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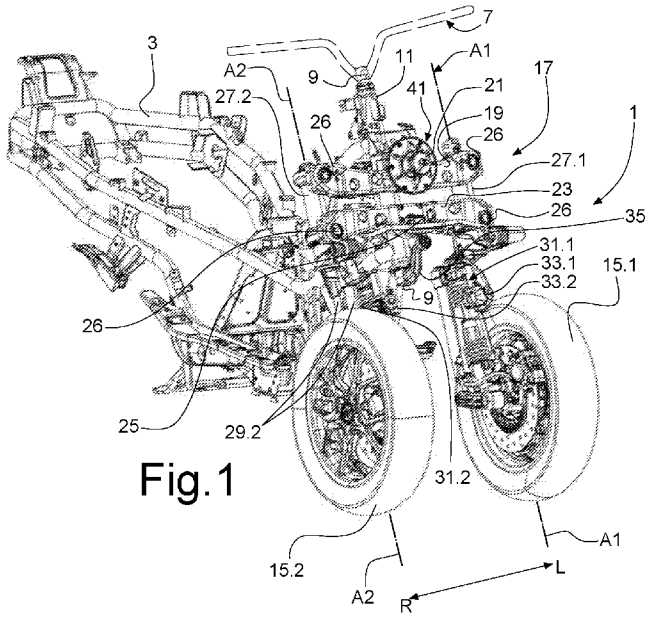

Fig.1

(57) Abstract: The rolling vehicle (1) comprises two front steered wheels (15.1) connected to the frame (1, 3) by means of a four-bar linkage mechanism. The four-bar linkage mechanism is equipped with a roll blocking device, which allows the movement of the components (19) hinged to one another of the four-bar linkage system to be blocked, in the conditions in which it is desirable or necessary to prevent the vehicle (1) from performing rolling movements, for example with the vehicle (1) stopped or almost stopped and with the vehicle (1) parked. The roll blocking device comprises two elements (43) coaxial to each other and movable with respect to each other to move toward and away from each other parallel to the common axis (B1) of said elements (43). The two elements (43) are torsionally connected to two distinct components (19) of the vehicle (1), for example two components (19) of the four-bar linkage mechanism or to one or these components (19) and to the frame (1, 3) of the vehicle (1), which rotate with respect to each other about the common axis (B1) of the two coaxial elements (43) when the vehicle (1) performs a rolling movement.

[Continued on next page]

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ROLLING SADDLE VEHICLE WITH ROLL BLOCKING DEVICE

DESCRIPTION

TECHNICAL FIELD

[0001] The present invention relates to tilting saddle vehicles having at least two front steered wheels connected to the frame of the vehicle by means of a four-bar linkage mechanism, which allows the vehicle to perform rolling movements, for example when the vehicle travels around a bend.

BACKGROUND ART

[0002] In the field of motor vehicles there is a growing offer of vehicles that combine the features of two-wheeled saddle vehicles (such as motorcycles and scooters) in terms of manoeuvrability, with the stability of four-wheeled vehicles. These vehicles include three-wheeled motor vehicles equipped with two front steered wheels and with one rear drive wheel, and four-wheeled motor vehicles, typically known as quads.

[0003] More in detail, the above-mentioned three-wheeled motor vehicles are provided with two front steered wheels, i.e., adapted to steer the vehicle controlled via the handlebar by the driver, and rolling, i.e., tilting or leaning laterally with a rolling movement. The rolling movement is a pivoting movement about an axis substantially oriented in the direction of forward movement. Three-wheeled vehicles further comprise a rear drive wheel, mechanically connected to the engine and having the purpose of supplying the torque and hence allowing traction, while the purpose of the paired front wheels is to define the direction of travel of the vehicle.

[0004] In addition to the steering movement, the paired front wheels are provided with a rolling movement and are connected to the frame of the vehicle by means of shock absorbers, which allow a springing movement. Due to the use of two paired front wheels, a rolling vehicle has, with respect to a motor vehicle with a single front wheel, greater stability guaranteed by the dual contact with the ground of the pair of front wheels, similarly to that provided by an automobile.

[0005] The front wheels are connected to each other via kinematic mechanisms that allow the wheels to roll and steer substantially synchronously, for example through the

interposition of one or two four-bar linkages that connect the front wheels to a front end frame. Moreover, these motor vehicles are often provided with two independent suspensions with shock absorbers, one for each front driving wheel. Each suspension is equipped with an elastic element (spring) and with a viscous element (damper).

[0006] Three-wheeled rolling motor vehicles (motorcycles) have many advantages over more conventional two-wheeled motorcycles, but also have some drawbacks. In particular, the increased width of the motorcycle in the front area determines greater resistance to forward movement, with respect to a conventional motorcycle with only one front steered wheel.

[0007] Although three- or four-wheeled rolling motor vehicles have high stability, in certain conditions they can fall over due to an uncontrolled rolling movement. This can occur in particular when travelling at low speed, or with the vehicle stopped or parked. To prevent this problem, three- or four-wheeled rolling motor vehicles are commonly equipped with a roll blocking or roll control device, which prevents the motor vehicle from falling over accidentally when it is stopped or travelling at low speed. Three-wheeled motor vehicles with roll blocking or roll control devices are disclosed, for example, in WO2017115293, WO2017115294; WO2017115295; WO2017115296; WO2017115297; WO2018116210; WO2018116211, EP1561612 and EP2913256.

[0008] The roll blocking devices known from the prior art are bulky and complex.

[0009] The object of embodiments described herein is to provide a roll blocking device which is more efficient and more compact compared to prior art devices.

SUMMARY

[0010] For this purpose, a rolling saddle vehicle is provided in which the vehicle comprises a frame with a saddle and a steering mechanism, as well as a left front steered wheel and a right front steered wheel, arranged side by side in a left-right direction of the vehicle. The vehicle further comprises a four-bar linkage mechanism which connects the left front steered wheel and the right front steered wheel to the frame, allowing the right front wheel and the left front wheel to perform steering movements and rolling movements. Associated with the four-bar linkage mechanism

is a roll blocking device, comprising a first element and a second element arranged coaxial to each other and rotatable with respect to each other about an axis of rotation of the roll blocking device when the vehicle performs a rolling movement. The first element is rotatable integral with a first component of the four-bar linkage mechanism and the second element is rotatable integral with the frame or with a second component of the four-bar linkage mechanism. Characteristically, the first element and the second element are configured so as to move relative to each other, in a direction parallel to the axis of rotation, between: a locked position, in which a first contact surface of the first element and a second contact surface of the second element are in contact and pressed together, generating a torque that prevents the relative rotation between the first element and the second element; and an unlocked position, i.e., a free position, in which the first contact surface and the second contact surface are spaced apart from each other so that the first element and the second element are free to rotate relative to each other.

[0011] The roll blocking device thus configured can be produced with small dimensions, i.e., with a small footprint. In this way, the presence of this component is less binding with regard to the design of the vehicle and for the design of the components inside the body of the vehicle. Moreover, the device thus conceived has a lower impact on the weight of the vehicle. Finally, the blocking device according to the present invention is compact and easy to install, uninstall and maintain.

[0012] In the present context, two components, parts or elements are “rotatable integral” with each other when they rotate together with each other, i.e. when they perform the same rotation movement around the same axis.

[0013] In advantageous embodiments, the first element and the second element form components of a conical clutch. The conical configuration makes it possible to obtain a roll blocking device of particularly small size. In fact, the conical shape of the surfaces of mutual contact between the two elements, coaxial and axially movable with respect to each other, of the roll blocking device makes it possible to obtain a high torque with a very small mean radius of the contact surface, and high friction forces with a limited thrust between the two elements of the roll blocking device.

[0014] In particular, a conical clutch is obtained by configuring one of said first

element and second element of the roll blocking device with a convex, i.e., external, conical contact surface, and the other of said first element and second element of the roll blocking device with a concave, i.e., internal, conical contact surface. The concave conical surface and the convex conical surface have an axis coincident with the axis of rotation of the roll blocking device. To maximize the efficiency of the roll blocking device, it can be advantageous to use small semi-angles of aperture of the conical surface. For example, the semi-angle at the apex of the conical surfaces can be between 10° and 20°, but will preferably be equal to or less than 18° and more preferably equal to or less than 16°. Angles below 10° are not suitable, as they can lead to difficulties in the relative movement of the two conical surfaces and can result in the risk of irreversible adhesion between the conical surfaces.

[0015] In particular, for reduced semi-angles and for small movements of the two contact surfaces the convex conical surface can be housed at least partially within the concave conical surface. This reduces the axial dimensions of the roll blocking device.

[0016] In general, one or both of the contact surfaces of the two axially movable elements of the roll blocking device can have an angular development of less than 360°. Preferably, however, to maximize the torque with which the two elements of the roll blocking device are torsionally blocked with respect to each other, it is advantageous for both the contact surfaces to develop 360° around the mutual axis of rotation, i.e., about the axis along which the two elements are movable with respect to each other.

[0017] An annular development, i.e., of 360°, of the contact surfaces also makes it possible to prevent bending stresses from occurring and ensures that the resultant of the forces exchanged between the two contact surfaces is axial.

[0018] The locking and unlocking movement, i.e., the relative movement in axial direction of the first element and of the second element of the roll blocking device can be obtained with an actuator, which can be operated manually by the driver or which can be activated automatically, for example by means of a control unit that receives an input signal function of the speed of forward movement of the vehicle. Alternatively, or in combination, the actuator can be operated by an electric signal generated by a roll locking-unlocking command imparted manually by means of a push button, a lever, or

any other interface element, present on the handlebar of the vehicle.

[0019] To minimize the footprint and optimize the operation of the roll blocking device, in advantageous embodiments the actuator is placed coaxially to the first element and to the second element. Preferably, the actuator can be placed in front of the first element and of the second element of the roll blocking device with respect to the direction of forward movement of the vehicle.

