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The present invention relates to a rail vehicle according to preamble of claim 1 with a car body and a first running gear with at least one first wheel unit having two speed-coupled wheels, wherein the car body has a longitudinal axis, a transverse axis and a vertical axis, and the car body is supported directly on the first wheel unit by means of a spring stage.

In the case of rail vehicles, in particular locomotives, running gears are often used in the form of bogies with a two-stage suspension. In these bogies, a bogie frame is initially supported on the wheel units by means of a so-called primary spring stage, while the car body is then supported on the bogie frame via a so-called secondary spring stage. Although a good boring behavior of the running gear with respect to the car body can be achieved with this, this is advantageous when driving on track curves. The design of the running gear as a bogie, on the one hand, has the disadvantage that it is comparatively complex and requires a comparatively large amount of space. On the other hand, comparatively long distances are to be traced from the wheels into the car body during the tractive force transmission, and the components have to be dimensioned appropriately in the flux of the force.

Furthermore, vehicles of the low-floor type according to the invention are known with a single-stage suspension in which the car body is supported directly on the wheel units of the undercarriage by means of only one spring stage. Such a generic vehicle is, for example, the tram of the company Alstom, FR, which is designated by the name "Citadis", in which the running gears designated by the name "Arpège" are used. In these generic vehicles according to the invention, the wheel bearings of two wheel units of a running gear are articulated in the longitudinal direction at the running gear sides in each case by way of a longitudinal beam so that the two wheel units are guided in the transverse direction of the vehicle relative to one another in the manner of a parallel guide. This has the disadvantage that although the wheel units can follow the respective transverse offset with respect to the car body when driving on track curves, the wheel units can result in comparatively steep starting angles of the wheel rims on the rails, which are connected with corresponding wear of the wheel and rail and the corresponding noise windings.

Finally, EP 0 177 460 A2 discloses a rail vehicle in which a car body is supported directly on wheel units by means of a spring stage, each wheel being rotatable independently of one another. In each case, the wheel units are pivoted about the vertical axis of rotation on the car body via a two-armed coupling. A turning movement of the respective wheel set about a vertical axis, which slightly reduces the starting angle of the wheel rims on the rails, is nevertheless achieved here when driving on track curves, yet the starting angles are still comparatively high here.

Document US 4,823,706 A describes a generic rail vehicle. EP 0 649 782 A1, EP 0 803 425 A1 and DE 876 249 C describe further rail vehicles with coupled wheel sets.

It is therefore an object of the present invention to provide a railway vehicle of the type mentioned at the outset which does not have the disadvantages mentioned above or at least to a significantly lesser extent and, in particular, has a more favorable wear behavior when traveling on track curves in a simple and cost-effective manner.

The present invention solves this task from a rail vehicle according to the preamble of claim 1 by the features indicated in the characterizing clause of claim 1.

The present invention is based on the technical theory that a more favorable wear behavior is obtained when the first wheel unit is pivoted on the car body in such a way that the first wheel unit is displaced with respect to the car body in the direction of the transverse axis, as occurs when driving on track curves, a turning movement about a turning axis extending in the direction of the vertical axis is imparted. As a result of this turning movement, a reduction in the starting angle is achieved which is advantageously further supported by the speed coupling of the wheels of the first wheel unit and the resulting turning moment acting on the wheel unit in the same direction so that, compared to the known rail vehicles, there is a considerable reduction of the starting angle and thus the wear of the wheel and the rail as well as the noise development.

According to one aspect, the present invention therefore relates to a rail vehicle with a car body and a first running gear which has at least a first wheel unit with two speed-coupled wheels, where the car body has a longitudinal axis, a transverse axis and a vertical axis and the car body is supported on the first wheel unit by means of a spring stage. The first wheel unit is pivoted on the car body by means of a turning device, whereby the turning device is designed such that it imparts (imposes) a turning movement about a vertical axis to the first wheel unit when a wheel of the first wheel unit deflects in the direction of the longitudinal axis of the car body.

The rotational speed coupling of the wheels of the first wheel unit can be solved in any suitable manner, for example via an appropriate transmission. However, the design is particularly simple and robust if the first wheel unit is designed as a wheel set, i.e. as a wheel unit, with a wheel set shaft connecting the two wheels in a rotationally fixed manner. This also applies, of course, to all further wheel units mentioned in the following.

The turning device can be pivoted at any suitable location on the wheel unit. For example, it can be pivoted in the space between the wheels. Furthermore, it can be pivoted at any component of the wheel unit, for example in the case of a wheel set, by means of a corresponding coupling on the wheel set shaft. The turning device is preferably pivoted on the wheel set bearings of the wheel unit, since in this case a particularly simple linkage with a high supporting width is possible. It is particularly advantageous if the first wheel unit has external wheel bearings and the turning device is pivoted on the wheel bearings.

The first running gear comprises a second wheel unit with two speed-coupled wheels, in particular a wheel set, on which the car body is directly supported by a spring stage. The turning device is then connected to the second wheel unit in such a way that it also imparts a turning movement to the second wheel unit about a turning axis extending in the direction of the vertical axis when a wheel of the second wheel unit is deflected in the direction of the longitudinal axis of the car body.

The turning device is designed in such a way that it imparts synchronous turning movements to the first wheel unit and the second wheel unit.

In principle, the turning device can be configured in any suitable manner in order to achieve the desired turning movement during the deflection of a wheel of the wheel units in the direction of the longitudinal axis. According to the invention, the turning device has at least one first transverse beam. The first transverse beam extends in the transverse direction of the car body and has a first end, a second end and a middle section lying between the first end and the second end. The first transverse beam is pivoted in its center section about a pivot axis extending in the direction of the vertical axis on the car body while it is coupled at its first end and its second end to the first wheel unit. In particular, a defined force input from the first wheel unit into the car body can be achieved in a particularly short way by means of a few components, as a result of which the design of the components located in the flux of the force and thus the complexity of the running gear is considerably reduced.

The linkage of the first transverse beam to the first wheel unit can in principle be solved in any suitable manner. For example, it can be provided that a simple single-axle or multi-axle joint connection is provided between the first transverse beam and the first wheel unit. According to the invention, the first transverse beam is coupled at its first end and its second end to the first wheel unit via a respective first link device. In this case, use is preferably made of guides which are designed in a sufficiently well-known manner and have rubber bracing elements which are capable of compensating for distance and / or angular deviations. Further on, preferably, the respective first link device comprises a first longitudinal link which, in the unloaded condition of the running gear, extends in a plane parallel to the longitudinal center plane of the vehicle so that a notably good force input from the wheel unit in the transverse beam and hence in car body can be achieved.

In the case of advantageous variants of the rail vehicle according to the invention, a further wheel unit is provided which is also pivoted on the first transverse beam and which a respective (generally synchronous) turning movement is thereby imposed. Accordingly, the first running gear comprises a second wheel unit with two speed-coupled wheels, in particular a wheel set, whereby the car body is supported directly on the second wheel unit via a spring stage. The first transverse beam is then coupled at its first end and its second end to the second wheel unit.

Again, the coupling of the first transverse beam to the second wheel unit can again be solved in any suitable manner. However, the first transverse beam is preferably coupled at its first end and its second end to the second wheel unit via a respective second link device. Preferably, also in this case, the respective second link device comprises a second longitudinal link which, in the unloaded condition of the running gear, extends in a plane parallel to the longitudinal center plane of the vehicle.

In other variants of the rail vehicle according to the invention, however, a separate second transverse beam of the turning device can also be provided, by means of which a corresponding turning movement is imposed to the second wheel unit. Accordingly, the first running gear comprises a second wheel unit with two speed-coupled wheels, in particular a wheel set, on which the car body is directly supported by a spring stage. The turning device then has at least one second transverse beam which extends in the transverse direction of the car body and has a first end, a second end, and a middle section lying between the first end and the second end. The second transverse beam is pivoted in its center section about a pivot axis extending in the direction of the vertical axis on the car body and is coupled at its first end and its second end to the second wheel unit.

The provision of separate transverse beams for the two wheel units has the advantage that a desired ratio between the turning movement of the first wheel unit and the second wheel unit can be achieved in a simple manner. For example, a virtually arbitrarily pre-determinable transmission ratio between the two turning motions can be achieved by means of a corresponding coupling of the two transverse beams, for example a corresponding transmission.

Also here, the articulation of the second transverse beam on the second wheel unit can again take place in any suitable manner. Preferably, again, provision is also made here for the second transverse carrier to be coupled at its first end and its second end to the second wheel unit via a respective link device. Also in this case, the respective link device again comprises a longitudinal link which, in the unloaded condition of the first running gear, extends in a plane running parallel to the longitudinal center plane of the vehicle due to the favorable force introduction.

The first transverse beam and the second transverse beam can be designed without mutual mechanical coupling so that the turning movements of the first wheel unit and the second wheel unit are independent of one another. However, it is preferably provided that the first transverse beam and the second transverse beam are coupled to one another via a coupling device in order to achieve a desired favorable relationship between the turning movement of the first wheel unit and the second wheel unit.

In preferred variants of the rail vehicle according to the invention, the first transverse beam and the second transverse beam have a neutral setting in the unloaded state of the first running gear. The coupling device then comprises at least one coupling spring device which is designed and / or arranged in such a way that it counteracts a deflection of the first transverse beam and the second transverse beam from the neutral setting by an elastic resetting force. This makes it possible, for example, for the wheel units to be arch-radially adjusted against the resetting force of the coupling device when passing through track curves, while the coupling device in the straight track section returns to a favorable neutral position under dynamic aspects. Hence, in this case, the coupling device can additionally comprise a damping device which is connected to the two transverse beams and which dampens the relative movements between the two transverse beams and thus contributes to the improvement of the running properties in the straight track.

The coupling device can basically be connected to the two transverse carriers at any suitable location. Thereby, it can be exclusively connected to the transverse beams. In the case of advantageous variants of the rail vehicle according to the invention, the pivotable coupling of at least one of the transverse beams to the car body takes place via the coupling device, which is then arranged correspondingly pivotably on the car body. Preferably, the coupling device is therefore pivotally mounted on the car body via a pivot pin about a pivot axis extending in the direction of the vertical axis.

In order to achieve a defined movement of the relevant transverse beams on the car body in these variants, it is preferably provided that the coupling device is at least substantially rigidly connected to the first transverse beam about an axis extending in the direction of the vertical axis. A compensation of relative movements between the car body and the relevant wheel unit in the direction of the vertical axis, as, for example, occurs during the compression of the spring stage between the car body and the wheel unit, can, for example, be achieved via a corresponding configuration of the respective coupling between the coupling device and the first transverse beam. For example, a coupling which can be pivoted about an axis extending in the transverse direction can be provided. In particular, however, the coupling device can also be formed in one piece with the first transverse beam. A compensation of relative movements between the car body and the relevant wheel unit in the direction of the vertical axis can then take place, for example, via a corresponding design of the pivot pin.

