(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
19 December 2024 (19.12.2024)

WIPO | PCT

(10) International Publication Number
WO 2024/256948 A1

(51) International Patent Classification:
B60T 7/04 (2006.01) *B60T 13/68* (2006.01)
B60T 13/66 (2006.01) *B60T 13/74* (2006.01)

(21) International Application Number:
PCT/IB2024/055652

(22) International Filing Date:
10 June 2024 (10.06.2024)

(25) Filing Language: Italian

(26) Publication Language: English

(30) Priority Data:
102023000011946 12 June 2023 (12.06.2023) IT

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

(72) Inventors: **DI STEFANO, Massimo**; c/o BREMBO S.P.A., Via Brembo, 25, I-24035 Curno, BERGAMO (IT). **TRUFFELLO, Martina**; c/o BREMBO S.P.A., Via Brembo, 25, I-24035 Curno, BERGAMO (IT). **SALVATELLI, Michele**; c/o BREMBO S.P.A., Via Brembo, 25, I-24035 Curno, BERGAMO (IT). **SABINO, Simone**; c/o BREMBO S.P.A., Via Brembo, 25, I-24035 Curno, BERGAMO (IT).

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

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MU, MW, MX, MY, MZ, NA,

(54) Title: BRAKING SYSTEM

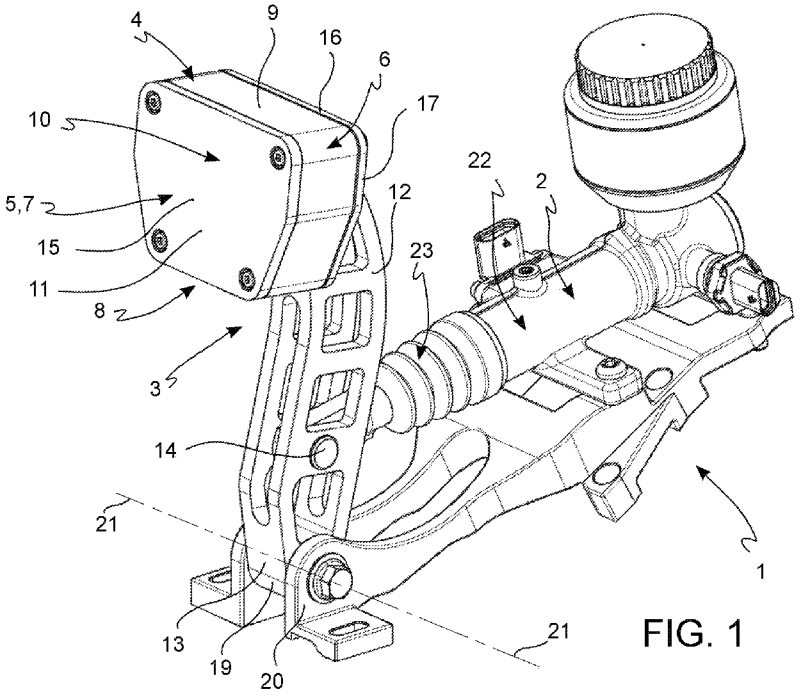

FIG. 1

(57) Abstract: A braking system (1) for a vehicle 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 actuation 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 a signaling and detection system (4), comprising an interface device (8), configured to be operable or touchable by the driver while driving the vehicle; a haptic feedback actuator (5), configured to transmit a haptic feedback to the interface device (8); a sensor (6), configured to detect parameters related to the braking system (1), including the haptic feedback transmitted by the haptic feedback actuator (5) to the interface device (8).

WO 2024/256948 A1

[Continued on next page]

NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *of inventorship (Rule 4.17(iv))*

Published:

— *with international search report (Art. 21(3))*

— *in black and white; the international application as filed contained color or greyscale and is available for download from PATENTSCOPE*

Braking system

[0001] Field of the invention

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

[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 an additional 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 alert.

[0015] A further criticality of the known BBW braking system is that the known simulator devices have large dimensions which make them difficult to install inside the passenger compartment of the vehicle, in which there is less space available, either in the hanging brake pedal configuration or in the floor brake pedal configuration. Due to the large volume, the known simulator devices are generally installed in the engine compartment of the vehicle, under the hood.

[0016] The high number of components also adversely affects the cost and maintenance requirements of the known simulator devices.

[0017] Solution

[0018] 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.

[0019] 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.

[0020] It is a further particular object of the present invention to provide a more compact braking system adapted to be installed inside the vehicle passenger compartment, e.g., either in the hanging brake pedal configuration or in the floor brake pedal configuration.

[0021] It is a further particular object of the present invention to provide a braking system which has small size and low complexity.

[0022] These and other objects are achieved by a braking system according to claim 1.

[0023] The dependent claims relate to preferred and advantageous embodiments of the present invention.

[0024] Figures

[0025] 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:

[0026] – figure 1 is a perspective view of a connecting system, according to an embodiment of the invention;

[0027] – figure 2 is a diagrammatic view of a braking system, according to an embodiment of the invention;

[0028] – figure 3 is a diagrammatic view of a braking system, according to a further embodiment of the invention;

[0029] – figure 4 is a diagrammatic view of a braking system, according to a further embodiment of the invention;

[0030] – figure 5 is a diagrammatic view of a braking system, according to a further embodiment of the invention;

[0031] – figure 6 is a front perspective view of a component of a braking system according to an embodiment of the invention;

[0032] – figure 7 is a rear perspective view of the component shown in figure 6;

[0033] – figure 8 is a side view of a component of a braking system according to an embodiment of the invention;

[0034] – figure 9 is a front view of the component in figure 8;

[0035] – figure 10 is a rear view of the component shown in figure 8;

[0036] – figure 11 is a longitudinal section view of a component of a braking system according to an embodiment of the invention;

[0037] – figure 12 is a detail view of the longitudinal section shown in figure 11;

[0038] – figure 13 is an exploded view of the component of a braking system shown in figure 11;

[0039] – figure 14 is a front perspective view of a component of a braking system according to an embodiment of the invention;

[0040] – figure 15 is a front perspective view of a component of a braking system according to an embodiment of the invention.

[0041] Description of some preferred embodiments

[0042] The present invention relates to a braking system of the Brake-By-Wire ("BBW") type of a vehicle 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 motorcars and the like and a brake lever for motorcycles, mopeds, and the like, unless otherwise specified. Moreover, "electrically

connected" means a connection for the transmission of electric power and/or electric signals.

[0043] Braking system 1

[0044] With reference to the figures, a braking feel simulator device is generally indicated by reference numeral 1.

[0045] In particular, the braking system 1 is a braking system of the "BBW" type, suitable for vehicles with two or more wheels.

[0046] The braking system 1 comprises a braking feel simulator device 2.

[0047] Moreover, the braking system 1 comprises a brake pedal 3 operatively connected to the braking feel simulator device 2.

[0048] The braking system 1 is configured so that an actuation 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.

[0049] According to an aspect of the invention, the braking system 1 comprises a signaling and detection system 4.

[0050] The signaling and detection system 4 comprises an interface device 8.

[0051] The interface device 8 is configured to be operable or touchable by the driver while driving the vehicle.

[0052] In particular, the interface device 8 is placeable inside the passenger compartment of a motorcar or on the external frame of a motorcycle.

[0053] Moreover, the signaling and detection system 4 comprises a haptic feedback actuator 5.

[0054] The haptic feedback actuator 5 is configured to generate haptic feedback and transmit the haptic feedback to the interface device 8. The haptic feedback actuator 5 can thus transmit haptic feedback, e.g., a vibration, to the driver.

[0055] Haptic feedback actuator 5 also means a "tactile feedback actuator".

[0056] The signaling and detection system 4 further comprises a sensor 6.

[0057] The sensor 6 is configured to detect parameters related to the braking system 1.

[0058] The parameters 1 related to the braking system detectable by the sensor 6 comprises the haptic feedback generated by the haptic feedback actuator 5.

[0059] In particular, the sensor 6 is configured to detect the haptic feedback transmitted from the haptic feedback actuator 5 to the interface device 8.

[0060] 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 5 to the interface device 8. Moreover, the braking system 1 thus configured allows transmitting particular alerts or warning signals relating to the interface device 1 itself, such as an engagement or disengagement alert of the electronic parking brake ("EPB") or an activation or deactivation alert of the electronic stability control ("ESC"), or an engagement or disengagement alert of the ignition key of the vehicle, or a malfunction alert of the braking system 1, or a activation or deactivation alert of the regenerative braking to the brake pedal 8, and thus to the driver. Moreover, the braking system 1 allows transmitting an insufficient or excessively light braking force alert to the interface device 8, 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.

[0061] With further advantage, a braking system 1 thus configured allows the detection of parameters related to the actuation of the braking system 1, such as the actuation force of the braking system 1 applied by the driver to the brake pedal or lever 3, or the vibrations transmitted by the haptic feedback actuator 5, by means of the sensor 6.

[0062] Haptic feedback actuator 5

[0063] According to an embodiment, the haptic feedback actuator 5 is a voice coil 7. Preferably, the haptic feedback actuator 5 is a voice coil 7, preferably of passive type, i.e., electrically powered by an electrical power source external to the voice coil 7.

[0064] Voice coil 7 means an electromagnetic device comprising a coil assembly and a magnetic mass in which the voice coil 7 moves in a given direction by applying an electrical voltage to the voice coil 7 through its power supply. By reversing the polarity of the applied voltage, the voice coil 7 moves in the opposite direction. The vibration force generated by voice coil 7 is proportional to the current flowing through the coil assembly.

[0065] Advantageously, the haptic feedback generatable by a voice coil 7 is remarkably adaptable, in terms of vibration intensity, duration, and frequency, thus allowing it to be configured differently for different drivers. Moreover, the use of a voice coil 7 has low cost and small size.

[0066] According to an embodiment, the haptic feedback actuator 5 comprises a plurality of voice coils 7.

[0067] According to an embodiment, the haptic feedback actuator 5 comprises a plurality of voice coils 7 positioned on mutually incident respective planes.