[0020] The actuator can be a mechanical, electro-mechanical or electro-magnetic actuator. In advantageous embodiments, the actuator is hydraulic and can be configured with a cylinder-piston system coaxial to the first element and to the second element of the roll blocking device, i.e., with a cylinder coaxial to the mutual axis of rotation of the first and of the second element of the roll blocking device.

[0021] Using a hydraulic actuator, it is possible to employ a single hydraulic control unit to control the roll blocking device and hydraulic actuators for blocking the front suspensions, as described in more detail below. This offers advantages in terms of simplification and reduction of the components of the vehicle, resulting in reductions in the costs and an increase in the reliability of the vehicle.

[0022] In embodiments described herein, the actuator is a single acting cylinder-piston actuator, which maintains the roll blocking device in a free, i.e., unlocked, position in the absence of pressure in the circuit, due to a resilient member. With this architecture, roll unblocking is guaranteed in the event of damage to the hydraulic system, thus ensuring that the safety of the driver and of the passenger, if present, are not endangered. In fact, it is known that the forward movement of a vehicle with a narrow wheel track, i.e., of less than 500 mm, and a height the same as a normal motorcycle, is very dangerous if the vehicle is not able to roll. In fact, even for minimum steering angles, a high centrifugal force is created, which tends to cause the vehicle to tip over on the opposite side with respect to the side toward which the vehicle is steering. Consequently, it is important to unblock rolling each time the roll blocking device is unable to operate correctly and the device thus conceived does this.

[0023] A similar control logic can also be used if the actuator of the unblocking device is not hydraulic or pneumatic. For example, if an electromagnet with moving armature is used for this purpose, the moving element of the roll blocking device can

normally be in an unlocked position, under the effect of a resilient member, and is taken to the locked position by the thrust generated by the electromagnet. If this is faulty or is not correctly powered, the roll blocking device remains deactivated.

[0024] The four-bar linkage mechanism can be any known rolling mechanism. In some embodiments, the four-bar linkage mechanism comprises two four-bar linkages symmetrical with respect to a vertical median plane. In this case, the roll blocking device can be duplicated, one for each four-bar linkage. Alternatively, the blocking device has a first element connected to a cross member of a four-bar linkage and the second element connected to a cross member of the other four-bar linkage. In this case, the cross members must be at the same height, i.e., both the upper cross members or both the lower cross members.

[0025] In other embodiments, the four-bar linkage mechanism comprises a single four-bar linkage. The single four-bar linkage can comprise, in combination:

- an upper cross member centrally hinged to the frame by means of an upper central hinge and having a left end and a right end;
- a lower cross member centrally hinged to the frame by means of a lower central hinge and having a left end and a right end;
- a left upright, hinged below to the left end of the lower cross member and above to the left end of the upper cross member;
- a right upright, hinged below to the right end of the lower cross member and above to the right end of the upper cross member.

[0026] This architecture of the four-bar linkage allows the front wheels to roll as occurs in a conventional in-line two-wheeled motorcycle.

[0027] In this case, the left front steered wheel can be connected to the left upright via a left support, rotatable about a left steering axis, a left shock absorber being interposed between the left front steered wheel and the left support. Similarly, the right front steered wheel can be connected to the right upright via a right support, rotatable about a right steering axis, a right shock absorber being interposed between the right front steered wheel and the right support. The left support and the right support can extend downward with respect to the four-bar linkage, so that the suspensions and the front wheels are placed at a height lower than the height of the lower cross member of

the four-bar linkage.

[0028] With this architecture, also known with the term "high four-bar linkage", it is possible to obtain a running gear and suspension of the motorcycle comparable to high performance two-wheeled motorcycles. Moreover, the unevenness of the terrain can be more effectively mitigated.

[0029] It would also be possible for the invention to be implemented in a vehicle in which the rolling four-bar linkage is in low position, i.e., at least partially included between the left front steered wheel and the right front steered wheel.

[0030] The lower cross member can be constrained by the lower central hinge to a steering tube, and the upper cross member can be constrained by the upper central hinge to the steering tube.

[0031] In configurations with a single four-bar linkage having horizontal cross members extending in a left-to-right direction, the roll blocking device can advantageously be placed coaxial to the central hinge of the upper cross member or of the lower cross member, obtaining a mechanism that is symmetrical with respect to a vertical median plane of the vehicle. However, it would also be possible for the roll blocking device to be arranged in another position, for example at one of the hinges joining one of the uprights with one of the cross members. In this case, one of the above-mentioned first element and second element of the roll blocking device will be torsionally, i.e., rotatably, constrained to a cross member and the other of said first element and second element will be torsionally, i.e., rotatably, constrained to the upright.

[0032] In the following description, the first contact surface and the second contact surface of the first element and of the second element of the roll blocking device are substantially smooth surfaces, i.e., without toothings. This makes it possible to produce a roll blocking device with an infinity of blocking positions. In other words, the two elements that carry the first contact surface and the second contact surface can be rotatably blocked with respect to each other in any mutual angular position.

[0033] In other embodiments, the first element of the roll blocking device can comprise a first contact surface forming a first front toothing, and the second element

of the roll blocking device can comprise a second contact surface forming a second front toothing facing the first front toothing. The two toothings are complementary to each other, in the sense that they can mesh one inside the other, forming a Hirth coupling. In this case a torsional shape coupling is obtained, which does not require a high thrust to generate a high mutual friction force between the two front surfaces. However, the roll blocking device in this case has a limited number of mutual angular blocking positions of the first element and of the second element of the roll blocking device.

[0034] In a further embodiment, the first contact surface of the first element and said second contact surface of the second element can be contained in a closed housing casing, so as to be isolated from the outside environment and from possible debris or particles that would compromise correct operation of the roll blocking device, thereby prolonging its useful life and improving its reliability.

[0035] In less advantageous embodiments, the first contact surface formed on the first element of the roll blocking device and the second contact surface formed on the second element of the roll blocking device can be flat surfaces rather than conical surfaces, and in this way configure a disc clutch, rather than a conical clutch.

[0036] Further advantageous features and possible embodiments of the vehicle and of the related roll blocking device are described below and defined in the appended dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0037] In the accompanying drawings:

Fig.1 shows an axonometric view of a vehicle in an embodiment, with parts removed;

Fig.2 shows a side view of the vehicle of Fig.1;

Fig.3 shows a section of a roll blocking device and of the steering tube to which it is attached, according to a vertical median plane of the vehicle;

Fig.4 shows an axonometric view of a portion of the upper cross member of the rolling four-bar linkage of the vehicle with the roll blocking device and a pin integral with the frame sectioned according to a vertical median plane;

Fig.5 shows a section in axonometric view according to a median plane of the

roll blocking device, of a part of the upper cross member of rolling four-bar linkage and of the pin integral with the frame in unlocked position;

Fig.5A shows a section similar to Fig.5 with the roll blocking device in locked position;

Fig.6 shows an exploded view of the components of the roll blocking device; and

Figs. 7 and 8 show external axonometric views of the roll blocking device removed from the vehicle; and

Fig. 9 shows a schematic view of the hydraulic and electronic control system of the roll blocking device.

DETAILED DESCRIPTION

[0038] Figs.1 and 2 show the main parts of a vehicle 1 on which a roll blocking device according to the present invention is installed. In the drawing, the arrows U-D indicate the up-down direction and the arrows L-R indicate the left-right direction.

[0039] The vehicle 1 comprises a frame 3 on which a saddle 5, schematically shown, is installed. The vehicle further comprises a handlebar schematically indicated with 7 with a steering column 9 rotatably housed in a steering tube 11. A rear driving wheel, mechanically connected to an engine (removed from the figures for simplicity of representation), is indicated with reference number 13. At the front, the vehicle 1 has a left front steered wheel 15.1 and a right front steered wheel 15.2. The front steered wheels are connected to the frame 1 via a four-bar linkage mechanism 17, which allows the vehicle 1 to perform rolling movements, i.e., to tilt about axes that develop in front-back F-B direction and passing through the contact point between the front steered wheels 15.1, 15.2 and a bearing plane P on which the vehicle 1 moves forward (see Fig.2).

[0040] In the embodiment described here, the four-bar linkage mechanism comprises a single four-bar linkage, hereinafter also indicated as rolling four-bar linkage, indicated as a whole with 17. In other embodiments, the four-bar linkage mechanism can comprise two four-bar linkages symmetrical with respect to a vertical median plane and having a common component.

[0041] In the illustrated embodiment, the rolling four-bar linkage 17 comprises an

upper cross member 19 centrally constrained to the frame 3 by means of an upper central hinge 21 and developing in left-right direction (L-R) from a left end to a right end. The rolling four-bar linkage 17 further comprises a lower cross member 23 centrally hinged to the frame 3 by means of a lower central hinge 25 and developing in left-right direction from a left end to a right end. The rolling four-bar linkage 17 further comprises: a left upright 27.1, hinged below to the left end of the lower cross member 23 and above to the left end of the upper cross member 19; and a right upright 27.2, hinged below to the right end of the lower cross member and above to the right end of the upper cross member. The four components 19, 23, 27.1 and 27.2 that form the four-bar linkage 17 are hinged to one another about hinge axes parallel to one another and parallel to the hinge axes of the upper central hinge 21 and of the lower central hinge 25.

[0042] The left front steered wheel 15.1 is connected to the left upright 27.1 of the rolling four-bar linkage 17 via a left support 29.1, which can be rotatably supported inside the left upright 27.1. The left support 29.1 rotates about a left steering axis to allow steering movements of the left front steered wheel 15.1. A left shock absorber 31.1 is interposed between the left front steered wheel 15.1 and the left support 29.1.

