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(54) Rail vehicle unit with a rolling support

Schienenfahrzeugeinheit mit einer Wankstütze

Unité de véhicule ferroviaire avec support de roulement

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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a rail vehicle unit, comprising a first vehicle component, a second vehicle component and a rolling support device counteracting rolling motion between the first vehicle component and the second vehicle component about a rolling axis. The rolling support device comprises a torsion bar, a first torsion arm and a second torsion arm. The first torsion arm is rotationally rigidly connected to a first end section of the torsion bar and is articulated to the first vehicle component, while the second torsion arm is rotationally rigidly connected to a second end section the torsion bar and is articulated to the first vehicle component as well. Furthermore, the torsion bar is pivotably mounted to the second vehicle component via a first support element and a second support element, the first support element and the second support element being mutually spaced by a support distance along a longitudinal torsion bar axis of the torsion bar. The present invention further relates to a rail vehicle comprising such a running gear.

[0002] In modern rail vehicles such rolling support devices are used to improve running stability of the rail vehicle by preventing excessive rolling motion about a rolling axis (typically extending substantially parallel to the longitudinal axis of the vehicle) between components of the running gear (for example, between the wheelsets and the running gear frame supported thereon) or between the running gear and the wagon body supported thereon, as it is known e.g. from closest prior art.

[0003] EP 1 075 407 B1 (Klopfer et al.), EP 1 915 283 A1 (Brundisch et al.), EP 0388 999 A2 (Harsy), EP 0 397 291 A1 (Kelzer) and GB 471,083 A.

[0004] In modern rail vehicles, in particular, modern high-speed rail vehicles (adapted for operation at nominal operating speeds above 200 km/h and more), with the ongoing need to improve running stability and passenger comfort the vibrational behavior is becoming more and more important. In this context, the comparatively long torsion bars of the known rolling support devices may be the source of considerable vibration resulting from specific bending modes of the torsion bar at specific excitations during operation of the rail vehicle. Furthermore, space requirements, in particular, within the running gear become more and more strict due to the increasing number of components to be placed in the area of modern running gears leading to increased problems in placing the components and, in particular, providing a sufficient amount of free space for the motion of the torsion arms of the rolling support device.

SUMMARY OF THE INVENTION

[0005] It is thus an object of the present invention to provide a rail vehicle unit as outlined above that, at least to some extent, overcomes the above disadvantages. It

is a further object of the present invention to provide a rail vehicle unit that provides improved dynamic properties at an overall space-saving configuration.

[0006] The above objects are achieved starting from a rail vehicle unit according to the preamble of claim 1 by the features of the characterizing part of claim 1.

[0007] The present invention is based on the technical teaching that improvement of the dynamic behavior of the running gear, in particular, at high speeds, maybe achieved with an overall space-saving configuration if the at least one intermediate element located in between the support elements is co-operating with the torsion bar. This intermediate element, for example, may serve as further support or as a damper that modifies the bending vibrational modes of the torsion bar. This allows increasing the length of the torsion bar while at the same time nevertheless improving its vibrational behavior, in particular, at high speeds. An increased length of the torsion bar on the other hand provides the opportunity to place the torsion arms (in the transverse direction of the vehicle) further to the outer side of the running gear where the necessary free space for their motion is more readily available than in a more central area of the running gear.

[0008] Hence, according to one aspect, the present invention relates to a rail vehicle unit comprising a first vehicle component, a second vehicle component and a rolling support device, the rolling support device counteracting rolling motion between the first vehicle component and the second vehicle component about a rolling axis. The rolling support device comprises a torsion bar, a first torsion arm and a second torsion arm, the first torsion arm being rotationally rigidly connected to a first end section of the torsion bar and being articulated to the first vehicle component, the second torsion arm being rotationally rigidly connected to a second end section the torsion bar and being articulated to the first vehicle component. The torsion bar is pivotably mounted to the second vehicle component via a first support element and a second support element, the first support element and the second support element being mutually spaced by a support distance along a longitudinal torsion bar axis of the torsion bar. Furthermore, at least one intermediate element is provided, the intermediate element being connected to the second vehicle component and cooperating with the torsion bar, the intermediate element further being located between the first support element and the second support element.

[0009] The intermediate element may be a further support element substantially rigidly supporting and, in particular, guiding the torsion bar in a substantially rigid manner in a direction transverse to the torsion bar axis. According to the invention, the intermediate support element comprises a damping element, the damping element cooperating with the torsion bar to damp bending vibrations of the torsion bar about a bending axis running transverse to the torsion bar axis. This solution has the beneficial effect that not only the bending vibrational modes of the torsion bar modified in a favorable way, but

also damping of the vibrations is achieved in a very simple manner.

