission element 9 in the manner described above and not repeated here to avoid redundancy. Moreover, the transmission of the haptic feedback from the thrust shaft 41 to the at least one elastic element 40 by means of the connecting means 12, e.g., connection screws 13, through the damping means 11 interposed between the thrust shaft 41 and the at least one elastic element 40, in the manner described above and not repeated here to avoid redundancy, is prevented or otherwise

greatly damped. Moreover, such a configuration of braking system 1 allows detecting the actuation force applied by the driver onto the brake pedal 3 by means of the relative movement, and subsequent transfer of the actuation force of brake pedal 3, between the thrust shaft 41 and the at least one elastic element 40.

[00187] According to a further embodiment, the signaling and detection system 6 is positioned at the mechanical connection device 36 (**fig. 14**).

[00188] Preferably, the mechanical linkage device 36 connects a thrust shaft 41 of the braking feel simulator device 2 to the pedal crank 30 of the brake pedal 3.

[00189] According to this embodiment, the first body 4 corresponds to the brake pedal 3, in particular the pedal crank 30. Moreover, the second body 5 corresponds to the braking feel simulator device 2, in particular to the thrust shaft 41.

[00190] According to an alternative embodiment, the second body 5 corresponds to the brake pedal 3, in particular to the pedal crank 30. Moreover, the first body 4 corresponds to the braking feel simulator device 2, in particular to the thrust shaft 41.

[00191] Advantageously, such a configuration of the braking system 1 allows transmitting the haptic feedback, generated by haptic feedback actuator 7, to the driver by means of the pedal pad 29 connected to the pedal crank 30. At the same time, the haptic feedback 7 is transmitted to the sensor 8 by means of the transmission element 9 in the manner described above and not repeated here to avoid redundancy. Moreover, the transmission of haptic feedback from the brake pedal 3, in particular the pedal crank 30, to the braking feel simulator device 2, in particular the thrust shaft 41, by means of the connecting means 12, e.g., the connection screws 13, is prevented or otherwise significantly damped, by means of the damping means 11 interposed between the brake pedal 3, in particular the pedal crank 30, and the braking feel simulator device 2, in particular the thrust shaft 41, in the manner described above and not repeated herein to avoid redundancy. Moreover, such a configuration of the braking system 1 allows detecting the actuation force applied by the driver onto brake pedal 3 by means of the relative movement, and subsequent transfer of the actuation force of the brake pedal 3, between the brake pedal 3, in particular the pedal crank 30 and the braking feel simulator device 2, in particular the thrust shaft 41.

[00192] According to a further embodiment, the signaling and detection system 6 is positioned at a motorcycle brake lever 42 (**fig. 15**) or a motorcycle brake pedal 43 (**fig. 16**).

[00193] According to an embodiment, the braking system 1 comprises at least a second brake caliper.

[00194] Moreover, the braking system 1 comprises an electronic processing unit electrically connected to the at least one brake caliper, the brake pedal 3, the braking feel simulator device 2, and the signaling and detection system 6.

[00195] The electronic processing unit is configured to actuate the at least one brake caliper upon the detection of an actuation and/or movement of the brake pedal 3 and/or an actuation and/or a movement of the braking feel simulator device 2.

[00196] The electronic processing unit is further configured to command the haptic feedback actuator 7 to generate haptic feedback and is configured to acquire and process the force and haptic feedback readings detected by the sensor 8.

[00197] Obviously, those skilled in the art will be able to make changes or adaptations to the present invention, without however departing from the scope of the following claims.

List of reference signs

1. Braking system
2. Braking feel simulator device
3. Brake pedal
4. First body
5. Second body
6. Signaling and detection system
7. Haptic feedback actuator
8. Sensor
9. Transmission element
10. Clearance
11. Damping means
12. Connecting means
13. Connection screw
14. Threaded hole
15. Through-hole
16. Threaded stem
17. Screw axis
18. Screw head
19. Ring-shaped element made of elastomeric material
20. Transmission axis
21. Backing wall
22. Threaded seat
23. Threaded wall
24. Thrust wall
25. Sensor seat
26. Detection wall
27. Housing seat
28. Voice coil
29. Pedal pad
30. Pedal crank
31. Pressure wall
32. Fixing wall
33. Screw
34. Support wall

- 35. Hinge
- 36. Mechanical connection device
- 37. First hinge body
- 38. Second hinge body
- 39. Hinge axis
- 40. Elastic element
- 41. Thrust shaft
- 42. Motorcycle brake lever
- 43. Motorcycle brake pedal

Claims

1. A braking system (1), comprising a braking feel simulator device (2) and a brake pedal (3), wherein the brake pedal (3) is operatively connected to the braking feel simulator device (2),

wherein the braking system (1) is configured so that an actuating force applied to the brake pedal (3) by a driver corresponds to a reaction force applied by the braking feel simulator device (2) on the brake pedal (3) against an actuation of the brake pedal (3),

wherein the braking system (1) comprises at least a first body (4) and a second body (5), mechanically connected to each other so that the actuating force applied by the driver to the brake pedal (3) is transferred from the first body (4) towards the second body (5), or from the second body (5) towards the first body (4),

wherein the braking system (1) comprises a signaling and detection system (6), comprising:

- a haptic feedback actuator (7), configured to transmit a haptic feedback to the brake pedal (3);

- a sensor (8), configured to detect parameters related to the braking system (1), including the actuating force applied by the driver to the brake pedal (3), and the haptic feedback transmitted from the haptic feedback actuator (7) to the brake pedal (3);

- a transmission element (9), configured to transmit to the sensor (8) the haptic feedback generated by the haptic feedback actuator (7) and/or to transfer the actuating force applied by the driver to the brake pedal (3) between the first body (4) and the second body (5),

wherein the haptic feedback actuator (7) and the transmission element (9) are positioned at the first body (4), while the sensor (8) is positioned at the second body (5),

wherein the transmission element (9) leads from the first body (4) and is positioned to abut against the sensor (8), so as to define a clearance (10) between the first body (4) and the second body (5),

wherein the braking system (1) comprises connecting means (12), configured to connect the first body (4) to the second body (5),

wherein the braking system (1) comprises damping means (11), positioned to be interposed between the first body (4) and the second body (5),

and wherein the damping means (11) are configured to damp movements or vibrations transmissible, through the connecting means (12), between the first body (4) and the second body (5).

2. A braking system (1) according to claim 1, wherein the connecting means (12) are distinct from the transmission element (9),
wherein the damping means (11) are positioned at the connecting means (12),
wherein the connecting means (12) comprise at least one connection screw (13), preferably a plurality of connection screws (13),
wherein the first body (4) comprises at least one threaded hole (14), and the second body (5) comprises at least one through-hole (15) formed at the threaded hole (14) of the first body (4),
and wherein the connection screw (13) is inserted through a respective through-hole (15) of the second body (5) and is screwed to the respective threaded hole (14) of the first body (4).

3. A braking system (1) according to claim 2, wherein the connection screw (13) comprises a threaded stem (16) screwed into the threaded hole (14), wherein the threaded stem (16) extends along a screw axis (17),
wherein the connection screw (13) comprises a screw head (18), extending from the threaded stem (16) in a transverse direction to the screw axis (17), and positioned to be opposite to the threaded stem (16) with respect to the second body (5),
and wherein the damping means (11) are placed to be interposed between the screw head (18) and the second body (5).