[0043] Similarly, the right front steered wheel 15.2 is connected to the right upright 27.2 of the rolling four-bar linkage 17 by means of a right support 29.2, which can be rotatably supported inside the right upright 27.2. The right support 29.2 rotates about a right steering axis to allow steering movements of the right front steered wheel 15.2. A right shock absorber 31.2 is interposed between the right front steered wheel 15.2 and the right support 29.2. Each shock absorbers 31.1 and 31.2 comprises a resilient element and a viscous element and thus allow the front steered wheels 15.1 and 15.2 to perform autonomous movements in up-down direction, dampened by the suspensions.

[0044] The number 34 indicates a steering bar connected, by means of a bracket 35, to the steering column 9. The steering bar 34 is hinged at opposite left and right ends to the left support 29.1 and to the right support 29.2 to transmit the steering movement imparted by the handlebar 7 to the front steered wheels 15.1 and 15.2.

[0045] Each of the two shock absorbers 31.1 and 31.2 is associated with a respective

locking actuator 33.1 and 33.2, which blocks the lifting and lowering movement of the respective front steered wheels 15.1, 15.2 when necessary, in particular when the roll blocking device is activated, as described below.

[0046] With the arrangement described above, by means of the handlebar 7, the steering column 9, the bracket 35 and the steering bar 34, rotation movements about the steering axes A1 and A2 are imparted to the front steered wheels 15.1 and 15.2. During travel, the vehicle 1 can roll due to the deformability of the rolling four-bar linkage 17, which allows the two front steered wheels 15.1, 15.2 to pivot about the rolling axes, oriented in front-back direction (arrows F-B) and passing through the point of contact of the front steered wheels 15.1, 15.2 with the ground P.

[0047] When the vehicle 1 is stopped or almost stopped, it is preferable for the rolling movement to be blocked for driving comfort. For this purpose, blocking actuators 33.1, 33.2 of the shock absorbers 31.1 and 31.2 are provided to block the lifting and lowering movement of the front steered wheels 15.1, 15.2. Moreover, a roll blocking device is provided, indicated as a whole with 41 and forming the specific subject matter of the present invention. The roll blocking device 41 is illustrated in detail in Figs. 3 to 8 and described below.

[0048] In an alternative embodiment of the present invention, the blocking actuators of the shock absorbers are absent and rolling is only blocked by the roll blocking device 41. In this case, complete blocking of the rolling movement is not obtained, as the suspensions are still capable of allowing the vehicle to tilt laterally. However, the rolling travel is greatly limited and in certain motorcycles, in particular those with a sufficiently wide wheel track or sufficiently low centre of gravity of the motorcycle, the decrease in rolling implemented by the roll blocking device 41 is acceptable and not dangerous. For example, the vehicle can be easily parked without using the centre stand without the risk of the vehicle tipping over.

[0049] Further implementation details of the blocking actuators 33.1, 33.2 of the shock absorbers 31.1 and 31.2 are described in the document EP1571016B1, the disclosure whereof is incorporated herein by reference for the construction details of the suspension stroke stop device, or in the document WO2020245712A1, the disclosure whereof is incorporated herein by reference for the construction details of

the device acting on the shock absorber.

[0050] In the illustrated embodiment, the roll blocking device 41 is associated with the upper central hinge 21, but it would also be possible to associate the roll blocking device with the lower central hinge 23, for example by positioning the steering bar 34 in a different way.

[0051] The roll blocking device 41 comprises a first element 43 and a second element 45. The first element 43 of the roll blocking device 41 and the second element 45 of the roll blocking device 41 are shown separated from one another in the exploded view of Fig.6. In the illustrated embodiment, the first element 43 comprises a first contact surface 47, adapted to cooperate with a second contact surface 49 formed on the second element 45 of the roll blocking device 41. The roll blocking device 41 can therefore be placed at the upper central hinge 21 or the lower central hinge 23. Alternatively, the roll blocking device 41 can be placed at one of the outermost hinges of the four bar linkage 17, each labeled 26. For a matter of overall dimensions and the normal shape of the vehicle fairing, it is preferable to have an arrangement in correspondence with one of the central hinges 21, 23. In any case, the axis of rotation B1 of the roll blocking device coincides with or is parallel to one of the axes of the hinges of the four bar linkage 17.

[0052] In the illustrated embodiment, the first contact surface 47 is a convex conical surface, i.e., an external conical surface and can be formed by a coating layer of abradable material with a high coefficient of friction. The semi-angle of aperture, indicated with α in Fig.6, of the conical contact surface 47 can, for example, be between 10° and 20°, preferably between 12° and 18°, more preferably between 14° and 16°. It is understood that the aforementioned values are indicative and that the present description also comprises any sub-range included in any of the above indicated ranges of values.

[0053] In the illustrated embodiment, the second contact surface 49 is a concave conical surface, i.e., an internal conical surface complementary to the external, i.e., convex, conical surface 47. The angle at the apex of the concave conical contact surface 49 is thus substantially the same as the angle at the apex of the convex conical contact surface 47. Therefore, when the first element 43 of the roll blocking device 41

and the second element 45 of the roll blocking device 41 are pressed against each other, the first conical contact surface 47 and the second conical contact surface 49 are in contact with each other along the whole of the extension of the smaller of the two surfaces, the convex conical surface 47 in the example.

[0054] Advantageously, in the illustrated embodiment the convex conical contact surface 47 is a continuous surface that develops for an angle of 360° and thus completely surrounds the axis of the conical surface, indicated with B1 in Fig.6, coincident with the axis of the upper central hinge 21. Similarly, the concave conical contact surface 49 is a continuous surface that develops for an angle of 360° and thus completely surrounds the axis B1 of the conical surface. It would also be possible for at least one of the two conical surfaces 47, 49 to be discontinuous and/or to extend for less than 360° about the axis B.

[0055] In the illustrated embodiment, the first element 43 of the roll blocking device 41 is mounted on a shaft 51, so as to be angularly coupled with the shaft 51, i.e., to rotate integral therewith about the axis B1. The first element 43 of the roll blocking device 41 is, however, free to slide axially with respect to the shaft 51 in a direction parallel to the axis B1 of the roll blocking device 41. For this purpose, the shaft 51 can have an external groove and the first element 43 of the roll blocking device 41 can have a complementary internal groove. For greater construction simplicity, in the illustrated embodiment, the coupling between shaft 51 and first element 43 of the roll blocking device 41 is obtained by means of a key 53 inserted in a slot 55 formed in a through hole 56 of the first element 43 of the roll blocking device 41, as better illustrated in Fig. 4. The through hole 56 is formed in a sleeve 57 which, together with a disc-shaped portion on which the outer conical surface 47 is formed, forms the first element 43 of the roll blocking device 41.

[0056] The shaft 51 comprises a terminal end 51.1 facing the frame 3 of the vehicle 1, with an axial cavity 51.3 having a non-circular, for example, hexagonal, cross section. A pin 61, which forms the pin of the upper central hinge 21, is inserted into the axial cavity 51.3, as better illustrated in Figs. 3, 4 and 5. In the illustrated embodiment, the pin 61 has an end portion 61.1 having a cross section complementary to the cross section of the axial cavity 51.3, for example a hexagonal cross section. In this way, a torsional coupling is obtained between the hinge pin 61 and the shaft 51,

and thus between the hinge pin 51 and the first element 43 of the roll blocking device 41. The first element 43 of the roll blocking device 41 is angularly blocked with respect to the hinge pin 61 and thus with respect to the frame 3. This means that the first element 43 of the roll blocking device 41 cannot rotate about the axis B1 with respect to the frame 3 of the vehicle 1.

[0057] In the illustrated embodiment, the shaft 51 is fixed axially to the second element 45 of the roll blocking device 41 by means of an elastic ring 51.5 that engages with a portion of the first element 45, preferably with a bearing 63 housed in a seat 65 formed in an inner flange of the first element 45 of the roll blocking device 41, as better illustrated in Figs. 5 and 5A. The bearing 63 supports the shaft 51, the end portion 51.1 whereof is inserted into the inner ring of the bearing 63.

[0058] In the illustrated embodiment, the roll blocking device 41 further comprises a threaded pin 65 coaxial to the shaft 51, screwed into a threaded hole 67 of the pin 61 to provide an additional coupling system between the roll blocking device 41 and the frame 3. However, as will be clear from the description below, this threaded pin 65 is not strictly necessary.

[0059] A resilient member is associated with the first element 43 of the roll blocking device 41, and is adapted to urge the roll blocking device in the unlocked position, i.e., in a position in which the first element 43 of the roll blocking device 41 and the second element 45 of the roll blocking device 41 are spaced from each other and not in contact. In the illustrated embodiment, the resilient member comprises a helical compression spring 67 placed coaxial to the shaft 51 and on one side resting against a plate 69 shrink fitted on the shaft 51. In the mounted arrangement, the compression spring 67 is pre-loaded between the plate 69 and the first element 43 of the roll blocking device 41 and urges the first element 43 into a position moved away from the first element 45 of the roll blocking device 41.

[0060] The roll blocking device 41 further comprises an actuator that urges the first element 43 of the roll blocking device 41 into the blocking position, in which the convex conical surface 47 of the first element 43 is pressed against the concave conical surface 49 of the second element 45. The actuator can be manually activated by the driver or via an automatic system, or both, optionally based on a setting chosen by the

driver. In the illustrated embodiment, an actuator 71 is provided, placed in coaxial position with respect to the first element 43 and to the second element 45 of the roll blocking device 41. In some embodiments, the actuator 71 can comprise an electro-mechanical or electro-magnetic actuator, for example comprising a moving armature housed in a coil coaxial to the axis B1 and movable parallel to the axis B1 to exert a thrust on the first element 43 toward the second element 45 against the force of the spring 67.