[0068] According to an embodiment, the haptic feedback actuator 5 comprises three voice coils 7. Preferably, the three voice coils 7 are positioned on three distinct, mutually incident planes. In particular, the three voice coils 7 are positioned so that each voice coil 7 defines an angle of about 120° with respect to the other two voice coils 7. Alternatively, the three voice coils 7 are positioned in three distinct incident planes so that each voice coil 7 defines an angle of about 60° with respect to the other two voice coils 7.

[0069] According to an embodiment, the haptic feedback actuator 5 comprises four voice coils 7. Preferably, the four voice coils 7 are positioned on four distinct mutually incident planes. In particular, the four voice coils 7 are positioned so that each voice coil 7 defines an angle of about 90° with respect to the other two voice coils 7. According to an embodiment, the four voice coils 7 are positioned in an "X" configuration. Alternatively, the four voice coils 7 are positioned according to a "square" configuration.

[0070] According to alternative embodiments, the haptic feedback actuator 5 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.

[0071] According to an embodiment, the haptic feedback actuator 5 comprises any combination of any of the actuators described above.

[0072] According to an embodiment, the haptic feedback actuator 5 is configured to transmit a vibration transmitted to the interface device 8 according to a mode or a plurality of vibration modes, or vibration patterns, e.g., a clicking vibration, an increasing or decreasing ramp vibration, a pulsed vibration, a continuous intensity vibration, or a vibration interspersed with pauses of different durations, or continuous intensity vibrations of different durations, or vibrations at different vibration frequencies, or vibrations of different vibration intensities. In particular, each vibration mode can correspond to a different signal or alert.

[0073] Advantageously, a braking system 1 thus configured allows transmitting modulated signals or alerts to a driver.

[0074] According to an embodiment, the haptic feedback actuator 5, preferably the at least one voice coil 7, is configured to transmit vibrations with a frequency between 5 Hz and 10 Hz.

[0075] Advantageously, such a frequency range mimics the brake pedal trembling frequencies of a conventional braking system triggered when the ABS intervenes. Thereby, the haptic feedback actuator 5 thus configured returns to the driver the feeling

of the triggering of the ABS system in a conventional braking system.

[0076] With further advantage, such a frequency is usable to signal the triggering of the ABS system according to different road conditions, such as dry or wet road surfaces, or snow or ice.

[0077] According to an embodiment, the haptic feedback actuator 5, preferably the at least one voice coil 7, is configured to transmit vibrations with a frequency between 50 Hz and 200 Hz.

[0078] Advantageously, such a frequency range is usable to provide the driver with particular alerts or warning signals related to the braking system 1. For example, with a vibration in such a frequency range, an electronic parking brake ("EPB") engagement or disengagement alert, an electronic stability control ("ESC") activation or deactivation alert, a vehicle ignition key on or off alert, a braking system malfunction alert 1, a regenerative braking activation or deactivation alert, or an insufficient braking force regenerative braking to avoid a vehicle crash is signaled to the driver.

[0079] According to a preferred embodiment, the haptic feedback actuator 5, preferably the at least one voice coil 7, is configured to transmit vibrations either with frequency between 5 Hz and 10 Hz or with frequency between 50 Hz and 200 Hz.

[0080] Advantageously, such vibration frequency ranges are mutually distinct and distinguishable by the driver, so that the driver can clearly perceive and distinguish between a signal or alert issued in the frequency range between 5 Hz and 10 Hz, e.g., ABS trigger warning, and a different signal or warning issued in the frequency range between 50 Hz and 200 Hz, e.g., warnings or warnings related to the braking system 1.

[0081] Sensor 6

[0082] According to an embodiment, the sensor 6 is configured to detect an actuating and/or movement and/or contact force applied by the driver to the interface device 8.

[0083] According to an embodiment, the sensor 6 is either a position sensor, a pressure sensor, a force sensor, or a combination thereof. According to an embodiment, the sensor 6 is either a laser position sensor, an infrared pressure sensor, an elastomeric sensor, a piezoelectric sensor, a Hall effect sensor, a magnetoresistive sensor, or 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.

[0084] Signaling and detection system 4

[0085] According to an embodiment, the signaling and detection system 4 comprises a housing body 9.

[0086] The housing body 9 forms a housing seat 10.

[0087] The haptic feedback actuator 5 is housed inside the housing seat 10. The haptic feedback actuator 5 is thus configured to transmit haptic feedback, in particular vibrations, to the housing body 9.

[0088] Moreover, the housing body 9 is connected to the interface device 8. The housing body 9 is thus configured to transmit the haptic feedback generated by the haptic feedback actuator 5 to the interface device 8.

[0089] According to an embodiment, the housing body 9 is connected to the interface device 8 by means of an articulated connection. According to a further embodiment, the interface device 8 either incorporates or forms the housing body 9.

[0090] According to an embodiment, the housing body 9 is at least partially made of metallic material.

[0091] Advantageously, such a configuration promotes the transmission of vibrations from the haptic feedback actuator 5 to the interface device 8, and thus to the driver.

[0092] According to an embodiment, the sensor 6 is connected to the housing body 9. Preferably, the sensor 6 is fixed to the housing body 9.

[0093] According to an embodiment, the housing body 9 defines a sensor seat 26, and the sensor 6 is housed inside the sensor seat 26. The sensor 6 is thus positionable facing the haptic feedback actuator 5.

[0094] The sensor 6, connected to the housing body 9, is positioned so as to receive and detect the haptic feedback generated by the haptic feedback actuator 5.

[0095] Moreover, the sensor 6 is positioned so as to receive and detect an actuation force and/or a movement force and/or a contact force applied by the interface device 8 to the driver.

[0096] Specifically, the interface device 8, the housing body 9, and the sensor 6 are connected to each other so that haptic feedback generated by the haptic feedback actuator 5 is transmitted from the housing body 9 to the interface device 8, so as to be perceptible by the driver, and is transmitted to the sensor 6 so that the sensor receives and detects the haptic feedback generated by the haptic feedback actuator 5.

[0097] Moreover, the interface device 8, the housing body 9, and the sensor 6 are connected to each other so that a driving force and/or the movement force and/or the contact force applied by the driver to the interface device 8 is transmitted to the sensor 6 so that the sensor 6 receives and detects the driving force and/or the movement force and/or the contact force applied by the driver to the interface device 8.

[0098] Advantageously, the signaling and detection system 4 thus configured, comprising a housing body 9 to which both the haptic feedback actuator 5 and the sensor 6 are connected, in particular housed and fixed, allows both the transmission to an interface device 8 of signals and alerts by means of haptic feedback generated and transmitted by the haptic feedback actuator 5, and the detection of the haptic feedback generated by the haptic feedback actuator 5 by means of the sensor 6, as well as the detection of actuation and/or movement and/or contact forces applied by the driver on interface device 8 by means of the sensor 6, e.g., the actuation force applied by the driver on the brake pedal 3.

[0099] The housing body 9 thus configured, to which the haptic feedback actuator 5 and sensor 6 are connected, is thus a sort of a single assembly having high compactness and small size, which is thus easily installable in the vehicle, particularly at any human-machine interface or HMI. Moreover, the compact signaling and detection 4 system is adapted to be connected to retraction means, which are configured to retract the signaling and detection 4 system under autonomous vehicle driving conditions.

[00100] According to an embodiment, the housing body 9 comprises a transmission element 18.

[00101] The transmission element 18 is configured to transmit the haptic feedback generated by the haptic feedback actuator 5 to the sensor 6.

[00102] Moreover, the transmission element 18 is configured to transfer, from the interface device 8 to the sensor 6, an actuation and/or movement and/or contact force applied by the driver to the interface device 8.

[00103] The transmission element 18 is connected to the housing body 9 and is positioned facing the sensor 6.

[00104] According to an embodiment, the transmission element 18 leads from the housing body 9 and is positioned to abut against the sensor 6.

[00105] A haptic feedback or force is thus transmittable through the transmission element 18 between the housing body 9 and the sensor 6.

[00106] According to an embodiment, the transmission element 18 is interposed between the housing compartment 10 and the sensor seat 26.

[00107] Brake pedal 3

[00108] According to an embodiment, the brake pedal 3 is the brake pedal of a motorcar.

[00109] The brake pedal 3 comprises a pedal pad 11 fixed to a pedal crank 12.

[00110] The pedal pad 11 is fixed to an end of the pedal crank 12.

[00111] The opposite end of the pedal crank 12 is fixed to a hinge 13 configured to connect the pedal crank 12 to the chassis of a vehicle.

[00112] The brake pedal 3 is operatively connected to the braking feel simulator 2 by means of a mechanical connection device 14. An actuation force applied by a driver on the brake pedal 3 is thus mechanically transferred to the braking feel simulator device 2.

[00113] For example, the mechanical connection device 14 is a hinge mechanism or an articulated connection.

[00114] Preferably, the connection device 14 is configured to connect the pedal crank 12 to the braking feel simulator device 2, so that an actuation of brake pedal 3 corresponds to an actuation of the braking feel simulator device 2.

[00115] According to an embodiment, the signaling and detection 4 is positioned at the brake pedal 3.

[00116] According to this embodiment, the interface device 8 is a brake pad 3.

[00117] According to an embodiment, the interface device 8 is the pedal pad 11 of the brake pedal 3.

[00118] According to an embodiment, the brake pedal 3 comprises a housing body 9.

[00119] According to an embodiment, the pedal pad 11 of the brake pedal 3 forms the housing body 9.

[00120] According to this embodiment, the haptic feedback actuator 5 is housed inside the pedal pad 11 and the sensor 6 is connected to the pedal pad 11.

[00121] The pedal pad 11 comprises a pressure wall 15 and an opposite fixing wall 16.

[00122] The pressure wall 15 faces the driver and is configured to be pressed by a driver's foot so as to actuate the brake pedal 3.

[00123] The fixing wall 16 faces towards the pedal crank 12 and is fixed to the pedal crank 12.

[00124] Specifically, the pedal crank 12 comprises a support wall 17 facing the pedal pad 11 and fixed to the pedal pad 11.

[00125] Therefore, the fixing wall 16 of the pedal pad 11 is fixed to the support wall 17 of the pedal crank 12.

[00126] The pressure wall 15 and the fixing wall 16 of the pedal pad 11 form a housing body 9 to which the sensor 6 is connected, and together define a housing seat 10 in which the haptic feedback actuator 5, preferably the voice coil 7, is housed.