The connection between the second transverse beam and the coupling device can optionally correspond to the connection between the first transverse beam and the coupling device. In other variants of the rail vehicle according to the invention, it is provided that the coupling device is pivotally connected to the second transverse beam about an axis running in the direction of the vertical axis. This makes a counter-coupling between the turning movement of the first wheel unit and the turning movement of the second wheel unit possible, which allows, for example, an arc-radial adjustment of the wheel units when passing through track curves.

Likewise the connection between the coupling device and the first transverse beam, the coupling device here can at least be connected rigidly to the second transverse carrier about an axis running in the direction of the vertical axis. In particular, the coupling device can also be designed in one piece with the second transverse beam.

The first transverse beam and / or the second transverse beam can basically be configured in any suitable manner. Preferably, the first transverse beam and / or the second transverse beam has an angled configuration with a first and second end pointing in the direction of the associated wheel unit. Hereby, a favorable flux of force in the transverse beam can be achieved.

The invention can be used both for driven and non-driven running gears. The drive can be designed in any desired manner. In particular, the transmission of the drive torque to the wheels of the wheel unit can take place in any known manner. Thus, for example, the drive torque can be transmitted to the wheels of the wheel unit via a corresponding transmission from a motor arranged outside the running gear. Preferably, a drive-internal drive is provided. For this purpose, a first drive motor unit, which is supported on the first wheel unit, for example by means of a tamping bearing, is preferably provided. In this case, the first transverse beam is preferably connected essentially rigidly to the first drive motor unit, so that a compact and robust unit is formed. It is further preferably provided that the first transverse beam is an integral component of the first drive motor unit, for example, is formed by the housing of the drive motor unit in order to achieve a particularly space-saving configuration.

In order to support the drive torque, the first drive motor unit can be supported on the car body via a first support device, in particular at least one first torque support. Preferably, the first support device is then arranged, in particular, on the side of the first transverse support facing away from the first drive motor unit. This results in a large supporting length and, accordingly, a lower supporting force on the torque support, whereby the components involved in the support can be correspondingly simplified. Furthermore, this is also advantageous with regard to a smaller reduction of the wheel contact forces on the wheel unit (resulting from a specific direction of rotation of the drive). Accordingly, a high tractive power can always be transmitted to the rails.

Analogously to the drive of the first wheel unit, a corresponding drive can also be provided for the second wheel unit. Preferably, also in this case, a second drive motor unit, which is supported on the second wheel unit, is provided, whereby the second transverse beam is connected essentially rigidly to the second drive motor unit, in particular an integral component of the second drive motor unit. Likewise, the second drive motor unit can, in turn, be supported on the car body via a second support device, in particular at least one second torque support, the second support device being arranged in particular on the side of the second transverse support facing away from the second drive motor unit.

In the case of further preferred variants of the rail vehicle according to the invention, the turning device comprises a first turning unit and a second turning unit, whereby the first turning unit and the second turning unit are mounted on different sides of the car body, on the car body and on the first wheel unit. The first turning unit and the second turning unit are coupled to one another mechanically by way of a coupling unit in such a way that they impart a turning movement about a vertical axis to the first wheel unit when a wheel of the first wheel unit deflects in the direction of the longitudinal axis of the car body.

The first turning unit and the second turning unit as well as the coupling unit can be designed in any suitable manner. For example, it is possible for the turning units to be formed by a respective hydraulic cylinder, which is connected on the one hand to the car body and, on the other hand, to the wheel unit, and whose working chambers are coupled in opposite directions to one another as a coupling unit to effect the desired turning movement. Any suitable mechanical transmission can also be provided which produces the desired turning movement. Of course, any combination of hydraulic and mechanical transmissions is also possible. Thus, for example, the coupling unit can be designed as a hydraulic component, while the turning units are purely mechanical components.

Preferably, the first turning unit comprises a first angle lever with a first free lever end and a second free lever end while the second turning unit comprises a second angle lever with a third free lever end and a fourth free lever end. The respective angle lever is pivoted about the pivot axis extending transversely to the longitudinal axis on the car body. The first lever end of the first angle lever is pivoted on the first wheel unit, in particular by way of a first connecting link, while the third lever end of the second angle lever is pivoted on the first wheel unit, in particular via a second connecting link. The second lever end of the first angle lever and the fourth lever end of the second angle lever are in turn connected to one another via the coupling unit. This results in a particularly simple and small design with few robust components.

The coupling unit may be designed in any suitable manner. For example, a hydraulic coupling can be provided by the second lever end and the fourth lever end acting on hydraulic cylinders, whose working spaces are correspondingly coupled. Likewise, a purely mechanical coupling can take place via a simple coupling rod or the like extending in the transverse direction of the car body. Preferably, the first running gear comprises a second wheel unit with two wheels, in particular a second wheel set, on which the car body is directly supported by a spring stage and which forms the coupling unit. Hereby, on the one hand, an additional component for coupling the angle levers can advantageously be dispensed. On the other hand, the angle levers can take over the transverse guidance of the second wheel unit.

In further preferred variants of the rail vehicle according to the invention, the turning device has at least one turning unit with a first coupling shaft, a first coupling lever and a second coupling lever. In this case, the coupling shaft has a longitudinal axis which extends in the direction of the transverse axis of the car body and is rotatably mounted on the car body about an axis of rotation parallel to the transverse axis of the car body. The first coupling lever is arranged at a first end of the coupling shaft and is braced on the first wheel unit, in particular via a first coupling rod. The second coupling lever is arranged at a second end of the coupling shaft and is braced on the first wheel unit, in particular via a second coupling rod. The first coupling lever and the second coupling lever are arranged so as to rotate with respect to the longitudinal axis of the coupling shaft so that the turning movement about the vertical axis is imparted to the first wheel unit when a wheel of the first wheel unit is deflected in the direction of the longitudinal axis of the car body. By using such a torsion shaft, a particularly space-saving configuration can be achieved since the torsion shaft must only be able to rotate about its longitudinal axis so that only a small space is required for the torsion shaft to be driven from one vehicle side to the other.

The first coupling lever and the second coupling lever can, in principle, be rotated about an arbitrary suitable angle to one another, as long as it is ensured that a corresponding turning movement is still imparted to the first wheel unit during a rotation of the coupling shaft. Preferably, the first coupling lever and the second coupling lever are arranged at least 60 °, preferably at least 120 °, furthermore preferably 180 ° relative to the longitudinal axis of the coupling shaft. In the case of an arrangement of the levers deviating from 180 °, a favorable influence on the driving dynamics and / or the wear behavior can be taken over by the resulting differences in the movement of the two wheel units.

The turning unit with the coupling shaft with the coupling levers can be used for individual wheel units. However, it is particularly advantageous in the case of running gears with a plurality of wheel units since, in a simple manner, it permits an almost freely selectable transmission between the turning movement in the first wheel unit and an adjacent second wheel unit. Accordingly, it is preferably provided that the first running gear comprises a second wheel unit with two speed-coupled wheels, in particular a wheel set, on which the car body is directly supported by a spring stage, and the turning unit is coupled to the second wheel unit.

The coupling of the turning unit to the second wheel unit can take place via further coupling levers. However, it is preferably provided that the first wheel unit is connected to the first coupling lever via a first coupling rod and to the second coupling lever via a second coupling rod and that the second wheel unit is connected to the first coupling lever via a third coupling rod and to the second coupling rod via a fourth coupling rod. The radial distance between the articulation points of the coupling rods on the first coupling lever and the second coupling lever relative to the longitudinal axis of the coupling shaft is selected such that a predeterminable transmission results between the turning movement of the first wheel unit and the turning movement of the second wheel unit.

This coupling can be applied at any point on the vehicle. It is particularly advantageous in the region of an end running gear of the vehicle since, for example, a stronger turning movement of the wheel unit located closer to the vehicle end can be achieved here than in the wheel unit further away from the vehicle end. This ultimately leads to an advantageous arc-radial adjustment of the wheel units when passing through track curves. Thus, the first wheel unit is preferably a wheel unit nearest to an end of the vehicle. In order to achieve a support between the first turning movement and the second turning movement, the radial distance between the articulation points of the first coupling rod and the second coupling link on the first coupling lever and the second coupling lever is greater than the radial distance between the articulation points of the third coupling rod and the fourth coupling rod on the first coupling lever and the second coupling lever.

The coupling rods can, in turn, be arranged in any desired manner. Preferably, again they also run in the unloaded condition of the running gear in a plane which runs parallel to the longitudinal center plane of the vehicle in order to achieve a favorable force input.

The present invention can be applied to any number of running gears of a rail vehicle. Thus, it is possible to connect only one of the running gears of the rail vehicle to the car body in the manner described above. Preferably, however, a plurality of running gears is connected to the car body in the manner described above. In advantageous variants of the rail vehicle according to the invention, a second running gear is provided, which is designed and arranged essentially symmetrically to the first running gear with respect to a transverse plane of the car body which is perpendicular to the longitudinal axis of the car body. The wheel units of the two running gears are then coupled to one another in a symmetrical manner by means of corresponding turning devices, so that a correspondingly favorable adjustment of the wheel units takes place, in particular in the case of travelling through curve, independently of the direction of travel of the vehicle.

The spring stages, by means of which the car body is directly supported on the respective wheel unit, can be designed in any suitable manner and connected to the car body. Preferably, at least one of the spring stages, by means of which the vehicle body is supported directly on a wheel unit, is connected to the car body via a tilting rail, as a result of which the turning of the wheel unit relative to the car body is facilitated.

The present invention can be used for any rail vehicle. Of particular advantage is the use of locomotives. Preferably, the rail vehicle according to the invention is accordingly designed in the manner of a locomotive.

Further preferred embodiments of the invention result from the subclaims or the following description of preferred exemplary embodiments, which refers to the attached drawings.

Figure 1 shows a schematic side view of a preferred embodiment of the rail vehicle according to the invention;

Figure 2 is a schematic sectional view along line II-II from FIG. 1;

Figure 3 shows a schematic section through a further preferred embodiment of the rail vehicle according to the invention;

Figure 4 shows a schematic section through a further rail vehicle which is not part of the invention;

Figure 5 shows a schematic section through a further preferred embodiment of the rail vehicle according to the invention;

Figure 6 shows a schematic section through a further rail vehicle which is not part of the invention;

Figure 7 shows a schematic section through a further rail vehicle which is not part of the invention;

Figure 8 shows a schematic section through a further rail vehicle which is not part of the invention;

Figure 9 is a schematic side view of a further rail vehicle which is not part of the invention;

Figure 10 is a schematic sectional view along line X - X from FIG. 9.

First Embodiment

A first preferred embodiment of the railway vehicle according to the invention is described below with reference to FIGS. 1 and 2. FIGS. 1 and 2 show schematic representations of a part of a railway vehicle according to the invention in the form of a locomotive 101. The vehicle 101 comprises a car body 102, which is supported on a plurality of running gears, inter alia on a first running gear 103.

