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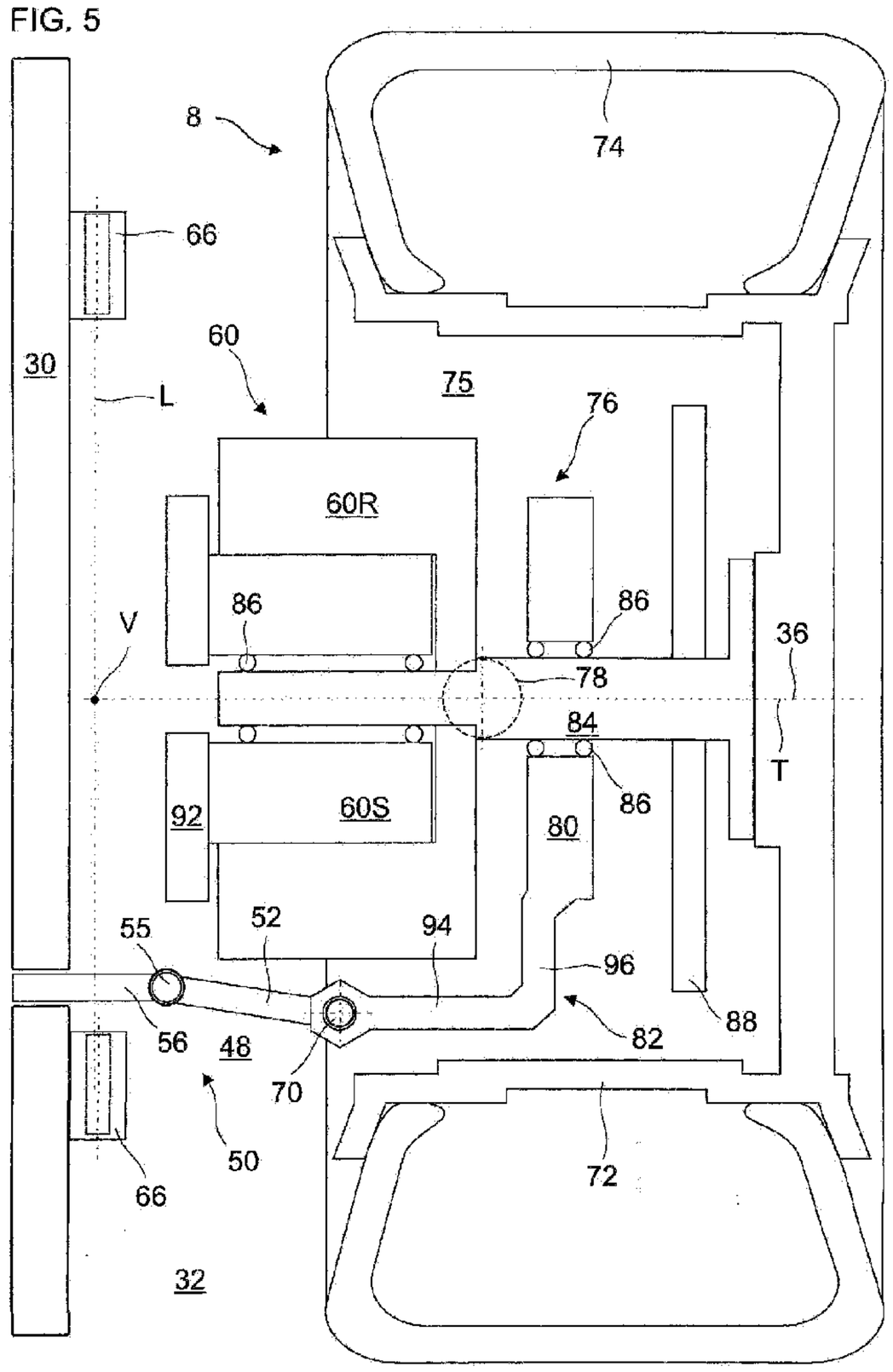
(54) **BUS STEERING SYSTEM.**

(57) The invention provides a steering unit (32) for a vehicle, notably a bus. The steering unit (32) is coupled with a suspension system and comprises: a support formed by a passenger platform and a wheel housing, a longitudinal axis, a steering knuckle (76) with an in-wheel engine (60) exhibiting a transversal rotation axis which is arranged transversally with respect to the longitudinal axis, an actuator mechanism (48) adapted for pivoting the steering knuckle. The steering knuckle (76) further comprises a lever (82) which is linked to the actuator mechanism (48) and which includes a transversal portion (94) extending transversally along the in-wheel engine (60). The invention is adapted for an articulated bus with at least two bodies, said bodies each exhibits four or eight identical and independent steering units (32).

FIG. 5



# BUS STEERING SYSTEM

## Technical field

The invention lies in the field of vehicle steering units. The invention provides a steering unit for a vehicle, wherein the steering units includes a steering knuckle receiving an in-wheel engine adapted for driving said vehicle. The invention also provides a mass transportation vehicle, notably a bus, with steering units.

## Background of the invention

A vehicle, notably a bus, is dotted with steering units in order to drive it along accurate curves. In order to improve drive capacity, the or each steering unit includes an inner engine connected to the wheel. However, this engine requires an important place within the steering knuckle, and reduces the angle about wheel the steering unit may pivot the steered wheel.

Consequently, the manoeuvrability of the vehicle is reduced, which at a certain point, may render the latter unsuitable to cities with narrow streets which communicate through sharp crossroads. A solution in order to address the current solution would be to reduce the size of the engines. Yet, it reduces their maximal power and prevents use on motorways.

Then, there is a need for providing a compromise between the steering angle and the capacities of a vehicle. The weight is also a concern of the prior art in addition to the abilities.

## Technical problem to be solved

It is an objective of the invention to present a device, which overcomes at least some of the disadvantages of the prior art.

## Summary of the invention

According to a first aspect of the invention a steering unit is provided. The steering unit, notably for a bus, the steering unit comprising: a longitudinal axis, a steering knuckle with an in-wheel engine exhibiting a transversal rotation axis which is arranged transversally with respect to the longitudinal axis, an actuator mechanism adapted for pivoting the steering knuckle, the steering knuckle comprising a lever which is linked to the actuator mechanism and which includes a transversal portion extending transversally along the in-wheel engine.

Preferably, the steering unit comprises a brake disk; the lever, notably the transversal portion, extending transversally toward the opposite direction of the brake disk.

Preferably, the steering knuckle comprises a main body, notably between the in-wheel engine and the brake disk, the lever further comprising a first longitudinal portion connecting the transversal portion to the main body.

Preferably, the lever further comprises a second longitudinal portion connecting the transversal portion to the main body, the in-wheel engine being disposed transversally between the first longitudinal portion and the second longitudinal portion.

Preferably, the knuckle includes an inboard plate, the in-wheel engine being disposed between the inboard plate and the main body.

Preferably, the steering unit further comprises an upper arm and a lower arm which are pivotably mounted to the steering knuckle, at least one of the upper arm and the lower arm being adapted for being pivotably fixed to a platform or a wheel housing of the bus.

Preferably, the steering unit further comprises a wheel with a rim in which the steering knuckle is disposed, the rim including an inner cavity in which the transversal portion possibly extends.

Preferably, the actuator mechanism includes an actuator device and a tie rod, said tie rod connecting the lever to the actuator device, and possibly the transversal portion to the actuator device.

Preferably, along the transversal rotation axis, the transversal portion includes an inboard end and/or an outboard end transversally at distance from the electric engine.

Preferably, the actuator mechanism is disposed below the transversal rotation axis, and preferably vertically at distance from the transversal rotation axis.

Preferably, the actuator mechanism includes a sliding bar with a sliding direction, the sliding direction and the transversal rotation axis define an angle (β) ranging from 15° to 45°, preferably from 0° to 30°.

Preferably, the steering knuckle comprises an upper ball joint and a lower ball joint vertically at distance from the transversal portion.

Preferably, the steering unit includes a longitudinal beam with a transversal hole, the actuator mechanism being arranged in said transversal hole, possibly the sliding bar slides through said transversal hole.

Preferably, the in-wheel engine comprises a first portion, notably an in-board portion, inside the wheel; and a second portion, notably an outboard portion, outside the wheel.

Preferably, the in-wheel engine is in contact of the steering knuckle.

Preferably, the steering knuckle defines an inner space in which the in-wheel engine is disposed.

Preferably, the in-wheel engine is an electric engine.

Preferably, the in-wheel engine is configured for rotating the wheel, notably for driving a vehicle, possibly the bus.

Preferably, the actuator mechanism, notably the actuator device and/or the tie rod, is vertically level with the in-wheel engine.

Preferably, the actuator mechanism is an electric actuator mechanism.

Preferably, the transversal portion is partially outside the in-wheel engine.

Preferably, the actuator mechanism is vertically and/or longitudinally level with the rim.

Preferably, the sliding bar is adapted for sliding through the transversal hole.

Preferably, the beam to which the actuator mechanism is fixed is at least one of a longitudinal beam, a transversal beam or a biased beam.

Preferably, the beam to which the actuator mechanism is fixed is a horizontal beam.

Preferably, the lower plate and the upper plate are facing each other.

Preferably, the in-wheel engine is at least partially disposed in the wheel, and possibly partially outside the wheel.

Preferably, the transversal portion is disposed vertically between the upper arm and a lower arm.

Preferably, the wheel is a driving wheel.

Preferably, the wheel and the in-wheel engine have parallel, and/or colinear, and/or the same transversal rotation axis.

Preferably, the transversal portion is linked to and/or in contact of the actuator mechanism, notably to/of the tie rod.

Preferably, along the rotation axis, the transversal portion overlaps the in-wheel engine, and/or is longer than the in-wheel engine.