[00127] According to an embodiment, the haptic feedback actuator 5 is positioned in

contact with the pressure wall 15.

[00128] Advantageously, such a configuration facilitates the transmission and perception of the haptic feedback by the driver because the haptic feedback is transmitted directly to the pressure wall 15 on which the driver rests his/her foot to control the braking action.

[00129] According to an embodiment, the sensor 6 is configured to detect an actuation force applied by the driver on the brake pedal 3, and in particular on the pedal pad 11.

[00130] According to an embodiment, the sensor 6 is housed in the pedal crank 12.

[00131] According to an embodiment, the sensor 6 is housed in the support wall 17 of the pedal crank 12.

[00132] According to an embodiment, the sensor 6 is positioned facing the haptic feedback actuator 5, so as to detect haptic feedback emitted by the haptic feedback actuator 5.

[00133] Moreover, the sensor 6 is positioned facing the pedal pad 11, preferably connected to the fixing wall 16, so as to detect the actuation force applied by the driver on the pedal pad 11.

[00134] The haptic feedback actuator 5 is configured to transmit haptic feedback, such as a vibration, to the pressure wall 15 of the pedal pad 11. The haptic feedback is thus perceivable by the driver acting on the brake pedal 3, and in particular on the pedal pad 11. Moreover, the haptic feedback is transferred from the pressure wall 15 to the fixing wall 16. The fixing wall 16 thus transfers the haptic feedback to the sensor 6, and the sensor 6 is thus capable of detecting the haptic feedback and thus enable its subsequent processing by an electronic processing unit connected to the sensor 6.

[00135] With further advantage, the positioning of the haptic feedback actuator 5 and sensor 6 inside the brake pedal 3 as previously reported guarantees a high transmission of haptic feedback to the driver while providing direct detection of the actuation force applied by the driver on the brake pedal 3, in addition to a reduction in the total size of the signaling and detection system 6 at the same time.

[00136] Moreover, the signaling and detection system 4 thus configured is capable of transmitting an actuation force of the brake pedal 3 applied by the driver from the pressure wall 15 to the fixing wall 16. The fixing wall 16 thus transfers such an actuation force to the sensor 6, and the sensor 6 is thus capable of detecting the actuation force and thus enabling its subsequent processing by an electronic processing unit connected to the sensor 6.

[00137] Alternative embodiments

[00138] According to an embodiment, the signaling and detection system 4 is positioned at the hinge 13.

[00139] The hinge 13 comprises a first hinge body 19 and a second hinge body 20 hinged to each other so as to be mutually rotatable about a hinge axis 21.

[00140] The first hinge body 19 is connected to the pedal crank 12, while the second hinge body 20 is connected to the frame of the vehicle.

[00141] According to this embodiment, the interface device 8 is a brake pad 3.

[00142] According to an embodiment, the interface device 8 is the pedal pad 11 of the brake pedal 3.

[00143] According to this embodiment, the hinge 13 comprises a housing body 9.

[00144] According to an embodiment, the first hinge body 19 forms the housing body 9. Alternatively, the second hinge body 20 forms the housing body 9.

[00145] According to this embodiment, the haptic feedback actuator 5 is housed inside the hinge 13, preferably it is housed inside the first hinge body 19, and the sensor 6 is connected to the hinge 13, preferably it is connected to the first hinge body 19.

[00146] According to an embodiment, the sensor 6 is configured to detect an actuation force applied by the driver on the brake pedal 3, and in particular on the pedal pad 11.

[00147] Advantageously, such a configuration of the signaling and detection system 4 allows transmitting the haptic feedback, in particular vibrations, generated by the haptic feedback actuator 5, to the driver by means of the pedal crank 12 connected to the first hinge body 19. At the same time, the haptic feedback is transmitted to the sensor 6 by means of the housing body 9, and the sensor 6 is thus capable of detecting the haptic feedback and thus enabling its subsequent processing by an electronic processing unit connected to the sensor 6.

[00148] Moreover, the signaling and detection system 4 thus configured is capable of transmitting an actuation force of the brake pedal 3 applied by the driver, to the hinge 13. The actuation force of the brake pedal 3 is thus transferable and detectable by the sensor 6, which is thus capable of detecting such an actuation force and allowing its subsequent processing by an electronic processing unit connected to the sensor 6.

[00149] According to an embodiment, the signaling and detection system 4 is positioned at the braking feel simulator device 2.

[00150] The braking feel simulator device 2 comprises at least one elastic element 22. The at least one elastic element 22 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 22 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.

[00151] Moreover, the braking feel simulator device 2 comprises a thrust shaft 23. The thrust shaft 23, configured to be biased against the at least one elastic element 22, in response to an actuation of the brake pedal 3. The at least one elastic element 22 thus applies a counteracting force upon actuation of the brake pedal 3.

[00152] According to this embodiment, the interface device 8 is a brake pad 3.

[00153] According to an embodiment, the interface device 8 is the pedal pad 11 of the brake pedal 3.

[00154] According to an embodiment, the braking feel simulator device 2 comprises the housing body 9.

[00155] According to an embodiment, the thrust shaft 23 comprises the housing body 9. Alternatively, the at least one elastic element 22 comprises the housing body 9.

[00156] According to this embodiment, the haptic feedback actuator 5 is housed in the braking feel simulator device 2, preferably is housed in the thrust shaft 23, and the sensor 6 is connected to the braking feel simulator device 2, preferably is connected to the thrust shaft 23.

[00157] According to an embodiment, the sensor 6 is configured to detect an actuation force applied by the driver on the brake pedal 3, and in particular on the pedal pad 11.

[00158] Advantageously, such a configuration of the signaling and detection system 4 allows transmitting the haptic feedback, in particular vibration, generated by the haptic feedback actuator 5, to the driver by means of the brake pedal 3, preferably by means of the pedal crank 12, connected to the thrust shaft 23. At the same time, the haptic feedback is transmitted to the sensor 6 by means of the housing body 9, and the sensor 6 is thus capable of detecting the haptic feedback and thus enabling its subsequent processing by an electronic processing unit connected to the sensor 6.

[00159] Moreover, the signaling and detection system 4 thus configured is capable of transmitting an actuation force of the brake pedal 3 applied by the driver, to the braking feel simulator device 2. The actuation force of the brake pedal 3 is thus transferable and detectable by the sensor 6, which is thus capable of detecting such an actuation force and allowing its subsequent processing by an electronic processing unit connected to the sensor 6.

[00160] According to an embodiment, the signaling and detection system 4 is positioned at the mechanical connection device 14.

[00161] Preferably, the mechanical connection device 14 connects the thrust shaft 23 of the braking feel simulator device 2 to the pedal crank 12 of the brake pedal 3.

[00162] According to this embodiment, the interface device 8 is a brake pad 3.

[00163] According to an embodiment, the interface device 8 is the pedal pad 11 of the brake pedal 3.

[00164] According to an embodiment, the mechanical connection device 14 comprises a housing body 9.

[00165] According to this embodiment, the haptic feedback actuator 5 is housed inside the mechanical connection device 14, and the sensor 6 is connected to the mechanical connection device 14.

[00166] According to an embodiment, the pedal brake 3, preferably the pedal crank 12, comprises the housing body 9. Alternatively, the thrust shaft 23 comprises the housing body 9.

[00167] According to an embodiment, the sensor 6 is configured to detect an actuation force applied by the driver on the brake pedal 3, and in particular on the pedal pad 11.

[00168] Advantageously, such a configuration of the signaling and detection system 4 allows transmitting the haptic feedback, in particular the vibration, generated by the haptic feedback actuator 5, to the driver by means of the brake pedal 3, preferably by means of the pedal crank 12, connected to the mechanical connection device 14. At the same time, the haptic feedback is transmitted to the sensor 6 by means of the housing body 9, and the sensor 6 is thus capable of detecting the haptic feedback and thus enabling its subsequent processing by an electronic processing unit connected to the sensor 6.

[00169] Moreover, the signaling and detection system 4 thus configured is capable of transmitting an actuation force of the brake pedal 3 applied by the driver, to the mechanical connection device 14. The actuation force of the brake pedal 3 is thus transferable and detectable by the sensor 6, which is thus capable of detecting such an actuation force and allowing its subsequent processing by an electronic processing unit connected to the sensor 6.

[00170] According to an embodiment, the signaling and detection system 4 is positioned at a brake lever of a motorcycle 24. According to this embodiment, the interface device 8 is a brake lever of a motorcycle 24. Moreover, the brake lever of a motorcycle 24 comprises a housing body 9. Optionally, the sensor 6 is configured to detect an actuation force applied by the driver on the brake lever of a motorcycle 24.

[00171] According to an embodiment, the signaling and detection system 4 is positioned at the brake pedal of a motorcycle 25. According to this embodiment, the interface device 8 is a brake pedal of a motorcycle 25. Moreover, the brake pedal of a motorcycle 25 comprises the housing body 9. Optionally, the sensor 6 is configured to detect an actuation force applied by the driver on the brake pedal of a motorcycle 25.

[00172] According to an embodiment, the signaling and detection system 4 is positioned at a clutch pedal of a motorcycle. According to this embodiment, the interface device 8 is a clutch pedal of a motorcycle. Moreover, the clutch pedal of a motorcycle comprises the housing body 9. Optionally, the sensor 6 is configured to detect an actuation force applied by the driver on the clutch pedal.

[00173] According to an embodiment, the signaling and detection system 4 is positioned at a clutch pedal of a motorcar. According to this embodiment, the interface device 8 is a clutch pedal of a motorcar. Moreover, the clutch pedal of a motorcar comprises the housing body 9. Optionally, the sensor 6 is configured to detect an actuation force applied by the driver on the clutch pedal.

[00174] According to an embodiment, the signaling and detection system 4 is positioned at an accelerator pedal of a motorcar. According to this embodiment, the interface device 8 is an acceleration pedal of a motorcar. Moreover, the acceleration pedal of a motorcar comprises the housing body 9. Optionally, the sensor 6 is configured to detect an actuation force applied by the driver on the acceleration pedal.

[00175] According to an embodiment, the signaling and detection system 4 is positioned at the steering, in particular the steering wheel, of a vehicle. According to this embodiment, the interface device 8 is the steering wheel of the vehicle. Moreover, the steering, preferably the steering wheel, comprises the housing body 9. Optionally, the sensor 6 is configured to detect an actuation force applied by the driver on the steering wheel and/or the brake pedal 3.