[0061] In the illustrated embodiment, the actuator 71 is a cylinder-piston actuator, preferably a hydraulic cylinder-piston actuator. In the illustrated embodiment, the actuator 71 comprises a piston 73 slidably housed in a cylinder 75 formed in a component 77. Gaskets (not illustrated) are housed in one or both the circular grooves 86. In practical embodiments, the component 77 forms a closure lid of a housing casing of the roll blocking device 41. The housing casing is formed by the second element 45 of the roll blocking device 41. The coupling between the housing casing formed by the second element 45 of the roll blocking device 41 and by the lid 77 is obtained by means of screws 81 that join a flange 45.1 of the second element 45 of the roll blocking device 41 and a flange 77.1 of the component 77 to each other. The closure of the internal environment of the second element 45 and of the component 77 is thus isolated from the external environment. Therefore, debris, water or dirt, normally present on or around a motorcycle, cannot deposit on the concave conical surface 49 of the second element 45 and/or on the convex conical surface 47 of the first element 43. In this way, the useful life of the roll blocking device 41 is greatly extended and malfunctions thereof due to atmospheric agents almost eliminated.

[0062] The working fluid of the actuator 71 is fed into the pressure chamber formed between the cylinder 75 and the piston 73 by means of a fitting 79.

[0063] In the component 77 forming the closure lid of the housing in which the roll blocking device 41 is contained, a seat 83 can be formed for a support bearing 85 that radially supports the first element 43 of the roll blocking device 41.

[0064] The casing formed by the second element 47 of the roll blocking device 41 is fixed to the upper cross member 19 of the four-bar linkage 17 by means of screws 87 which engage in through holes of a flange 89 integral with the upper cross member 19

and are screwed into threaded blind holes 91 formed in the second element 45 of the roll blocking device 41.

[0065] The roll blocking device 41 thus configured is extremely compact and easy to mount. In some embodiments, it can be completely pre-assembled and mounted on the vehicle as a single assembly.

[0066] In particular, in the illustrated embodiment, the roll blocking device 41 can be mounted as follows. The shaft 51 is mounted by means of the elastic ring 51.5 on the second element 45 of the roll blocking device 41, after the bearing 63 has been mounted. In this step, the plate 69, the spring 67 and the first element 43 of the roll blocking device 41 can be mounted before or after the shaft 51 is mounted on the second element 45.

[0067] After these components have been mounted, the assembly thus obtained can be mounted on the pin 61 by inserting the end portion 61.1 into the cavity 51.3 and tightening the threaded pin 65. The second element 45 of the roll blocking device 41 is fixed by means of the screws 87 to the upper cross member 19.

[0068] Subsequently, the piston 73 is mounted in the cylinder 75 and the lid 77 is fixed by means of the screws 81. The roll blocking device 41 is now completely mounted and only hydraulic connection has to be made through the union 79.

[0069] If the threaded pin 65 is omitted, mounting of the whole roll blocking device 41, including assembly of the lid 77 on the housing casing formed by the second element 45, can be carried out before mounting the complete roll blocking device 41 on the vehicle 1 by means of the screws 87.

[0070] Mounting is thus very quick and simple.

[0071] The roll blocking device 41 can generate a high blocking torque between the elements 43, 45 of the roll blocking device 41 and thus between the upper cross member 19 and the frame 3, as the second element 45 of the roll blocking device 41 is fixed by means of the screws 87 to the upper cross member 19, while the first element 43 is torsionally coupled to the frame 3 by means of the hinge pin 61.

[0072] In the unlocked position, illustrated in Fig.5, the spring or other resilient

component urges the first element 43 of the roll blocking device 41 into a position spaced with respect to the second element 45 of the roll blocking device 41. The two conical surfaces 47 and 49 are thus spaced apart from each other. The two elements 43, 45, and thus the cross member 19 and the frame 3, can perform movements of rotation about the axis B1 of the central hinge of the upper cross member 19. The vehicle 1 is thus free to perform rolling movements.

[0073] When the vehicle 1 is stopped or almost stopped, to prevent it from tilting laterally as a result of the deformation of the four-bar linkage 17 performing an unwanted rolling movement, the actuator 71 urges the first element 43 toward the second element 45 of the roll blocking device 41, bringing the first contact surface 47 to press against the second contact surface 49. The pressure between the two surfaces angularly blocks the two elements 43, 45 with respect to each other and thus prevents rotation of the upper cross member 19 with respect to the frame 3. Consequently, the four-bar linkage 17 remains blocked with respect to the frame 3 and the rolling movement is prevented. The simultaneous activation of the actuators 33.1 and 33.2 also blocks the suspensions 31.1 and 31.2, also preventing any rolling movements that can be caused by an asymmetrical deformation of the two suspensions.

[0074] In this way, the only component adapted to generate rolling is represented by the elasticity of the tyres of the front wheels, which however is negligible with respect to the rolling that can be generated with the four-bar linkage 17 and also with elasticity of the suspensions 31.1 and 31.2.

[0075] As schematically shown in Fig. 9, which schematically illustrates the hydraulic system and the electronic system for activation of the roll blocking device 41, the vehicle 1 further comprises a hydraulic pump 88 operated by an electromechanical actuator 92 controlled by an electronic control unit 90 for controlling rolling. The electronic roll control unit 90 is electrically connected to an electronic control unit 93 for controlling the engine. In some embodiments, the two electronic control units 90 and 93 can be combined in a single control unit for controlling rolling and the engine, and optionally other assemblies or components of the vehicle.

[0076] The electronic control unit 90 for controlling rolling is also electrically

connected to a push button or other control interface, indicated with 94, preferably arranged on the handlebar 7 of the vehicle 1. The electronic control unit 90 for controlling rolling controls the electromechanical actuator 92 of the hydraulic pump 88 based on signals received from the control push button 94 and/or the electronic control unit 93 for controlling the engine. The electronic control unit 90 for controlling rolling can also be electrically connected to respective speed sensors 95 of the front wheels 15.1 and 15.2.

[0077] By way of example, if the speed signal recorded by one or said speed sensors 95 is above a given threshold, the electronic control unit 90 for controlling rolling controls the electromechanical actuator 92 of the hydraulic pump 88 to perform unblocking of the roll blocking device 41. On the contrary, if said speed sensors 95 record speed signals below a further threshold and the control push button 94, operated by the driver of the vehicle 1, sends a roll blocking signal, the electronic control unit 90 for controlling rolling controls the electromechanical actuator 92 of the hydraulic pump 88 to perform unblocking of the roll blocking device 41. Manual activation of blocking of the rolling movement can be inhibited when the speed signal indicates a speed above a minimum threshold, below which roll blocking can be activated.

CLAIMS

1. A rolling saddle vehicle, wherein the vehicle comprises:

a frame with a saddle and a handlebar;

a left front steered wheel and a right front steered wheel arranged side by side in a left-right direction of the vehicle;

a four-bar linkage mechanism which connects the left front steered wheel and the right front steered wheel to the frame, allowing the right front wheel and the left front wheel to perform steering movements and rolling movements;

a roll blocking device; wherein the roll blocking device comprises a first element and a second element arranged coaxial to each other and rotatable with respect to each other about an axis of rotation of the roll blocking device when the vehicle performs a rolling movement; wherein the first element is rotatably integral with a first component of the four-bar linkage mechanism and the second element is rotatably integral with the frame or with a second component of the four-bar linkage mechanism;

characterized in that:

said first element and second element are configured so as to move relative to each other, in a direction parallel to the axis of rotation, between a locked position, in which a first contact surface of the first element and a second contact surface of the second element are in contact and pressed together, generating a torque that prevents the relative rotation between the first element and the second element, and an unlocked position in which the first contact surface and the second contact surface are spaced apart from each other so that the first element and the second element are free to rotate relative to each other.

2. The vehicle of claim 1, wherein the first element and the second element constitute components of a conical clutch.

3. The vehicle of claim 1 or 2, wherein one of said first element and second element comprises a convex conical contact surface and the other of said first element and second element comprises a concave conical contact surface, and wherein the concave conical surface and the convex conical surface have an axis coincident with the axis of rotation of the roll blocking device.

4. The vehicle of claim 3, wherein the convex conical surface and the

concave conical surface have an aperture with a semi-angle at the apex between 10° and 20°, preferably between 12° and 18°, more preferably between 14° and 16°.

5. The vehicle of claim 3 or 4, wherein the convex conical surface is housed at least partially within the concave conical surface.

6. The vehicle of one or more of the preceding claims, wherein at least one, and preferably both the first contact surface and the second contact surface develop 360° around the axis of rotation

7. The vehicle of one or more of the preceding claims, wherein the roll blocking device comprises an actuator, configured to apply a force adapted to bring the device into said blocking position.

8. The vehicle of claim 7, wherein the actuator is placed coaxially to the first element and to the second element, preferably placed in front of the first element and of the second element of the roll blocking device with respect to the direction of travel of the vehicle.

9. The vehicle of claim 7 or 8, wherein the actuator is a hydraulic actuator, preferably a cylinder-piston actuator, even more preferably a single-acting cylinder-piston actuator.

10. The vehicle of claim 7 or 8 or 9, comprising a resilient member interposed between the first element and the second element configured to apply a repelling force adapted to bring the device into the unlocked position.

11. The vehicle of one or more of the preceding claims, wherein the four-bar linkage mechanism comprises:

- an upper cross member centrally hinged to the frame by means of an upper central hinge and having a left end and a right end;
- a lower cross member centrally hinged to the frame by means of a lower central hinge and having a left end and a right end;
- a left upright, hinged below to the left end of the lower cross member and above to the left end of the upper cross member;
- a right upright, hinged below to the right end of the lower cross member and

above to the right end of the upper cross member.