[0010] The damping element may, in principle, be of any suitable design providing the desired damping properties. Preferably, the damping element comprises a polymeric element, thereby providing good damping properties while at the same time achieving sufficient lifetime. Generally, any suitable polymers providing the appropriate damping and lifetime properties may be used. Preferably, the polymeric element is made of a readily compressible polymer, thereby providing good vibration energy absorption properties.

[0011] With preferred embodiments of the invention the compressible polymer, upon compression in a direction of compression, shows a relative elongation in a direction transverse to the direction of compression of less than 10%, preferably less than 5%, more preferably substantially 0%. Such a material has the advantage that the damping element during operation largely keeps its outer shape interfacing with its holder such that, if at all, only very moderate stresses and/or motion occurs at the outer interface area of the damping element and its holder. This is highly beneficial in terms of the lifetime of the intermediate element.

[0012] An example for such a material is a cellular polyurethane elastomer material sold under the trade name Vufcoco[®] by P+S Polyurethan-Elastomere GmbH & Co. KG, 49356 Diepholz, DE.

[0013] It will be appreciated that the damping properties of the damping element may be constantly available irrespective of the frequency of the vibration. However, with certain embodiments of the invention, the damping effect may vary as a function of the frequency of the vibration. With certain preferred embodiments of the invention, the damping element is adapted to be effective at a frequency of the bending vibrations above 1 Hz, preferably from 1 Hz to 15 Hz, more preferably from 3 Hz to 10 Hz, these frequencies being particularly relevant in terms of the running stability of high-speed rail vehicles.

[0014] The intermediate element may, in principle, be of any suitable design providing the desired support and/or damping functionality as outlined above. Preferably, with variants providing a very simple and reliable design, the intermediate element comprises a holding element and a bush element, the holding element being connected to the second vehicle component and the bush element surrounding the torsion bar and being held, at its outer circumference, in a receptacle of the holding element.

[0015] Preferably, the bush element is under compressive pre-stress in an unloaded state of the rolling support device (as is the case, for example, at a standstill of the vehicle on a straight level track). Such a pre-stress has the advantage that the damping properties of the bush element may already become effective at very low bending deflections of the torsion bar.

[0016] It will be appreciated that, in particular, depending on the available space for the interface with the sec-

ond vehicle component, the intermediate elements may be placed at any suitable and available location in between the first and second support element. Preferably, the intermediate element is in an area where, otherwise (i.e. in a configuration without such an intermediate element) maximum deflection of the torsion bar is to be expected during operation of the rail vehicle. By this means, maximum effectiveness of the intermediate element may be achieved.

[0017] Hence, with preferred embodiments of the invention, the torsion bar, in a reference configuration during an operational state of the rail vehicle unit, has a mode of bending vibration showing at least one relative maximum of bending deflection at a bending maximum location. The intermediate element is located, along the torsion bar axis, at a distance from the bending maximum location which is less than 10% of the support distance, preferably less than 5% of the support distance, more preferably 3% to 0% of the support distance. In this case, as already indicated above, the reference state configuration is a configuration wherein, under omission of the at least one intermediate element, the torsion bar is exclusively connected to the second vehicle component via the first support element and the second support element.

[0018] It will be appreciated that the operational state of the rail vehicle may be any operational state where a correspondingly intense bending vibration of the torsion bar is to be expected. For example, this may be an operational state wherein the frequency of the excitation of torsion bar lies in the range of a natural bending frequency of the torsion bar. With certain embodiments of the invention, the operational state of the rail vehicle unit, may be a state wherein the rail vehicle unit is operated at its nominal operating speed.

[0019] It will be further appreciated that the damping effect of the intermediate element may be chosen as a function of the negative impact of the bending vibration of the torsion bar on either one of the running stability and the passenger comfort level achieved in the respective rail vehicle. Preferably, the intermediate element is adapted to provide, compared to the reference configuration, a reduction of a maximum amplitude of the bending vibrations by at least 80%, preferably by at least 90%, more preferably by at least 95%. Hereby, particularly beneficial improvements of running stability and/or passenger comfort may be achieved.

[0020] In principle, any desired number of intermediate elements may be provided. These intermediate elements may, at least partially, vary in their design and/or their dynamic properties, in particular, their damping properties. However, particularly simple configurations show substantially identical intermediate elements.