Preferably, the transversal portion is at a greater distance from the transversal rotation axis than the in-wheel engine.

Preferably, the lever is in contact of the actuator mechanism.

Preferably, the steering knuckle is monobloc.

Preferably, the steering unit further comprises a support, notably a passenger platform portion and/or a wheel housing portion, the steering knuckle pivoting with respect to said support about a substantially vertical pivot axis.

Preferably, the longitudinal portion crosses the in-wheel engine.

Preferably, the upper ball joint and the lower ball joint are within the rim.

Preferably, the actuator mechanism includes a sliding bar with a sliding direction which is inclined with respect to the longitudinal direction of an angle ($\alpha$) ranging from 45° to 80°, preferably from 46° to 75°.

Preferably, the lever and the actuator mechanism include a control joint vertically level with the in-wheel engine, and/or within the wheel, and/or within the rim.

Preferably, the in-wheel engine comprises a stator rigidly fixed to steering knuckle, possibly to the main body and/or to the inboard plate.

Preferably, the outer diameter of the in-wheel engine is greater than the outer diameter of the brake disk.

It is another aspect of the invention to provide a steering unit, notably for a bus, the steering unit comprising: a transversal axis, a steering knuckle with an in-wheel engine exhibiting a transversal rotation axis, an actuator mechanism being adapted for swivelling the steering knuckle, the steering

knuckle exhibiting a lever which is linked to the actuator mechanism and which includes a transversal portion overlapping transversally the in-wheel engine.

It is another aspect of the invention to provide a bus comprising at least one steering unit, preferably a plurality of steering units, the steering unit or each steering unit being in accordance with the invention, preferably the bus comprises a passenger platform.
Preferably, the actuator mechanism is arranged within the passenger platform, the vertical thickness of the passenger platform possibly representing at most two times the vertical thickness of the actuator mechanism.
Preferably, the passenger platform comprises a transversal hole, the actuator mechanism being connected to the steering knuckle through said transversal hole.
Preferably, the passenger platform includes a lower plate and an upper plate in contact of a beam to which the actuator mechanism is fixed.
Preferably, the upper plate forms the passenger floor of the passenger platform and spans over at least the half of the surface of a passenger compartment of the bus, the upper plate being distant of at most: 50 cm, or 40 cm from the ground.
Preferably, the bus is an articulated bus comprising at least two articulated bodies, each body comprising at least four, or at least eight identical steering units.
Preferably, the steering units are independent from one another.
Preferably, the steering units are disposed by pairs in at least one or in each wheel housing.
Preferably, the actuator mechanisms of the bus are independent from one another.
Preferably, the steering units of the bus are identical.
Preferably, the vertical thickness TH of the platform is of at most: 15 cm, or 10 cm, or 8 cm.

It is another aspect of the invention to provide a bus comprising a passenger platform with a beam exhibiting a hole, and a steering unit linked to said beam and comprising a steering knuckle; the bus further comprising an actuator disposed within the passenger platform and controlling the steering angle of the knuckle through the hole and/or through the platform, the bus possibly forming a steering unit in accordance with the invention.

The different aspects of the invention may be combined to each other. In addition, the preferable options of each aspect of the invention may be combined with the other aspect of the invention, unless the contrary is explicitly mentioned.

Technical advantages of the invention
The invention provides a solution adapted for steering a wheel dotted with an in-wheel engine and a steering knuckle also within the wheel. The lever according to the invention is adapted for the

space between the rim and the in-wheel engine, an provides a junction starting from the steering knuckle to the final actuator dedicated to the steering unit.

The invention offers an accurate position of the control joint with respect to the in-wheel engine.

The position of the control joint suggested by the invention enables a wide steering angle where the in-wheel engine exhibits a large outer diameter. Thus, the equipped vehicle may reach high speed whereas its turning radius may be reduced. Thus, these two parameters may be optimized together.

The size and the position of the in-wheel engine may be handled even with rims of reduced diameter in order to increase the size of the tire, and consequently the passenger comfort.

The position of the actuator device within the passenger platform enables a transversal arrangement, and notably a transversal sliding direction. Consequently, the steering angle may be controled more efficiently, and notably with a reduced number of cranks. Thus, the steering unit become more reliable, and safer. Providing a transversal hole through a beam or support of the passenger platform allows an adaptation of the actuator mechanism to a compact environment, which notably correspond to a low floor and a thin passenger platform. As a reminder, a thin passenger platform with a low floor eases the access to a bus, and avoids steps at the doors of the bus.

Brief description of the drawings

Several embodiments of the present invention are illustrated by way of figures, which do not limit the scope of the invention, wherein:

- figure 1 provides a schematic illustration of a side view of a bus in accordance with a preferred embodiment of the invention;
- figure 2 provides a schematic illustration of a side view of a wheel housing with two steering units in accordance with a preferred embodiment of the invention;
- figure 3 provides a schematic illustration of a longitudinal view of a steering unit in accordance with a preferred embodiment of the invention;
- figure 4 provides a schematic illustration of a transversal view of a steering unit in accordance with a preferred embodiment of the invention;
- figure 5 provides a horizontal cut out of a steering unit in accordance with a preferred embodiment of the invention;
- figure 6 provides a horizontal cut out of a steering unit in accordance with a preferred embodiment of the invention;
- figure 7 provides a horizontal cut out of a steering unit in accordance with a preferred embodiment of the invention;
- figure 8 provides a horizontal cut out of a steering unit in accordance with a preferred embodiment of the invention.

Detailed description of the invention

This section describes the invention in further detail based on preferred embodiments and on the figures. Similar reference numbers will be used to describe similar or the same concepts throughout different embodiments of the invention.

It should be noted that features described for a specific embodiment described herein may be combined with the features of other embodiments unless the contrary is explicitly mentioned. Features commonly known in the art will not be explicitly mentioned for the sake of focusing on the features that are specific to the invention. For example, the steering unit in accordance with the invention is evidently connected to a power supply, even though such power supply is not explicitly referenced on the figures nor referenced in the description.

In the current description, the longitudinal direction may correspond to the main elongation of the vehicle, and/or the main driving direction. The transversal direction is transversal to the longitudinal direction, for instance perpendicular. The words "inboard" and "outboard" may correspond to a position with respect to the vehicle centre line, for instance the word "outboard" may toward the environment of the vehicle. These words may be considered along the transversal direction.

Figure 1 shows a vehicle for mass transportation. The longitudinal axis L, the transversal axis T and the vertical axis V are provided for the sake of clarity.

The vehicle is adapted for transportation of passengers in cities and may transport about one hundred passengers, for instance one hundred and twenty passengers. The vehicle may be a bus 2, notably an electric bus 2. The bus 2 may include electric driving engines and electric batteries (not represented) powering the electric driving engines. The bus 2 may be exclusively driven by electric power.

The bus 2 may be an articulated bus. It may comprise a first body 4 and a second body 4 (partially represented). Each body 4, may form a passenger cart, and/or may form a rigid element. Each body 4 may be a trailer and/or a tractor. Each body 4 may be self-supporting. The bodies 4 may be similar or identical. These bodies 4 may be joined by a connection, for instance a hinged connection 6 enabling the bodies 4 to swivel with respect to each other. In the current illustrative example, only two bodies 4 are represented, however it is contemplated in the current invention that the electric bus 2 includes three, four, or more bodies 4, which are linked and articulated by hinged connection 6. Then, the passenger capacity may be of more than two hundred.

A bus formed of a single body is also considered.

Each body 4 may include several wheels 8 engaging the ground G. Pairs of symmetric wheels 8 may form axles, for instance four axle for each body 4. The axles and thus the wheels 8 may be

distributed along the length of the bus 2. At least one pair of wheels is formed of steered wheels. Optionally, each wheel 8 of the bus 2 or of at least one body 4 are steered wheels. The steered wheels may be part of steering units. The wheels 8, notably the steered wheels, may be driving wheels; and possibly suspended wheels.

The bus 2 may include a structure. The structure may include a roof 10, and/or a passenger platform 16, and/or side walls 14. Two transversally opposite side walls 14 may go down from the roof 10 to the passenger platform 16 which may be part of the bus structure. The side walls 14 may form the bodywork of the bus 2.

For instance; the side walls 14 may close the wheel housings 18. The latter may notably receive the wheels 8 by couples. Optionally, at least one or each wheel housing 18 may receive two longitudinally spaced wheels 8. The wheel housings 18 may form downwardly open boxes.

The side walls 14 may receive windows 20. Optionally, doors 22 are be arranged in one of the two side walls 14, notably between windows 20.

As an alternative, each wheel is received in an independent wheel housing.

Figure 2 provides a schematic illustration of a portion of the bus 2. The portion is centred about a wheel housing 18. The wheel housing 18 may receive at least one or at least two wheels 8. The bus may correspond to the bus 2 as described in relation with figure 1.

The wheel housing 18 may be a left one or a right one. Its upper end may be delimited by the transversal outer beams 24, and the longitudinal ends may be formed by the transversal bars 26. The latter may be connected to the transversal outer beams 24 by means of vertical bars 28. The passenger platform 16, and notably a longitudinal beam 30, are apparent in the background, notably behind the wheels 8. The longitudinal beam 30 may be a main longitudinal beam. The "main" aspect may be understood in that the longitudinal beam 30 is the thickest of the passenger platform 16.

The wheels 8 may be movable with respect to the passenger platform 16, notably through a steering unit 32. The wheels 8 may pivot about a vertical pivot axis. The steering unit 32 may allow a pivot motion of each wheel 8 about a substantially vertical axis V. At least one or each steering unit 32 may be coupled to a suspension system 34. With respect to the passenger platform 16, the wheels 8 may be movable between an upper position (currently represented in solid lines) and a lower position (virtually represented in dotted lines). These positions, or configurations, may respectively correspond to a boarding position where the passenger platform 16 is lowered in order to ease access to the passenger compartment, and a driving position where the ground clearance GC is increased in order to avoid striking an obstacle on the ground G.