[00176] According to an embodiment, the signaling and detection system 4 is positioned at a handlebar of a motorcycle. According to this embodiment, the interface device 8 is the handlebar of the motorcycle. Moreover, the handlebar of the motorcycle comprises the housing body 9. Optionally, the sensor 6 is configured to detect an actuation force applied by the driver on the handlebar and/or brake pedal 3.

[00177] According to an embodiment, the signaling and detection system 4 is positioned at a seat belt of a vehicle. According to this embodiment, the interface device 8 is the seat belt of the vehicle. Moreover, the seat belt of the vehicle comprises the housing body 9. Optionally, the sensor 6 is configured to detect an actuation force applied

by the driver on the seat belt and/or brake pedal 3.

[00178] According to an embodiment, the signaling and detection system 4 is positioned at a seat of a vehicle. According to this embodiment, the interface device 8 is the seat of the vehicle. Moreover, the seat of the vehicle comprises the housing body 9. Optionally, the sensor 6 is configured to detect an actuation force applied by the driver on the seat and/or brake pedal 3.

[00179] According to an embodiment, the signaling and detection system 4 is positioned at a saddle of a motorcycle. According to this embodiment, the interface device 8 is the saddle of the motorcycle. Moreover, the saddle of the motorcycle comprises the housing body 9. Optionally, the sensor 6 is configured to detect an actuation force applied by the driver on the saddle and/or brake pedal 3.

[00180] Braking system 1

[00181] According to an embodiment, the braking system 1 comprises an electronic processing unit electrically connected to the at least one brake caliper with the brake pedal 3, with the braking feel simulator device 2 with the interface device 8, and with the signaling and detection system 4.

[00182] 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.

[00183] The electronic processing unit is further configured to command the haptic feedback actuator 5 to generate haptic feedback and is configured to acquire and process the force and haptic feedback readings detected by the sensor 6.

[00184] According to an embodiment, the braking feel simulator device 2 can be either of the dry type, i.e., not immersed in hydraulic fluid, or of the wet type, i.e., immersed in hydraulic fluid.

[00185] According to an embodiment, the braking system 1 comprises a plurality of additional sensors electrically connected to the electronic processing unit.

[00186] According to an embodiment, the additional sensors are configured to detect at least one driving parameter, preferably a plurality of driving parameters.

[00187] According to an embodiment, the additional sensors are configured to detect one or more of the following driving parameters: an electronic parking brake ("EPB") engagement or disengagement, and/or an electronic stability control ("ESC") activation or deactivation, and/or a vehicle ignition key switching on or off, and/or a malfunction of the braking system 1, and/or an activation or deactivation of a regenerative braking action performed by the braking system 1, and/or to detect the strength of the braking force

actuated by the braking system 1, and/or to detect a distance of the vehicle in which the braking system 1 is integrated from other vehicles.

[00188] Moreover, the electronic processing unit is configured to command the haptic feedback actuator 5 to transmit haptic feedback to the interface device 8 at one or more of the previous detections performed by the additional sensors.

[00189] 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. Signaling and detection system
5. Haptic feedback actuator
6. Sensor
7. Voice coil
8. Interface device
9. Housing body
10. Housing seat
11. Pedal pad
12. Pedal crank
13. Hinge
14. Mechanical connection device
15. Pressure wall
16. Fixing wall
17. Support wall
18. Transmission element
19. First hinge body
20. Second hinge body
21. Hinge axis
22. Elastic element
23. Thrust shaft
24. Motorcycle brake lever
25. Motorcycle brake pedal
26. Sensor seat

Claims

1. A braking system (1) for a vehicle, 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 a signaling and detection system (4), comprising:
- an interface device (8), configured to be operable or touchable by the driver while driving the vehicle;
- a haptic feedback actuator (5), configured to generate haptic feedback and transmit the haptic feedback to the interface device (8);
- a sensor (6), configured to detect parameters related to the braking system (1), including the haptic feedback generated by the haptic feedback actuator (5).

2. A braking system (1) according to claim 1, wherein the haptic feedback actuator (5) is a voice coil (7), preferably of passive type electrically powered by an electrical power source outside the voice coil (7).

3. A braking system (1) according to claim 1 or 2, wherein the haptic feedback actuator (5) comprises a plurality of voice coils (7) positioned on mutually incident respective planes,
and/or wherein the haptic feedback actuator (5) comprises three voice coils (7) positioned on three distinct, mutually incident planes, preferably wherein the three voice coils (7) are positioned so that each voice coil (7) defines an angle of about 120° with respect to the remaining two voice coils (7), or wherein the three voice coils (7) are positioned on three distinct incident planes so that each voice coil (7) defines an angle of about 60° with respect to the remaining two voice coils (7),
and/or wherein the haptic feedback actuator (5) comprises four voice coils (7) positioned on four distinct, mutually incident planes, preferably wherein each voice coil (7) defines an angle of about 90° with respect to the remaining two voice coils (7), and wherein the four voice coils (7) are positioned according to an "X" configuration, or according to a "square" configuration.

4. A braking system (1) according to claim 1, wherein the haptic feedback actuator (5) is a piezoelectric actuator, or an eccentric rotating mass ("ERM") motor, or a linear resonant actuator ("LRA"), or a solenoid actuator, or a brushless actuator, or a stepper actuator, or a bass shaker actuator, or any combination of the preceding actuators.

5. A braking system (1) according to any one of the preceding claims, wherein the haptic feedback actuator (5) is configured to transmit vibrations with a frequency between 5 Hz and 10 Hz,
and/or wherein the haptic feedback actuator (5) is configured to transmit vibrations with a frequency between 50 Hz and 200 Hz.

6. A braking system (1) according to any one of the preceding claims, wherein the sensor (6) is configured to detect an actuating and/or movement and/or contact force applied by the driver to the interface device (8),
and/or wherein the sensor (6) 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.

7. A braking system (1) according to any one of the preceding claims, wherein the signaling and detection system (4) comprises a housing body (9) forming a housing seat (10),
wherein the haptic feedback actuator (5) is housed inside the housing seat (10), so as to transmit haptic feedbacks, in particular vibrations, to the housing body (9),
and wherein the housing body (9) is connected to the interface device (8), so as to transmit the haptic feedback generated by the haptic feedback actuator (5) to the interface device (8),
and wherein, optionally, the housing body (9) is at least partially made of a metal material.

8. A braking system (1) according to claim 7, wherein the sensor (6) is connected to the housing body (9), preferably fixed to the housing body (9),
and wherein the sensor (6) is positioned so as to receive and detect the haptic feedback

generated by the haptic feedback actuator (5), and receive and detect an actuating force and/or a movement force and/or a contact force applied by the driver to the interface device (8).

9. A braking system (1) according to claim 8, wherein the housing body (9) comprises a transmission element (18) configured to transmit the haptic feedback generated by the haptic feedback actuator (5) to the sensor (6),
wherein the transmission element (18) is configured to transfer, from the interface device (8) to the sensor (6), an actuating and/or movement and/or contact force applied by the driver to the interface device (8),
wherein the transmission element (18) is connected to the housing body (9) and is positioned facing the sensor (6),
wherein, optionally, the transmission element (18) leads from the housing body (9) and is positioned to abut against the sensor (6).

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, comprising a pedal pad (11) fixed to a pedal crank (12),
wherein the signaling and detection system (4) is positioned at the brake pedal (3),
and wherein the interface device (8) is the brake pedal (3), in particular wherein the interface device (8) is the pedal pad (11) of the brake pedal (3).

11. A brake system (1) according to claim 10, wherein the pedal pad (11) comprises a pressure wall (15) and an opposite fixing wall (16), wherein the pressure wall (15) 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 (16) faces the pedal crank (12) and is fixed to the pedal crank (12),
wherein the pedal crank (12) comprises a support wall (17) facing the pedal pad (11) and fixed to the pedal pad (11),
wherein the pressure wall (15) and the fixing wall (16) of the pedal pad (11) form a housing body (9) to which the sensor (6) is connected, and wherein the pressure wall (15) and the fixing wall (16) of the pedal pad (11) together define a housing seat (10) in which the haptic feedback actuator (5), preferably the voice coil (7), is housed,
wherein, optionally, the haptic feedback actuator (5) is placed in contact with the pressure wall (15),

and wherein, optionally, the sensor (6) is housed in the support wall (17) of the pedal crank (12).

12. 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, comprising a pedal pad (11) fixed to an end of a pedal crank (12), and wherein the opposite end of the pedal crank (12) is fixed to a hinge (13) configured to connect the pedal crank (12) to the vehicle chassis,
wherein the signaling and detection system (4) is positioned at the hinge (13),
and wherein the interface device (8) is the brake pedal (3), in particular wherein the interface device (8) is the pedal pad (11) of the brake pedal (3),
and wherein, optionally, the hinge (13) comprises a first hinge body (19) and a second hinge body (20) hinged to each other so as to be mutually rotatable about a hinge axis (21), wherein the first hinge body (19) is connected to the pedal crank (12), while the second hinge body (20) is connected to the vehicle chassis, and wherein the hinge (13) comprises a housing body (9) forming a housing seat (10), wherein the haptic feedback actuator (5) is housed inside the housing seat (10), so as to transmit haptic feedbacks, in particular vibrations, to the housing body (9).

13. 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, comprising a pedal pad (11) fixed to a pedal crank (12), and wherein the brake pedal (3) is operatively connected to the braking feel simulator device (2) by means of a mechanical connection device (14), so that an actuating force applied by the driver to the brake pedal (3) is mechanically transferred to the braking feel simulator device (2),
wherein the signaling and detection system (4) is positioned at the braking feel simulator device (2),
and wherein the interface device (8) is the brake pedal (3), in particular wherein the interface device (8) is the pedal pad (11) of the brake pedal (3),
and wherein, optionally, the braking feel simulator device (2) comprises at least one elastic element (22) configured to apply a reaction force to the brake pedal (3) in response to an actuation of the brake pedal (3) by a driver, wherein the braking feel simulator device (2) comprises a thrust shaft (23) configured to be biased against the at least one elastic element (22) in response to an actuation of the brake pedal (3) so that the at least one elastic element (22) applies a counteracting force on the actuation of the brake pedal (3), and wherein the braking feel simulator device (2) comprises a housing

body (9) forming a housing seat (10), wherein the haptic feedback actuator (5) is housed inside the housing seat (10) so as to transmit haptic feedbacks, in particular vibrations, to the housing body (9).