[0021] With certain preferred embodiments of the invention showing good dynamic properties, in particular good damping properties, at comparatively low expense, two intermediate elements are provided, each of the intermediate elements being located, along the torsion bar

axis, at an intermediate element distance from the respective closer one of the first support element and the second support element. The intermediate element distance is 25% to 45% of the support distance, preferably 30% to 40% of the support distance, more preferably 33% to 37% of the support distance. It will be appreciated that the two intermediate elements may be the sole intermediate elements present in the rail vehicle unit. However, with other embodiments of the invention, further intermediate elements located at different locations may be added.

[0022] The first and second vehicle component, in principle, may be any components of the rail vehicle which are prone to execute an undesired mutual rolling motion. These may be, for example, a wheel unit (such as a wheel set or a wheel pair) and a running gear frame supported thereon via a primary spring device (one of both forming the first vehicle component and the other one forming the second vehicle component). Furthermore, one of a running gear and a wagon body (typically supported thereon via a secondary spring device) may form the first vehicle component while the other one forms the second vehicle component.

[0023] Certain preferred embodiments of the rail vehicle unit according to the invention comprise a running gear, the first vehicle component being a running gear frame of the running gear and the second vehicle component a bolster or a wagon body supported on the running gear frame via a secondary spring device. Such configurations, typically, providing the advantage that the bolster or the wagon body allows simpler integration of the torsion bar (extending in the transverse direction of the rail vehicle and spanning a major fraction of the total width of the running gear in this transverse direction) provide a more readily available interface space for the mounting of the torsion bar.

[0024] Preferably, the second vehicle component is a bolster extending in a transverse direction of the rail vehicle unit, the first support element and the second support element being located in the region of transversally opposite ends of the bolster. Such a configuration has the advantage that the ends of the torsion bar with the torsion arms mounted thereon are located comparatively far laterally outside from the center of the running gear where free building space for integrating the linkage to the first vehicle component is more readily available.

[0025] It will be appreciated that the lateral position of the support elements (in the transverse direction of the rail vehicle) may be selected as a function of the free building space available for integration of the rolling support device. Preferably, the rail vehicle unit comprises a wheel unit defining a track width and the support distance is at least 120% of the track width, preferably at least 150% of the track width, more preferably 160% to 180% of the track width. Such a configuration again has the above advantages of a configuration with torsion arms that are located comparatively far laterally outside from the center of the running gear.

[0026] It will be appreciated that the present invention may be used for any desired rail vehicle operating at any desired nominal operating speed. However, the beneficial effect of the present invention or a particularly visible in the high-speed operations. Hence, preferably, the running gear it is adapted for a nominal operating speed above 250 km/h, preferably above 300 km/h, more preferably above 350 km/h.

[0027] The present invention furthermore relates to a rail vehicle with a rail vehicle unit according to the invention as it has been outlined above.

[0028] Further embodiments of the present invention will become apparent from the dependent claims and the following description of preferred embodiments which refers to the appended figures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029]

Figure 1 is a schematic perspective top view of a preferred embodiment of a rail vehicle unit according to the present invention used in a preferred embodiment of the vehicle according to the present invention;

Figure 2 is a further schematic top view of a detail of the rail vehicle unit of Figure 1

DETAILED DESCRIPTION OF THE INVENTION

[0030] With reference to Figures 1 and 2 a preferred embodiment of a rail vehicle 101 according to the present invention comprising a preferred embodiment of a rail vehicle unit in the form of a running gear 102 according to the invention will now be described in greater detail. In order to simplify the explanations given below, an xyz-coordinate system has been introduced into the Figures, wherein (on a straight, level track) the x-axis designates the longitudinal direction of the running gear 102, the y-axis designates the transverse direction of the running gear 102 and the z-axis designates the height direction of the running gear 102.

[0031] The vehicle 101 is a high-speed rail vehicle with a nominal operating speed above 250 km/h, more precisely above 300 km/h to 380 km/h. The vehicle 101 comprises a wagon body (not shown) supported by a suspension system on the running gear 102. The running gear 102 comprises two wheel units in the form of wheel sets 103 supporting a running gear frame unit 104 via a primary spring unit 105. The running gear frame unit 104 supports the wagon body via a secondary spring unit 106.

[0032] Each wheel set 103 and is driven by a drive unit 107. The drive unit 107 comprises a motor unit 108 (suspended to the running gear frame unit 104) and a gearing 109 (sitting on the shaft of the wheel set 103) connected via a motor shaft 110. Both drive units 107 are of substantially identical design and arranged substantially

symmetrically with respect to the center of the running gear frame unit 104.