In the currently represented upper position, the rotations axis/axes 36 may be over the passenger platform 16. The rotation axis/axes 36 may be vertically distant from the passenger platform 16, and thus of its top surface 38. The top surface 38 may exhibit a main level 38L. The main level 38L

may correspond to the average level of the floor surface of the passenger platform 16. The rotations axis/axes 36 may be vertically level with the passenger compartment 40.

In the lower position of the wheel(s) 8, the rotation axis/axes 36 may be vertically level with the passenger platform 16. The rotation axis/axes 36 may be vertically level with the longitudinal beam 30 and/or the transversal beams 24. The rotation axis/axes 36 may be below the main level 38L. The rotation axis/axes 36 may be vertically above the bottom surface 42 of the passenger platform 16, in the lower position as in the upper position.

The distance D between the upper position of the wheels 8 and the lower position may be greater than the thickness TH of the passenger platform 16. The distance D may be measured at the top of the wheels 8. The thickness TH may be constant along one or the two wheels 8. The thickness TH may be constant TH all along the wheel housing 18.

The longitudinal distance 44 between the right wheel and between the left wheel may be smaller than the distance D between the upper position and the lower position. This longitudinal distance 44 may be measured between a couple of wheels 8, on the left side and/or on the right side of the bus. The longitudinal distance 44 may be measured in the upper position and/or in the lower position.

The current description refers to a single wheel housing 18. However, the current teaching may apply to several, or to all the wheel housings of the bus; respectively the vehicle.

Figure 3 provides a schematic illustration of a steering unit 32 along the longitudinal axis L. The steering unit 32 may correspond to the one as described in relation with figure 2.

The steering unit 32 is currently represented in the lower configuration, and an illustration of the upper configuration is provided through an illustrative rotation axis 36I of the wheel 8. Distance D illustrates the course of the rotation axis 36 between the lower position and the upper position.

The bus 2 may be generally symmetric with respect to a sagittal plan. Said sagittal plan may include the longitudinal axis L and the vertical axis V.

The currently represented right steering unit 32 may be connected to a left steering unit (not represented) by the passenger platform 16.

A seat 46 may disposed above the steering unit 32, and over the wheel 8. The wheel housing 18 may be arranged bellow the seat 46. The transversally outer beams 24 may span longitudinally over the wheel 8. The wheel housing 18 may separate the passenger compartment 40 from the wheel 8. The platform 16 defines the ground clearance GC, which may be greater than thickness TH of the passenger platform 16.

The transversal beam 31 (partially represented) and the longitudinal beam 30 of the passenger platform may exhibit a same vertical thickness TH. The distance D between the upper position and the lower position may larger than the thickness TH, notably the average thickness or the maximal thickness, of the passenger platform 16.

The steering unit 32 may comprise an actuator mechanism 48. The actuator mechanism 48 may be vertically within the thickness TH of the passenger platform 16. The actuator mechanism 48 may comprise an actuator device 50 and a tie rod 52.

The actuator device 50 may convert an energy supply into a mechanical effort. It may be an electric actuator, and possibly a hydraulic actuator. The actuator device 50 may be a mover. The actuator device 50 may cross a beam, notably a horizontal and/or longitudinal beam. It may cross the longitudinal beam 30 delimiting the wheel housing 18. The actuator device 50 may project within the wheel housing 18.

The longitudinal beam 30 may exhibit a hole 54, for instance a transversal hole 54. The hole 54 may cross transversally the longitudinal beam 30. The actuator device 50 may cross said hole 54. More precisely the actuator device 50 may comprise a sliding bar 56. The sliding bar 56 may slide through the hole 54. The actuator device 50 may comprise a main part 58 receiving the sliding bar 56. The main part 58 may be fixed to the passenger platform 16, for instance to one horizontal beam therein. It may be fixed to the transversal beam 31, and/or a longitudinal beam. It may be fixed to a top plate 39 forming the top surface 38, notably the passenger floor, and/or to a plate forming the bottom surface 42.

The actuator mechanism 48 may be disposed between the top surface 38 and the bottom surface 42.

The tie rod 52 may be outside the passenger platform 16. The tie rod 52 may connect the sliding bar 56 to a steering knuckle (not represented). The latter may be arranged in the wheel, and may receive an engine, for instance an in-wheel engine 60. The in-wheel engine 60 may project outside the wheel 8. It may fill a sub portion of the wheel housing 18. This arrangement permits to use bigger and more powerful engines, however free space inside the wheel housing reduces.

The steering knuckle may comprise a control joint 70 which is fixed to the tie rod 52. The control joint 70 may comprise a ball joint, or a pivot joint. The control joint 70 may at the inboard interface of the wheel 8. It may transform a transversal sliding motion of the actuator device 50 into a rotation of the wheel 8 in order to steer it. Consequently, the orientation of the wheel 8 may be controlled through the position of the control joint 70.

An upper arm 62 and a lower arm 64 may connect the wheel 8 to the structure of the bus, notably to the wheel housing 18 and the passenger platform 16. Pivot joints 66 may be used. As a consequence, the arms (62; 64) may oscillate about longitudinal axes in order to allow motion of the wheel 8 between the upper position and the lower position.

The upper arm 62 and the lower arm 64 may be wishbones. The upper arm 62 and the lower arm 64 may be joined to the steering knuckle at their outboard joints. The lower arm 64 may be linked to the longitudinal beam 30, which may be an outboard longitudinal beam 30, through the lower pivot joints 66. The longitudinal beam 30 may combine the hole 54 and the lower pivot joint(s) 66. The hole 54 may be above at least one or the lower pivot joint(s) 66.

A resilient element (not represented) and a damping device (not represented) may be joined to the upper arm 62 and the lower arm 64 in order to form the suspension system 34.
The current description refers to a single steering unit 32 18. However, the current teaching may apply to several, or to all the steering units 32 of the bus; respectively the vehicle.

Figure 4 provides a schematic illustration of a transversal view of a steering unit 32. The steering unit 32 is represented from inside; for instance, from the centre line of the vehicle. The steering unit 32 may correspond to the ones as described in relation with figures 2 and/or 3. For the sake of conciseness, the following description will be carried out in relation with one steering unit 32, however it could apply to several or to all the steering units of the vehicle, respectively the bus 2.
The steering unit 32 is currently represented in an intermediate position, between the lower position and the upper position; which may be a maximal lower position and a maximal upper position respectively. The longitudinal beam 30 and the lower arm 64 are represented with doted lines for the sake of clarity.
The wheel 8 may comprise a rim 72 and a tire 74. The rim 72 may comprise a substantially rigid material such an alloy. The tire 74 may comprise resilient material(s), such as rubber. The rim 72 and the tire 74 may define an annular chamber which is inflated. The inflating pressure reduces the flat of the tire 74 against the ground G. The rim 72 may exhibit an inner cavity 75 about the rotation axis 36.
The steering unit 30 may comprise a steering knuckle 76. The steering knuckle 76 may comprise/be a king pin. The steering knuckle 76 may be housed in the inner cavity 75 of the rim 72, possibly totally. The rim 74 may be joined to the steering knuckle 76 by a rotating joint. The knuckle 76 may be within the wheel 8, for instance within the rim 74. The steering knuckle 76 may be linked to the upper arm and to the lower arm 64 by ball joints 78. Consequently, the steering knuckle 76 and the wheel 8 may pivot about a vertical axis V passing through the centres of the ball joints 78. The or each ball joint 78 may be replaced by a pivot joint, or a set of pivot joints.
The engine, notably the in-wheel engine 60, may be an electric engine. It may be adapted for rotating the wheel 8 about the rotation axis 36, in order to drive the bus 2. The in-wheel engine 60 may be fixed to the steering knuckle 76. It may be encircled by the rim 74. It may be at distance from the rim 74, for instance contact free therewith. The rotation axis 36 of the wheel 8 may correspond to the one of the in-wheel engine 60.
The steering knuckle 76 may comprise a main body 80, for instance between the upper and lower ball joints 78. It may additionally comprise a lever 82. The main body 80 may be vertically larger than the in-wheel engine 60. The lever 82 may project from the main body 80. It may be perpendicular to the vertical axis V about which the steering knuckle 76 swivels. An end, for instance a free end, of the lever 82 may be linked to the actuator mechanism (not represented), for instance at the control joint 70.

The length and/or the orientation of the lever 82 may be adapted in order to get around the in-wheel engine 60. Thus, the control joint 70 may be at distance from the in-wheel engine 60. It may be at a greater radius with respect to the rotation axis 36.

The hole 54 crosses the longitudinal beam 30. The hole may be a transversal hole 54. It may be crossed by the actuator mechanism (not represented). The hole 54 may be above the pivot 66. In the current configuration it may be vertically level with the control joint 70. The transversal hole 54 may face the wheel 8. It may transversally face the tire 74. It may be opened toward a side flange of the tire 74. Alternatively, the hole may face the rim 72, or at least the inner cavity 75.

The current description refers to a single steering unit 32 18. However, the current teaching may apply to several, or to all the steering units 32 of the bus; respectively the vehicle.

Figure 5 provides a schematic illustration of a steering unit 32 in accordance with the invention. The steering unit 32 may correspond to the ones as described in relation with any one of the figures 2 to 4.

In the current illustration, the transversal rotation axis 36 and the transversal axes T are aligned. However, the transversal rotation axis 36 may be pivoted about the vertical axis V. Then, the angle between the longitudinal axis L and the transversal rotation axis 36 may vary during steering manoeuvre.