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, comprising a pedal pad (11) fixed to a pedal crank (12), and wherein the brake pedal (3) is operatively connected to the braking feel simulator device (2) by means of a mechanical connection device (14), so that an actuating force applied by the driver to the brake pedal (3) is mechanically transferred to the braking feel simulator device (2),
wherein the signaling and detection system (4) is positioned at the mechanical connection device (14),
and wherein the interface device (8) is the brake pedal (3), in particular wherein the interface device (8) is the pedal pad (11) of the brake pedal (3),
and wherein, optionally, the mechanical connection device (14) comprises a housing body (9) forming a housing seat (10), wherein the haptic feedback actuator (5) is housed inside the housing seat (10), so as to transmit haptic feedbacks, in particular vibrations, to the housing body (9).

15. A braking system (1) according to any one of claims 1 to 9, wherein the signaling and detection system (4) is positioned at a motorcycle brake lever (24), wherein the interface device (8) is the motorcycle brake lever (24), and wherein the motorcycle brake lever (24) comprises a housing body (9) forming a housing seat (10), wherein the haptic feedback actuator (5) is housed inside the housing seat (10) so as to transmit haptic feedbacks, in particular vibrations, to the housing body (9),
and/or
wherein the signal and detection system (4) is positioned at a motorcycle brake pedal (25), wherein the interface device (8) is the motorcycle brake pedal (25), and wherein the motorcycle brake pedal (25) comprises a housing body (9) forming a housing seat (10), wherein the haptic feedback actuator (5) is housed inside the housing seat (10) so as to transmit haptic feedbacks, in particular vibrations, to the housing body (9),
and/or
wherein the signaling and detection system (4) is positioned at a clutch pedal of a motorcycle or motor vehicle, wherein the interface device (8) is the clutch pedal of a motorcycle or motor vehicle, and wherein the clutch pedal of a motorcycle or motor

vehicle comprises a housing body (9) forming a housing seat (10), wherein the haptic feedback actuator (5) is housed inside the housing seat (10) so as to transmit haptic feedbacks, in particular vibrations, to the housing body (9),

and/or

wherein the signaling and detection system (4) is positioned at an acceleration pedal of a motor vehicle, wherein the interface device (8) is the acceleration pedal of a motor vehicle, and wherein the acceleration pedal of a motor vehicle comprises a housing body (9) forming a housing seat (10), wherein the haptic feedback actuator (5) is housed inside the housing seat (10) so as to transmit haptic feedbacks, in particular vibrations, to the housing body (9),

and/or

wherein the signaling and detection system (4) is positioned at a steering, in particular a steering wheel, of a vehicle, wherein the interface device (8) is the steering wheel of the vehicle, and wherein the steering, preferably the steering wheel, comprises a housing body (9) forming a housing seat (10), wherein the haptic feedback actuator (5) is housed inside the housing seat (10) so as to transmit haptic feedbacks, in particular vibrations, to the housing body (9),

and/or

wherein the signaling and detection system (4) is positioned at a handlebar of a motorcycle, wherein the interface device (8) is the handlebar of the motorcycle, and wherein the handlebar of the motorcycle comprises a housing body (9) forming a housing seat (10), wherein the haptic feedback actuator (5) is housed inside the housing seat (10) so as to transmit haptic feedbacks, in particular vibrations, to the housing body (9),

and/or

wherein the signaling and detection system (4) is positioned at a seat belt of a vehicle, wherein the interface device (8) is the seat belt of the vehicle, and wherein the seat belt of the vehicle comprises a housing body (9) forming a housing seat (10), wherein the haptic feedback actuator (5) is housed inside the housing seat (10) so as to transmit haptic feedbacks, in particular vibrations, to the housing body (9),

and/or

wherein the signaling and detection system (4) is positioned at a seat of a vehicle, wherein the interface device (8) is the seat of the vehicle, and wherein the seat of the vehicle comprises a housing body (9) forming a housing seat (10), wherein the haptic feedback actuator (5) is housed inside the housing seat (10) so as to transmit haptic feedbacks, in particular vibrations, to the housing body (9),

and/or
wherein the signaling and detection system (4) is positioned at a saddle of the motorcycle, wherein the interface device (8) is the saddle of the motorcycle, and wherein the saddle of the motorcycle comprises a housing body (9) forming a housing seat (10), wherein the haptic feedback actuator (5) is housed inside the housing seat (10) so as to transmit haptic feedbacks, in particular vibrations, to the housing body (9).

16. A braking system (1) according to any one of the preceding claims, comprising an electronic processing unit electrically connected to the at least one brake caliper, the brake pedal (3), the braking feel simulator device (2), the interface device (8), and the signaling and detection system (4),
and 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 also 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 (6).

17. A braking system (1) according to claim 16, comprising a plurality of additional sensors electrically connected to the electronic processing unit, wherein the additional sensors are configured to detect one or more of the following driving parameters: an engagement or disengagement of the electronic parking brake ("EPB"), and/or an activation or deactivation of the electronic stability control ("ESC"), and/or a switching on or off of the vehicle ignition key, and/or a malfunction of the braking system (1), and/or an activation or deactivation of a regenerative braking action performed by the brake system (1), and/or to detect the strength of the braking force actuated by the brake system (1), and/or to detect a distance of the vehicle in which the brake system is integrated (1) from other vehicles,
and wherein the electronic processing unit is configured to command the haptic feedback actuator (5) to transmit a haptic feedback to the interface device (8) at one or more of said detections performed by the additional sensors.