4. A braking system (1) according to claim 3, wherein the connection screw (13) comprises a backing wall (21), extending between the screw head (18) and the threaded stem (16), wherein the backing wall (21) extends from the threaded stem (16) in a transverse direction to the screw axis (17),
wherein the backing wall (21) is positioned passing through the through-hole (15), passing through the clearance (10) between the first body (4) and the second body (5),
and wherein the backing wall (21) is positioned to abut against the first body (4).

5. A braking system (1) according to any one of the preceding claims, wherein the damping means (11) comprise at least one ring-shaped element (19) made of elastomeric material,
and, preferably, the ring-shaped element (19) made of elastomeric material is an O-ring, or it is made of "EPDM" (Ethylene-Propylene Diene Monomer) rubber.

6. A braking system (1) according to claims 3 and 5, wherein the ring-shaped element (19) made of elastomeric material is positioned about the connection screw (13), against the screw head (18), coaxial to the screw axis (17), and wherein the connection screw (13) is screwed to the first body (4) so as to pre-compress the respective ring-shaped element (19) made of elastomeric material between the screw head (18) and the second body (5).

7. A braking system (1) according to any one of the preceding claims, wherein the first body (4) comprises a threaded seat (22), wherein the transmission element (9) is a threaded pin and comprises a threaded wall (23), screwed to the threaded seat (22), wherein the transmission element (9) is connected to the first body (4), leads from the first body (4), faces the sensor (8), and extends through the clearance (10) between the first body (4) and the second body (5), and wherein, optionally, the transmission element (9) comprises a thrust wall (24) configured to transmit to the sensor (8) a haptic feedback generated by the haptic feedback actuator (7) and to allow a transfer of the actuating force applied by the driver to the brake pedal (3) between the first body (4) and the second body (5), wherein the thrust wall (24) is positioned to abut against the sensor (8).

8. A braking system (1) according to any one of the preceding claims, wherein the sensor (8) is positioned to be connected to the second body (5), facing the transmission element (9), wherein the second body (5) comprises a sensor seat (25), and wherein the sensor (8) is housed in the sensor seat (25) of the second body (5), facing the transmission element (9), and is configured to receive a haptic feedback generated by the haptic feedback actuator (7) from the transmission element (9) and to detect the actuating force applied by the driver to the brake pedal (3), and wherein, optionally, the sensor (8) is a position sensor or a pressure sensor or a force sensor, or a combination thereof, or 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 microelectromechanical system, or a fiber optic sensor, or a strain gage, or a proximity sensor, or an eddy current sensor, or a differential sine-cosine sensor, or a mechanical moment sensor, or a combination thereof.

9. A braking system (1) according to any one of the preceding claims, wherein the haptic feedback actuator (7) is connected to the first body (4), wherein the first body (4) comprises a housing seat (27) therein, and the haptic feedback actuator (7) is housed inside the first body (4), in the housing seat (27), so as to transmit haptic feedbacks, in particular vibrations, to the transmission element (9) connected to the first body (4), and wherein, optionally, the haptic feedback actuator (7) is configured to transmit a vibration transmitted according to one or a plurality of vibration modes, or vibration patterns, to the brake pedal (3) and transmission element (9), and/or wherein the haptic feedback actuator (7) is a voice coil (28), preferably of the passive type.

10. A braking system (1) according to any one of the preceding claims, wherein the brake pedal (3) is the brake pedal of a motor vehicle, and comprises a pedal pad (29) fixed to a pedal crank (30), wherein the signaling and detection system (6) is positioned at the brake pedal (3), and wherein the first body (4) corresponds to the pedal pad (29) of the brake pedal (3), and the second body (5) corresponds to the pedal crank (30) of the brake pedal (3).

11. A braking system (1) according to claim 10, wherein the pedal pad (29) comprises a pressure wall (31) and an opposite fixing wall (32), wherein the pressure wall (31) faces the driver and is configured to be pressed by a driver's foot so as to actuate the brake pedal (3), and wherein the fixing wall (32) faces the pedal crank (30) and is fixed to the pedal crank (30), wherein the pedal crank (30) comprises a support wall (34) facing the pedal pad (29) and fixed to the pedal pad (29), and wherein the fixing wall (32) of the pedal pad (29) is fixed to the support wall (24) of the pedal crank (30), wherein the pressure wall (31) and the fixing wall (32) of the pedal pad (29) together define a housing seat (27) in which the haptic feedback actuator (7), preferably a voice coil (28), is housed, wherein, preferably, the haptic feedback actuator (7) is housed inside the housing seat (27) and is positioned in contact with the pressure wall (31).

12. A braking system (1) according to claim 10, wherein the pedal pad (29) comprises a

pressure wall (31) and an opposite fixing wall (32), wherein the pressure wall (31) faces the driver and is configured to be pressed by a driver's foot so as to actuate the brake pedal (3), and wherein the fixing wall (32) faces the pedal crank (30) and is fixed to the pedal crank (30),

wherein the pedal crank (30) comprises a support wall (34) facing the pedal pad (29) and fixed to the pedal pad (29), and wherein the fixing wall (32) of the pedal pad (29) is fixed to the support wall (24) of the pedal crank (30),

wherein the fixing wall (32) is fixed to the pedal crank (30), and in particular to the support wall (34), by means of at least one connection screw (13), preferably a plurality of connection screws (13),

wherein the fixing wall (32) of the pedal pad (29) and the support wall (34) of the pedal crank (30) face each other and are spaced apart so as to define the clearance (10),

and wherein the damping means (11) are positioned to be interposed between the support wall (34) of the pedal crank (30) and one screw head (18) of the connection screws (13).

13. A braking system (1) according to claim 10, wherein the pedal pad (29) comprises a pressure wall (31) and an opposite fixing wall (32), wherein the pressure wall (31) faces the driver and is configured to be pressed by a driver's foot so as to actuate the brake pedal (3), and wherein the fixing wall (32) faces the pedal crank (30) and is fixed to the pedal crank (30),

wherein the pedal crank (30) comprises a support wall (34) facing the pedal pad (29) and fixed to the pedal pad (29), and wherein the fixing wall (32) of the pedal pad (29) is fixed to the support wall (24) of the pedal crank (30),

wherein the transmission element (9) is positioned to be fixed to the fixing wall (32) of the pedal pad (29), protruding from the fixing wall (32) and facing the support wall (34) of the pedal crank (30),

wherein the fixing wall (32) comprises a threaded seat (22) in which the transmission element (9) is connected,

and wherein the sensor (8) is housed in the pedal crank (30), preferably inside a sensor seat (25) included in the support wall (34) of the pedal crank (30).

14. A braking system (1) according to any one of claims 1 to 9, wherein the brake pedal (3) is the brake pedal of a motor vehicle, and comprises a pedal pad (29) fixed to an end of a pedal crank (30),

wherein the opposite end of the pedal crank (30) is fixed to a hinge (35) configured to connect the pedal crank (30) to the chassis of a vehicle,
wherein the signaling and detection system (6) is positioned at the hinge (35),
wherein the hinge (35) comprises a first hinge body (37) and a second hinge body (38) hinged to each other so as to be mutually rotatable about a hinge axis (39), wherein the first hinge body (37) is connected to the pedal crank (30), while the second hinge body (38) is connected to the vehicle chassis,
and wherein the first body (4) corresponds to the first hinge body (37), and the second body (5) corresponds to the second hinge body (38).