12. The vehicle of claim 11, wherein: the left front steered wheel is connected to the left upright via a left support, rotatable about a left steering axis, a left shock absorber being interposed between the left front steered wheel and the left support; the right front steered wheel is connected to the right upright via a right support, rotatable about a right steering axis, a right shock absorber being interposed between the right front steered wheel and the right support.

13. The vehicle of claim 11 or 12, wherein the lower cross member is constrained by the lower central hinge to a steering tube, and the upper cross member is constrained by the upper central hinge to the steering tube.

14. The vehicle of claim 12, 13 or 14, wherein the roll blocking device is placed coaxial to the central hinge of the upper cross member or the lower cross member.

15. The vehicle of one or more of the preceding claims, wherein the first element of the roll blocking device is torsionally coupled to the frame of the vehicle and movable with respect to it parallel to the axis of rotation of the roll blocking device, coincident with an axis of the upper central hinge or of the lower central hinge; and the second element of the roll blocking device is rigidly coupled to the upper cross member or the lower cross member.

16. The vehicle of claim 15, wherein the first element is slidably mounted on a shaft torsionally coupled to a hinge pin integral with the frame and forming the pin of the lower central hinge or of the upper central hinge; the first element being torsionally coupled to the shaft to be angularly integral therewith.

17. The vehicle of claim 16, wherein the second element of the roll blocking device forms a housing casing coaxial to the shaft and at least partially housing the first member of the roll blocking device; wherein the casing is supported by a first support bearing on the shaft and forms the second contact surface.

18. The vehicle of claim 17, comprising a housing casing closure lid; wherein the lid contains a second support bearing within which the first element of the roll blocking device is supported.

19. The vehicle of claim 18, wherein a cylinder of a cylinder-piston actuator is contained within the lid; wherein a piston coaxial to the first element of the roll blocking device is slidably housed in the cylinder; and wherein a pressurized fluid in the cylinder urges the piston against the first member of the roll blocking device, against the force of an opposing spring, to translate the first element of the roll blocking device from the unlocked position to the locked position.

20. The vehicle of one or more of the preceding claims, wherein the first contact surface and the second contact surface comprise respective front toothings meshing with each other when the roll blocking device is in the locked position.

21. The vehicle of one or more of claims 1, 6-19, wherein the first contact surface and the second contact surface form a disc clutch.

22. The vehicle of one or more of the preceding claims, wherein said first contact surface of the first element of the roll blocking device and said second contact surface of the second element of the roll blocking device are contained in a closed housing casing.

23. The vehicle of one or more of the preceding claims, wherein the rotation axis of the roll blocking device is coincident with a rotation axis of one of the hinges of the four bar linkage mechanism.

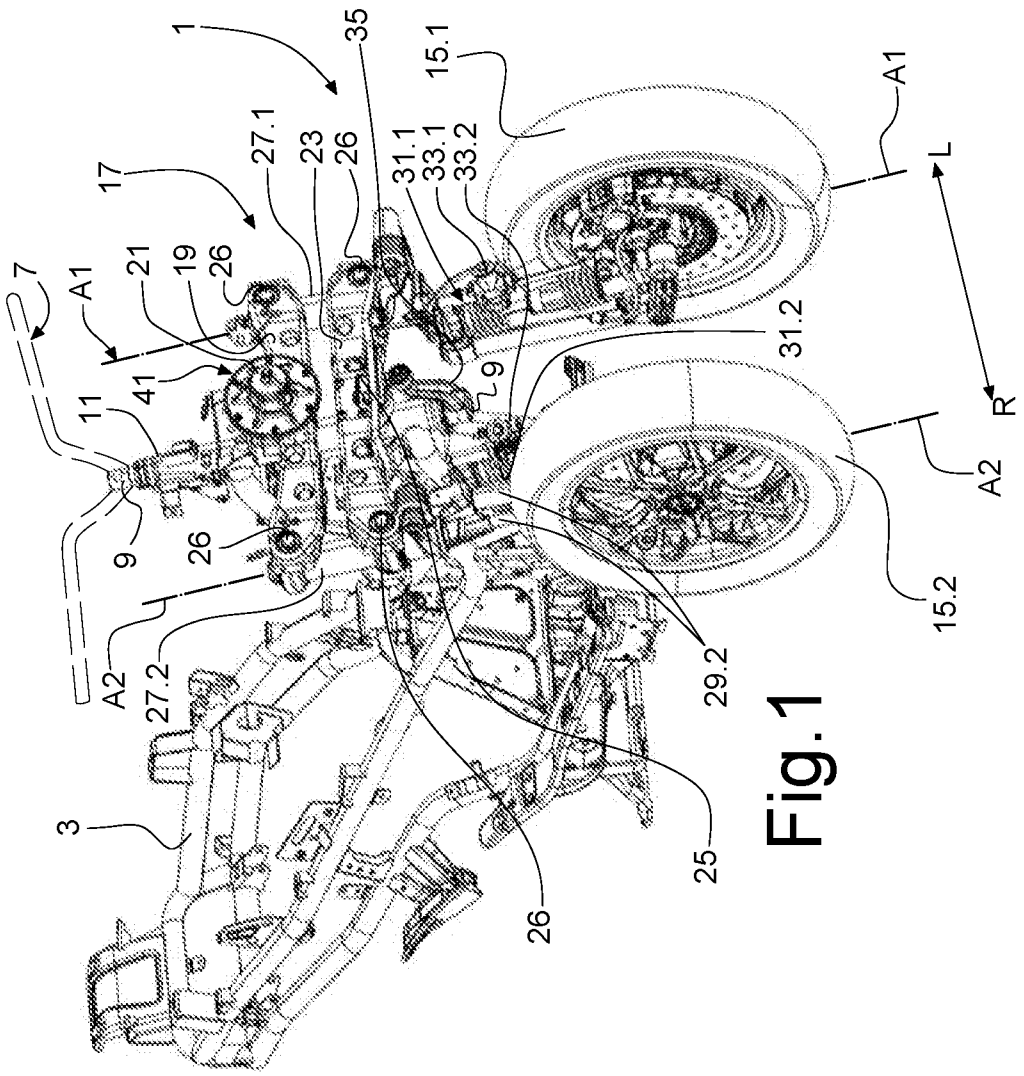
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Fig.1