The car body 102 comprises a longitudinal axis 102.1, a transverse axis 102.2 and a vertical axis 102.3, which run parallel to the depicted coordinate axes x, y, z in the straight horizontal track in the rest position of the vehicle 101, shown in FIGS 1 and 2.

The vehicle body 102 is supported by a single-stage suspension on the running gear, i.e. it is supported by a single spring stage 104 on a first wheel unit in the form of a first wheel set 105 and by a single spring stage 106 on a second wheel unit in the form of a second wheel set 107. The spring stage 104 comprises a first spring unit 104.1 by means of which the car body 102 is supported directly on the first wheel set bearing 105.1 of the first wheel set 105, and a second spring unit 104.2 by means of which the car body 102 is supported directly on the second wheel set bearing 105.2 of the first wheel set 105 Is. Analogically, the spring stage 106 comprises a third spring unit 106.1 by means of which the car body 102 is supported directly on the third wheel bearing 107.1 of the second wheel set 107 and a fourth spring unit 106.2 by means of which the car body 102 is supported directly on the fourth wheel set bearing 107.2 of the second wheel set 107.

Between the spring units 104.1, 104.2, 106.1, 106.2 and the car body, a sufficiently known tilting rail 104.3 or 106.3 is provided, thereby facilitating the unscrewing of the respective wheel set 105, 106 relative to the car body 102.

The first wheel set 105 and the second wheel set 108 are furthermore connected to the car body 102 via a turning device 108. The reversing device 108 is arranged in the space between the first wheel set 105 and the second wheel set 106.

The reversing device comprises a first transverse beam 108.1, which is pivotally mounted in its center region about a pivot axis parallel to the vertical axis 102.3 of the car body 102 on a pivot 108.2. The first transverse beam 108.1 extends in the direction of the transverse axis 102.2 of the car body from the one longitudinal side of the vehicle to the other longitudinal side of the vehicle.

On the one hand, at its first end, the first transverse beam 108.1 is coupled to the first wheel bearing 105.1 of the first wheel set 105 via a first longitudinal link device in the form of a first longitudinal link 108.3. On the other hand, the first transverse beam 108.1 is coupled at its first end to the third wheel bearing 107.1 of the second wheel set 107 via a second longitudinal rod device in the form of a second longitudinal link 108.4.

On the one hand, at its second end, the first transverse beam 108.1 is coupled to the second wheel bearing 105.2 of the first wheel set 105 via a further first longitudinal deflection device in the form of a further first longitudinal link 108.5. On the other hand, the first transverse beam 108.1 is coupled at its second end to the fourth wheel bearing 107.2 of the second wheel set 107 via a further second longitudinal link device in the form of a second longitudinal link 108.6.

The longitudinal links 108.3 to 108.6 are each connected in a well-known manner via elastic elements to the first transverse beam 108.1 or to the relevant wheel set 105, 107. Hereby, the elasticity of these elements can advantageously be adapted to the desired handling properties, in particular the desired dynamic properties. For example, high rotational stability of the elements about the high axis allows a good running stability at higher speeds while a lower radial stiffness in the direction of the longitudinal axis promotes an arc-radial adjustment of the wheel sets 105, 107 when driving on track curves.

The longitudinal links 108.3 to 108.6 are furthermore arranged in a plane which runs parallel to the longitudinal center plane of the car body 102 (shown in the rest state), i.e., perpendicular to the transverse axis 108.2 of the car body. For this reason, inter alia, a relative movement of the relevant wheel set 105, 107 with respect to the car body 102 in the direction of the transverse axis 102.2 and the vertical axis 102.3 of the car body 102 is possible.

On the one hand, the turning device 108 causes a defined turning movement to be imparted to the respective wheel set 105, 107 when a wheel of one of the wheel sets 105, 107 is deflected in the direction of the longitudinal axis 102.1 by a turning axis parallel to the vertical axis 102.3 of the car body (shown in the rest state), which is advantageous when traversing track curves with a view to reducing the start-up angle of the wheel rims on the rail and thus the wear of the wheel and the rail, as well as the noise development.

On the other hand, a defined force input from the wheel sets 105, 107 into the car body 102 is achieved via the reversing device over a small number of components over a short distance. This is advantageous since a particularly compact design is achieved with a few, simply designed components, which in the running gear 103 offers sufficient space for further components, such as, for example, drive motor units 109 of high power, brakes (not shown in the figures for reasons of clarity). This is particularly advantageous in the case of locomotives in which a high drive power is required. This design, of course, can also be used in a running gear without internal drive motors.

As can be seen in FIGS. 1 and 2, a co-rotating turning movement about the turning axis is imparted to the two wheel sets 105, 107 by the turning device 108. This turning movement of the wheel sets 105, 107 has the same magnitude in the present example, since the articulation points of the longitudinal links 108.3 to 108.6 have an identical distance from the axis of rotation of the pivot pin 108.2. Of course, by way of example, a deviating distance on the first transverse beam between the first longitudinal links 108.3 and 108.5 and the second longitudinal links 108.4 and 108.6 can lead to a transmission ratio and gear reduction, respectively, between the turning movements of the first wheel set 105 and the second wheel set 107. For example, by means of a reduced distance between the articulation points of the first longitudinal links 108.3 and 108.5 on the first transverse beam 108.1 (see dashed contour 108.10 in FIG. 2) and thus an arrangement of the first longitudinal beams 108.3 and 108.5 which is inclined with respect to the longitudinal axis 102.1, the turning movement of the first wheel set deviates from the turning movement of the second wheel set 107. As a result, an approximation to an arc-radial alignment of the wheel sets 105, 107 can be achieved, for example, in the track curve with the first wheel set 105 advancing ahead. Of course, the second longitudinal links 108.4 and 108.6 can, of course, additionally or alternatively have an arrangement which is inclined with respect to the longitudinal axis 102.1.

The drive motor units 109 are, on the one hand, in each case supported in the well-known manner via a misalignment bearing on the wheel set shaft of the respective wheel set 105. On the other hand, the drive motor units 109 are each supported on the car body 102 by means of a supporting lever 109.1 and a motor pendulum 109.2 as a torque support. The support lever 109.1 extends so far in the direction of the longitudinal axis 102.1 of the wagon body 102 that the motor pendulum 109.2 is arranged on the side of the first transverse carrier 108.1 facing away from the drive motor unit 109. This results in a large supporting length and accordingly a lower vertical supporting force on the torque support 109.2. This results on the one hand in a correspondingly simple design of the supporting lever 109.1 and of the motor pendulum 109.2. As has already been explained above, this design is also advantageous from the point of view of the transmissible traction performance. From the comparatively small vertical supporting force on the torque support 109.2 (in the case of a specific rotational direction of the respective drive 109), a smaller reduction in the wheel contact forces on one of the wheel sets 105, 107 results in the vertical force balance. Accordingly, a high tractive power can always be transmitted to the rails.

Of course, in other variants of the invention, such a torque support can also be arranged on the side of the first transverse beam 108.1, which faces the drive motor unit 109.1. In this case, in FIG. 1, the right torque support 109.2 would be assigned to the (shortened) support lever of the drive 109 on the right, first wheel set 105 and the left torque support 109.2 to the (shortened) support lever of the drive 109 on the left, second wheel set 107 (see dashed contour 109.4 in FIG. 2).

<u>Second Embodiment</u>

In the following, referredn to FIG. 3, a second preferred exemplary embodiment of the railway vehicle according to the invention in the form of a locomotive 201 is described. FIG. 3 shows the locomotive 201 in a schematic view similar to FIG. 2. In its basic design and operation, the locomotive 201 substantially corresponds to the locomotive 101 shown in FIGS. 1 and 2, so that reference is hereby made to the above remarks and only the differences are to be considered. In particular, identical or similar components are provided with reference symbols increased by the value 100.

The vehicle body (not shown) of locomotive 201 is also supported by a single-stage suspension directly on a first running gear 203, i.e. it rests on the wheel bearings 205 via a single spring stage 204, and on the wheel bearings of a second wheel set 207 via a single spring stage 206.

As can be seen in FIG. 3, a major difference from the embodiment of FIG. 1 is that the turning device 208, which is connected to the wheel sets 205, 207 and the car body and arranged between the wheel sets 205, 207, shows a second transverse beam 208.7 in addition to a first transverse beam 208.1.

While the first transverse beam 208.1 is seated in its center region about a pivot axis parallel to the vertical axis 202.3 of the car body 202 on a first pivot 208.2 secured to the car body, the second transverse beam 208.7 is seated in its center region about a pivot axis parallel to the axis (z-axis) of the car body pivotable on a second pivot 208.8 attached to the car body. In this case, the transverse beams 208.1, 208.7 extend in the direction of the transverse axis 202.2 of the car body from the one longitudinal side of the vehicle to the other longitudinal side of the vehicle.

The transverse beams 208.1, 208. 7 each have angled end regions, in the region of which they are connected to the respectively associated wheel set 205, 207. The first transverse support 208.1 is coupled at its first end to the first wheel bearing 205.1 of the first wheel set 205 via a first longitudinal link 208.3, while the second transverse beam 208.7 is coupled at its first end to the third wheel bearing 207.1 of the second wheel set 207 via a second longitudinal link 208.4. At its second end, the first transverse support 208.1 is coupled via a further first longitudinal link 208.5 to the second wheel bearing 205.2 of the first wheel set 205, while the second transverse support 208.7 is coupled at its second end to the fourth wheel bearing 207.2 of the second wheel set 207 via a further second longitudinal link 208.6.

The longitudinal links 208.3 to 208.6 are each connected to the first transverse beam 208.1 and the relevant wheel set 205, 207, respectively, in a well-known manner via elastic elements. The longitudinal links 208.3 to 208.6 are furthermore arranged in each case in a plane which runs parallel to the longitudinal center plane of the car body 202, i.e. perpendicular to the transverse axis 208.2 of the car body (shown in the rest state). For this reason, they allow, inter alia, a relative movement of the respective wheel set 205, 207 with respect to the car body 202 in the direction of the transverse axis 202.2 and the vertical axis 202.3 of the car body 202.

Of course, in other variants of the invention, it may also be provided that the longitudinal links 208.3 to 208.6 are missing and the first transverse beam 208.1 is directly connected to the wheel bearings 205.1, 205.2 of the first wheel set 205, while the second transverse beam 208.7 is connected directly to the wheel bearings 207.1, 207.2 of the second wheel set 207. The connection between the respective transverse beam 208.1, 208.7 and the associated wheel set 205, 207 can be articulated. In particular, it can be carried out using elastic elements (elastomer elements, layer rubber foils, etc.). Preferably, the connection between the respective transverse beam 208.1, 208.7 and the associated wheel set 205, 207 is essentially rigid, since a particularly simple configuration can be achieved with this.