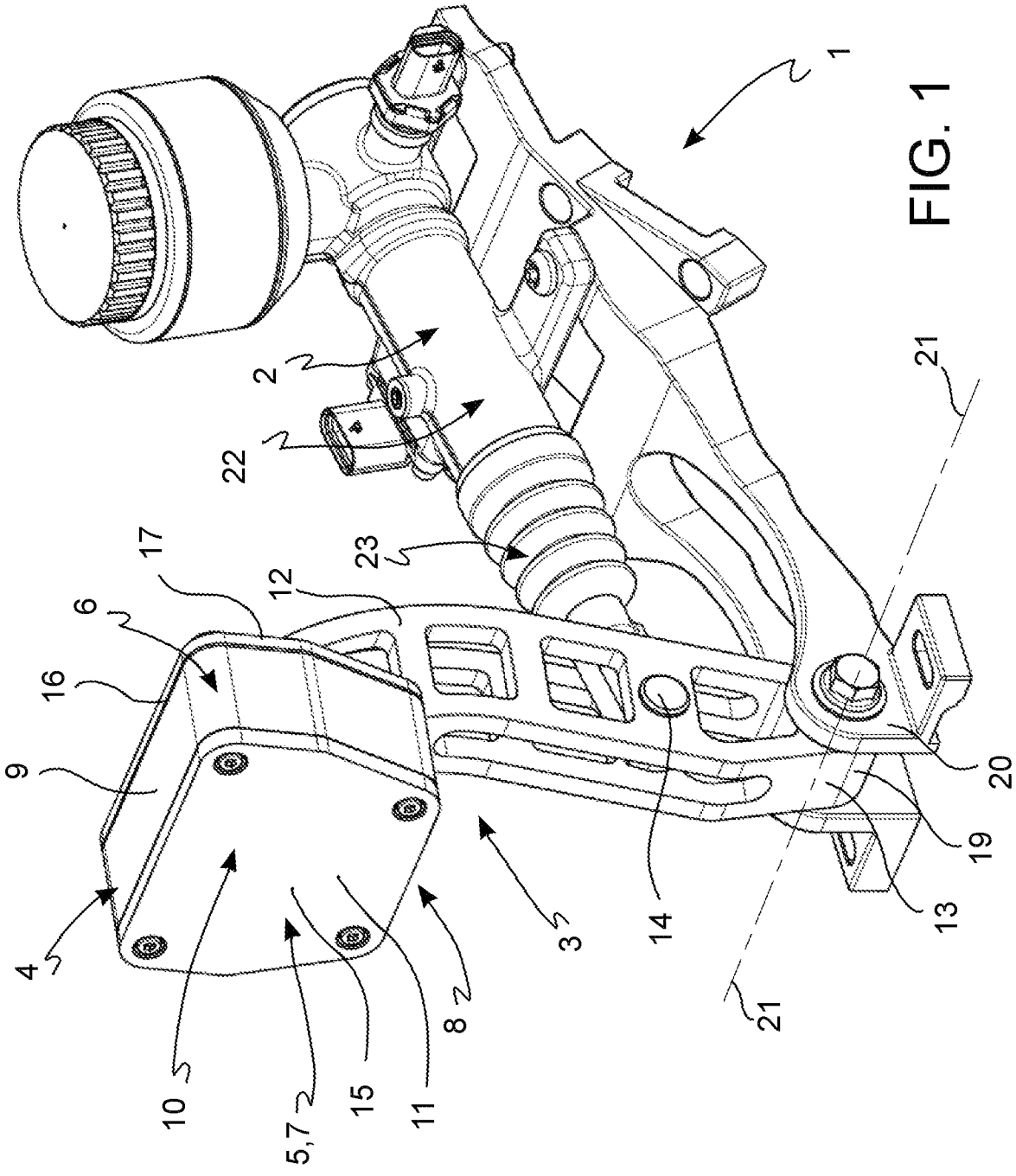

FIG. 1

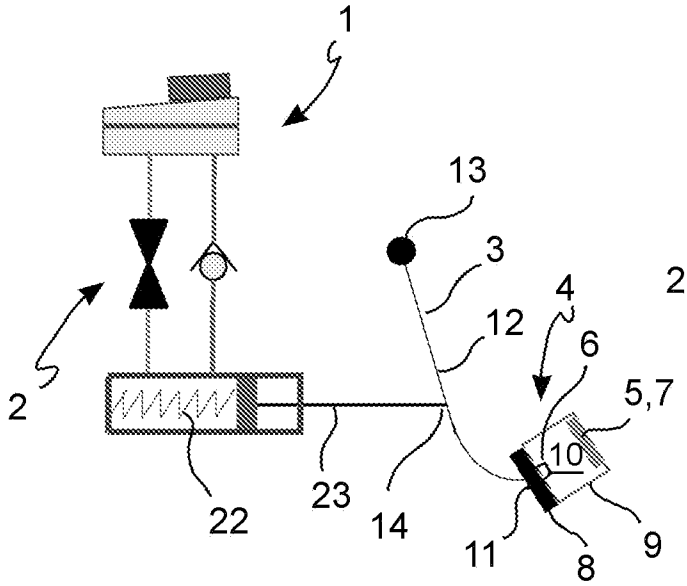

FIG. 2

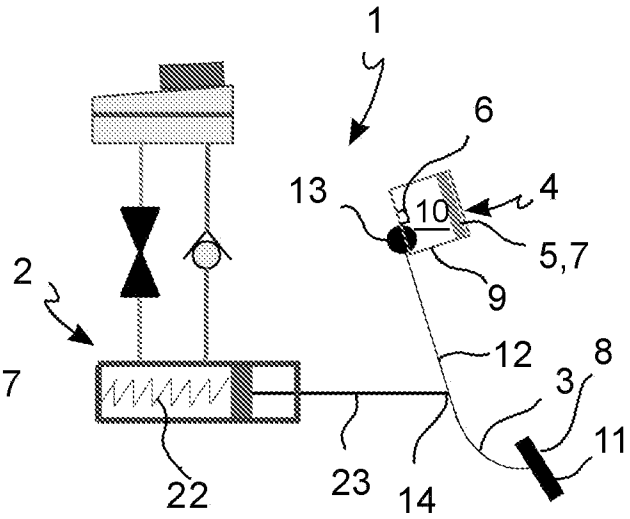

FIG. 3

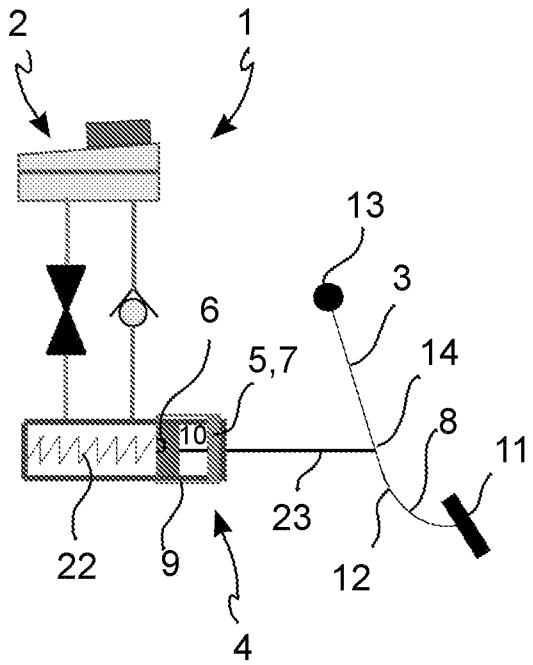

FIG. 4

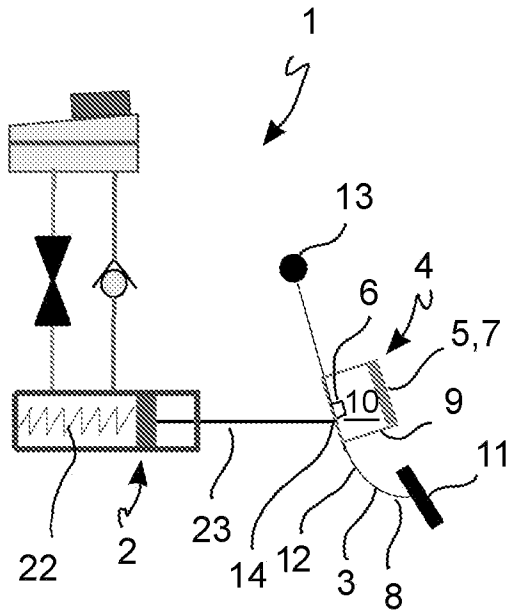

FIG. 5

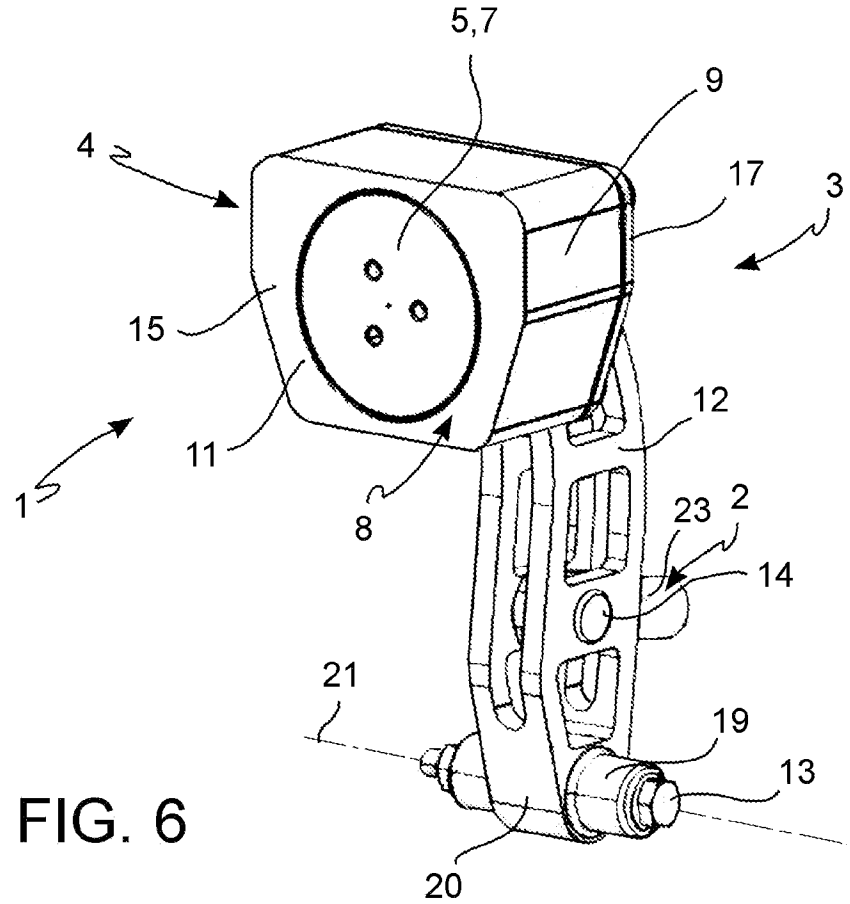
5,7
9
4
17
3
15
12
11
1
8
23
2
14
21
19
13
20

FIG. 6

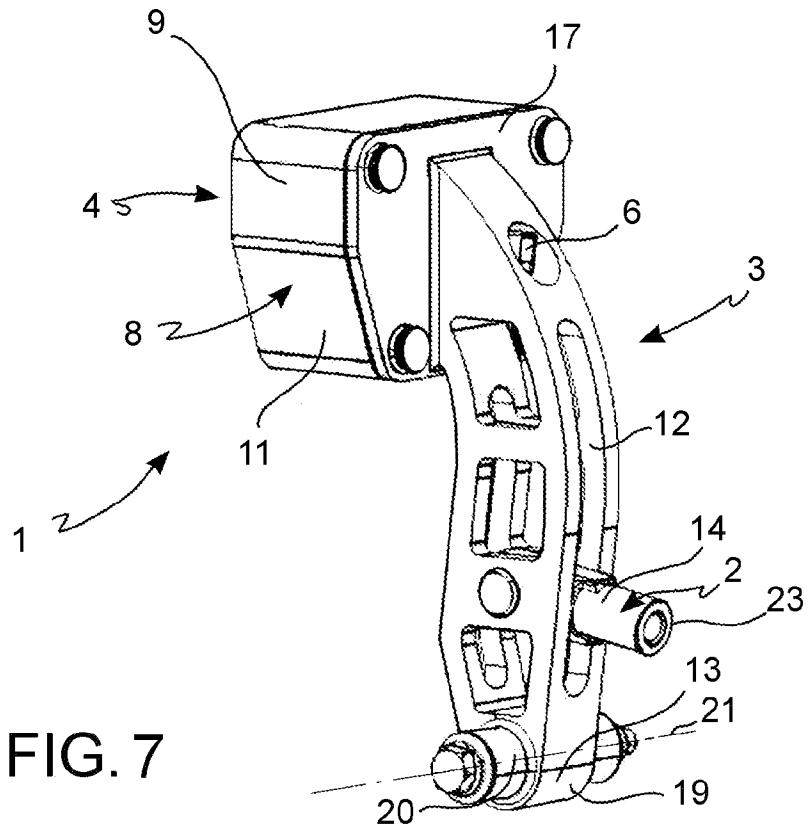
9
17
4
6
3
8
12
11
1
14
2
23
13
21
19
20