The longitudinal beam 30 may extend along the wheel 8. The longitudinal beam 30 may support pivot joints 66 to which the lower arm (not represented) is linked. The hole 54, notably the transversal hole, may cross transversally the longitudinal beam 30.

The steering unit 32 may comprise a shaft 84. The shaft 84 may be fixed to the wheel 8, notably to the rim 72. The shaft 84 may extend outside the wheel 8, for instance outside the inner cavity 75 of the rim 72. The shaft 84 may cross the steering knuckle 76, notably the main body 80. The shaft may cross the in-wheel engine 60. The shaft 84 may be rotatably mounted to the steering knuckle 76. Bearings 86 may be provided at the rotating interfaces.

The steering unit 32 may comprise a brake disk 88. The brake disk 88 may be fixed to the shaft 84, and notably to the rim 72. The brake disk 88 may be disposed in the rim 72. A brake calliper (not represented) may comprise brake pads which are pressed against the opposite disk surfaces of the brake disk 88 in order to brake the wheel rotation, and to stop and to reduce the bus speed. The brake calliper may be fixed to the steering knuckle 76.

The in-wheel engine 60 may comprise a rotor 60R and a stator 60S. The rotor 60R may be fixed to the shaft 84 and may be at distance from the steering knuckle 76. The steering knuckle 76 and the rotor 60R may be contact free.

The steering knuckle 76 may comprise an inboard plate 92. The inboard plate 92 may be disposed transversally between the longitudinal beam 30 and the in-wheel engine 60. The stator 60R may be fixed to said inboard plate 92. The stator 60S may be contact free with the shaft 84. The inboard

plate 92 may be connected to the main body 80 by means of transversal connections (not represented), which may be above and below the in-wheel engine 60. The in-wheel engine 60 may be sandwiched between the inboard plate 92 and the main body 80.

In the current embodiment, the rotor 60R is disposed around the stator 60S, however the contrary is also considered by the invention. Similarly, it is considered to place the stator toward the brake disk 88, and the rotor 60R toward the longitudinal beam 30. The in-wheel engine 60 may be partially in the wheel 8. Consequently, the in-wheel engine 60 may comprise a transversal portion outside the inner cavity 75, and an outboard portion within the inner cavity 75.

The position of the ball joints 78 is represented in dotted lines. Along the transversal rotation axis 36, the centre of the ball joints 78 may be disposed between the main body 80 and the in-wheel engine 60.

The actuator mechanism 48 may be represented through the tie rod 52 which is linked to the sliding bar 56 of the actuator device 50. the tie rod 52 which is linked to the sliding bar 56 may be linked by a ball joint 55. A control unit with a computer (not represented) may control the actuator mechanism 48. Since the tie rod 52, the upper arm and the lower arm may be of different lengths, the control unit may compensate for steering deviations due to the angle oscillations of the upper arm and the lower arm. Compensation due to the different positions of the pivot joints 66 and the ball joint 55 may be considered.

The lever 82 may comprise a transversal portion 94. The transversal portion 94 may extend mainly along the transversal direction T and/or the transversal rotation axis 36. The inboard end of the transversal portion 94 may receive the control joint 70. Said inboard end, and thus the control joint 70, may be along the in-wheel engine 60. The in-wheel engine 60 may overlap the control joint 70. The control joint 70 may be at a greater distance from the transversal rotation axis 36 than the in-wheel engine 60. The first longitudinal portion 94 may project perpendicularly to the main body 80, for instance perpendicularly to the transversal rotation axis 36. The control joint 70 may be astride a radial flange of the tire 74. The current arrangement optimizes the steering angle and space dedicated to the in-wheel engine 60. Thus, several engine configurations are allowed, and different engine performances are offered.

The lever 82 may comprise a longitudinal portion 96, for instance a first longitudinal portion 96. The first longitudinal portion 96 may connect the main body 80 to the transversal portion 94, for instance at the outboard transversal end thereof. The first longitudinal portion 96 may project longitudinally along the in-wheel engine 60. It may project away from the rotation axis 36.

The current description refers to a single steering unit 32. However, the current teaching may apply to several, or to all the steering units 32 of the bus; respectively the vehicle.

Figure 6 provides a schematic illustration of a steering unit 32 in accordance with the invention.
The current steering unit 32 may be similar or identical to the one as described in relation with figure 5.
The steering unit 32 may comprise a transversal axis T, a longitudinal axis L, a steering knuckle 76 with an in-wheel engine 60 exhibiting a transversal rotation axis 36 which is arranged transversally with respect to the longitudinal axis L. The steering unit 32 may further comprise an actuator mechanism 48 adapted for pivoting the steering knuckle 76 and the wheel 8 rotatably coupled thereon. The steering knuckle 76 may comprise a lever 82 which is linked to the actuator mechanism 48 and which includes a transversal portion 94 extending transversally along the in-wheel engine 60.
As an option, the longitudinal axis L and the transversal axis T may be generalized to a first axis and to the second axis which is inclined with respect to the first axis. The longitudinal axis L and the transversal axis T may be perpendicular to each other, and notably perpendicular to a vertical axis V.
The steering unit 32 in accordance with figure 6 may differ from the teaching of figure 5 in that the tie rod 52 is curved. Consequently, an in-wheel engine 60 with a greater outer diameter may be used. An in-wheel engine with a varying outer diameter too. The total width along the rotation axis 36 may also be increased. Then the maximum power of the in-wheel engine 60 may be increased. According to another advantage, the portion of in-wheel engine 60 outside the wheel 8 may be increased, and the portion of the in-wheel engine 60 inside the wheel 8, namely within the inner cavity 75, may be reduced. Consequently, more place remains in the inner cavity 75, for instance for the brake calliper (not represented). Indeed, the brake calliper may require a powerful second engine at distance from the in-wheel engine 60 which drives the wheel 8.
By contrast with figure 5, the transversal portion 94 may be shorter. The control joint 70 may be totally in the inner cavity 75. It may be at an end of the in-wheel engine 60, and possibly at an end of the stator 60S. Along the transversal rotation axis 36, the tie rod 52 may project over the majority of the in-wheel engine 60.
The position of the ball joints 78 is represented in dotted lines. The centre of the ball joints 78 may be disposed within the in-wheel engine 60 along the transversal rotation axis 36. The positions of the pivot joints 66 along the longitudinal beam 30 may be adapted. Their vertical positions may be adapted as well.
The current description refers to a single steering unit 32 18. However, the current teaching may apply to several, or to all the steering units 32 of the bus; respectively the vehicle.

Figure 7 provides a schematic illustration of a steering unit 32 in accordance with the invention.
The steering unit may be similar or identical to the ones as described in relation with figure 5 and 6.

The steering unit 32 may comprise a transversal axis T, a longitudinal axis L, a steering knuckle 76 with an in-wheel engine 60 exhibiting a transversal rotation axis 36 which is arranged transversally with respect to the longitudinal axis L. The steering unit 32 may further comprise an actuator mechanism 48 adapted for pivoting the steering knuckle 76 and the wheel 8 rotatably coupled thereon. The steering knuckle 76 may comprise a lever 82 which is linked to the actuator mechanism 48 and which includes a transversal portion 94 extending transversally along the in-wheel engine 60.

The lever 82 may include a second longitudinal portion 98. The second longitudinal portion 98 may project from the outboard plate 92. The first longitudinal portion 96 and the second transversal portion 98 may be connected by the transversal portion 94. The longitudinal portions 96 and 98 may embrace the in-wheel engine 60. The control joint 70 may be at a longitudinal end of the second longitudinal portion 98. The second longitudinal portion 98 may be outside the wheel 8, notably outside the inner cavity 75. It projects longitudinally along the in-wheel engine 60, the rim 72, and possibly the tire 74 in form of which the control joint 70 may be disposed.

The position of the ball joints 78 is represented in dotted lines. Along the transversal rotation axis 36, the centre of the ball joints 78 may be disposed within the main body 80, and notably at distance from the in-wheel engine 60.

The current description refers to a single steering unit 32. However, the current teaching may apply to several, or to all the steering units 32 of the bus; respectively the vehicle.

Figure 8 provides a schematic illustration of angles in a steering unit 32. The steering unit 32 may correspond to the ones as described in relation with figures 2 to 7. The longitudinal axis, the transversal axis T and the vertical axis V are provided. The current illustration may be an aerial view.

In the current illustration, the steering angle $\delta$ is increased, and substantially differs from 0° where the transversal rotation axis 36 and the transversal axis T would be parallel. The steering angle $\delta$ may correspond to the inclination between the transversal rotation axis 36 and the transversal axis T. The steering angle $\delta$ may vary from -20° to +20°, possibly -30° to +30°. The position of the currently illustrated transversal rotation axis 36 may be illustrative in order to define angles of the steering unit 32.

The actuator device 50 of the actuator mechanism 48 may comprise a sliding direction 100 along which an entity moves. The main part 58 may be fixed to a second longitudinal beam 102, notably an inboard longitudinal beam. The sliding bar 56 may slide along said sliding direction 100. The transversal hole 54 may be oriented along the sliding direction 100. The sliding direction 100 may be inclined with respect to the longitudinal axis L of an angle ($\alpha$) ranging from 45° to 80°, preferably from 60° to 75°. The sliding direction 100 may be inclined with respect to the transversal axis T of at most: 20°, or 10°. The sliding direction 100 and the transversal rotation axis T may

define an angle (β) ranging from 15° to 45° for the maximal values of the steering angle δ. The angle (β) may range from 0° to 30° when the steering angle δ is null, which means that the transversal rotation axis 36 and the transversal axis are aligned.

The current description refers to a single steering unit 32. However, the current teaching may apply to several, or to all the steering units 32 of the bus; respectively the vehicle.