The transverse mobility (in the direction of the transverse axis 202.2) and / or pitch mobility (about the transverse axis 202.2) of the arrangement of the respective transverse beam 208.1, 208.7 and the associated wheel set 205, 207 can be achieved by a corresponding design of the pivot arrangement with the respective pivot 208.2, 208.8, for example a corresponding elasticity of the pivot arrangement and / or a corresponding play within the pivot arrangement (e.g. a pivot guided in a slot in the crossbeam).

On the one hand, the turning device 208 causes a defined turning movement to be imparted to the respective wheel set 205, 207 in the direction of the longitudinal axis 202.1 for a deflection of one of the wheels of one of the wheel sets 205, 207 by a turning axis which is parallel to the vertical axis of the car body, which is advantageous when traversing track curves with a view to reducing the start-up angle of the wheel rims on the rail and thus the wear of the wheel and the rail as well as the noise development.

On the other hand, a defined force input from the wheel sets 205, 207 into the car body 202 is achieved via the reversing device over a small number of components over a short distance. This is advantageous in that a particularly compact design is achieved with a few, simply designed components, which in the running gear 203 provide sufficient space for further components such as, for example, drive motor units of high power (as indicated by dashed outline 209 in FIG. 3), brakes (for reasons of clarity, not shown in FIG. 3) etc. This is particularly advantageous in the case of locomotives in which a high drive power is required. Of course, this design can also be used in a running gear without internal drive motors.

The two transverse beams 208.1 and 208.7 are coupled to one another via a coupling device 210. For this purpose, the coupling device 210 comprises a coupling spring device in the form of a coupling spring 210.1 which is connected on the one hand to the first transverse beam 208.1 and on the other side to the second transverse beam 208.7. Furthermore, the coupling device 210 comprises a damper 210.2, which is likewise connected on the one hand to the first transverse beam 208.1 and on the other hand to the second transverse beam 208.7.

The coupling spring 210.1 counteracts a mutual resetting force of a mutual deflection of the first transverse support 208.1 and of the second transverse support 208.7 from the neutral position shown in FIG. 3. As a result, an at least approximately arc-radial adjustment of the wheel sets 205, 207 against the resetting force of the coupling spring 210.1 is possible, while the coupling spring 210.1 in the straight track section effects an advantageous return movement of the wheel sets 205, 207 into the neutral position. The damper 210.2 thereby dampens the relative movements between the two transverse beams 208.1, 208.7 and thus contributes advantageously to the improvement of the running properties in the straight track. Of course, the coupling spring 210.1 and / or the damper 210.2 can also be missing in other vehicles according to the invention, in particular vehicles which are intended for lower travel speeds.

<u>Third Embodiment</u>

A third preferred embodiment of the railway vehicle according to the invention in the form of a locomotive 301 is described below with reference to FIG. 4. FIG. 4 shows the locomotive 301 in a schematic view similar to FIG. 2. The locomotive 301 in its basic design and mode of operation substantially corresponds to the locomotive 201 of FIG. 3, so that reference is made here to the above remarks and the differences are to be considered only. In particular, identical or similar components are provided with reference symbols increased by the value 100.

The car body (not shown) is also supported on the locomotive 301 by a single-stage suspension directly on a first running gear 303, i.e. it rests on the wheel bearings 305 via a single spring stage 304, and on the wheel bearings of a second wheel set 307 via a single spring stage 306.

As shown in FIG. 4, a major difference from the embodiment of FIG. 3 is that the function of the first and second transverse beams of the reversing device 308 is taken over by the respective drive motor unit 309.1, so that the first and second transverse beam in the reversing device 308 is an integral part of the respective drive motor unit 309.1. This results in a particularly compact arrangement with few components.

The drive motor units 309 are supported in a known manner on the associated wheel set 305, 307. On the other hand, they are pivoted about a pivot axis parallel to the vertical axis (z-axis) of the car body via a support lever 309.1 on a first pivot 308.2 or second pivot 308.8 attached to the car body.

The respective support lever 309.1 of the drive motor units 309 has a joint which, inter alia, has a pivot axis 309.3 which is parallel to the transverse axis 302.2 of the car body (shown in the neutral position) while it is essentially rigid around the vertical axis of the car body. In this way, for example, a compression of the respective spring stage 304, 306 is possible, while the defined turning movement of the respective wheel set 305, 307 is ensured. If, for example, the respective pivot is located in a elongated hole (shown in the neutral position) in the direction of the transverse axis 302.2 in the support lever 309.1, displacements of the respective wheel set 305, 307 in the direction of the transverse axis are also possible. Likewise, such transverse movements can also be accommodated with the respective pivots 308.2, 308.8 by corresponding elasticities of the respective pivot arrangement.

The respective support lever 309.1 is furthermore supported on the car body by a motor pendulum 309.2 arranged in the region of the pivot axis 309.3 as a torque support. This has the advantage that, during the compression of the respective spring stage 304, 306, no tensile stress occurs.

Of course, the articulation with the pivot axis 309.3 can also be absent in other preferred (because very simple-fashioned) variants of the invention, and the pitching movement during the compression of the respective spring stage 304, 306 by corresponding elasticities of the pivot arrangement with the respective pivot 308.2, 308.8 can be recorded.

On the one hand, the reversing device 308 integrated into the drive motor units 309 causes the respective wheel set 305, 307 to deflect a defined turning movement by a (in the illustrated idle state) turning axis which is parallel to the vertical axis of the car body, which is advantageous when traversing track curves with a view to reducing the starting angle of the wheel rims on the rail and thus the wear of the wheel and the rail as well as the noise development.

On the other hand, a defined force input from the wheel sets 305, 307 into the car body 302 is achieved via the reversing device over a small number of components over a short distance. This is advantageous in that a particularly compact construction is achieved with a few, simply designed components which provide sufficient space for additional components, such as brakes (not shown for reasons of clarity in FIG. 4), in the running gear 303. This is particularly advantageous in the case of locomotives in which a high drive power is required.

The two drive motor units 309 are in turn coupled to one another via a coupling device 310. For this purpose, the coupling device 310 comprises a coupling spring device in the form of a coupling spring 310.1, which is connected to the two drive motor units 309. Furthermore, the coupling device 310 comprises a damper 310. 2, which is also connected to the two drive motor units 309.

The coupling spring 310.1 counteracts a mutual deflection of the drive motor units 309 from the neutral position shown in FIG. 4 by an elastic resetting force. As a result, an arc-radial adjustment of the wheel sets 305, 307 against the restoring force of the coupling spring 310.1 is possible, while the coupling spring 310.1 in the straight track section effects an advantageous return movement of the wheel sets 305, 307 into the neutral position. The damper 310.2 thereby dampens the relative movements between the two drive motor units 309 and thus contributes advantageously to the improvement of the running properties in the straight track. Of course, the coupling spring 310.1 and / or the damper 310.2 can also be omitted in other vehicles according to the invention, in particular vehicles which are intended for lower travel speeds.

<u>Fourth Embodiment</u>

A fourth preferred embodiment of the railway vehicle according to the invention in the form of a locomotive 401 will be described below with reference to FIG.5. FIG. 5 shows the locomotive 401 in a schematic view similar to FIG.2. In its basic design and mode of operation, the locomotive 401 substantially corresponds to the locomotive 201 from FIG. 3, so that the present invention is directed to the above explanations and only the differences are to be considered. In particular, identical or similar components are provided with reference symbols increased by the value 200.

The car body (not shown) is also supported on the locomotive 401 by a single-stage suspension directly on a first running gear 403, i.e. it rests on the wheel bearings 405 via a single spring stage 404 and on the wheel bearings of a second wheel set 407 via a single spring stage 406.

As shown in FIG. 4, the difference between the embodiment shown in FIG. 3 is that the articulation of the first transverse carrier 408.1 and of the second transverse carrier 408.7, which is pivotable about the vertical axis (z-axis), takes place via the coupling device 410, which couples the first transverse beam 408.1 with the second transverse beam 408.7.

For this purpose, a coupling element 410.3 is pivotally mounted about the vertical axis (z-axis) on a pivot 408.2 fixed to the car body. The coupling element 410.3 is connected on the one hand to the first transverse beam 408.1 and on the other hand to the second transverse beam 408.7. Since the two transverse supports 408.1, 408.7 are in turn connected to the two wheel sets 405, 407 via longitudinal link elements 408.3 to 408.6, the coupling element 410.3 can be rigidly connected to the two transverse supports, so that the two wheel sets are subjected to a co-rotating turning movement.

In the illustrated example, however, the coupling element 410.3 is pivotally connected to the first transverse beam 408.1 about the vertical axis (z-axis) via a first coupling joint 410.4. As a result, it is possible for the two transverse beams 408.1, 408.7 to perform counter-rotating or at least different turning movements. Of course, in other variants of the invention, it may also be provided that the first coupling joint 410.4 coincides with the pivot 408.2, so that both transverse beams 408.1, 408.7 are pivotally mounted on the pivot 408.2.

A coupling spring 410.1 of the coupling device 410 in turn counteracts a mutual resetting force of the transverse beams 408.1 and 408.7 from the neutral position, shown in FIG. 5.

For example, as a result, an approximately arc-radial adjustment of the wheel sets 405, 407 against the resetting force of the coupling spring 410.1 is possible, while the coupling spring 410.1 in the straight track section effects an advantageous return movement of the wheel sets 405, 407 into the neutral position. The damper 410.2 thereby dampens the relative movements between the two transverse carriers 408.1 and 408.7 and thus contributes advantageously to the improvement of the running properties in the straight track. Of course, the coupling spring 410.1 and / or the damper 410.2 can also be omitted in other vehicles according to the invention, in particular vehicles which are intended for lower travel speeds.

Further on, of course, in other variants of the invention, it is also possible to provide the two transverse beams not via the longitudinal links 408.2 to 408.6 but (as already described above in connection with the second exemplary embodiment) to connect directly, in particular, rigidly, on the wheel sets 405, 407. In this case, in addition to the first coupling joint 410.4, a second coupling joint can be provided (indicated by the dashed contour 410.5 in FIG. 5), via which the coupling element 410.3 is connected to the second transverse support 408.7. In this case, the first and second coupling joints 410.4, 410.5 are designed in such a way that they allow the spring stages 404, 406 to be deflected. For this purpose, the second coupling joint 410.5 can, for example (as shown in FIG. 5), have a pivot axis which runs parallel to the transverse axis 402.2 (in the illustrated neutral position). It may also be provided that the first coupling joint 410.4 and the second coupling joint 410.5 are identical. Thus, on either side of the pivot 408.2, a coupling joint in the manner of the first coupling joint 410.4 or a coupling joint in the manner of the second coupling joint 410.5 can be provided.

In this case, of course, the respective pivot axes of the coupling joints 410.4, 410.5, don’t need to be provided via physical pivot axes. The pivot axes can again be realized by a corresponding elasticity of the respective joint body (elastomer element, rubber layer spring, etc.).