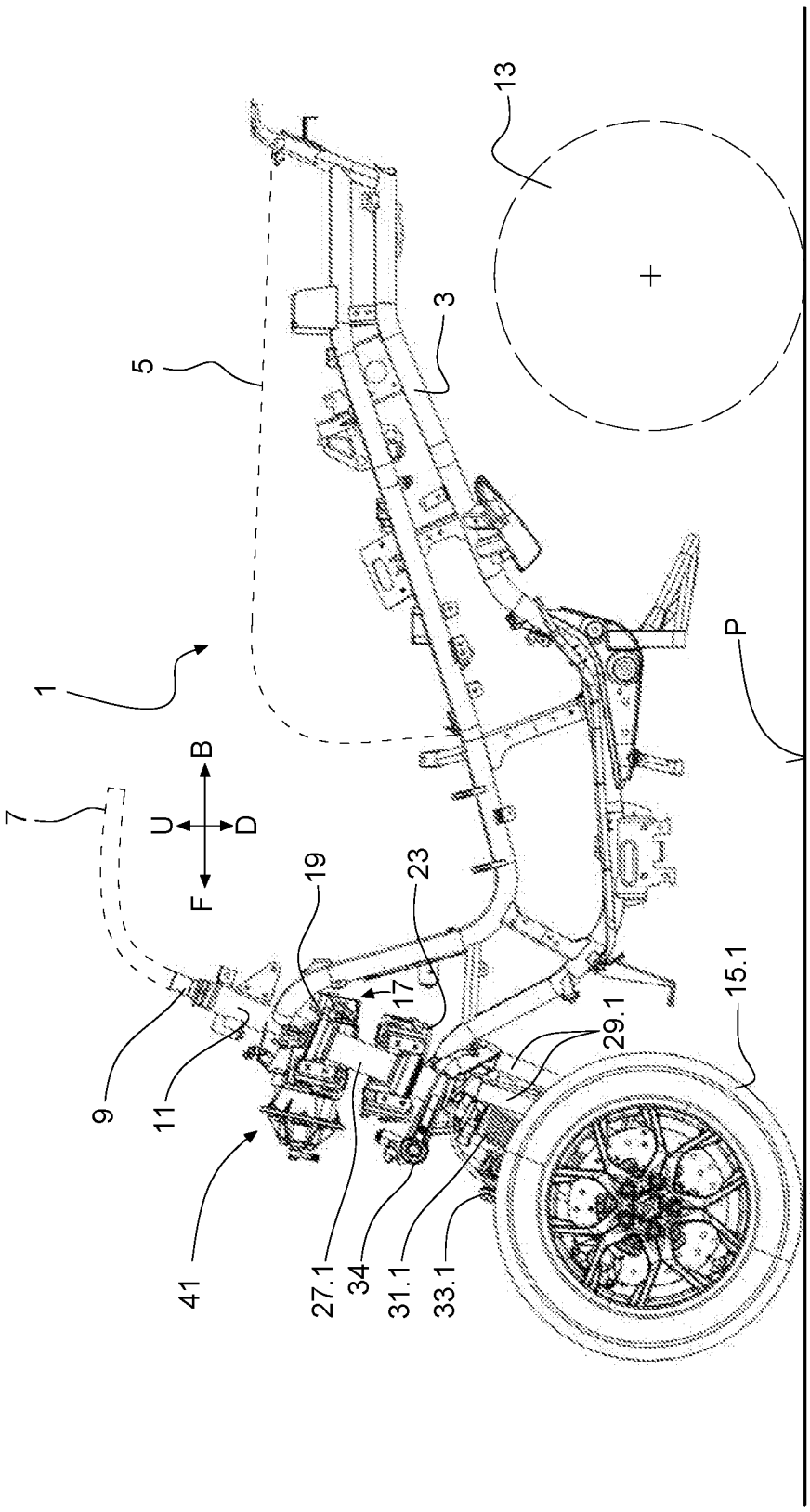

Fig.2

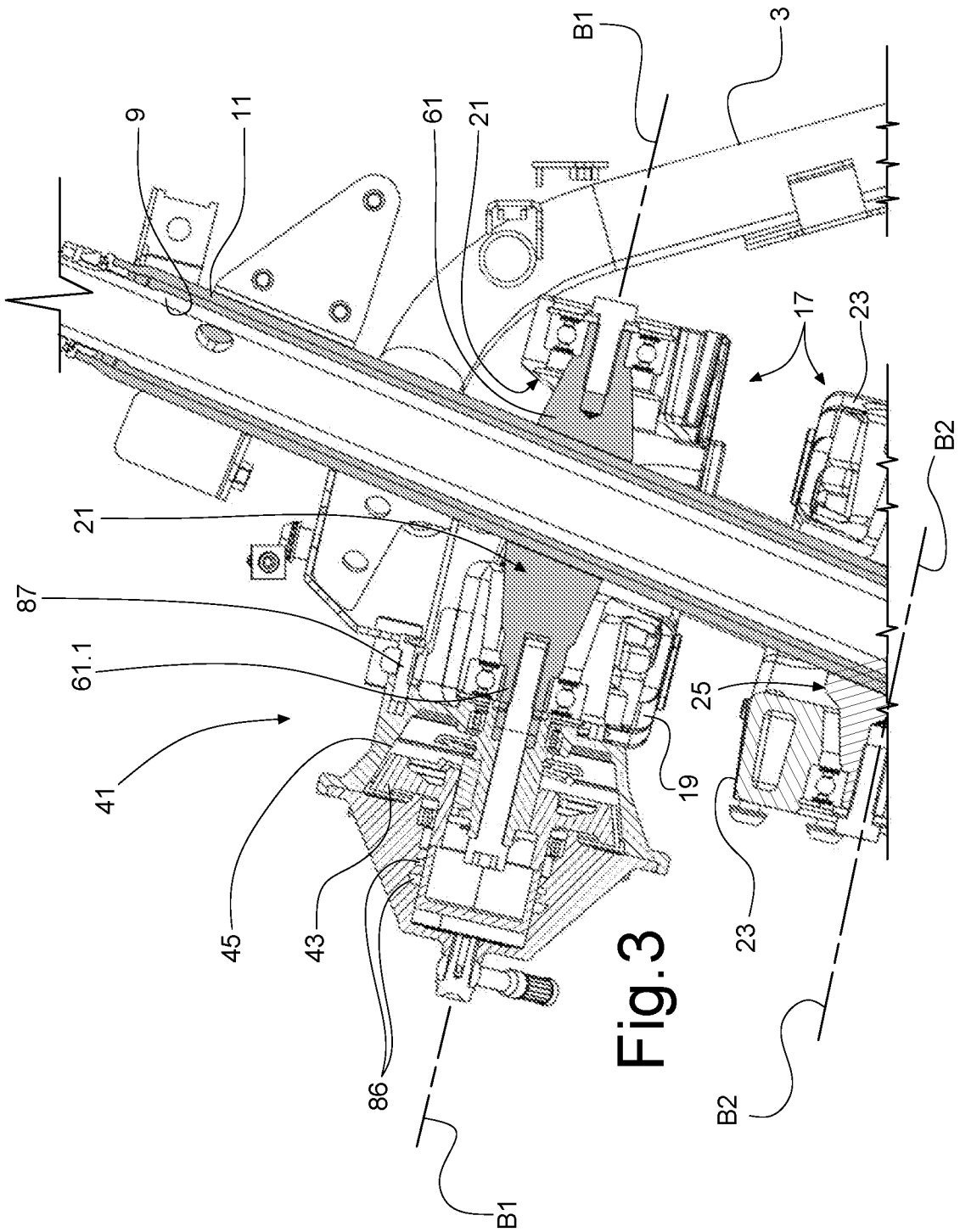

Fig.3

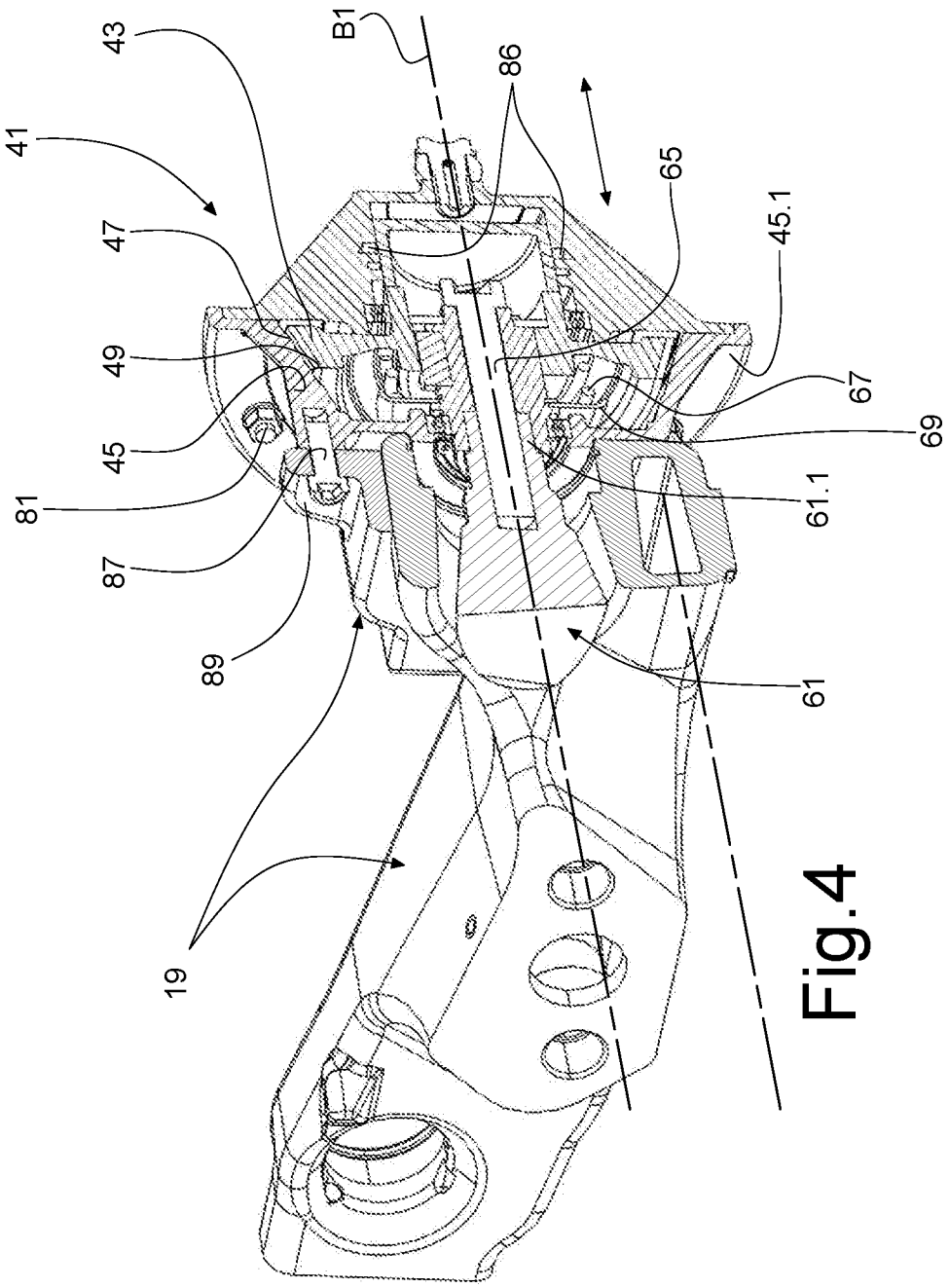

Fig.4

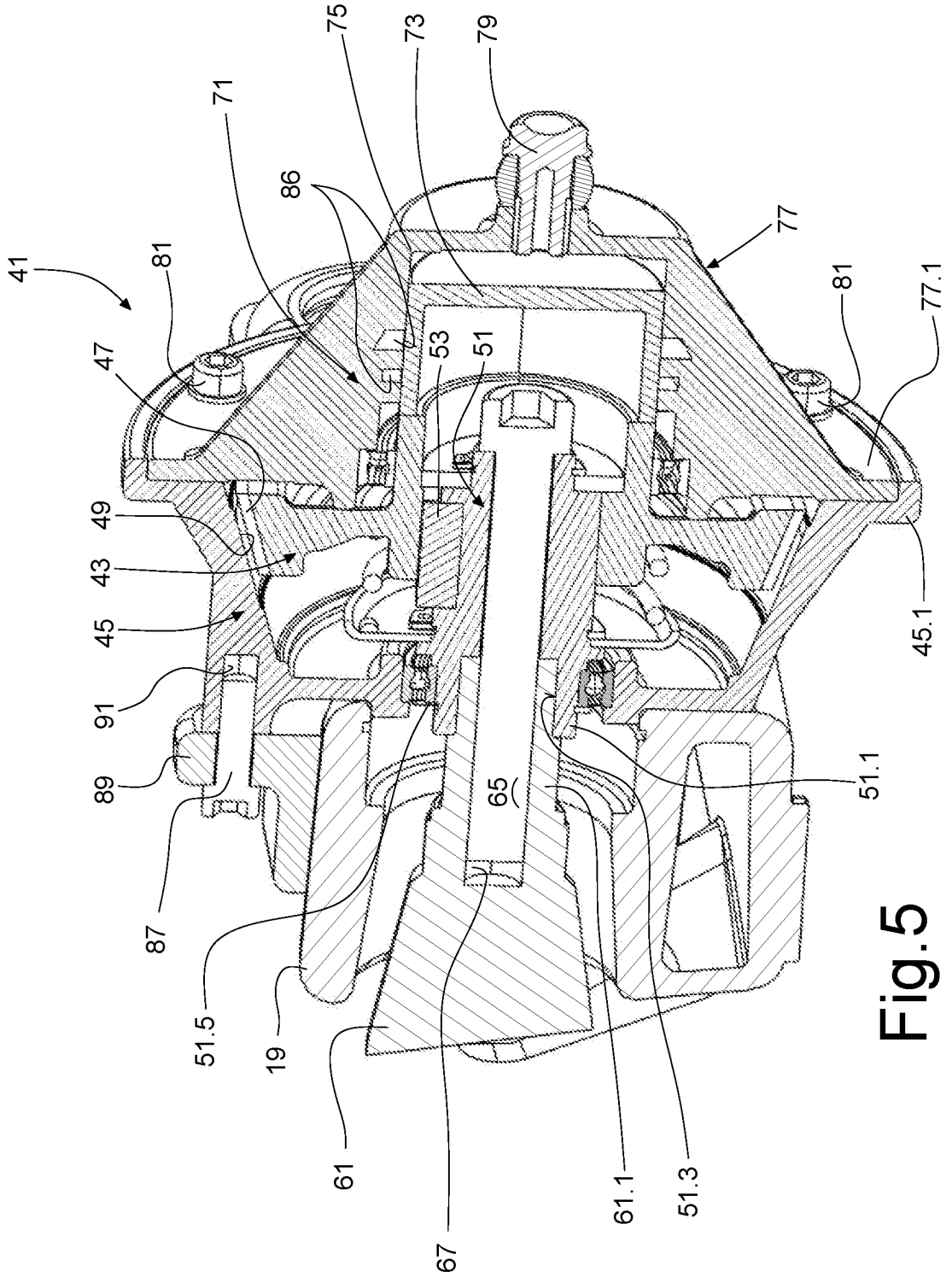
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Fig.5