15. A braking system (1) according to any one of claims 1 to 9, wherein the brake pedal (3) is the brake pedal of a motor vehicle, and comprises a pedal pad (29) fixed to an end of a pedal crank (30),
wherein the signaling and detection system (6) is positioned at the braking feel simulator device (2),
wherein the braking feel simulator device (2) comprises at least one elastic element (40) configured to apply a reaction force in response to an actuation of the braking feel simulator device (2),
wherein the braking feel simulator device (2) comprises a thrust shaft (41) configured to be biased against the at least one elastic element (40) in response to an actuation of the brake pedal (3) so that the at least one elastic element (40) applies a counteracting force on the actuation of the brake pedal (3),
and wherein the first body (4) corresponds to the thrust shaft (41), and the second body (5) corresponds to the at least one elastic element (40), or vice versa.

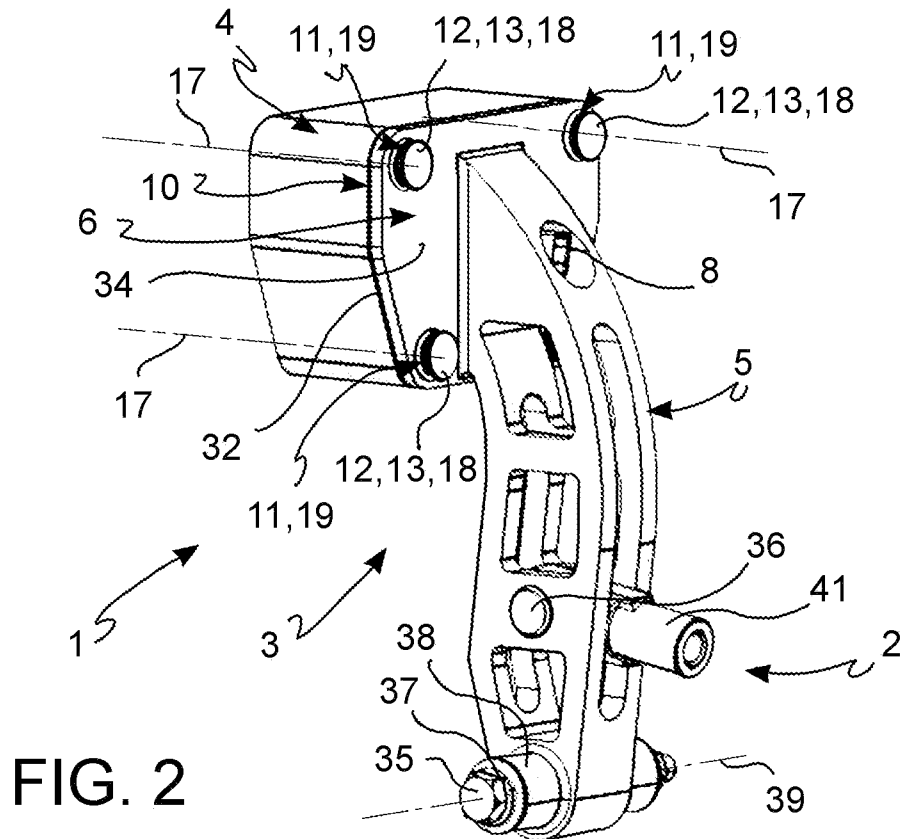
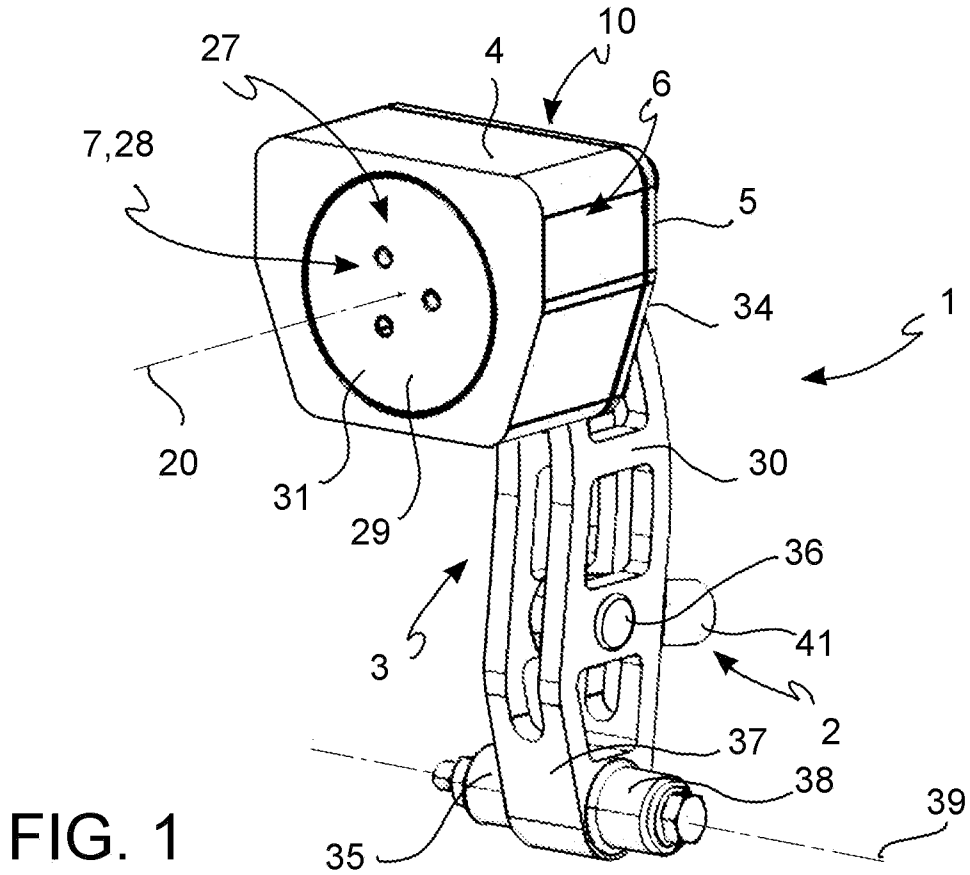
16. A braking system (1) according to any one of claims 1 to 9, wherein the brake pedal (3) is the brake pedal of a motor vehicle, and comprises a pedal pad (29) fixed to an end of a pedal crank (30),
wherein the brake pedal (3) is operatively connected to the braking feel simulator device (2) by means of a mechanical connection device (36), so that an actuating force applied by the driver on the brake pedal (3) is mechanically transferred to the braking feel simulator device (2),
wherein, preferably, the mechanical connection device (36) is a hinge mechanism or an articulated connection,
wherein the signaling and detection system (6) is positioned at the mechanical

connection device (36),

wherein the mechanical connection device (36) connects a thrust shaft (41) of the braking feel simulator device (2) to the pedal crank (30) of the brake pedal (3), and wherein the first body (4) corresponds to the brake pedal (3), in particular to the pedal crank (30), and the second body (5) corresponds to the braking feel simulator device (2), in particular to the thrust shaft (41).

17. A braking system (1) according to any one of claims 1 to 9, wherein the signaling and detection system (6) is positioned at a motorcycle brake lever (42) or a motorcycle brake pedal (43).

18. A braking system (1) according to any one of the preceding claims, comprising at least one brake caliper and an electronic processing unit electrically connected to the at least one brake caliper, the brake pedal (3), the braking feel simulator device (2), and the signaling and detection system (6), wherein the electronic processing unit is configured to actuate the at least one brake caliper upon the detection of an actuation and/or movement of the brake pedal (3) and/or an actuation and/or a movement of the braking feel simulator device (2), and wherein the electronic processing unit is further configured to command the haptic feedback actuator (7) to generate a haptic feedback and is configured to acquire and process the force and haptic feedback readings detected by the sensor (8).