A transverse mobility (in the direction of the transverse axis 402.2) and / or pitch mobility (about the transverse axis 402.2) of the entire arrangement of the transverse beams 408.1, 408.7 and the associated wheel sets 405, 407 can be achieved by means of a corresponding configuration of the pivot arrangement with the pivot 408.2, for example a corresponding elasticity of the pivot arrangement and / or a corresponding backlash within the pivot arrangement (e.g. in an elongated hole in the guided pivot).

On the one hand, the turning device 408 causes a defined turning movement to be imparted to the respective wheel set 405, 407 when a wheel of one of the wheel sets 405, 407 is deflected in the direction of the longitudinal axis 402.1 by a turning axis which is parallel to the vertical axis of the car body (in the illustrated idle state), which is advantageous when traversing track curves with a view to reducing the start-up angle of the wheel rims on the rail and thus the wear of the wheel and the rail as well as the noise development.

As indicated by the dashed contours 409 in FIG. 5, drive motor units can again be integrated into the running gear 403. In particular, they can be coupled to the associated transverse beam 408.1, 408.7, whereby, in the case of a rigid coupling between the drive motor unit 409 and the respective transverse beam 408.1, 408.7, a substantially rigid coupling between the transverse beam 408.1, 408.7 and the associated wheel set 405 is provided, and preferably one of the design variants of the coupling device 410 described above for this case is selected. In this case, it is also preferably provided that the respective transverse beam 408.1, 408.7 is supported on the car body via a torque support in the form of a motor pendulum 409.2.

Fifth embodiment

A fifth preferred embodiment of the railway vehicle according to the invention in the form of a locomotive 501 is described below with reference to FIGS. 6 to 8. FIG. 6 shows the locomotive 501 in a schematic view similar to FIG. 2. The locomotive 501 substantially corresponds, in its basic design and mode of operation, to the locomotive 101 from FIGS. 1 and 2, so that reference is made here to the above remarks and only the differences are to be considered. In particular, identical or similar components are provided with reference symbols increased by the value 300.

The car body (not shown) is also supported directly on a first running gear 503 by means of a single-stage suspension, i.e. it rests on the wheel bearings 505 via a single spring stage 504 and on the wheel bearings of a second wheel set 507 via a single spring stage 506.

As can be seen in FIG. 6, a significant difference from the embodiment of FIG. 1 is that the turning device 508, which is connected to the wheel sets 505, 507 and the car body and is arranged between the wheel sets 505, 507, comprises only two turning units 508.9, 508.10, which are arranged on both sides of the landing gear 503 and are coupled via the second wheel set 507 as a coupling unit.

The first turning unit 508.9 comprises a first angle lever 508.11 with a first free lever end and a second free lever end, while the second turning unit 508.10 comprises a second angle lever 508.12 with a third free lever end and a fourth free lever end. The respective angle lever 508.11, 508.12 is pivoted between its free lever ends about a pivot axis extending transversely to the longitudinal axis 502.1 on the car body. In the present example, this pivot axis (shown in the neutral position) runs parallel to the vertical axis (z-axis).

The first lever end of the first angle lever 508.11 is pivoted via the first longitudinal link or connecting link 508.3 on the first wheel set 505, while the third lever end of the second angle lever 508.12 is pivoted via the second longitudinal link 508.5 on the first wheel set 505. The second lever end of the first angle lever 508.11 and the fourth lever end of the second angle lever 508.12 are pivoted on the second wheel set 507, hence connected to one another via the second wheel set 507 as a coupling unit. This results in a particularly simple and small design with few, robust components.

The longitudinal links 508.3 and 508.5 are each connected in a well-known manner to the respective angle lever 508.1, 508.12 and the first wheel set 505, respectively, via elastic elements. The longitudinal links 508.3 to 508.6 are furthermore arranged in a plane which runs parallel to the longitudinal center plane of the car body 502, i.e., perpendicular to the transverse axis 508.2 of the car body (shown in the rest state). For this reason, they allow, inter alia, a relative movement of the first wheel set 505 with respect to the car body in the direction of the transverse axis 502.2 and the vertical axis 502.3 of the car body.

Furthermore, the pivot point of the respective angle lever 508.11, 508.12 and its articulation point on the second wheel set 507 lie in a plane perpendicular to the transverse axis 508.2 of the car body in the illustrated rest state or the illustrated neutral position. Accordingly, the two angular levers 508.11, 508.12 form a transverse guide of the second wheel set 507, which causes a relative movement of the second wheel set 507 with respect to the car body 502 in the direction of the transverse axis 502.2 and the vertical axis 502.3 of the car body 502.

On the one hand, the turning device 508 causes a defined turning movement to be imparted to the first wheel set 505 when a deflection of one of its wheels is imposed in the direction of the longitudinal axis 502.1 by a turning axis which is parallel to the vertical axis of the car body (in the illustrated rest state). The second wheel set 507 is thereby displaced in the direction of the transverse axis 502.2. Both are advantageous when traversing track curves with a view to reducing the start-up angle of the wheel rims on the rail and thus the wear of the wheel and the rail as well as the noise development.

By an inclination of the plane, in which the pivot point of the respective angle lever 508.11, 508.12 and its articulation point lie on the second wheel set 507 (in the neutral position), relative to the (in the neutral position) transverse axis 508.2 of the car body it can be achieved that the second wheel set also performs a turning movement about a vertical axis. If the pivot points of the angle levers 508.11, 508.12 are offset further inwards in the direction of the longitudinal center plane on the second wheel set 507, as indicated by the dashed contour 508.13 in FIG. 6, the two wheel sets 505, 507 (with a certain amount) The offset which can be influenced by the offset) undergo a co-rotating turning movement. If, however, the pivot points of the angle levers 508.11, 508.12 are displaced further outwards, a counter-rotating turning movement of the wheel sets 505, 507 occurs.

On the other hand, a defined force input from the wheel sets 505, 507 into the car body 502 is achieved via the reversing device over a small number of components over a short distance. This is advantageous in that a particularly compact design is achieved with a few, simply designed components which provide sufficient space in the running gear 503 for further components such as, for example, high-power drive motor units (as indicated by dashed contour 509 in FIG. 6), brakes (for reasons of clarity, not shown in FIG. 6), etc. In particular, the use of the second wheel set 507 as a coupling unit between the two turning units 508.9 and 508.10 results in a further space saving. This is particularly advantageous in the case of locomotives in which a high drive power is required. Of course, this design can also be used in a running gear without internal drive motors.

FIG. 7 shows alternatives of the coupling unit between the two turning units 508.9, 508.10. Thus, on the one hand, a separate coupling rod can be provided, as is indicated in FIG. 7 by the dashed contour 508.14. Likewise, a hydraulic coupling unit 508.15 can also be provided in which a free lever end of the respective lever 508.11, 508.12 (which, as can be seen in FIG. 7, does not necessarily have to be an angle lever) acts on a hydraulic cylinder 508.16, 508.17, whose working spaces are correspondingly hydraulically coupled.

In the case of other variants of the invention, the longitudinal links 508.3, 508.5 and the levers 508.11, 508.12 can also be omitted, and the hydraulically coupled hydraulic cylinders 508.16, 508.17 (as indicated by dashed outline 508.22 in FIG. 7) can, on the one hand, directly engage the car box or can, on the other hand, directly engage the associated wheel set bearing 505.1, 505.2. As a result, a particularly compact design can be achieved.

FIG. 8 shows the four-axis locomotive 501, whose car body 502 is supported on two identical running gear units 503, as shown in FIG. 6. The two running gears 503 (shown in the neutral position) are arranged symmetrically with respect to a transverse plane of the car body 502 perpendicular to the longitudinal axis 502.1. When the track runs through, the two outer wheel sets closest to the vehicle ends respectively undergo a turning movement while the two central wheel sets only experience a displacement in the direction of the transverse axis 502.2. This is of advantage with regard to the reduction of the starting angle of the wheel rims on the rail and thus the wear of the wheel and the rail as well as the noise development.

Sixth Embodiment

A sixth preferred exemplary embodiment of the rail vehicle according to the invention in the form of a locomotive 601 is described below with reference to FIGS. 9 and 10. FIGS. 9 and 10 show locomotive 601 in a schematic view similar to FIGS. 1 and 2, respectively. In its basic design and mode of operation, the locomotive 601 largely corresponds to the locomotive 101 from FIGS. 1 and 2, so that reference is made here to the above remarks and the differences are to be considered only. In particular, identical or similar components are provided with reference symbols increased by the value 500.

In the case of the locomotive 601, the car body 602 is also supported directly on a first running gear 603 by means of a single-stage suspension, hence it rests on the wheel bearings 605 via a single spring stage 604 and on the wheel bearings of a second wheel set 607 via a single spring stage 606.

As can be seen in FIGS. 9 and 10, a significant difference from the embodiment of FIG. 1 is that the turning device 608, which is connected to the wheel sets 605, 607 and the car body and is arranged between the wheel sets 605, 607, has a turning unit 608.18 with a coupling shaft 608.19, a first coupling lever 608.20 and a second coupling lever 608.21.

The coupling shaft 608.19 has a longitudinal axis which extends in the direction of the transverse axis 602.2 of the car body 602. The coupling shaft 608.19 is rotatably mounted on the car body 602 about an axis of rotation parallel to the transverse axis 602.2 of the car body 602. The first coupling lever 608.20 is arranged non-rotatably on a first end of the coupling shaft 608.19 and is articulated to the first wheel set 605 via a longitudinal link or coupling link 608.3 and at the second wheel set 607 via a longitudinal link or coupling link 608.4. The second coupling lever 608.21 is arranged non-rotatably on the other, second end of the coupling shaft 608.19 and is articulated to the first wheel set 605 by a longitudinal link or coupling link 608.5 and at the second wheel set 607 articulated by a longitudinal link or coupling link 608.6.

The first coupling lever 608.20 and the second coupling lever 608.21 are arranged rotated by 180 ° with respect to the longitudinal axis of the coupling shaft 608.19, the first coupling lever 608.20 pointing upwards in the direction of the vertical axis 602.3 of the car body in the neutral position shown. As a result, a turning movement (which is the same in the present example) about a turning axis running in the direction of the vertical axis 602.3 is imparted to the first wheel set 605 and the second wheel set 607 when a deflection of one of its wheels is deflected in the direction of the longitudinal axis 602.1 of the car body 602. A particularly space-saving configuration can be achieved by the use of the coupling shaft 608.19, which represents a torsion shaft, since the coupling shaft 608.19 can only be rotated about its longitudinal axis, so that only a small installation space is required for the coupling of the coupling shaft 608.19 from the one vehicle side to the other.

The first coupling lever 608.20 and the second coupling lever 608.21 can, in principle, be rotated by an arbitrary suitable angle as long as it is ensured that a corresponding turning movement is still imparted to the wheel sets 605, 607 during a rotation of the coupling shaft 608.19.