[0033] The running gear frame unit 104 is of generally H-shaped design with a middle section in the form of a transverse beam 104.1 located between the wheel sets 103. The interface of the running gear 102 to the wagon body (not shown) is formed by a bolster 111 rigidly connected to the wagon body and supported on the running gear frame unit 104 via the secondary spring unit 106.

[0034] To counteract undesired rolling motion between the wagon body and the running gear frame unit 104 about a rolling axis which is generally parallel to the vehicle longitudinal axis (x-direction) a rolling support device 112 is provided. The rolling support device 112 acts between the running gear frame unit 104 (forming a first vehicle component in the sense of the present invention) and the bolster 111 (forming a second vehicle component in the sense of the present invention).

[0035] The rolling support device 112 comprises a torsion bar 112.1, a first torsion arm 112.2 and a second torsion arm 112.3. One end of the first torsion arm 112.2 is rotationally rigidly connected to a first end section of the torsion bar 112.1. The other end of the first torsion arm 112.2 is articulated to the running gear frame unit 104 via a first linkage element 112.4. Furthermore, the second torsion arm 112.3 is rotationally rigidly connected to a second end section the torsion bar 112.1. The other end of the second torsion 112.3 is articulated to the running gear frame unit 104 via a second linkage element 112.5.

[0036] The torsion bar 112.1 is mounted to the bolster 111 via a first support element 113.1 and a second support element 113.2, the first support element 113.1 and the second support element 113.2 being mutually spaced by a support distance SD along the longitudinal torsion bar axis 112.6 of the torsion bar 112.1. The first support element 113.1 and the second support element 113.2 hold the torsion bar 112.1 such that it is pivotable about the torsion bar axis 112.6.

[0037] The rolling support device 112, in a generally known manner (which, consequently, will not be described in further detail), counteracts an undesired rolling motion between the running gear frame unit 104 and the bolster 111 (and, hence, the wagon body) by an elastic torsion of the torsion bar 112.1 generating a corresponding counteracting moment about the rolling axis.

[0038] As can be seen from Figure 2, in addition to and in between the first and second support element 113.1, 113.2, a first intermediate element 114.1 and a second intermediate element 114.2 are mounted to the bolster 111. The first intermediate element 114.1 is located closer to the first support element 113.1 at an intermediate element distance IED (along the torsion bar axis 112.6), while the second intermediate element 114.2 is located closer to the second support element 113.2 at substantially the same intermediate element distance IED (along the torsion bar axis 112.6).

[0039] The first and second intermediate element

114.1 and 114.2 are formed as damping units co-operating with the torsion bar 112.1 to damp and reduce bending vibrations of the torsion bar 112.1 about a bending axis running transverse to the torsion bar axis 112.6. By this means an improvement of the dynamic behavior of the running gear 102, in particular, at high speeds, is achieved with an overall space-saving configuration.

[0040] This improvement is achieved since the intermediate elements 114.1, 114.2, on the one hand, modify the bending vibrational modes of the torsion bar 112.1 and, on the other hand, absorb vibration energy. Compared to conventional rolling supports, this allows increasing the length of the torsion bar 112.1 (along its torsion bar axis 112.6) while at the same time nevertheless improving its vibrational behavior, in particular, at high speeds. This increased length of the torsion bar 112.6, on the other hand, provides the opportunity to place the torsion arms 112.2, 112.3 (in the transverse direction of the vehicle) further to the outer side of the running gear 102 where the necessary free space for their motion is more readily available than in a more central area of the running gear 102.

[0041] Consequently, the lateral position of the support elements 113.1, 113.2 (in the transverse direction of the rail vehicle) is selected to be comparatively far laterally outside, namely in the region of opposite ends of the transversally extending bolster 111. More precisely, in the present example, the support distance SD is about 170% of the track width TW defined by the wheel sets 103.

[0042] In the present example, the intermediate element distance IED is about 35% of the support distance SD. By this means, as will be outlined in further detail below, a highly beneficial damping effect is achieved.

[0043] To achieve the damping effect, each of the intermediate elements 114.1, 114.2 comprises a polymeric bush element 114.3 received and held in a receptacle of a holding element 114.4. The holding element 114.4, in turn, is rigidly mounted to the bolster 111.

[0044] The bush element 114.3 surrounds the torsion bar 112.1 and is under compressive pre-stress in an unloaded state of the rolling support device 112 (as is the case, for example, at a standstill of the vehicle on a straight level track). Such a pre-stress has the advantage that the damping properties of the bush element 114.3 may already become effective at very low bending deflections of the torsion bar 112.1. It will be appreciated that, with certain other embodiments of the invention, a certain (eventually only very slight) radial play may be provided between the bush element 114.3 and the torsion bar 112.1.