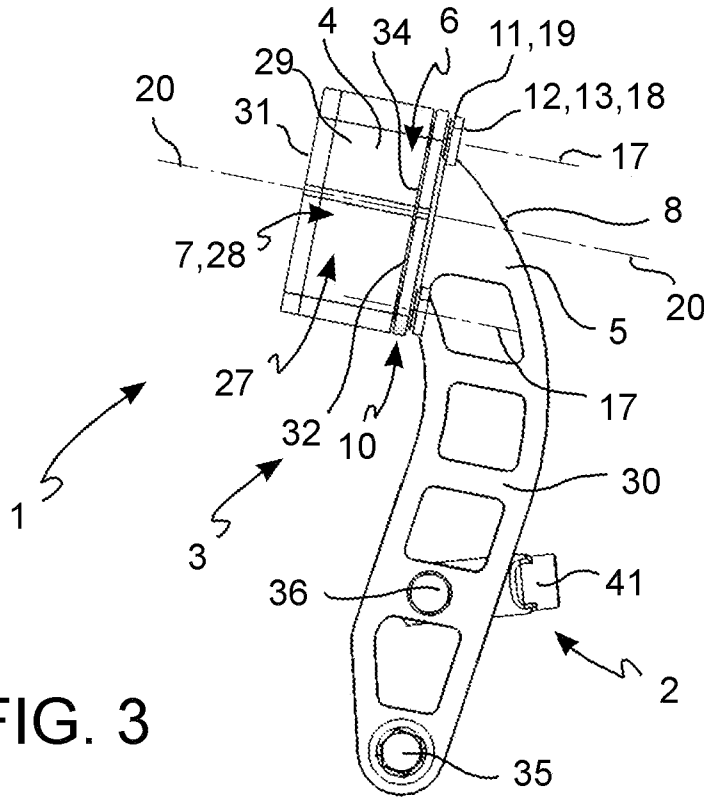


FIG. 3

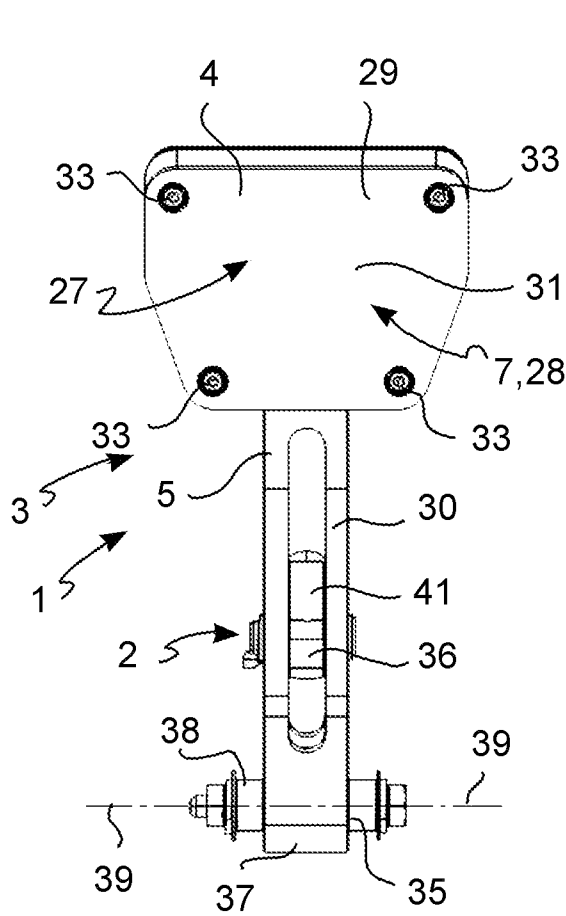


FIG. 4

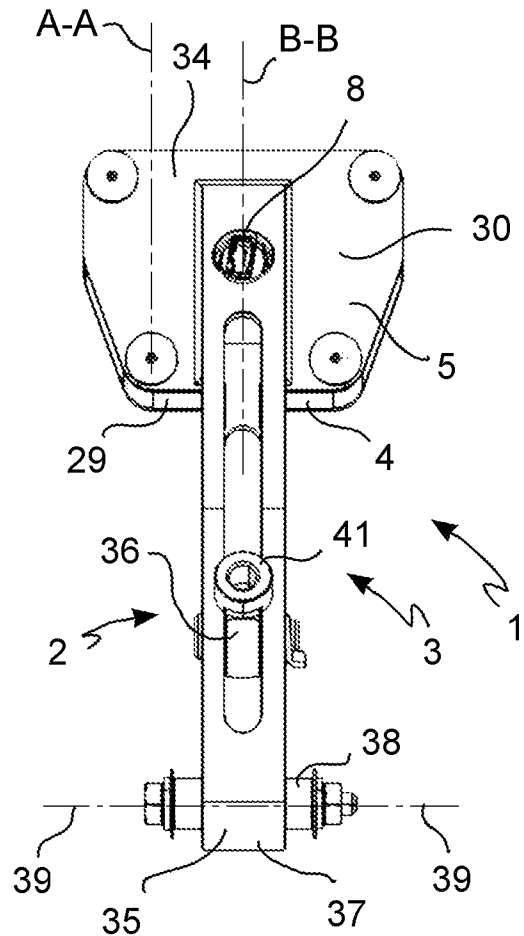


FIG. 5

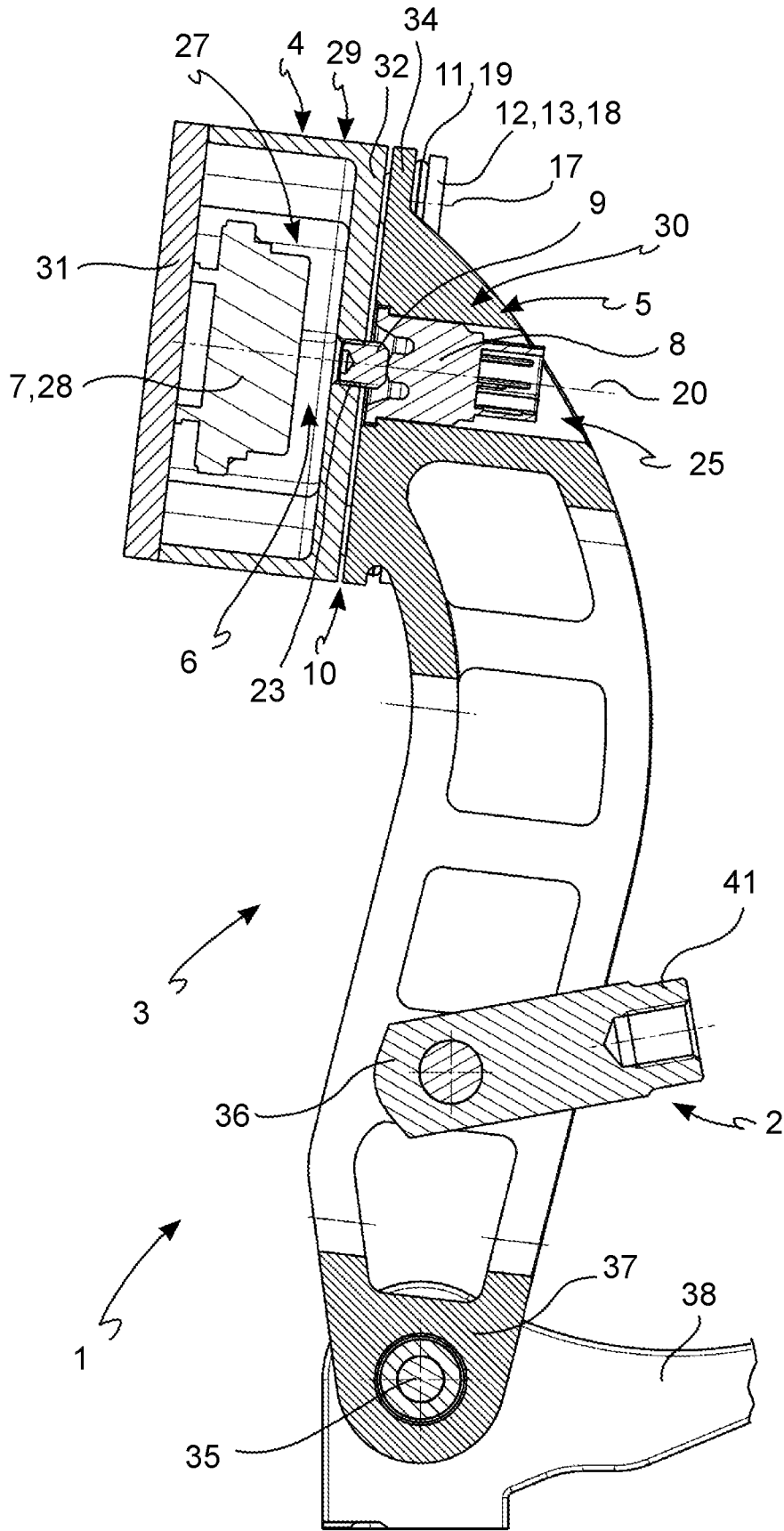


FIG. 6

B-B

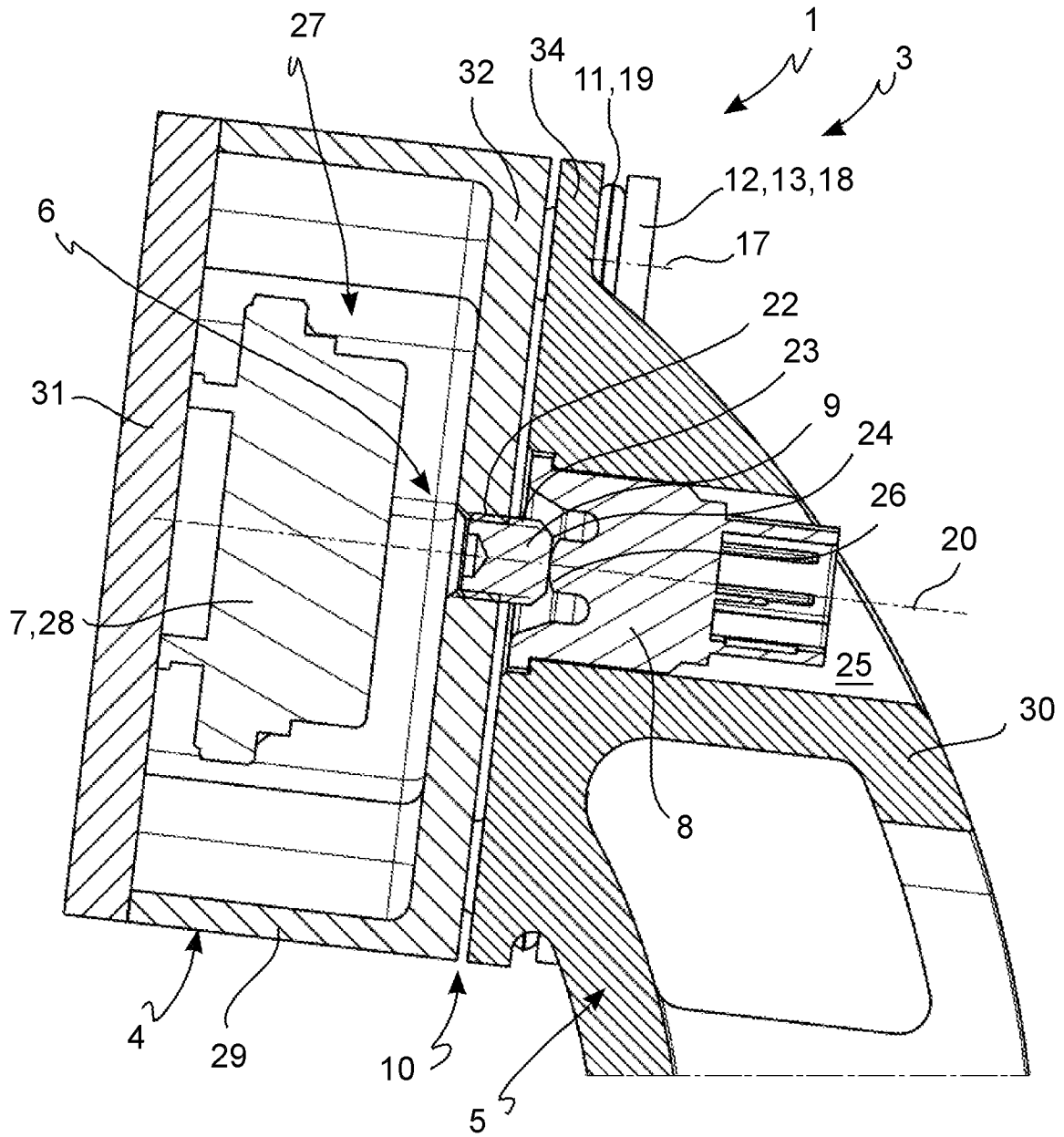


FIG. 7

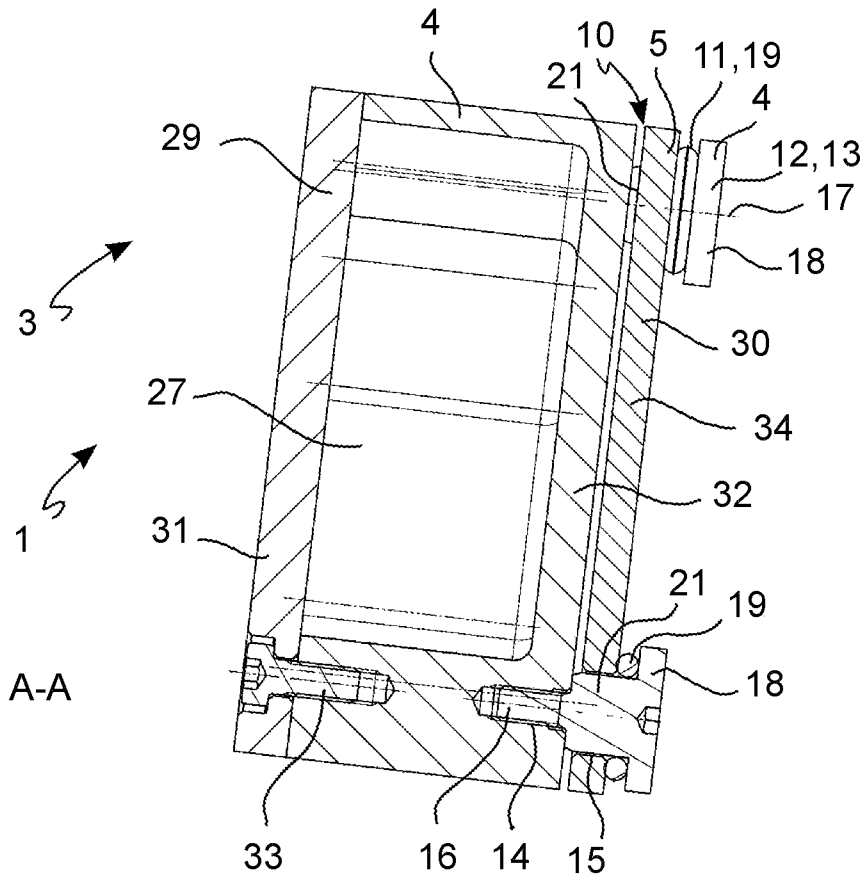


FIG. 8

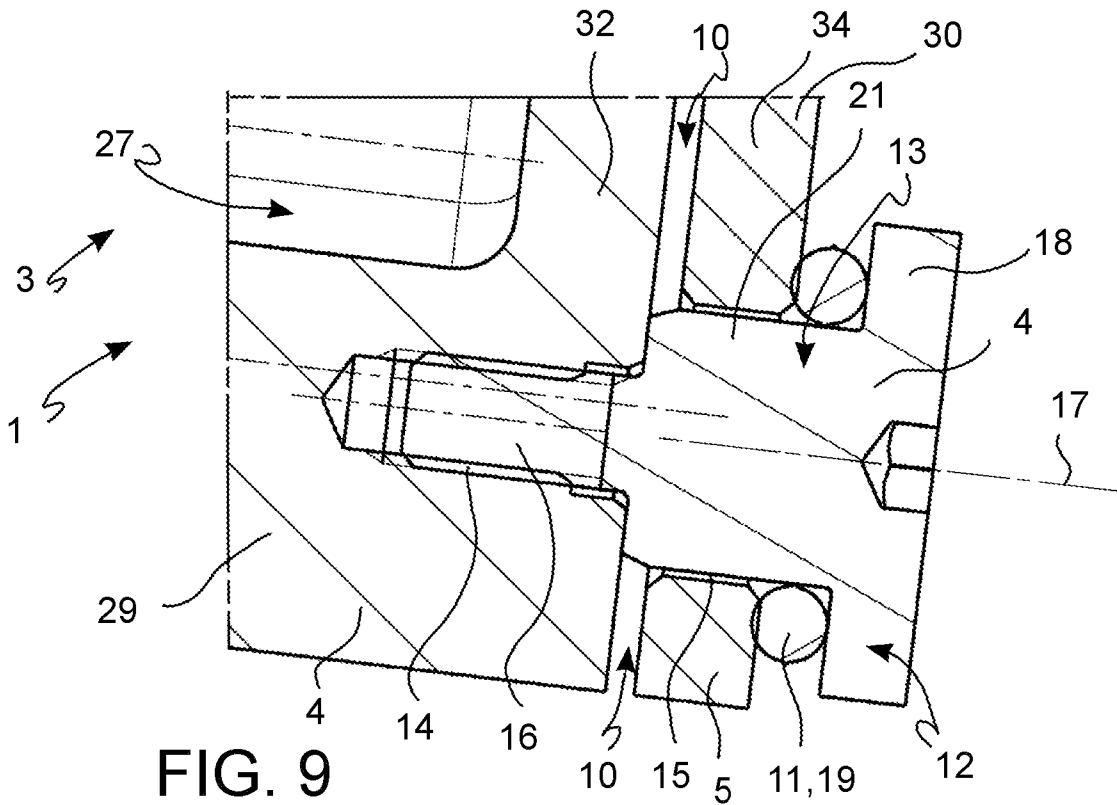


FIG. 9

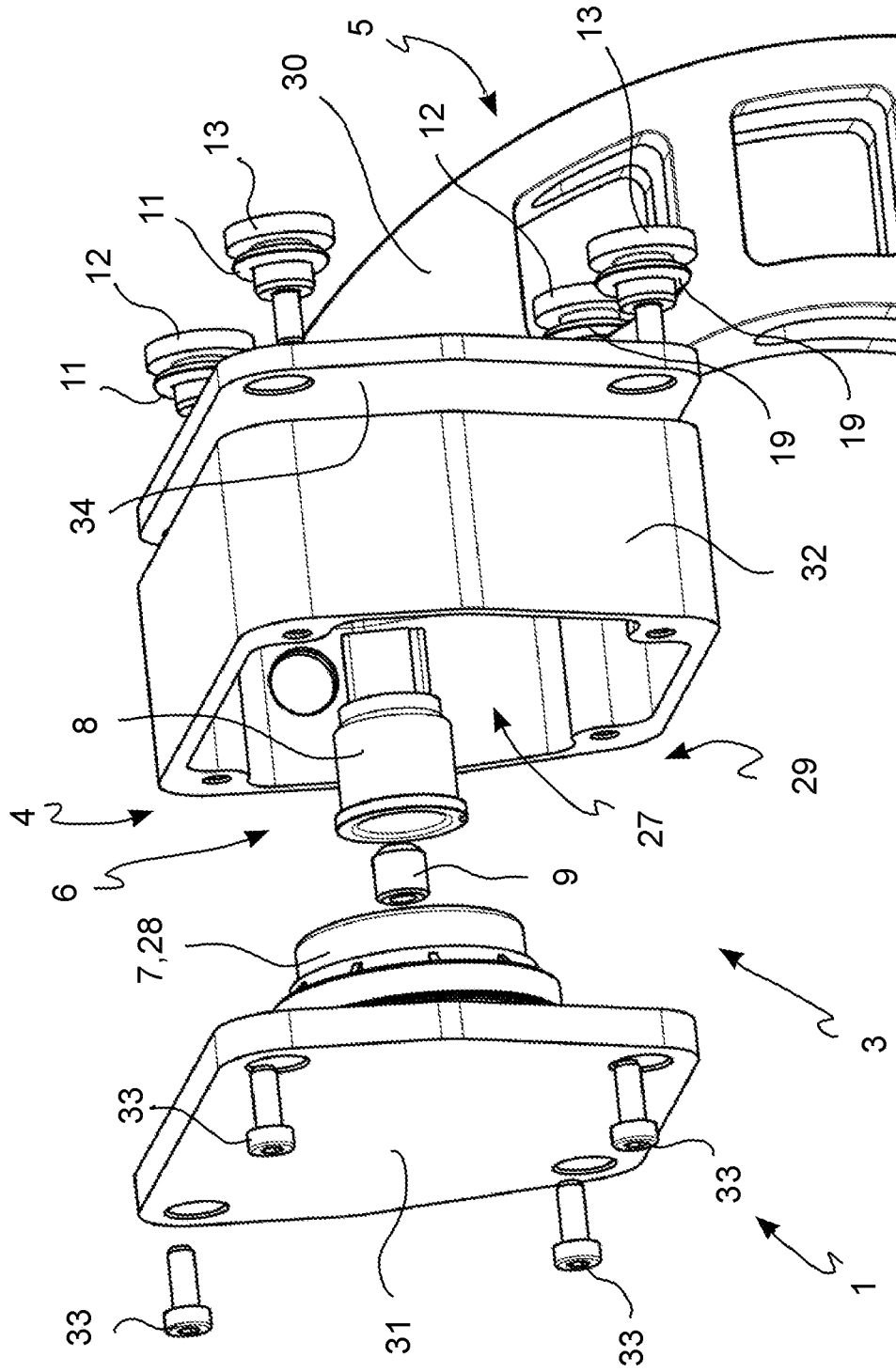


FIG. 10

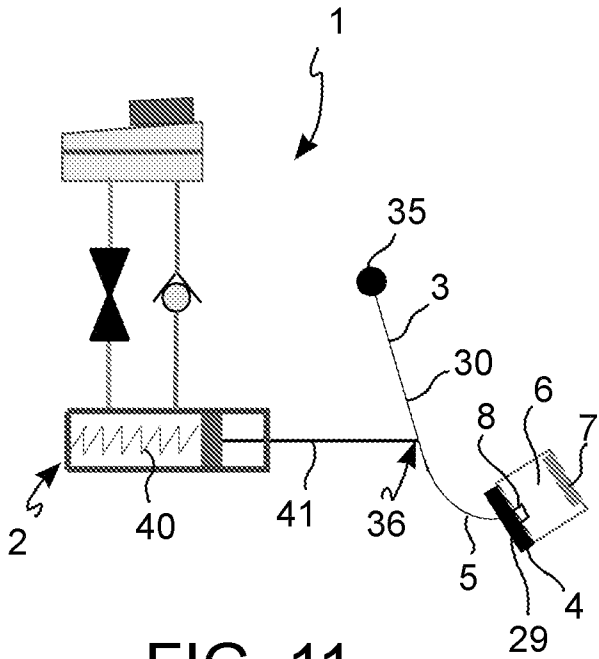


FIG. 11

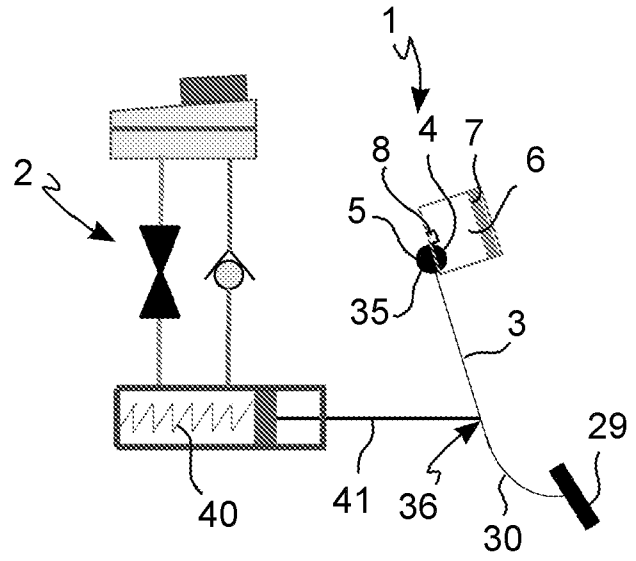


FIG. 12

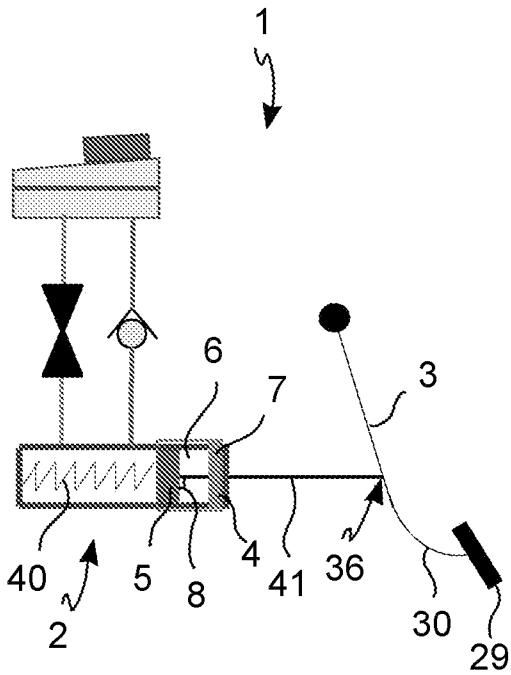