It should be understood that the detailed description of specific preferred embodiments is given by way of illustration only, since various changes and modifications within the scope of the invention will be apparent to the person skilled in the art. The scope of protection is defined by the following set of claims.

Claims

1. A steering unit (32), notably for a bus (2), the steering unit (32) comprising:
   - a longitudinal axis L,
   - a steering knuckle (76) with an in-wheel engine (60) exhibiting a transversal rotation axis (36) which is arranged transversally with respect to the longitudinal axis L,
   - an actuator mechanism (48) adapted for pivoting the steering knuckle (76),
   - the steering knuckle (76) comprising a lever (82) which is linked to the actuator mechanism (48) and which includes a transversal portion (94) extending transversally along the in-wheel engine (60).

2. The steering unit (32) in accordance with claim 1, wherein the steering unit comprises a brake disk (88); the lever (82), notably the transversal portion (94), extending transversally toward the opposite direction of the brake disk (88).

3. The steering unit (32) in accordance with any one of claims 1 to 2, wherein the steering knuckle (76) comprises a main body (80), notably between the in-wheel engine (60) and the brake disk (88), the lever (82) further comprising a first longitudinal portion (96) connecting the transversal portion (94) to the main body (80).

4. The steering unit (32) in accordance with claim 3, wherein the lever (82) further comprises a second longitudinal portion (98) connecting the transversal portion (94) to the main body (80), the in-wheel engine (60) being disposed transversally between the first longitudinal portion (96) and the second longitudinal portion (98).

5. The steering unit (32) in accordance with any one of claims 3 to 4, wherein the steering knuckle (76) includes an inboard plate (92), the in-wheel engine (60) being disposed between the inboard plate (94) and the main body (80).

6. The steering unit (32) in accordance with any one of claims 1 to 5, wherein the steering unit further comprises an upper arm (62) and a lower arm (64) which are pivotably mounted to the steering knuckle (76), at least one of the upper arm (62) and the lower arm (64) being adapted for being pivotably fixed to a platform (16) or a wheel housing (18) of the bus (2).

7. The steering unit (32) in accordance with any one of claims 1 to 6, wherein the steering unit further comprises a wheel (8) with a rim (72) in which the steering knuckle (76) is

disposed, the rim (72) including an inner cavity (75) in which the transversal portion (94) extends.

8. The steering unit (32) in accordance with any one of claims 1 to 7, wherein the actuator mechanism (48) includes an actuator device (50) and a tie rod (52), said tie rod (52) connecting the lever (82) to the actuator device (50), and possibly the transversal portion (94) to the actuator device (50).

9. The steering unit (32) in accordance with any one of claims 1 to 8, wherein along the transversal rotation axis (36), the transversal portion (94) includes an inboard end and/or an outboard end transversally at distance from the in-wheel engine (60).

10. The steering unit (32) in accordance with any one of claims 1 to 9, wherein the actuator mechanism (48) is disposed below the transversal rotation axis (36), and preferably vertically at distance from the transversal rotation axis (36).

11. The steering unit (32) in accordance with any one of claims 1 to 10, wherein the actuator mechanism (48) includes a sliding bar (56) with a sliding direction (100), the sliding direction (100) and the transversal rotation axis (36) define an angle (β) ranging from 15° to 45°, preferably from 0° to 30°.

12. The steering unit (32) in accordance with any one of claims 1 to 11, wherein the steering knuckle (76) comprises an upper ball joint (78) and a lower ball joint (78) vertically at distance from the transversal portion (94).

13. The steering unit (32) in accordance with any one of claims 1 to 12, wherein the steering unit includes a longitudinal beam (30) with a transversal hole (54), the actuator mechanism (48) being arranged in said transversal hole (54), possibly the sliding bar (56) slides through said transversal hole (54).

14. The steering unit (32) in accordance with any one of claims 1 to 13, wherein the in-wheel engine (60) comprises a first portion, notably an in-board portion, inside the wheel (8); and a second portion, notably an outboard portion, outside the wheel (8).

15. A bus (2) comprising at least one steering unit (32), preferably a plurality of steering units, the steering unit (32) or each steering unit (32) being in accordance with anyone of claims 1 to 14, preferably the bus (2) comprises a passenger platform (16).

16. The bus (2) in accordance with claim 15, wherein the actuator mechanism (48) is arranged within the passenger platform (16), the vertical thickness TH of the passenger

platform representing at most two times the vertical thickness of the actuator mechanism (48).

17. The bus (2) in accordance with any one of claims 15 to 16, wherein the passenger platform (16) comprises a transversal hole (54), the actuator mechanism (48) being connected to the steering knuckle (76) through said transversal hole (54).

18. The bus (2) in accordance with any one of claims 15 to 17, wherein the passenger platform (16) includes a lower plate and an upper plate (39) in contact of a beam (30; 31; 102) to which the actuator mechanism (48) is fixed.

19. The bus (2) in accordance with claim 18, wherein the upper plate (39) forms the passenger floor of the passenger platform (16) and spans over at least the half of the surface of a passenger compartment (40) of the bus (2), the upper plate being distant of at most: 50 cm, or 40 cm from the ground (G).

20. The bus (2) in accordance with any one of claims 15 to 19, wherein the bus is an articulated bus comprising at least two articulated bodies (4), each body (4) comprising at least four, or at least eight identical steering units (32).

**Revendications:**

1. Unité de direction (32), notamment pour un bus (2), l'unité de direction (32) comprenant:

• un axe longitudinal L,

• un porte-fusée de direction (76) avec un moteur (60) intégré dans une roue, le moteur présentant un axe de rotation transversal (36) qui est disposé transversalement par rapport à l'axe longitudinal L,

• un mécanisme d'actionnement (48) adapté pour pivoter le porte-fusée de direction (76),

le porte-fusée de direction (76) comprenant un levier (82) qui est lié au mécanisme d'actionnement (48) et qui comprend une partie transversale (94) s'étendant transversalement le long du moteur (60).

2. Unité de direction (32) selon la revendication 1, caractérisée en ce que l'unité de direction comprend un disque de frein (88) ; le levier (82), notamment la partie transversale (94), s'étend transversalement vers le sens opposé au disque de frein (88).

3. Unité de direction (32) selon l'une quelconque des revendications 1 à 2, caractérisée en ce que le porte-fusée de direction (76) comprend un corps principal (80), notamment entre le moteur (60) et le disque de frein (88), le levier (82) comprenant en outre une première partie longitudinale (96) reliant la partie transversale (94) au corps principal.

4. Unité de direction (32) selon la revendication 3, caractérisée en ce que le levier (82) comprend en outre une deuxième partie longitudinale (98) reliant la partie transversale (94) au corps principal (80), le moteur (60) étant disposé transversalement entre la première partie longitudinale (96) et la deuxième partie longitudinale (98).

5. Unité de direction (32) selon l'une quelconque des revendications 3 à 4, caractérisée en ce que le porte-fusée de direction (76) comprend une plaque intérieure (92), le moteur (60) étant disposé entre la plaque intérieure (94) et le corps principal (80).

6. Unité de direction (32) selon l'une quelconque des revendications 1 à 5, caractérisée en ce que l'unité de direction comprend en outre un bras supérieur (62) et un bras inférieur (64) qui sont montés de manière pivotante sur le porte-fusée de direction (76), au moins un des bras supérieur (62) et inférieur (64) étant adapté pour être fixé de manière pivotante à une plateforme (16) ou à un passage de roue (18) du bus (2).

7. Unité de direction (32) selon l'une quelconque des revendications 1 à 6, caractérisée en ce que l'unité de direction comprend en outre une roue (8) avec une jante (72) dans laquelle le porte-fusée de direction (76) est disposé, la jante (72) comprenant une cavité interne (75) dans laquelle s'étend la partie transversale (94).

8. Unité de direction (32) selon l'une quelconque des revendications 1 à 7, caractérisée en ce que le mécanisme d'actionnement (48) comprend un dispositif d'actionnement (50) et une biellette de direction (52), ladite biellette de direction (52) reliant le levier (82) au dispositif d'actionnement (50), et éventuellement à la partie transversale (94) au dispositif d'actionnement (50).

9. Unité de direction (32) selon l'une quelconque des revendications 1 à 8, caractérisée en ce que, le long de l'axe de rotation transversal (36), la partie transversale (94) comprend une extrémité intérieure et/ou une extrémité extérieure transversalement à distance du moteur (60).

10. Unité de direction (32) selon l'une quelconque des revendications 1 à 9, caractérisée en ce que le mécanisme d'actionnement (48) est disposé au-dessous de l'axe de rotation transversal (36), et de préférence verticalement à distance de l'axe de rotation transversal (36).

11. Unité de direction (32) selon l'une quelconque des revendications 1 à 10, caractérisée en ce que le mécanisme d'actionnement (48) comprend une barre coulissante (56) avec une direction de coulissement (100), la direction de coulissement (100) et l'axe de rotation transversal (36) définissent un angle (β) mesurant de 15° à 45°, de préférence de 0° à 30°.

12. Unité de direction (32) selon l'une quelconque des revendications 1 à 11, caractérisée en ce que le porte-fusée de direction (76) comprend une liaison rotule supérieure (78)

et une liaison rotule inférieure (78) verticalement à distance de la partie transversale (94).

13. Unité de direction (32) selon l'une quelconque des revendications 1 à 12, caractérisée en ce que l'unité de direction comprend une poutre longitudinale (30) avec un orifice transversal (54), le mécanisme d'actionnement (48) étant agencé dans ledit orifice transversal (54), éventuellement la barre coulissante (56) coulisse au travers dudit orifice transversal (54).