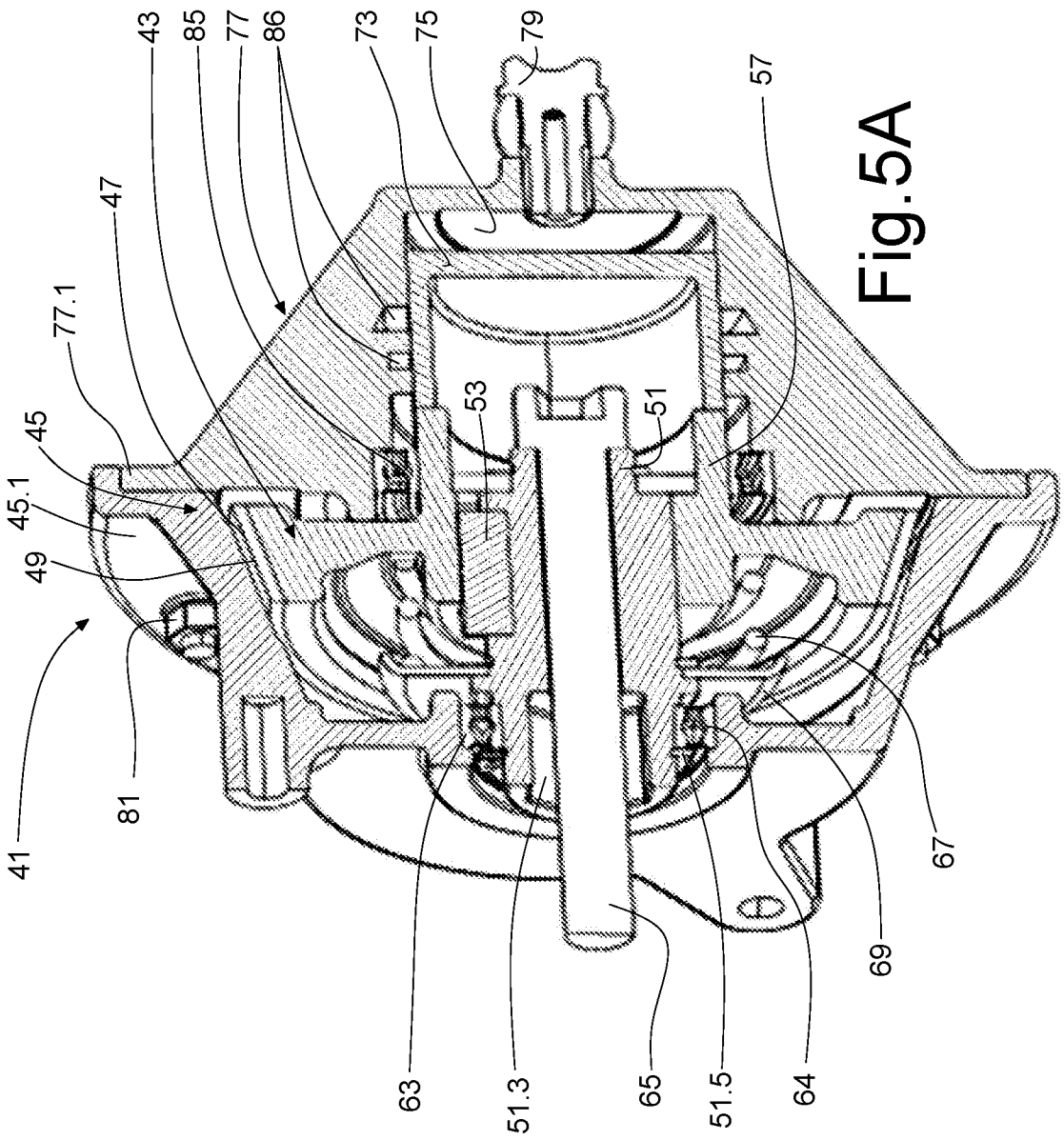
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Fig.5A

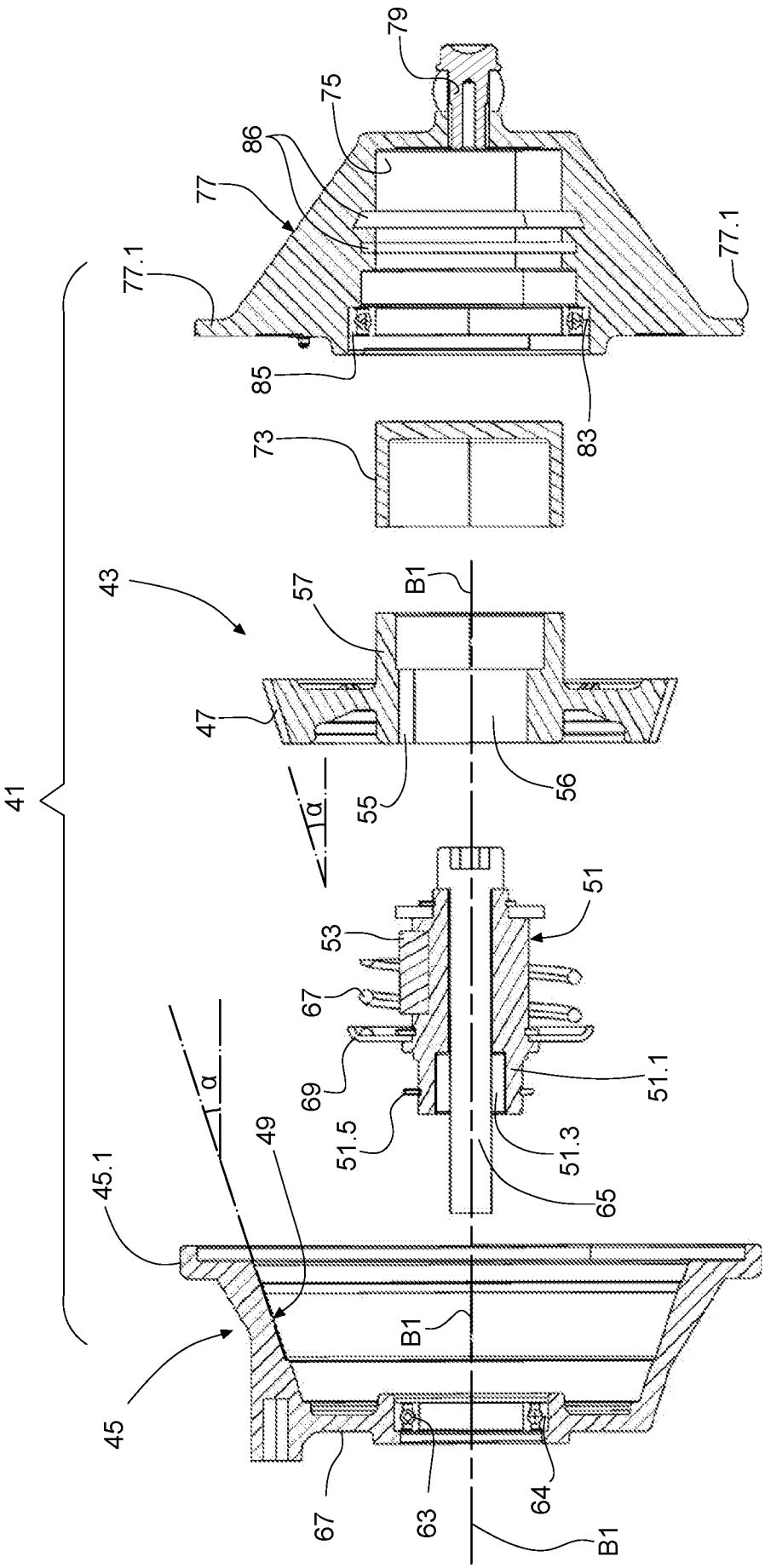
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Fig.6