[0045] For the bush element 114.3, generally, any suitable polymers providing the appropriate damping and lifetime properties may be used. In the present example, the polymeric element forming the bush element 114.3 is made of a readily compressible polymer, thereby providing good vibration energy absorption properties.

[0046] Furthermore, in the present example, the com-

pressible polymer, upon compression in a direction of compression, shows a relative elongation in a direction transverse to the direction of compression which is substantially 0%. Such a material has the advantage that the damping element 114.3 during operation largely keeps its outer shape interfacing with its holder 114.4 such that, if at all, only very moderate stress and/or motion occurs at the outer interface area of the damping bush 114.3 and its holder 114.4. This is highly beneficial in terms of the lifetime of the respective intermediate element 114.1, 114.2, in particular, in terms of the lifetime of the damping bush 114.3.

[0047] In the present example the polymeric material used for the bush 114.3 is a cellular polyurethane elastomer material sold under the trade name Vulcocell® by P+S Polyurethan-Elastomere GmbH & Co. KG, 49356 Diepholz, DE, showing these properties.

[0048] It will be appreciated that the damping element does not necessarily have to be formed as one single bush made from one single material. For example, with other embodiments, damping elements comprising a plurality of layers, eventually made of different materials, may also be used. In particular, in this case, not all of the layers used need to show corresponding damping properties. More precisely, one or more carrier layers or the like may be used to provide structural stability of the damping element.

[0049] It will be appreciated that the damping properties of the damping element 114.3 may be constantly available irrespective of the frequency of the vibration. However, with certain embodiments of the invention, the damping effect may vary as a function of the frequency of the vibration. In the present example, the damping element 114.3 is adapted to be effective at a frequency of the bending vibrations above 1 Hz, preferably from 1 Hz to 15 Hz, more preferably from 3 Hz to 10 Hz, these frequencies being particularly relevant in terms of the running stability of high-speed rail vehicles.

[0050] In the present example, each of the intermediate elements 113.1, 113.2 is located in an area where, otherwise (i.e. in a reference configuration without such an intermediate element, wherein the torsion bar 112.1 is exclusively connected to the bolster 111 via the first and second support element 113.1, 113.2) a maximum deflection of the torsion bar 112.1 is to be expected during operation of the rail vehicle 101. By this means, maximum effectiveness of the intermediate elements 113.1, 113.2 is achieved.

[0051] In the example shown, the torsion bar 112.1, in the above reference configuration during a given operational state of the rail vehicle unit, has a sinusoidal mode of bending vibration showing at least two relative maxima of bending deflection, each at a relative bending maximum location. Each one of the intermediate elements 113.1 and 113.2 is located, along the torsion bar axis 112.6 in the area of one of these bending maxima, at a distance from the respective bending maximum location which is less than 10% of the support distance SD.

[0052] In the embodiment shown, this slight distance from the respective bending maximum has the advantage that the connection between respective intermediate element 114.1, 114.2 and the bolster 111 may be formed in a very simple manner due to the given shape of the bolster 111. It will be appreciated that, with other embodiments of the invention, another distance to be respective bending maximum may be chosen. Furthermore, it may also be provided that the location of the respective intermediate element may coincide with the bending maximum.

[0053] It will be appreciated that the above operational state of the rail vehicle 101 and, hence, the running year 102 (wherein the bending maximum occurs) may be any operational state where a correspondingly intense bending vibration of the torsion bar 112.1 is to be expected. For example, this may be an operational state wherein the frequency of the excitation of torsion bar 112.1 lies in the range of a natural bending frequency of the torsion bar 112.1. With certain embodiments of the invention, the operational state of the rail vehicle unit may be a state wherein the rail vehicle unit is operated at its nominal operating speed.

[0054] In the present example, the two is substantially identically designed intermediate elements 114.1, 114.2 provide (compared to the reference configuration as outlined above) a reduction of a maximum amplitude of the bending vibrations by about 95% such that particularly beneficial improvements of running stability and/or passenger comfort are achieved in a very simple manner.

[0055] It will be appreciated that the lateral position of the support elements (in the transverse direction of the rail vehicle) may be selected as a function of the free building space available for integration of the rolling support device. Preferably, the rail vehicle unit comprises a wheel unit defining a track width and the support distance is at least 120% of the track width, preferably at least 150% of the track width, more preferably 160% to 180% of the track width. Such a configuration again has the above advantages of a configuration with torsion arms that are located comparatively far laterally outside from the center of the running gear.