By means of the respective distance between the rotational axis of the coupling shaft 608.19 and that of the articulation points of the coupling links 608.3, 608.5 to the first gear set 605 or the coupling link 608.4, 608.6 to the second wheel set 607, an almost freely selectable transmission ratio between the turning movement of the first wheel set 605 and the second wheel set 607 is possible. In particular, it is also possible, if the articulation points of the coupling links 608.3, 608.5 to the first wheel set 605 and the articulation points of the coupling links 608.4, 608.6 to the second wheel set 607 are arranged on different sides with respect to the axis of rotation of the coupling shaft 698, to obtain a counter-rotating turning movement of the two wheel sets 605, 607.

The coupling links 608.3 to 608.6 are each connected in a well-known manner to the respective coupling lever 608.20, 608.21 or the respective wheel set 605, 607 via elastic elements. The longitudinal links 608.3 to 608.6 are furthermore arranged in each case in a plane which runs parallel to the longitudinal center plane of the car body 602, i.e., perpendicular to the transverse axis 608.2 of the car body (shown in the rest state). For this reason, they allow, inter alia, a relative movement of the wheel sets 605, 607 with respect to the car body in the direction of the transverse axis 602.2 and the vertical axis 602.3 of the car body.

On the one hand, the turning device 608 causes a defined turning movement to be imparted to the wheel sets 605, 607 during deflection of one of their wheels in the direction of the longitudinal axis 602.1 by a turning axis which is parallel to the vertical axis of the car body (in the illustrated rest state). This is an advantage when traversing track curves with a view to reducing the start-up angle of the wheel rims on the rail and thus the wear of the wheel and the rail as well as the noise development.

On the other hand, a defined force input from the wheel sets 605, 607 into the car body 602 is achieved via the reversing device over a small number of components over a short distance. This is advantageous in that a particularly compact design is achieved with a few, simply designed components, which in the running gear 603 provide sufficient space for further components such as, for example, drive motor units 609 of high power, brakes (not shown for reasons of clarity in FIG. 6), etc. This is particularly advantageous in the case of locomotives in which a high drive power is required. Of course, this design can also be used in a chassis without internal drive motors.

The present invention has been described above exclusively with the aid of examples of a locomotive. Of course, that the invention can also be applied to any other rail vehicle.

**Patentkrav**

**1.** Skinnekøretøj med

- en vognkasse (102; 202; 402) og
- et første chassis (103; 203; 403), der omfatter mindst en første hjulenhed (105; 205; 405) med to omdrejningstalkoblede hjul og en anden hjulenhed (107; 207; 407) med to omdrejningstalkoblede hjul, hvor
- vognkassen (102; 202; 402) har en langsgående akse (102.1; 202.1; 402.1), en tværgående akse (102.2; 202.2; 402.2) og en højdeakse (102.3; 202.3; 402.3),
- vognkassen (102; 202; 402) i hvert tilfælde er understøttet direkte på den første hjulenhed (105; 205; 405) og direkte på den anden hjulenhed (107; 207; 407) via et fjedertrin (104; 204; 404), og
- den første hjulenhed (105; 205; 405) er forbundet med vognkassen (102; 202; 402) via en vendeindretning (108; 208; 408), hvor
- vendeindretningen (108; 208; 408) er udformet på en sådan måde, at den ved en afbøjning af et hjul af den første hjulenhed (105; 205; 405) i retning af vognkassens (102; 202; 402) langsgående akse (102.1; 202.1; 402.1) påfører en vendebevægelse på den første hjulenhed (105; 205; 405) omkring en vendeakse, der strækker sig i retning af vognkassens (102; 202; 402) højdeakse (102.3; 202.3; 402.3), og
- vendeindretningen (108; 208; 408) er forbundet med den anden hjulenhed (107; 207; 407) på en sådan måde, at den ved en afbøjning af et hjul af den anden hjulenhed (107; 207; 407) i retning af vognkassens (102; 202; 402) langsgående akse (102.1; 202.1; 402.1) påfører en vendebevægelse omkring en højdeakse på den anden hjulenhed (107; 207; 407), hvor
- vendeindretningen (108; 208; 408) er udformet på en sådan måde, at den påfører synkrone vendebevægelser på den første hjulenhed (105; 205; 405) og den anden hjulenhed (107; 207; 407),

**kendetegnet ved, at**

- vendeindretningen (108; 208; 408) omfatter mindst en første tværdrager (108.1; 208.1; 408.1), hvor
- den første tværdrager (108.1; 208.1; 408.1) strækker sig i vognkassens (102; 202; 402) tværgående retning,
- den første tværdrager (108.1; 208.1; 408.1) har en første ende, en anden ende og et midterafsnit mellem den første ende og den anden ende,

- den første tværdrager (108.1; 208.1; 408.1) til generering af vendebevægelsen af den første hjulenhed (105; 205; 405) i sit midterafsnit er forbundet med vognkassen (102; 202; 402) drejeligt omkring en drejeakse, der strækker sig i retning af højdeaksen (102.3; 202.3; 402.3), og
- den første tværdrager (108.1; 208.1; 408.1) i den første ende og den anden ende er koblet sammen med den første hjulenhed (105; 205; 405), hvor
- den første tværdrager (108.1; 208.1; 408.1) i den første ende og den anden ende er koblet sammen med den første hjulenhed (105; 205; 405) via hver især en første styreindretning (108.3, 108.5; 208.3, 208.5; 408.3, 408.5).

**2.** Skinnekøretøj ifølge krav 1, **kendetegnet ved, at**
- den første hjulenhed (105; 205; 405) er udformet som hjulsæt med en hjulsætaksel, der forbinder de to hjul,
og/eller
- den første hjulenhed (105; 205; 405) omfatter udvendige hjullejer, og vendeindretningen (108; 208; 408) er forbundet med hjullejerne.

**3.** Skinnekøretøj ifølge et af de foregående krav, **kendetegnet ved, at**
- den anden hjulenhed (107; 207; 407) er et hjulsæt.

**4.** Skinnekøretøj ifølge et af de foregående krav, **kendetegnet ved, at**
- den pågældende første styreindretning (108.3, 108.5; 208.3, 208.5; 408.3, 408.5) omfatter en første langsgående styrestang, der i chassisets ubelastede tilstand strækker sig i et plan, der strækker sig parallelt med køretøjets langsgående midterplan.

**5.** Skinnekøretøj ifølge et af de foregående krav, **kendetegnet ved, at**
- den første tværdrager (108.1) i den første ende og i den anden ende er koblet sammen med den anden hjulenhed (107), hvor
- især den første tværdrager (108.1) i den første ende og den anden ende er koblet sammen med den anden hjulenhed (107) via i hvert tilfælde en anden styreindretning (108.4, 108.6), hvor den pågældende anden styreindretning (108.4, 108.6) især omfatter en anden langsgående styrestang, der i chassisets ubelastede tilstand strækker sig i et plan, der strækker sig parallelt med køretøjets langsgående midterplan.

**6.** Skinnekøretøj ifølge krav 4, **kendetegnet ved, at**
- vendeindretningen (208; 408) omfatter mindst en anden tværdrager (208.7; 408.7), hvor
- den anden tværdrager (208.7; 408.7) strækker sig i vognkassens (202; 402) tværgående retning,
- den anden tværdrager (208.7; 408.7) har en første ende, en anden ende og et midterafsnit mellem den første ende og den anden ende,
- den anden tværdrager (208.7; 408.7) i sit midterafsnit er forbundet med vognkassen (202; 402) drejeligt omkring en drejeakse, der strækker sig i retning af højdeaksen, og
- den anden tværdrager (208.7; 408.7) i den første ende og i den anden ende er koblet sammen med den anden hjulenhed (207; 407), hvor
- især den anden tværdrager (208.7; 408.7) i den første ende og den anden ende er koblet sammen med den anden hjulenhed (207; 407) via i hvert tilfælde en styreindretning (208.4, 208.6; 408.4, 408.6), hvor den pågældende styreindretning (208.4, 208.6; 408.4, 408.6) især omfatter en langsgående styrestang, der i chassisets ubelastede tilstand strækker sig i et plan, der strækker sig parallelt med køretøjets langsgående midterplan.

**7.** Skinnekøretøj ifølge krav 6, **kendetegnet ved, at** den første tværdrager (208.1; 408.1) og den anden tværdrager (208.7; 408.7) er koblet sammen med hinanden via en koblingsindretning (210; 410), hvor
- især den første tværdrager (208.1; 408.1) og den anden tværdrager (208.7; 408.7) i det første chassis' (203; 403) ubelastede tilstand har en neutral stilling, og koblingsindretningen (210; 410) omfatter mindst en koblingsfjederindretning (210.1; 410.1), hvor koblingsfjederindretningen (210.1; 410.1) er udformet og/eller anbragt på en sådan måde, at den modvirker en afbøjning af den første tværdrager (208.1; 408.1) og den anden tværdrager (208.7; 408.7) fra den neutrale stilling en elastisk returkraft,
og/eller
- især koblingsindretningen (410) via en drejetap er forbundet med vognkassen (402) drejeligt omkring en drejeakse, der strækker sig i retning af højdeaksen (402.3), hvor
- koblingsindretningen (210; 410) især i det mindste omkring en akse, der strækker sig i retning af højdeaksen (202.3; 402.3), i det væsentlige er forbundet stift med den første tværdrager (208.1; 408.1), især er udformet i ét

stykke med den første tværdrager (208.1; 408.1)
og/eller
- koblingsindretningen (210; 410) især omkring en akse, der strækker sig i retning af højdeaksen, er forbundet med den anden tværdrager (208.7; 408.7)
eller
- koblingsindretningen (210; 410) især i det mindste omkring en akse, der strækker sig i retning af højdeaksen, i det væsentlige er forbundet stift med den anden tværdrager (208.7; 408.7), især er udformet i ét stykke med den anden tværdrager (208.7; 408.7).