FIG. 7

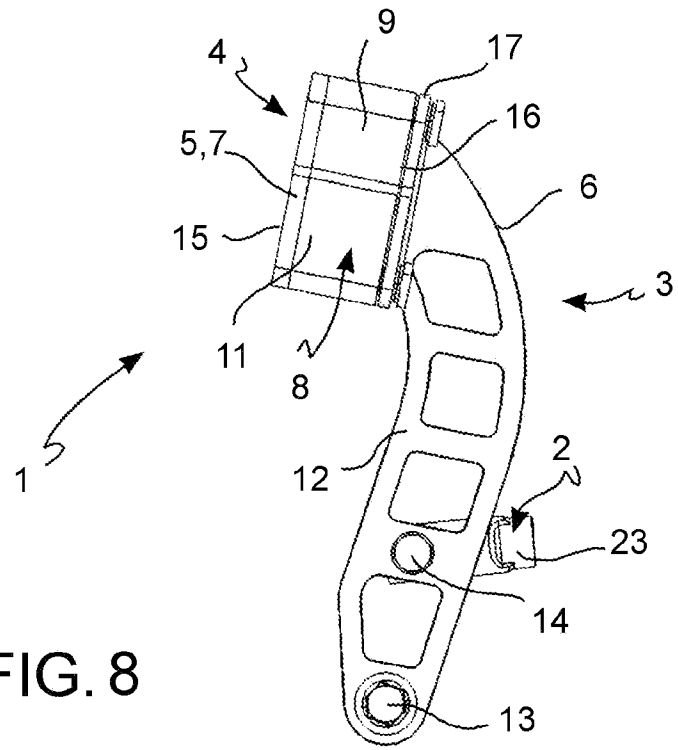

FIG. 8

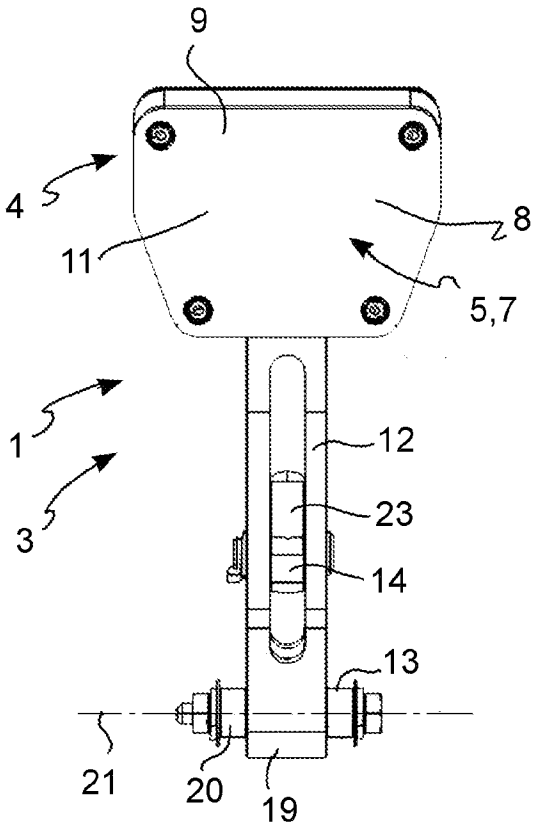

FIG. 9

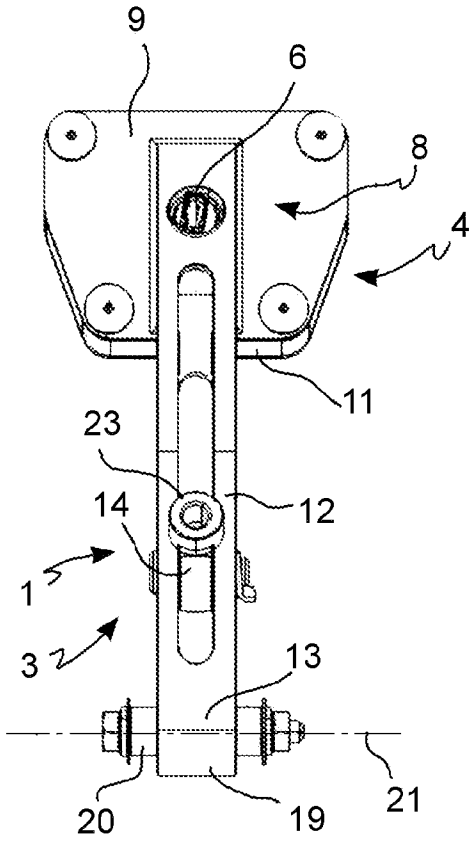

FIG.10

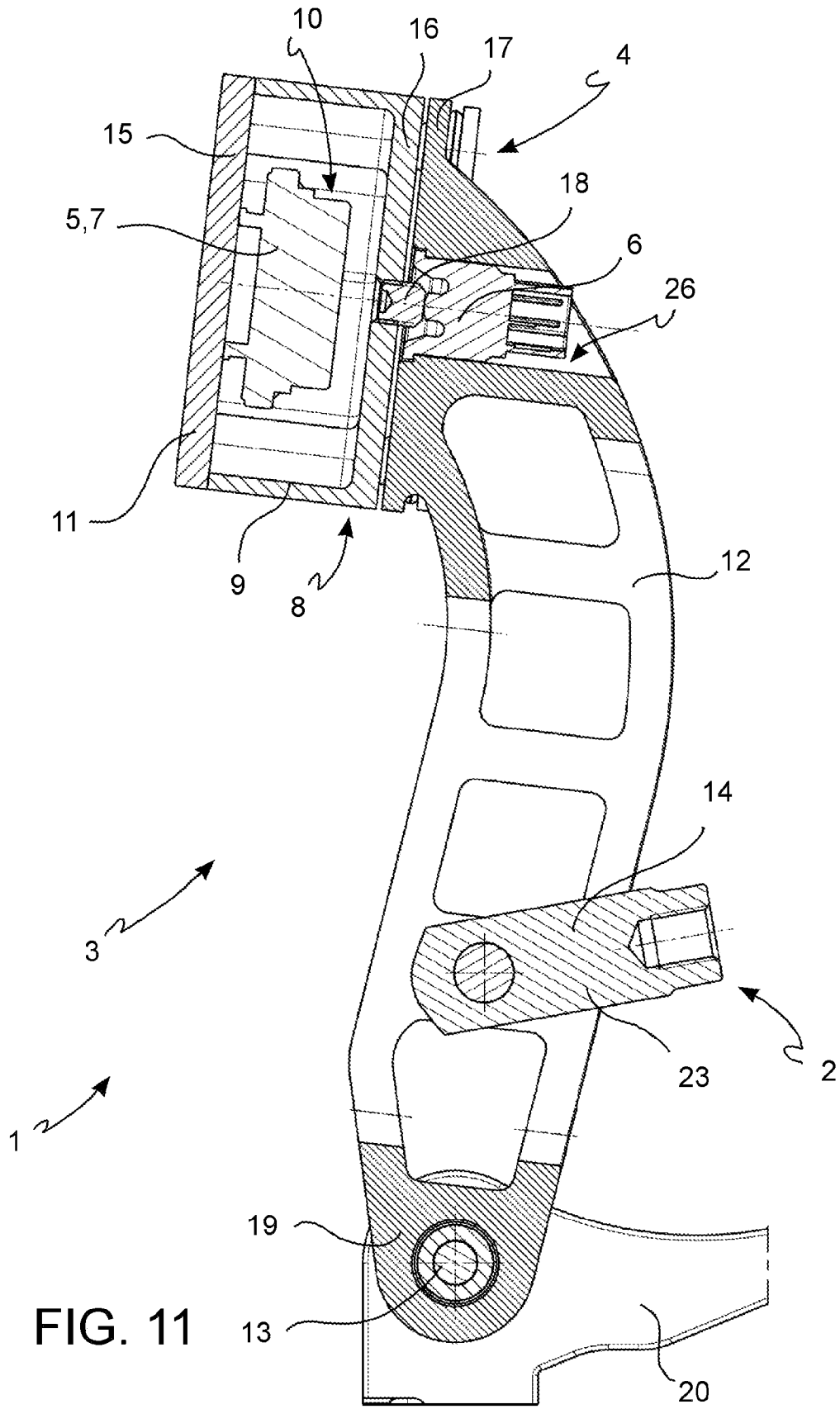

FIG. 11

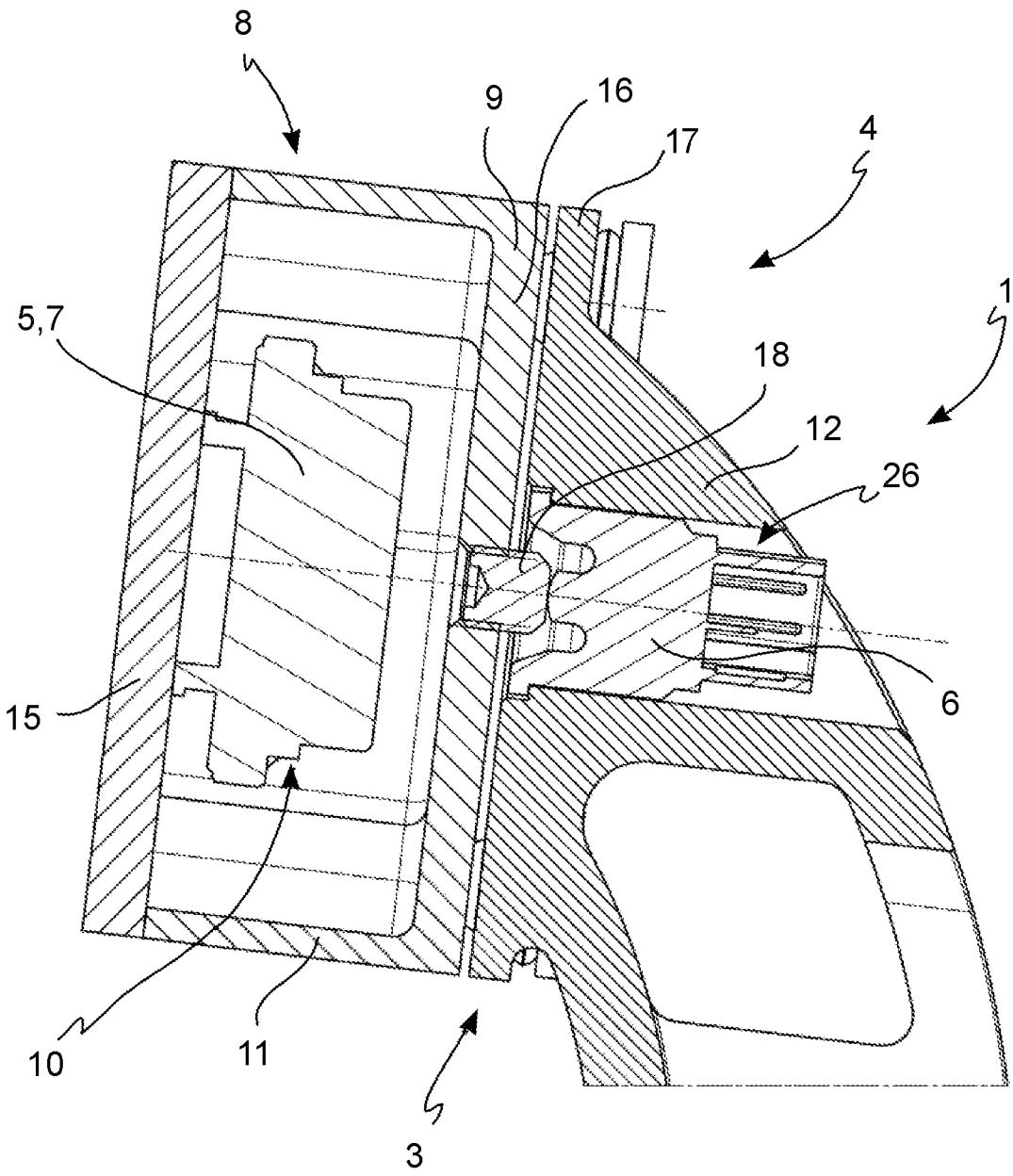

FIG. 12

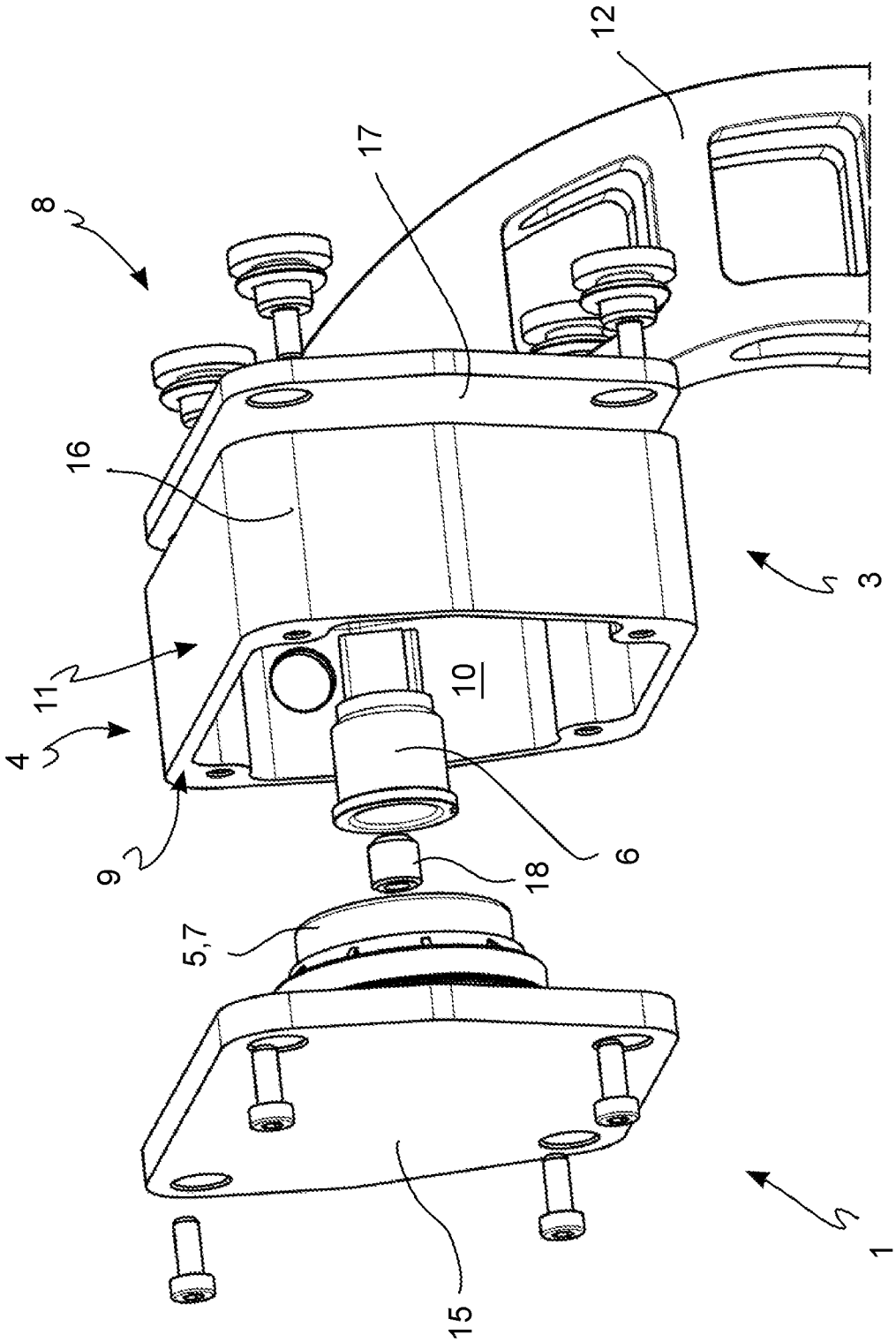

FIG. 13

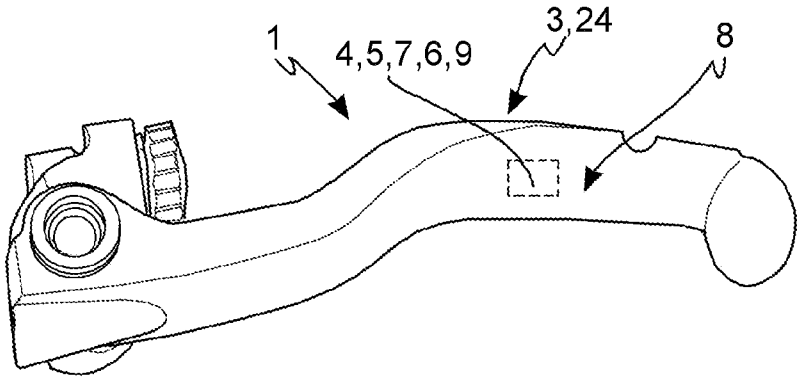

FIG. 14

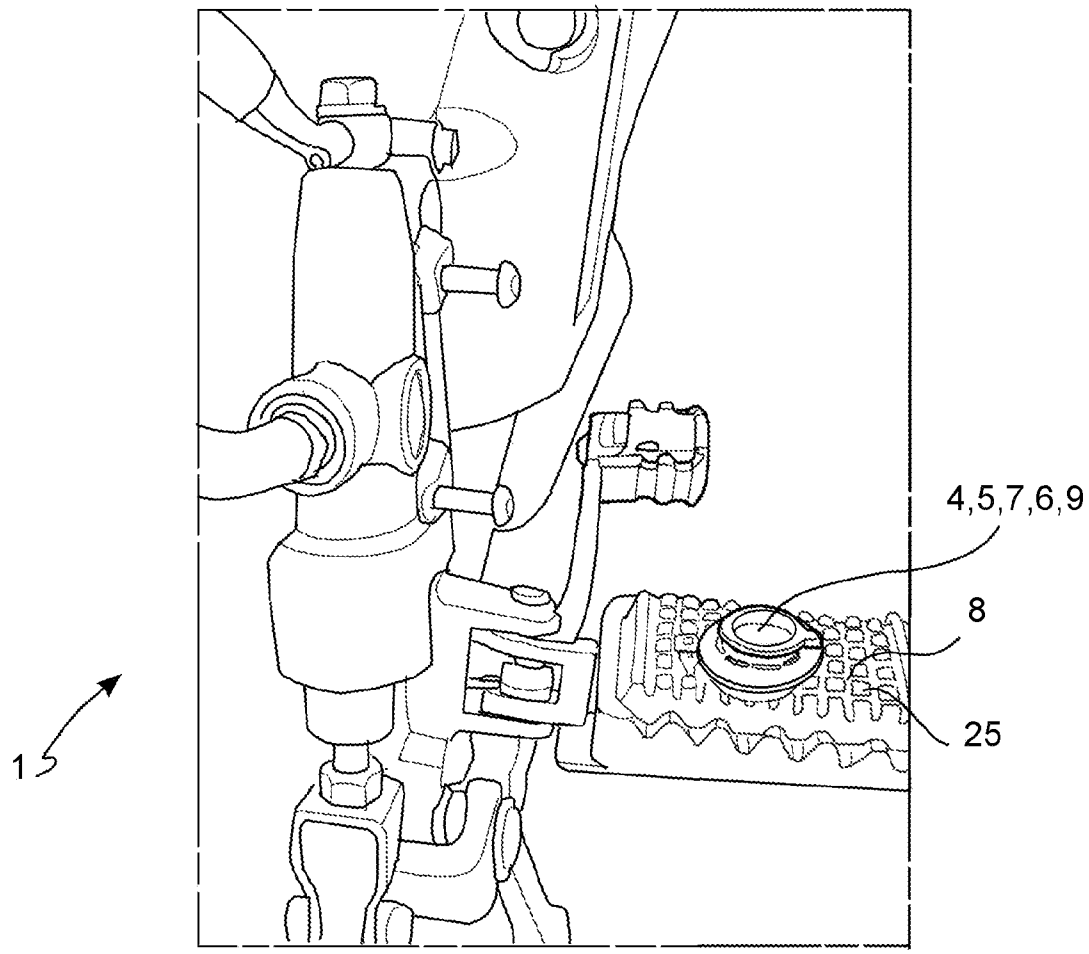

FIG. 15

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2024/055652

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.
X Y	US 2018/001875 A1 (HOUTMAN ALAN J [US] ET AL) 4 January 2018 (2018-01-04) paragraphs [0023] - [0025], [0028], [0029], [0031], [0034], [0037]; figures -----	1-3,5-9, 12-17 4,9-11
X Y	US 2020/001711 A1 (BURKE DENNIS MARK [US] ET AL) 2 January 2020 (2020-01-02) paragraphs [0041], [0063], [0067]; figures -----	1-3,5-8, 10,12-17 4,9,11
X	US 2020/148182 A1 (D'URSO LUCA [IT] ET AL) 14 May 2020 (2020-05-14) paragraphs [0062], [0100] - [0105]; figure 5 -----	1,4-6, 10,16,17
Y	WO 2016/184458 A1 (CONTINENTAL AUTOMOTIVE GMBH [DE]) 24 November 2016 (2016-11-24) figures -----	9-11

-/--

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

[x] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

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

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

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 September 2024	02/10/2024

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

1

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2024/055652

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DE 20 2013 103011 U1 (FORD GLOBAL TECH LLC [US]) 15 July 2013 (2013-07-15) paragraphs [0007], [0017] - [0021]; figure 1	4,9-11

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2024/055652

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	