FIG. 13

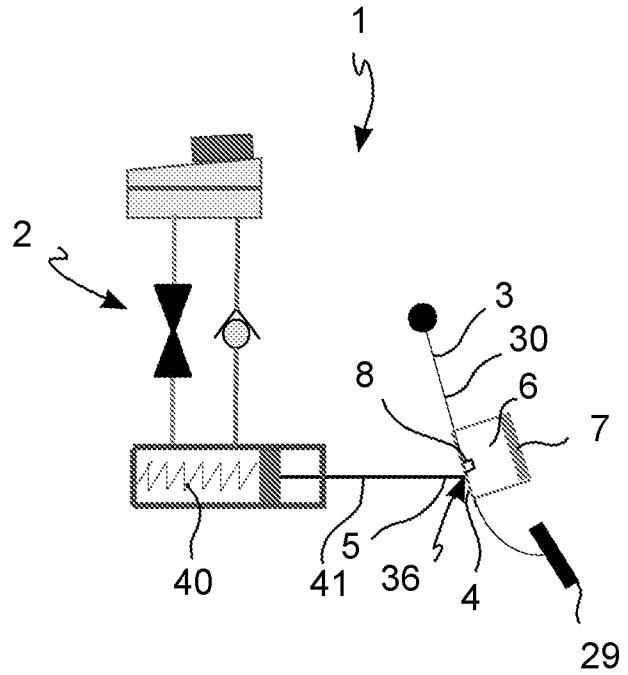


FIG. 14

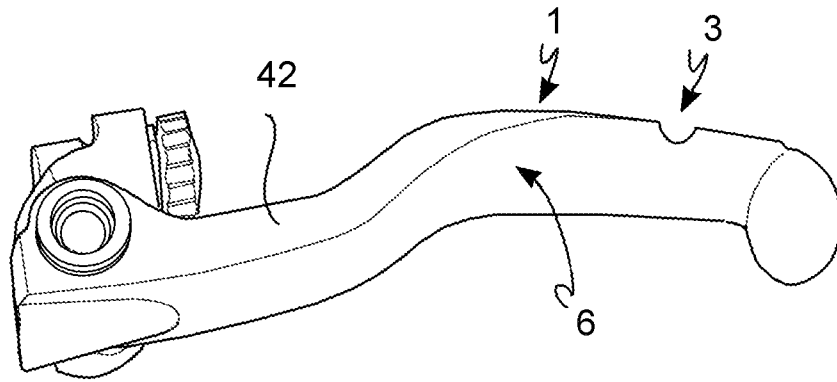


FIG. 15

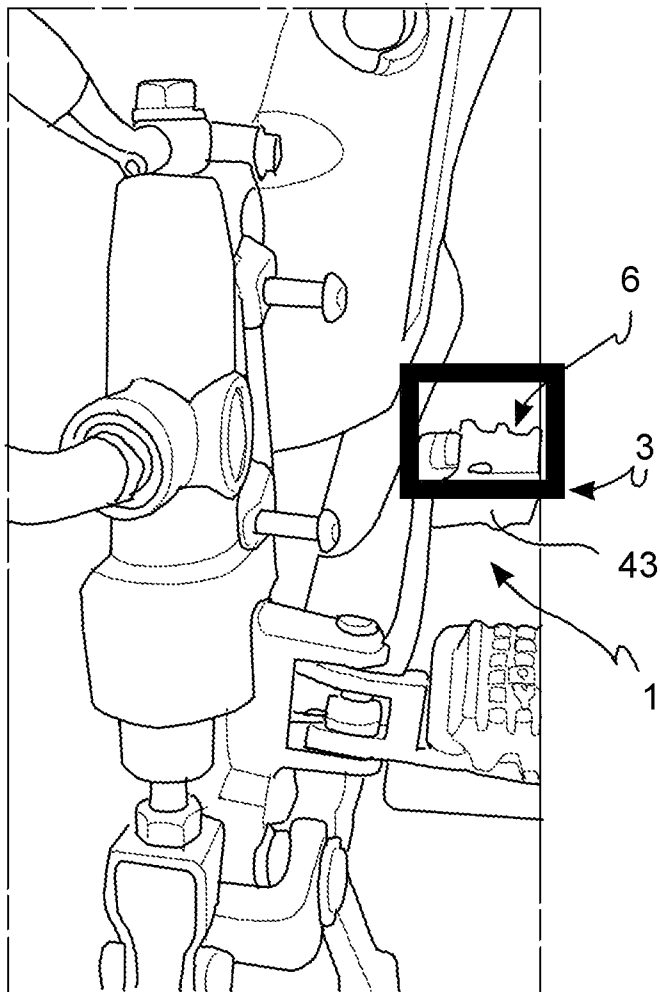


FIG. 16

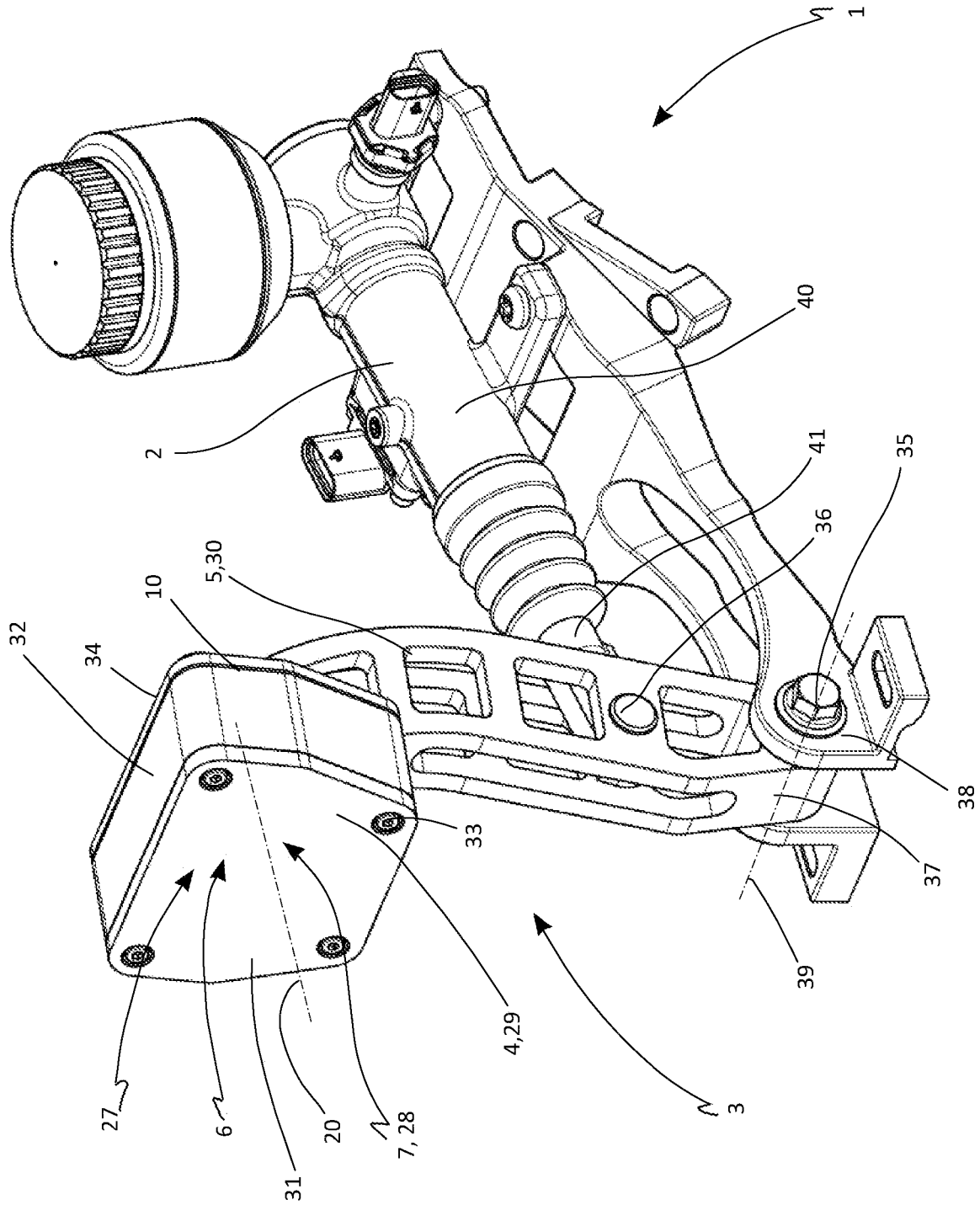


FIG. 17

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2024/055659

A. CLASSIFICATION OF SUBJECT MATTER
 INV. B60T7/04 B60T13/66 B60T13/68 B60T13/74
 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)
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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2018/001875 A1 (HOUTMAN ALAN J [US] ET AL) 4 January 2018 (2018-01-04) paragraphs [0029] - [0031], [0034], [0037] -----	1-18
A	US 2020/001711 A1 (BURKE DENNIS MARK [US] ET AL) 2 January 2020 (2020-01-02) paragraphs [0041], [0063], [0067]; figures -----	1-18
A	US 2020/148182 A1 (D'URSO LUCA [IT] ET AL) 14 May 2020 (2020-05-14) paragraphs [0062], [0100] - [0105]; figure 5 -----	1-18
A	WO 2016/184458 A1 (CONTINENTAL AUTOMOTIVE GMBH [DE]) 24 November 2016 (2016-11-24) figures -----	1,10,11
	- / - -	

Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search 16 September 2024	Date of mailing of the international search report 25/09/2024
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INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2024/055659

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 20 2013 103011 U1 (FORD GLOBAL TECH LLC [US]) 15 July 2013 (2013-07-15) paragraphs [0007], [0017] - [0021]; figures -----	1, 10, 11

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2024/055659

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2018001875 A1	04-01-2018	CN 107554500 A	09-01-2018
		DE 102017114048 A1	04-01-2018
		US 2018001875 A1	04-01-2018

US 2020001711 A1	02-01-2020	CN 110418740 A	05-11-2019
		DE 102017104278 A1	06-09-2018
		EP 3589518 A1	08-01-2020
		US 2020001711 A1	02-01-2020
		WO 2018158703 A1	07-09-2018

US 2020148182 A1	14-05-2020	CN 110730737 A	24-01-2020
		EP 3630559 A1	08-04-2020
		ES 2933134 T3	01-02-2023
		KR 20200014340 A	10-02-2020
		US 2020148182 A1	14-05-2020
		WO 2018220455 A1	06-12-2018

WO 2016184458 A1	24-11-2016	DE 102015209189 A1	24-11-2016
		DE 112016000498 A5	02-11-2017
		WO 2016184458 A1	24-11-2016

DE 202013103011 U1	15-07-2013	NONE	