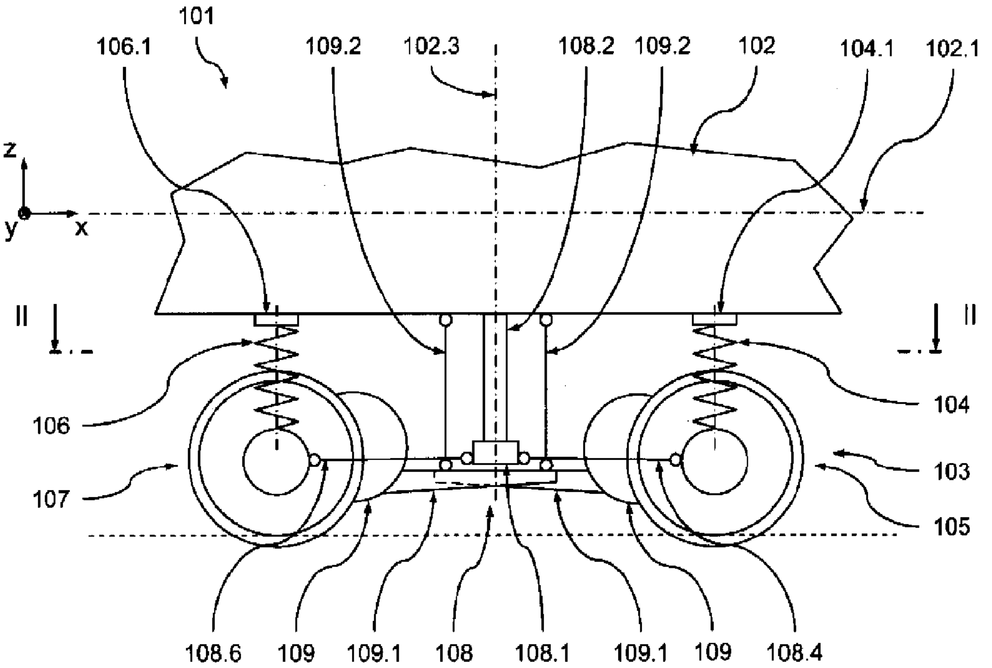
**8.** Skinnekøretøj ifølge et af kravene 6 eller 7, **kendetegnet ved, at** den første tværdrager (208.1) og/eller den anden tværdrager (208.7) har en vinklet udformning med en første og anden ende, der peger i retning af den tilhørende hjulenhed (205, 207).

**9.** Skinnekøretøj ifølge et af kravene 4 til 8, **kendetegnet ved, at** der er tilvejebragt en første drivmotorenhed (209; 309; 409), der understøttes på den første hjulenhed, og
- den første tværdrager (208.1; 408.1) i det væsentlige er forbundet stift med den første drivmotorenhed (209; 409), især er en integreret del af den første drivmotorenhed (209; 409),
og/eller
- den første drivmotorenhed (109; 209; 409) er understøttet på vognkassen (102; 202; 402) via en første støtteindretning, især mindst en første omdrejningsmomentunderstøtning, hvor
- den første støtteindretning især er anbragt på den side af den første tværdrager, der vender bort fra den første drivmotorenhed.

**10.** Skinnekøretøj ifølge et af kravene 6 til 8, **kendetegnet ved, at** der er tilvejebragt en anden drivmotorenhed (109; 209; 409), der understøttes på den anden hjulenhed, og
- den anden tværdrager (208.7; 408.7) i det væsentlige er forbundet stift med den anden drivmotorenhed (209; 409), især er en integreret del af den anden drivmotorenhed (209; 409),
og/eller

- den anden drivmotorenhed (109; 209; 409) er understøttet på vognkassen (102; 202; 402) via en anden støtteindretning, især mindst en anden omdrejningsmomentunderstøtning, hvor
- den anden støtteindretning især er anbragt på den side af den anden tværdrager, der vender bort fra den anden drivmotorenhed.

**11.** Skinnekøretøj ifølge et af de foregående krav, **kendetegnet ved, at**
- der er tilvejebragt et andet chassis (503), der er udformet og anbragt i det væsentlige symmetrisk i forhold til det første chassis (503) med hensyn til et tværgående plan af vognkassen (502) vinkelret på en langsgående akse af vognkassen (502),
og/eller
- mindst et af fjedertrinnene (104, 106; 604, 606), via hvilke vognkasser (102; 602) understøttes direkte på en hjulenhed (105, 107; 605, 607), er forbundet med vognkassen (102; 602) via en vippeskinne (104.1, 106.1; 604.1, 606.1),
og/eller
- det er udformet som et lokomotiv.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107
103
105
108.6
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109.1
108
108.1
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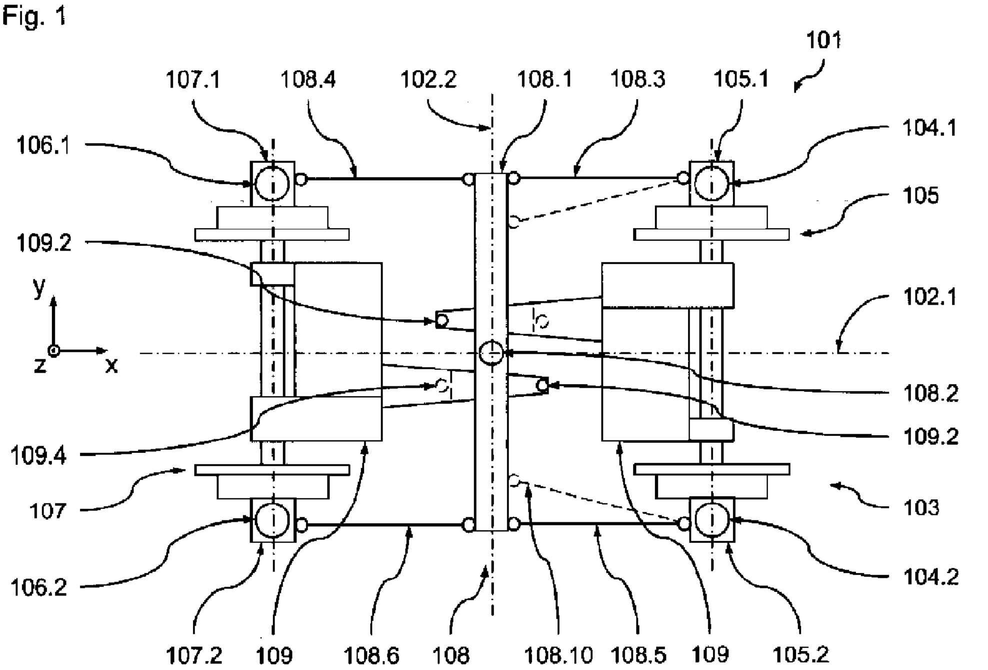
109
108.4

Fig. 1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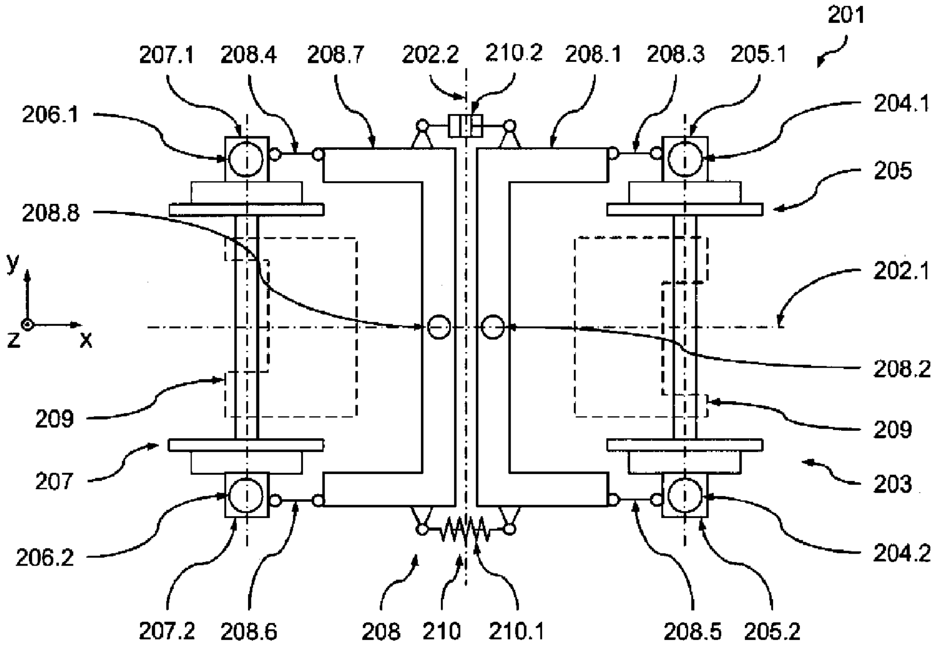
109
105.2

Fig. 2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210.1
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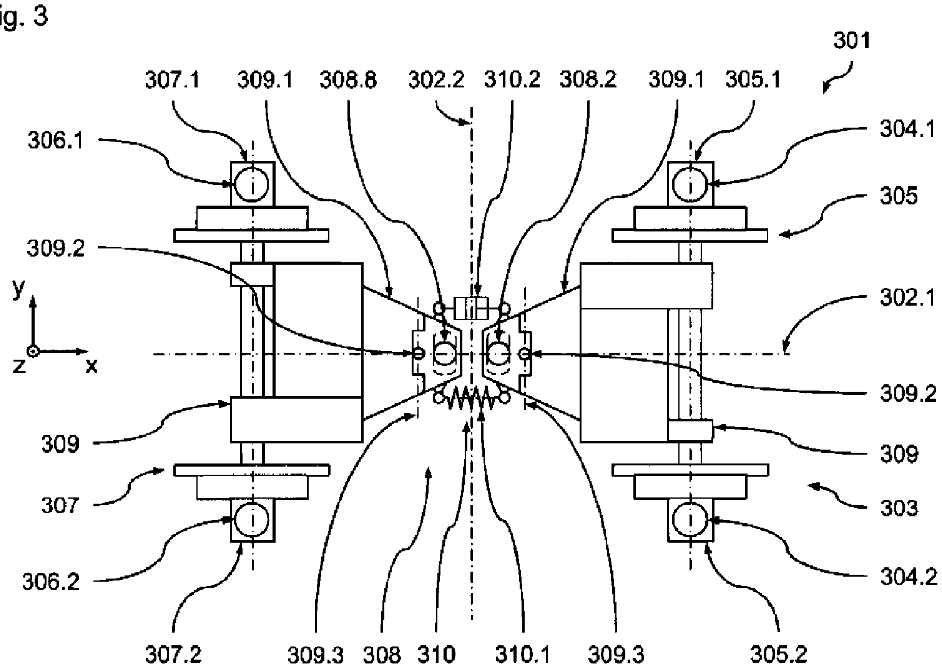
205.2