[0056] Although the present invention in the foregoing has only a described in the context of high-speed rail vehicles, it will be appreciated that it may also be applied to any other type of rail vehicle in order to overcome similar problems with respect to a simple solution for generally vibrational problems, such as running stability problems and acoustic problems.

Claims

1. A rail vehicle unit, comprising

- a first vehicle component (104),
- a second vehicle component (111) and
- a rolling support device (112);

- said rolling support device (112) counteracting rolling motion between said first vehicle component (104) and said second vehicle component (111) about a rolling axis;
- said rolling support device (112) comprising a torsion bar (112.1), a first torsion arm (112.2) and a second torsion arm (112.3);
- said first torsion arm (112.2) being rotationally rigidly connected to a first end section of said torsion bar (112.1) and being articulated to said first vehicle component (104);
- said second torsion arm (112.3) being rotationally rigidly connected to a second end section of said torsion bar (112.1) and being articulated to said first vehicle component (104);
- said torsion bar (112.1) being pivotably mounted to said second vehicle component (111) via a first support element (113.1) and a second support element (113.2), said first support element (113.1) and said second support element (113.2) being mutually spaced by a support distance along a longitudinal torsion bar axis (112.6) of said torsion bar (112.1);

characterized in that

- at least one intermediate element (114.1, 114.2) is provided;
- said intermediate element (114.1, 114.2) being connected to said second vehicle component (111) and cooperating with said torsion bar (112.1);
- said intermediate element (114.1, 114.2) being located between said first support element (113.1) and said second support element (113.2).
- said intermediate element (114.1, 114.2) comprises a damping element (114.3);
- said damping element (114.3) cooperating with said torsion bar (112.1) to damp bending vibrations of said torsion bar (112.1) about a bending axis running transverse to said torsion bar axis (112.6).

2. The rail vehicle unit according to claim 1, wherein

- said damping element (114.3) comprises a polymeric element;
- said polymeric element, in particular, being made of a compressible polymer, in particular a cellular polyurethane elastomer,
- said compressible polymer, in particular, upon compression in a direction of compression, showing a relative elongation in a direction transverse to said direction of compression of less than 10%, preferably less than 5%, more preferably substantially 0%.

3. The rail vehicle unit according to one of claims 1 or 2, wherein said damping element (114.3) is adapted

to be effective at a frequency of said bending vibrations above 1 Hz, preferably from 1 Hz to 15 Hz, more preferably from 3 Hz to 10 Hz.

4. The rail vehicle unit according to any one of claims 1 to 3, wherein

- said intermediate element (114.1, 114.2) comprises a holding element (114.4) and a bush element (114.3);
- said holding element (114.4) being connected to said second vehicle component (111);
- said bush element (114.3) surrounding said torsion bar (112.1) and being held, at its outer circumference, in a receptacle of said holding element (114.4);
- said bush element (114.3), in particular, being under compressive pre-stress in an unloaded state of said rolling support device (112).

5. The rail vehicle unit according to any one of claims 1 to 4, wherein

- said torsion bar (112.1), in a reference configuration during an operational state of said rail vehicle unit, has a mode of bending vibration showing at least one relative maximum of bending deflection at a bending maximum location;
- said intermediate element (114.1, 114.2), along said torsion bar axis (112.6), being located at a distance from said bending maximum location which is less than 10% of said support distance, preferably less than 5% of said support distance, more preferably 3% to 0% of said support distance;
- said reference state configuration being a configuration wherein, under omission of said at least one intermediate element (114.1, 114.2), said torsion bar (112.1) is exclusively connected to said second vehicle component (111) via said first support element (113.1) and said second support element (113.2);
- said operational state of said rail vehicle unit, in particular, being a state wherein said rail vehicle unit is operated at its nominal operating speed.

6. The rail vehicle unit according to claim 5, wherein said intermediate element (114.1, 114.2) is adapted to provide, compared to said reference configuration, a reduction of a maximum amplitude of said bending vibrations by at least 80%, preferably by at least 90%, more preferably by at least 95%.