14. Unité de direction (32) selon l'une quelconque des revendications 1 à 13, caractérisée en ce que le moteur (60) comprend une première portion, notamment une portion interne, à l'intérieur de la roue (8) ; et une deuxième portion, notamment une portion externe, à l'extérieur de la roue (8).

15. Bus (2) comprenant au moins une unité de direction (32), de préférence plusieurs unités de direction, caractérisé en ce que l'unité de direction (32) ou chaque unité de direction (32) étant conforme à l'une quelconque des revendications 1 à 14, de préférence le bus (2) comprend une plateforme pour passagers (16).

16. Bus (2) selon la revendication 15, caractérisé en ce que le mécanisme d'actionnement (48) est agencé à l'intérieur de la plateforme pour passages (16), l'épaisseur verticale TH de la plateforme pour passagers représentant au plus deux fois l'épaisseur verticale du mécanisme d'actionnement. (48).

17. Bus (2) selon l'une quelconque des revendications 15 à 16, caractérisé en ce que la plateforme pour passagers (16) comprend un orifice transversal (54), le mécanisme d'actionnement (48) étant relié au porte-fusée de direction (76) au travers dudit orifice transversal (54).

18. Bus (2) selon l'une quelconque des revendications 15 à 17, caractérisé en ce que la plateforme pour passagers (16) comprend une plaque inférieure et une plaque supérieure (39) en contact d'une poutre (30 ; 31 ; 102) à laquelle le mécanisme d'actionnement (48) est fixé.

19. Bus (2) selon la revendication 18, caractérisé en ce que la plaque supérieure (39) forme le plancher pour passagers de la plateforme pour passagers (16) et s'étend sur au

moins la moitié de la surface d'un habitacle (40) du bus (2), la plaque supérieure étant éloignée d'au plus : 50 cm, ou 40 cm, du sol (G).

20. Bus (2) selon l'une quelconque des revendications 15 à 19, caractérisé en ce que le bus est un bus articulé comprenant au moins deux corps (4) articulés, chaque corps (4) comprenant au moins quatre ou au moins huit unités de direction (32) identiques.

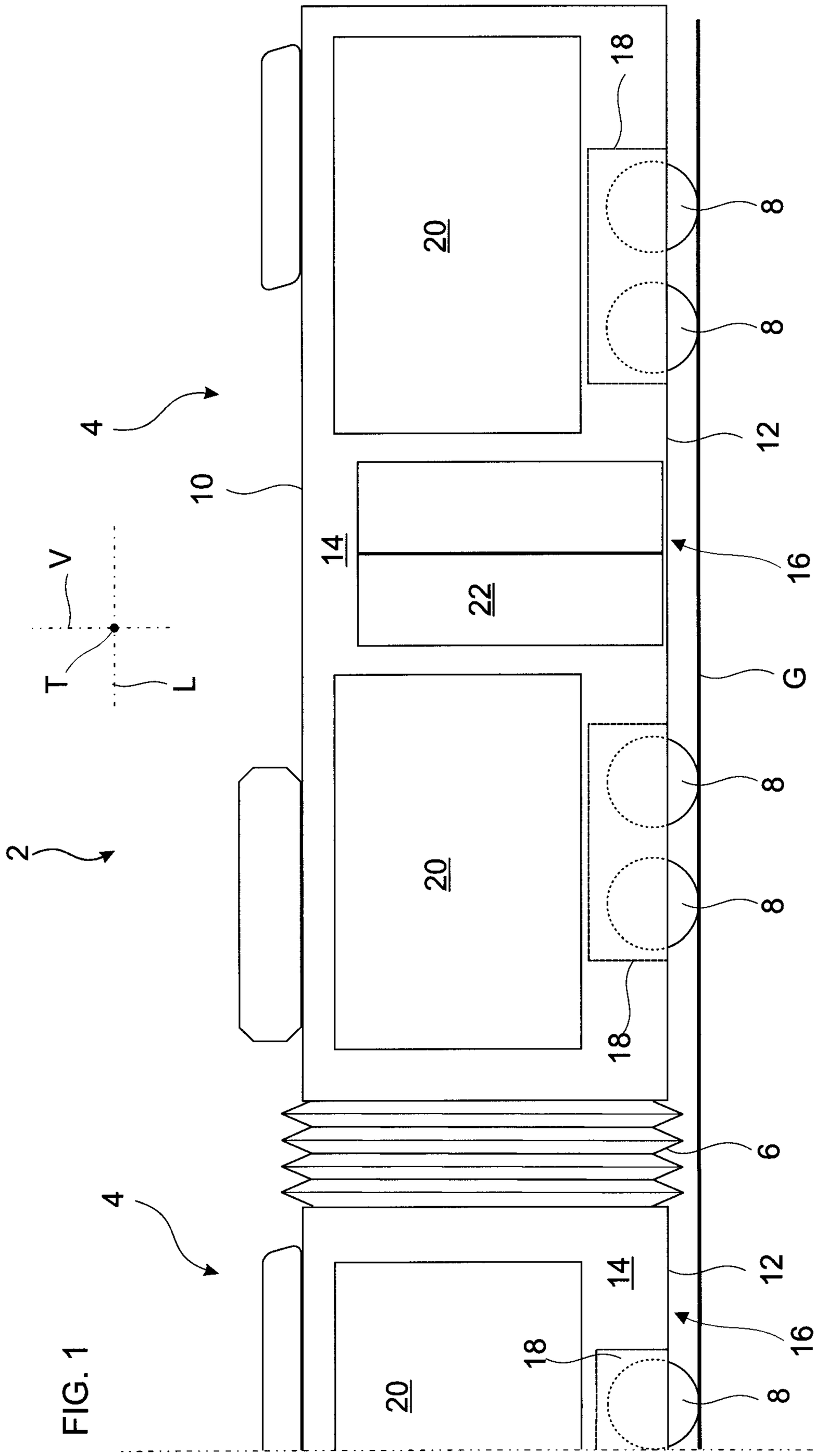



FIG. 1

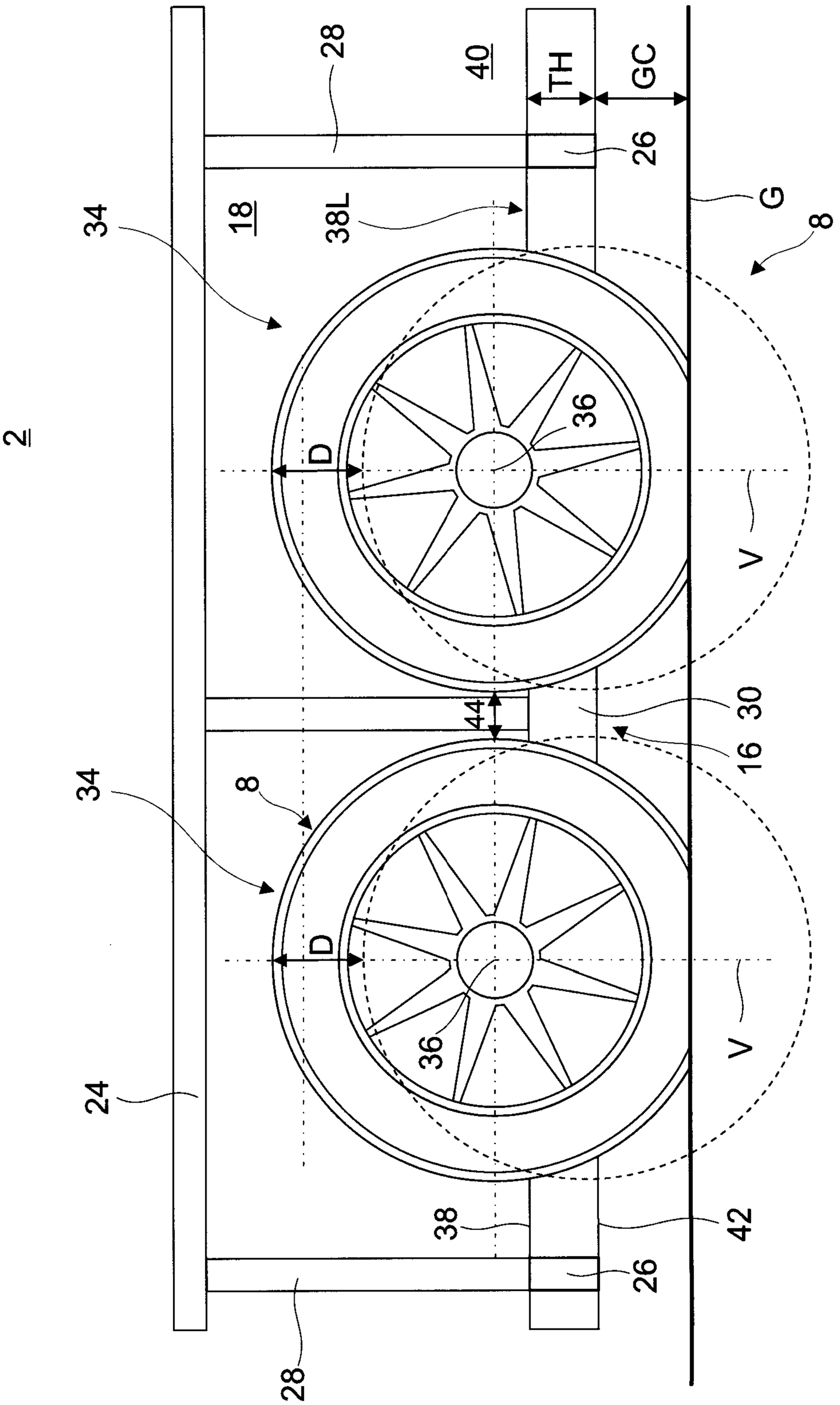
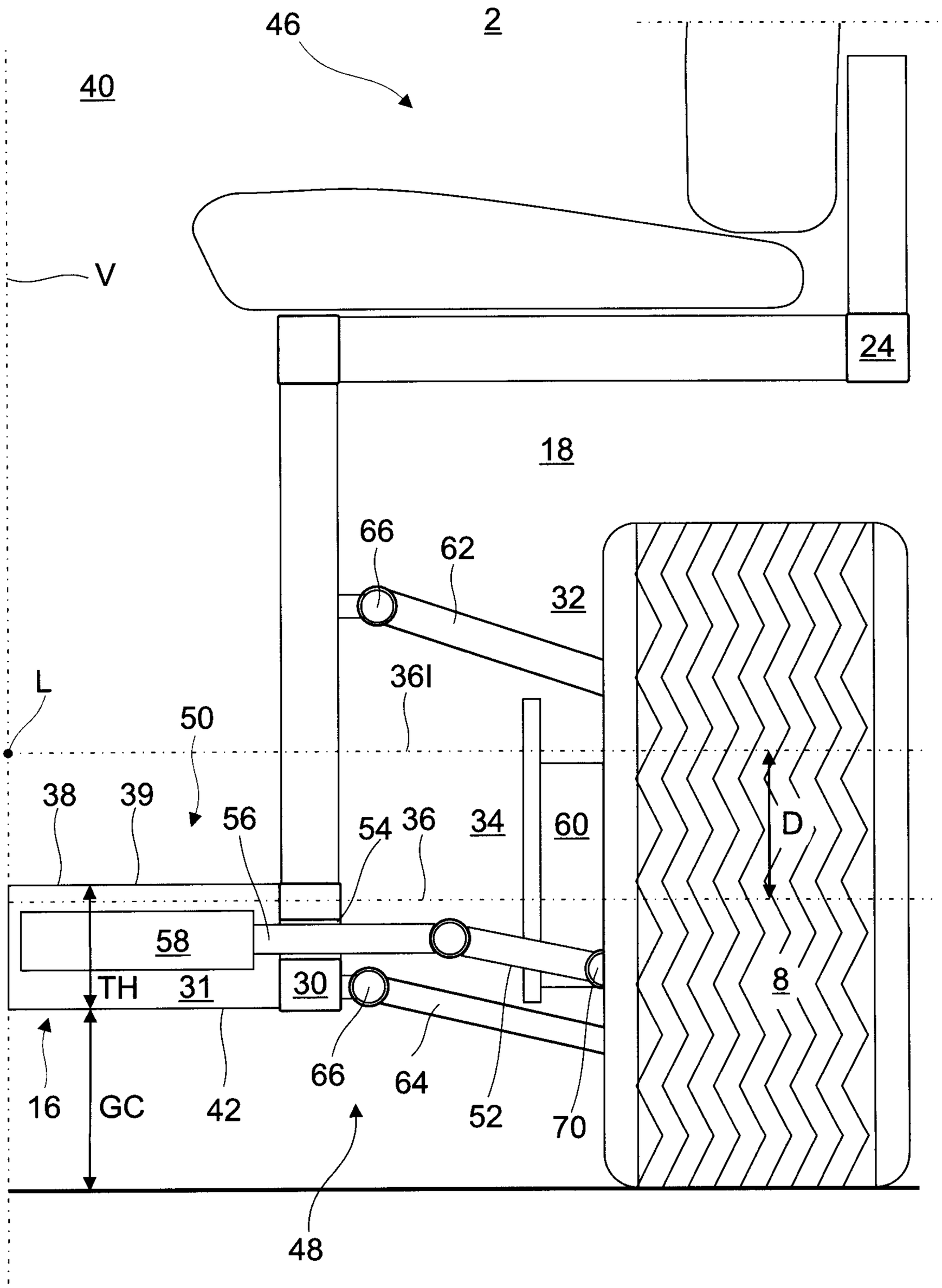