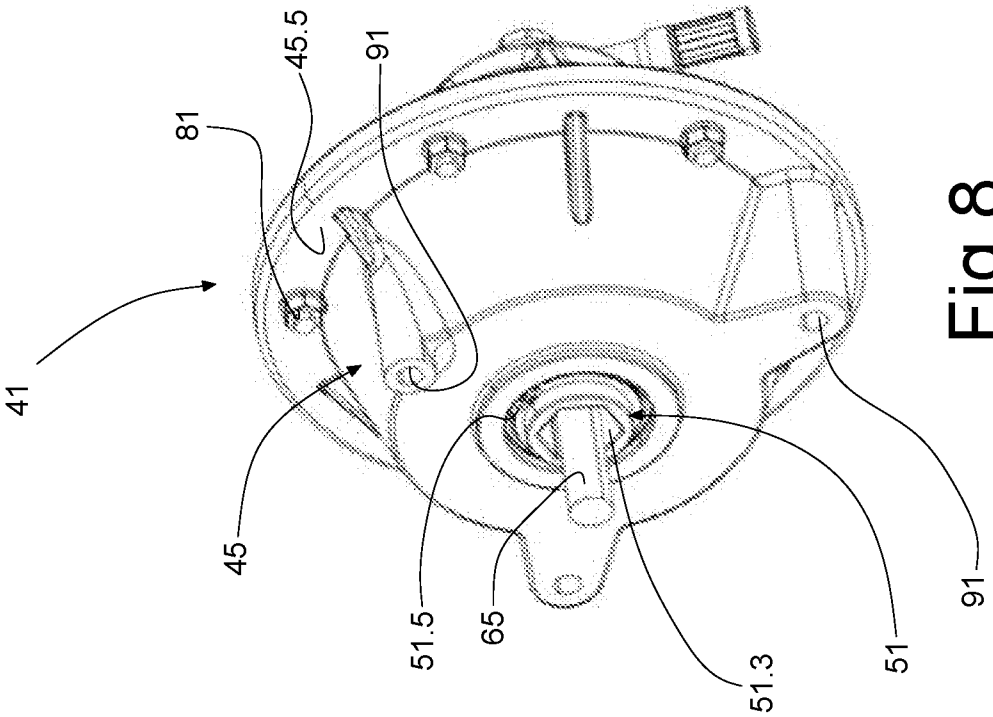

Fig.8

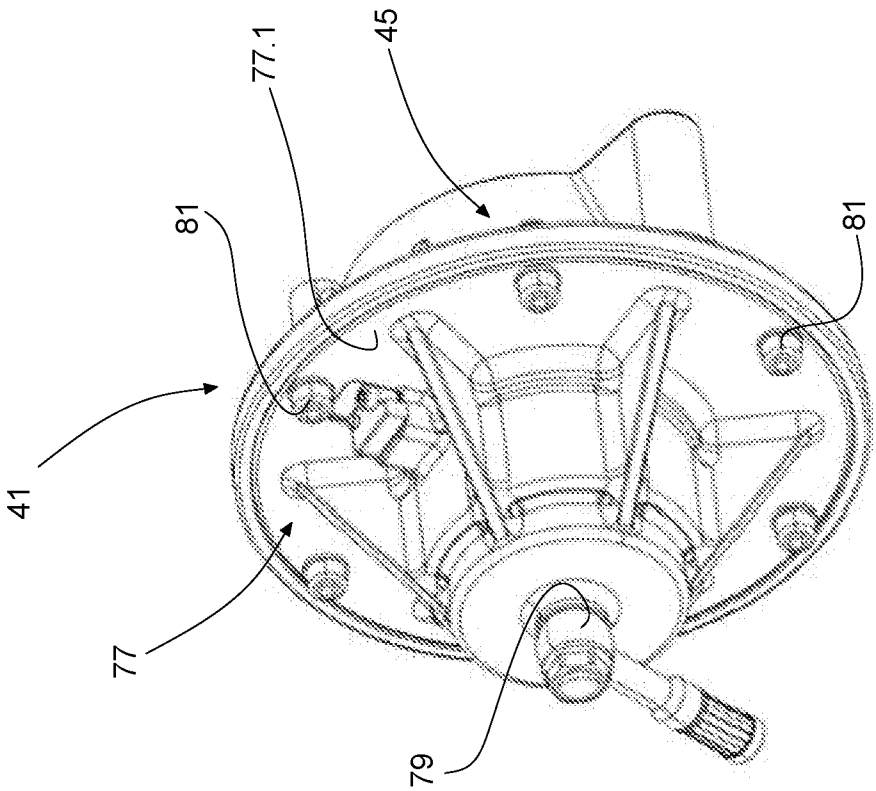

Fig.7

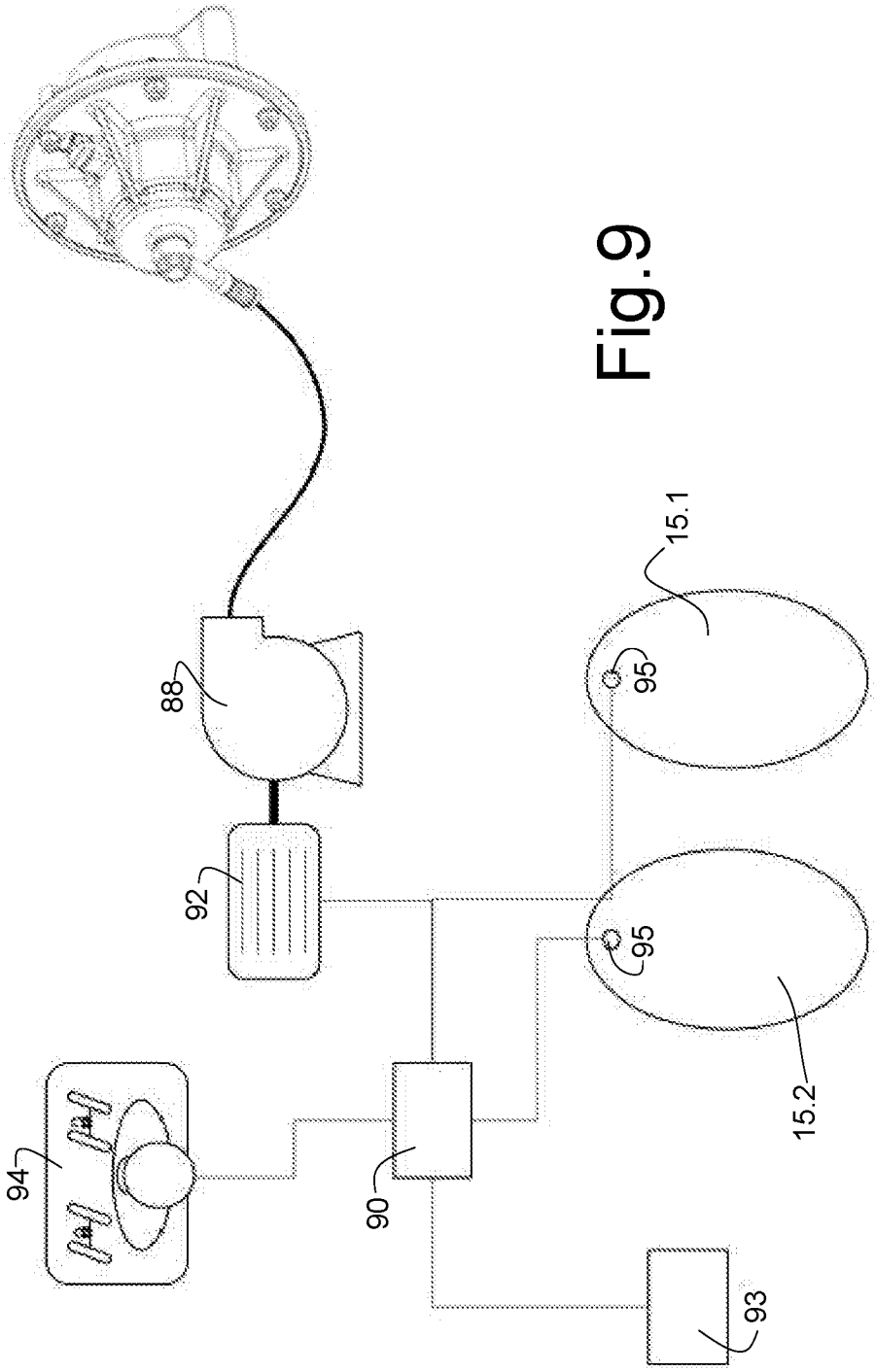

Fig.9

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2024/055523

A. CLASSIFICATION OF SUBJECT MATTER

INV. B62K5/027 B62K5/05 B62K5/08 B62K5/10 F16D7/02
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)

B62K F16D

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 10 882 372 B2 (PIAGGIO & C SPA [IT]) 5 January 2021 (2021-01-05) column 9, line 27 - column 10, line 20 figures 1-10	1-23
A	US 2021/129610 A1 (RAFFAELLI ANDREA [IT]) 6 May 2021 (2021-05-06) paragraphs [0045] - [0049], [0113] - [0121] figures 1-14	1-23
A	WO 2021/048800 A1 (PIAGGIO & C SPA [IT]) 18 March 2021 (2021-03-18) page 6, lines 15-21 page 17, line 32 - page 18, line 22 figures 1-23	1-23

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

☒ See patent family annex.

* Special categories of cited documents :

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"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
17 July 2024	02/08/2024

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	Fernández Plaza, P

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2024/055523

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