7. The rail vehicle unit according to any one of claims 1 to 6, wherein

- two intermediate elements (114.1, 114.2) are

- provided;
- each of said intermediate elements (114.1, 114.2) being located, along said torsion bar axis (112.6), at an intermediate element distance from the respective closer one of said first support element (113.1) and said second support element (113.2);
 - said intermediate element (114.1, 114.2) distance being 25% to 45% of said support distance, preferably 30% to 40% of said support distance, more preferably 33% to 37% of said support distance.
8. The rail vehicle unit according to any one of claims 1 to 7, wherein
- it comprises a running gear (102);
 - said first vehicle component, in particular, being a running gear frame (104) of said running gear;
 - said second vehicle component, in particular, being a bolster (111) or a wagon body supported on said running gear frame (104) via a secondary spring device (106).
9. The rail vehicle unit according to claim 8, wherein
- said second vehicle component is a bolster (111) extending in a transverse direction of said rail vehicle unit;
 - said first support element (113.1) and said second support element (113.2) being located in the region of transversally opposite ends of said bolster (111).
10. The rail vehicle unit according to any one of claims 1 to 9, wherein
- it comprises a wheel unit (103) defining a track width;
 - said support distance being at least 120% of said track width, preferably at least 150% of said track width, more preferably 160% to 180% of said track width.
11. The rail vehicle unit according to any one of claims 1 to 10, wherein it is adapted for a nominal operating speed above 250 km/h, preferably above 300 km/h, more preferably above 350 km/h.
12. A rail vehicle with a rail vehicle unit (102) according to any one of claims 1 to 11.

Patentansprüche

1. Schienenfahrzeugeinheit, umfassend

- eine erste Fahrzeugkomponente (104),
 - eine zweite Fahrzeugkomponente (111) und
 - eine Wankstützeinrichtung (112), wobei
 - die Wankstützeinrichtung (112) der Wankbewegung zwischen der ersten Fahrzeugkomponente (104) und der zweiten Fahrzeugkomponente (111) um eine Wankachse entgegenwirkt,
 - die Wankstützeinrichtung (112) einen Torsionsstab (112.1), einen ersten Torsionsarm (112.2) und einen zweiten Torsionsarm (112.3) aufweist,
 - der erste Torsionsarm (112.2) drehsteif mit einem ersten Endabschnitt des Torsionsstabes (112.1) verbunden ist und an der ersten Fahrzeugkomponente (104) angelenkt ist,
 - der zweite Torsionsarm (112.3) drehsteif mit einem zweiten Endabschnitt des Torsionsstabes (112.1) verbunden ist und an der ersten Fahrzeugkomponente (104) angelenkt ist,
 - die Torsionsstab (112.1) über ein erstes Stützelement (113.1) und ein zweites Stützelement (113.2) schwenkbar an der zweiten Fahrzeugkomponente (111) montiert ist, wobei das erste Stützelement (113.1) und das zweite Stützelement (113.2) um einen Stützabstand entlang einer Torsionsstablängsachse (112.6) des Torsionsstabes (112.1) voneinander beabstandet sind,
- dadurch gekennzeichnet, dass**
- wenigstens ein Zwischenelement (114.1, 114.2) vorgesehen ist,
 - das Zwischenelement (114.1, 114.2) mit der zweiten Fahrzeugkomponente (111) verbunden ist und mit dem Torsionsstab (112.1) zusammenwirkt,
 - das Zwischenelement (114.1, 114.2) zwischen dem ersten Stützelement (113.1) und dem zweiten Stützelement (113.2) angeordnet ist,
 - das Zwischenelement (114.1, 114.2) ein Dämpfungselement (114.3) aufweist,
 - das Dämpfungselement (114.3) mit der Torsionsstab (112.1) zusammenwirkt, um Biegeschwingungen des Torsionsstabes (112.1) um eine Biegeachse zu dämpfen, die quer zu der Torsionsstabachse (112.6) verläuft.

2. Schienenfahrzeugeinheit nach Anspruch 1, wobei

- das Dämpfungselement (114.3) ein polymeres Element umfasst, wobei
- das polymere Element insbesondere aus einem komprimierbaren Polymer, insbesondere einem porigen Polyurethan-Elastomer, hergestellt ist,
- das komprimierbare Polymer bei Komprimierung in einer Komprimierungsrichtung in einer Richtung, die quer zur Komprimierungsdichtung verläuft, insbesondere eine relative Längenän-

derung von weniger als 10%, vorzugsweise weniger als 5%, weiter vorzugsweise von im Wesentlichen 0%, aufweist.