FIG. 2

FIG. 3


46
2
40
V
24
18
66
62
32
L
50
36I
38
39
56
54
36
34
60
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TH
31
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8
16
GC
42
66
64
52
70
48

FIG. 4

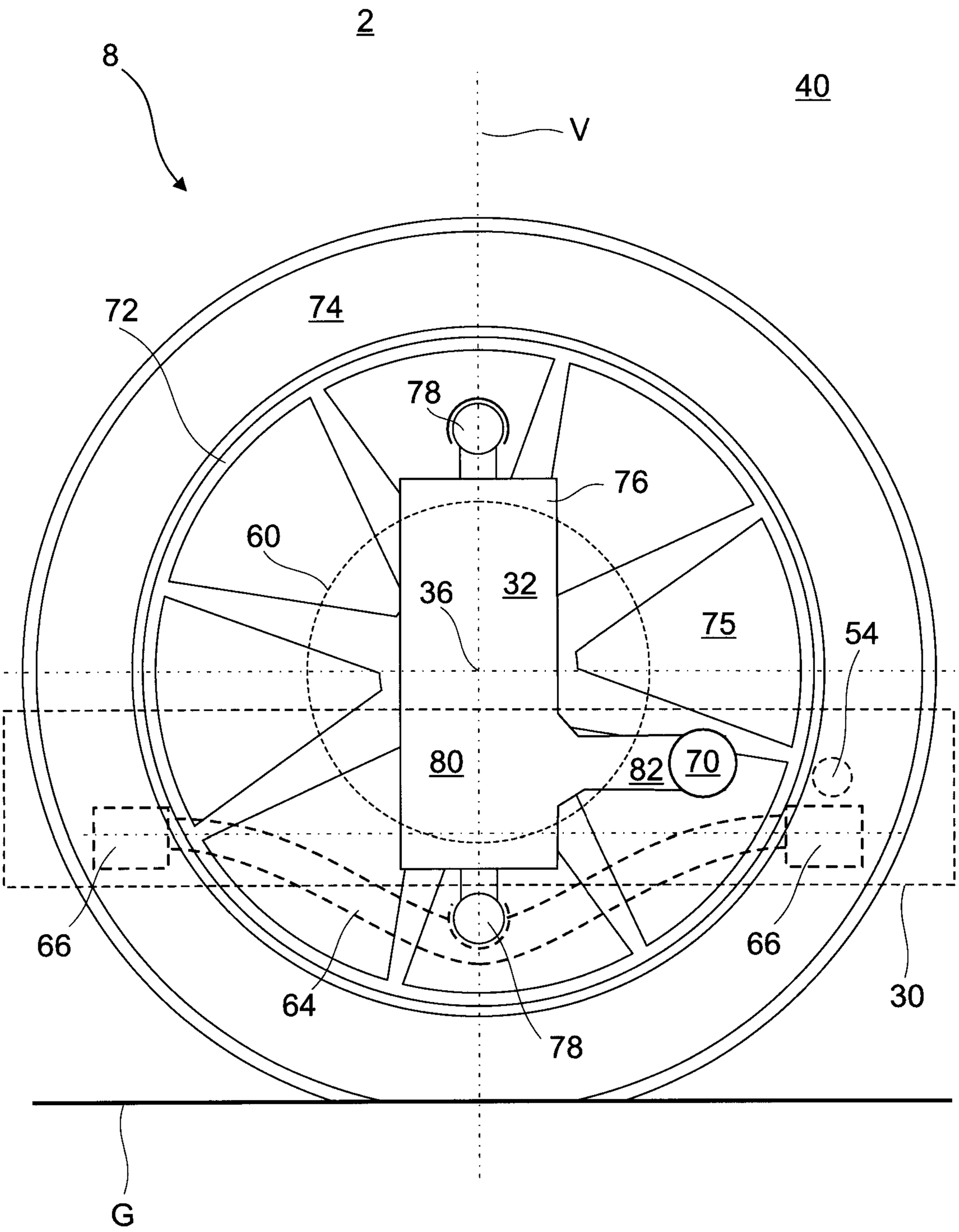
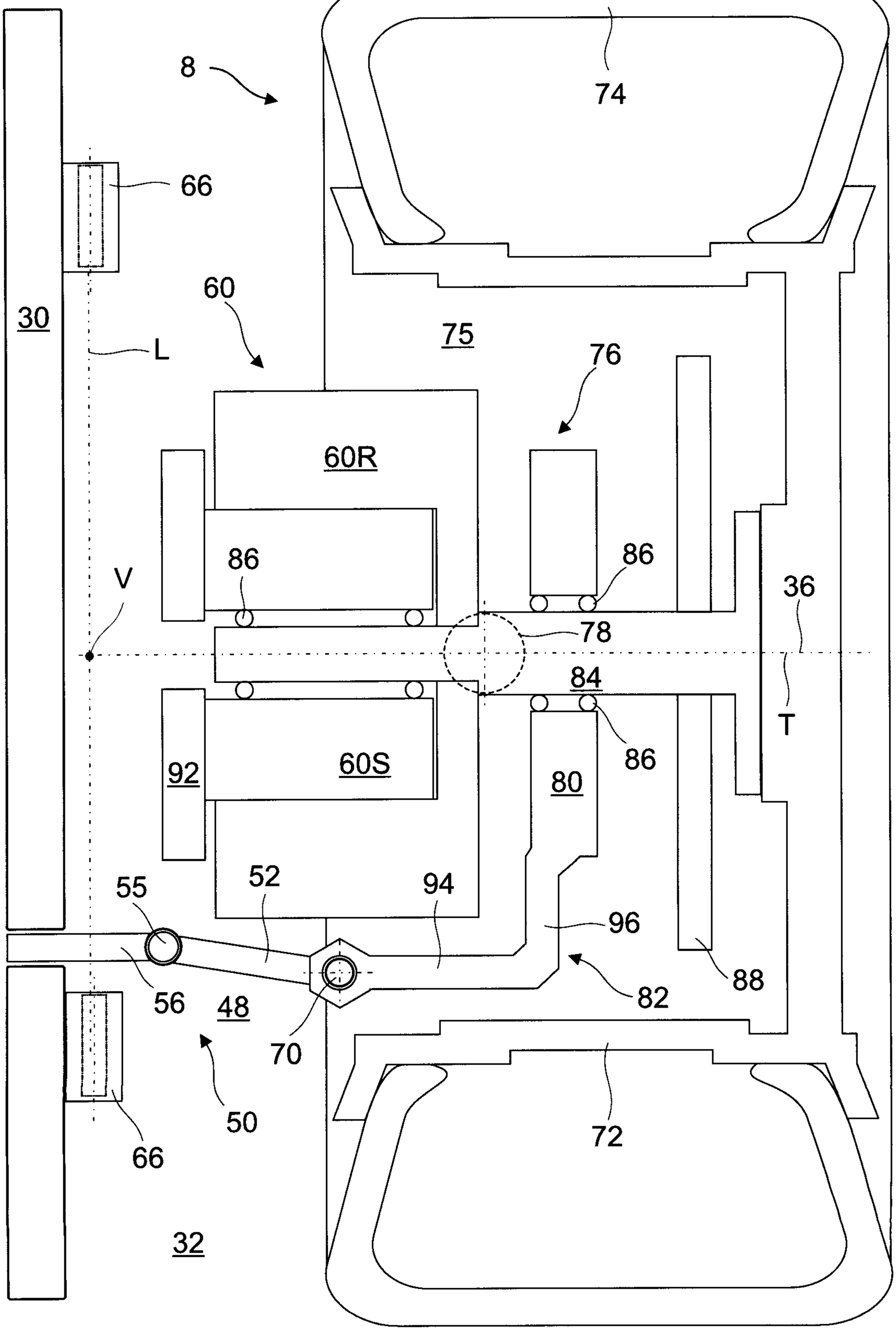