Fig. 3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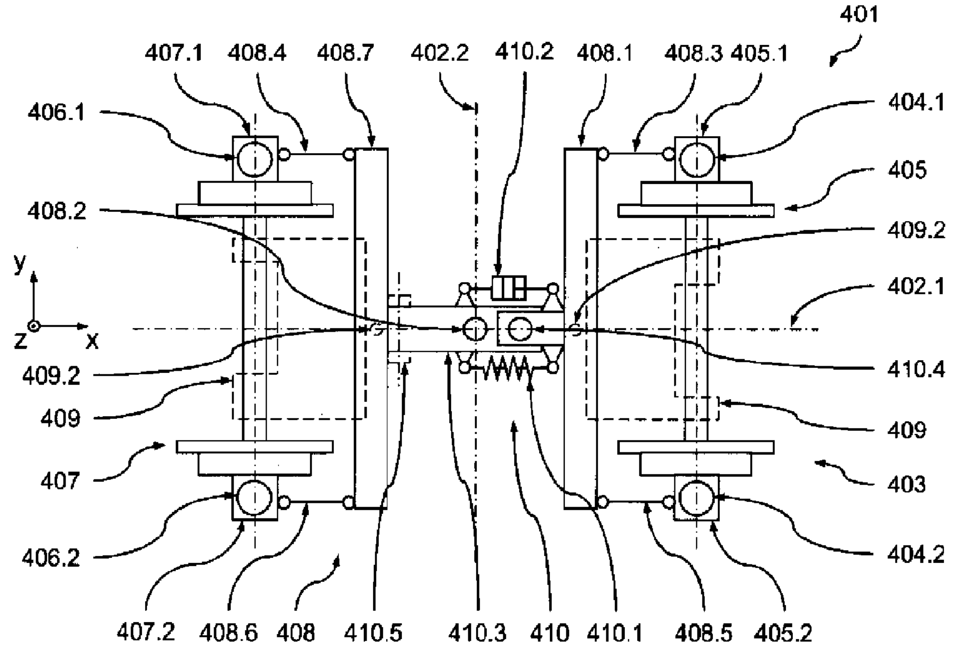
310.1
309.3
305.2

Fig. 4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408.5
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Fig. 5

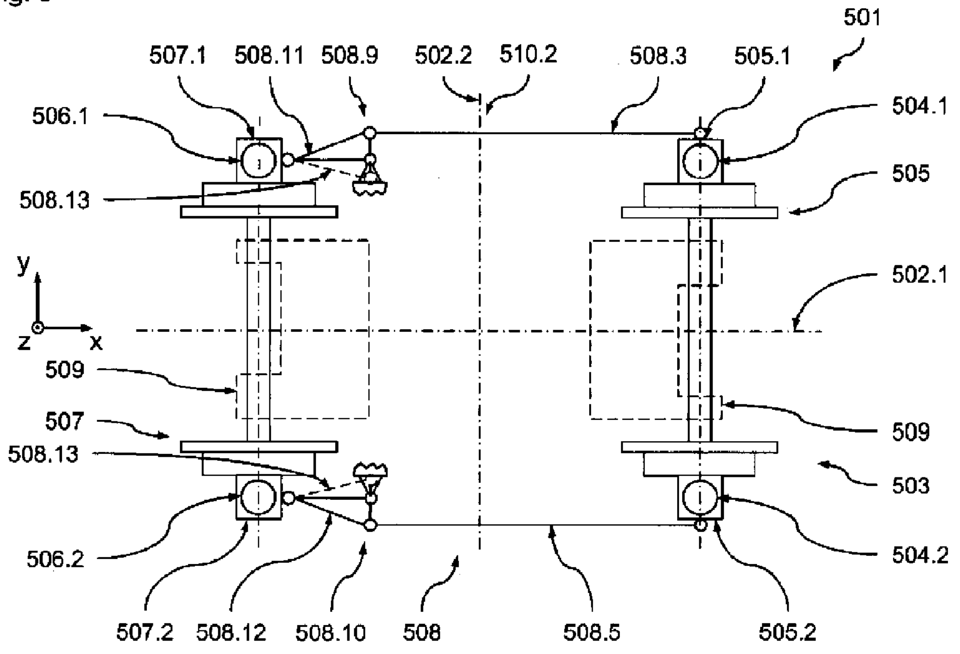
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Fig. 6

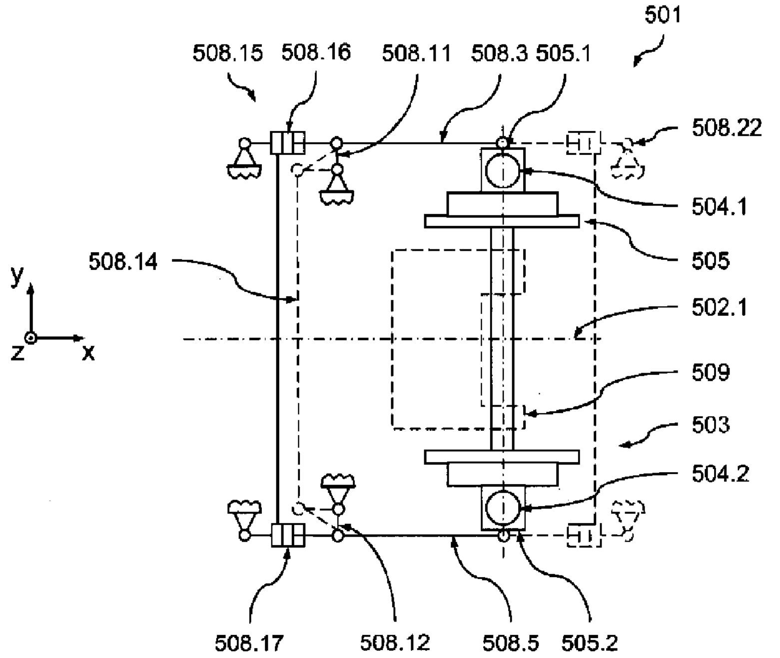
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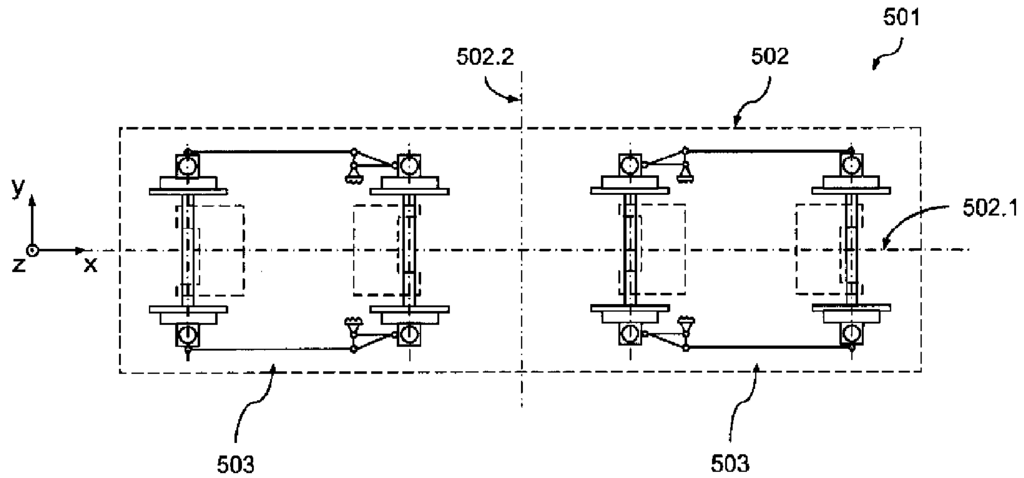
Fig. 7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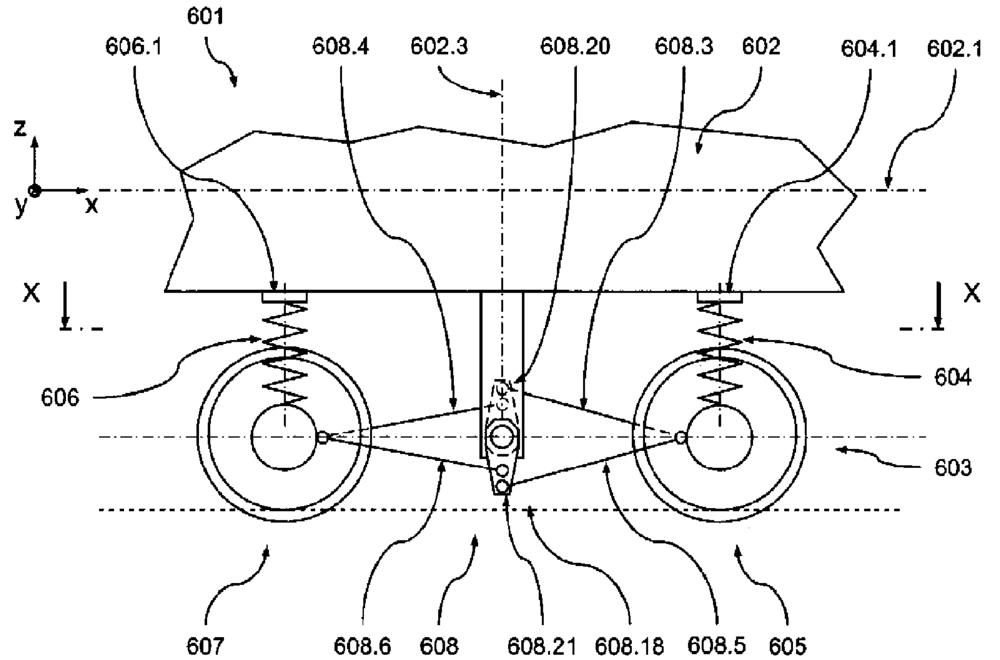
503
503

Fig. 8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605

Fig. 9

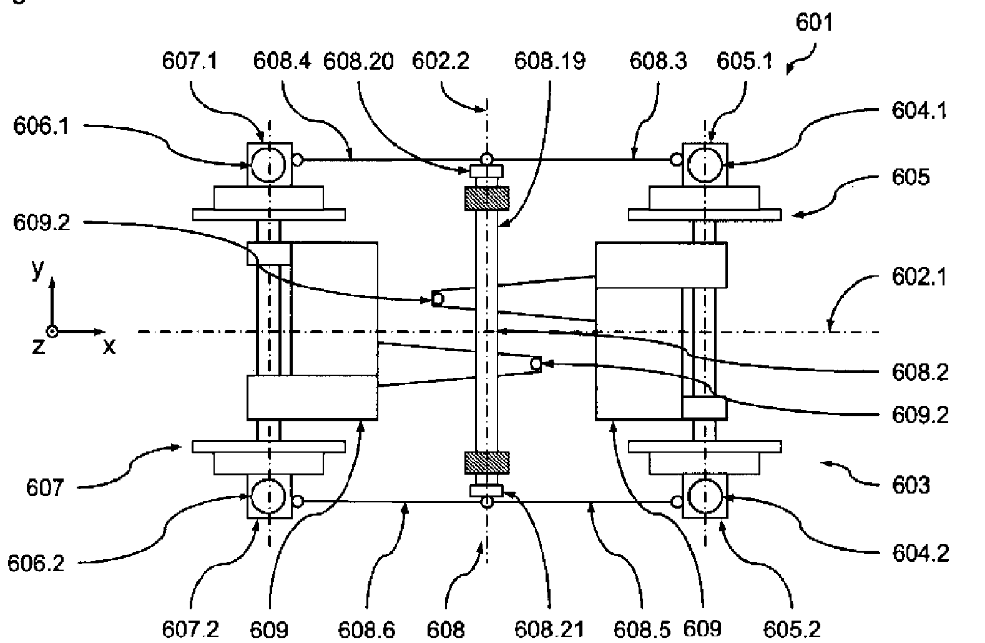
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Fig. 10