FIG. 5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L
75
76
60R
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36
78
84
T
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FIG. 6

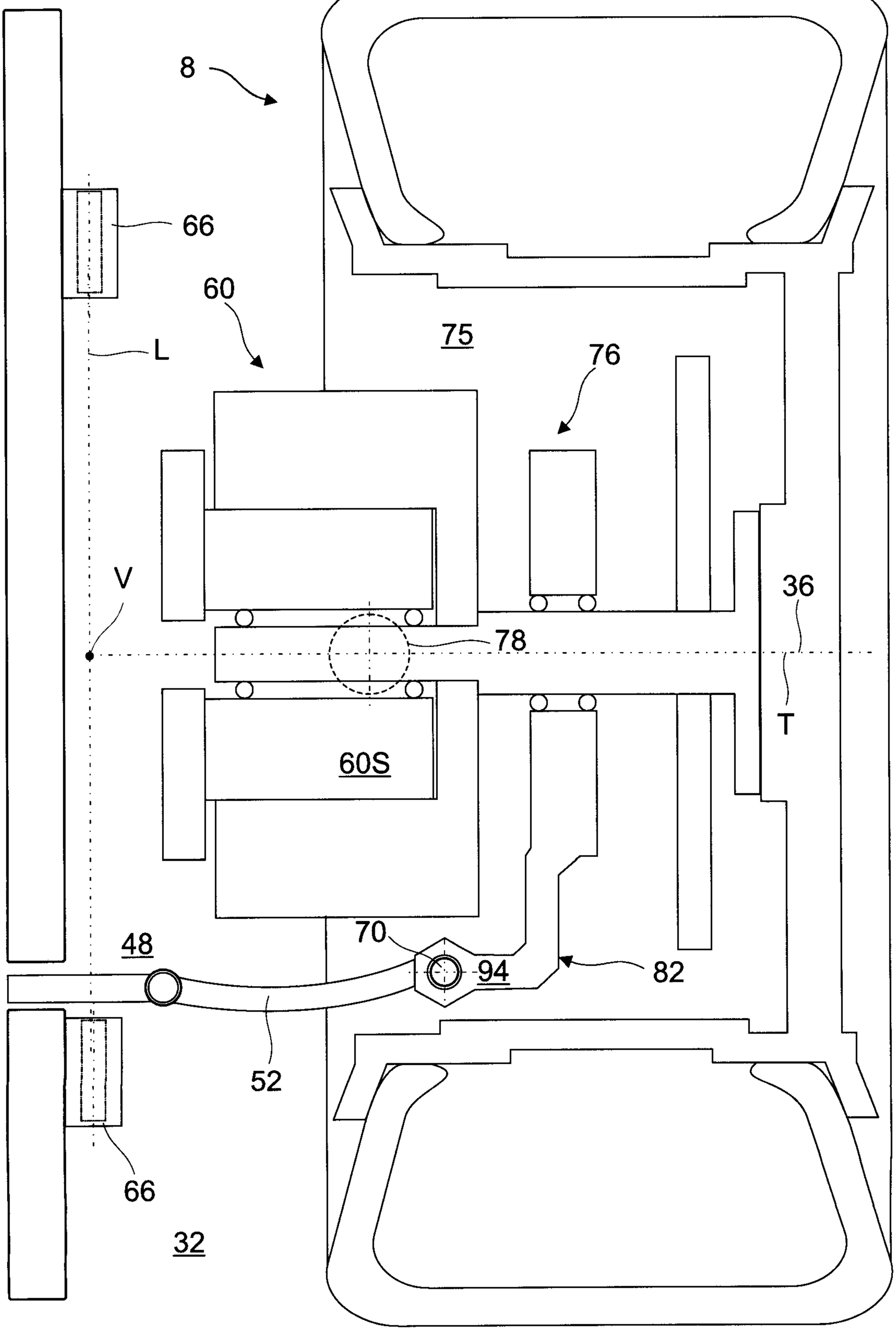

FIG. 7

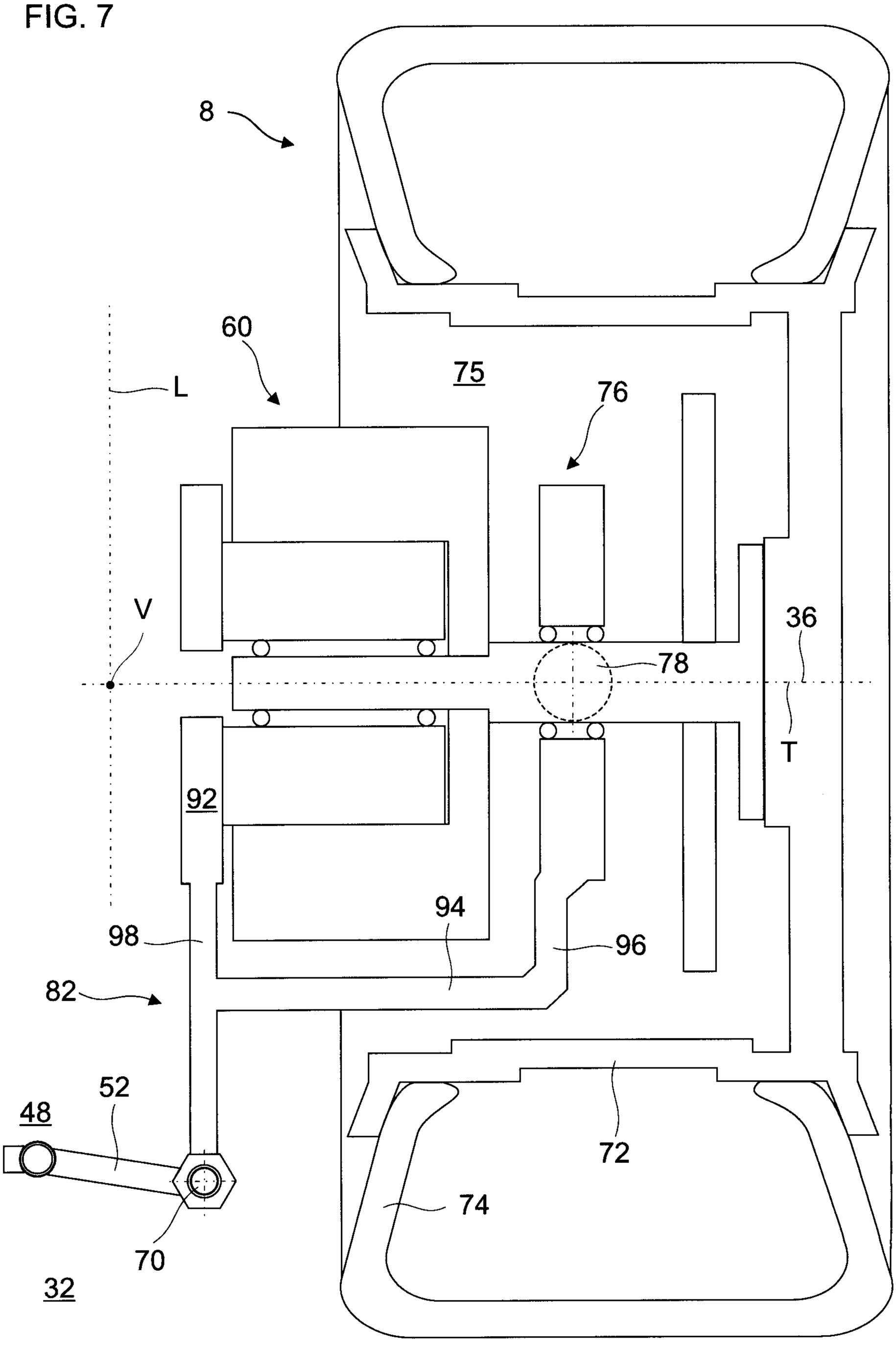

FIG. 8