3. Schienenfahrzeugeinheit nach einem der Ansprüche 1 oder 2, wobei das Dämpfungselement (114.3) dazu ausgebildet ist, seine Wirkung bei einer Frequenz der Biegeschwingungen von über 1 Hz, vorzugsweise von 1 Hz bis 15 Hz, weiter vorzugsweise von 3 Hz bis 10 Hz, zu entfalten. 5
10
4. Schienenfahrzeugeinheit nach einem der Ansprüche 1 bis 3, wobei
 - das Zwischenelement (114.1, 114.2) ein Halteelement (114.4) und ein Buchsenelement (114.3) aufweist, 15
 - das Halteelement (114.4) mit der zweiten Fahrzeugkomponente (111) verbunden ist,
 - das Buchsenelement (114.3) den Torsionsstab (112.1) umgibt und an seinem äußeren Umfang in einer Aufnahme des Halteelements (114.4) gehalten wird, 20
 - das Buchsenelement (114.3) in einem unbelasteten Zustand der Wankstützeinrichtung (112) insbesondere unter Druckvorspannung ist. 25
5. Schienenfahrzeugeinheit nach einem der Ansprüche 1 bis 4, wobei 30
 - die Torsionsstab (112.1) in einer Referenzkonfiguration während eines Betriebszustands der Schienenfahrzeugeinheit einen Biegeschwingungsmodus hat, der wenigstens ein relatives Maximum der Biegeauslenkung an einer Biegemaximumposition aufweist, 35
 - das Zwischenelement (114.1, 114.2) entlang der Torsionsstabachse (112.6) in einem Abstand von der Biegemaximumposition liegt, der weniger als 10% des Stützabstands, vorzugsweise weniger als 5% des Stützabstands, weiter vorzugsweise 3% bis 0% des Stützabstands, beträgt, 40
 - die Referenzzustandskonfiguration eine Konfiguration ist, bei welcher der Torsionsstab (112.1) unter Weglassen des wenigstens einen Zwischenelements (114.1, 114.2) ausschließlich über das erste Stützelement (113.1) und das zweite Stützelement (113.2) mit der zweiten Fahrzeugkomponente (111) verbunden ist, 50
 - der Betriebszustand der Schienenfahrzeugeinheit insbesondere ein Zustand ist, in dem die Schienenfahrzeugeinheit mit ihrer Nennbetriebsgeschwindigkeit betrieben wird. 55
6. Schienenfahrzeugeinheit nach Anspruch 5, wobei

das Zwischenelement (114.1, 114.2) dazu ausgebildet ist, bezüglich der Referenzkonfiguration eine Verringerung einer maximalen Amplitude der Biegeschwingungen um wenigstens 80%, vorzugsweise wenigstens 90%, weiter vorzugsweise wenigstens 95%, bereitzustellen.

7. Schienenfahrzeugeinheit nach einem der Ansprüche 1 bis 6, wobei
 - zwei Zwischenelemente (114.1, 114.2) vorgesehen sind,
 - jedes der Zwischenelemente (114.1, 114.2) entlang der Torsionsstabachse (112.6) in einem Zwischenelementabstand von dem jeweils Näheren des ersten Stützelements (113.1) und des zweiten Stützelements (113.2) angeordnet ist,
 - der Zwischenelementabstand (114.1, 114.2) 25% bis 45% des Stützabstands, vorzugsweise 30% bis 40% des Stützabstands, weiter vorzugsweise 33% bis 37% des Stützabstands, beträgt.
8. Schienenfahrzeugeinheit nach einem der Ansprüche 1 bis 7, wobei
 - sie ein Fahrwerk (102) umfasst,
 - die erste Fahrzeugkomponente insbesondere ein Fahrwerksrahmen (104) des Fahrwerks ist,
 - die zweite Fahrzeugkomponente insbesondere eine Wiege (111) oder ein Wagenkasten ist, die/der über eine Sekundärfedereinrichtung (106) auf dem Fahrwerksrahmen abgestützt ist.
9. Schienenfahrzeugeinheit nach Anspruch 8, wobei
 - die zweite Fahrzeugkomponente eine Wiege (111) ist, die sich in einer Querrichtung der Schienenfahrzeugeinheit erstreckt, wobei
 - das erste Stützelement (113.1) und das zweite Stützelement (113.2) im Bereich voneinander transversal entgegengesetzter Enden der Wiege (111) angeordnet sind.
10. Schienenfahrzeugeinheit nach einem der Ansprüche 1 bis 9, wobei
 - sie eine Radeinheit (103) umfasst, die eine Spurweite definiert,
 - der Stützabstand wenigstens 120% der Spurweite, vorzugsweise wenigstens 150% der Spurweite, weiter vorzugsweise wenigstens 160% bis 180% der Spurweite, beträgt.
11. Schienenfahrzeugeinheit nach einem der Ansprüche 1 bis 10, wobei sie für eine Nennbetriebsgeschwindigkeit von über 250 km/h, vorzugsweise über 300 km/h, weiter vorzugsweise über 350 km/h

ausgelegt ist.

12. Schienenfahrzeug mit einer Schienenfahrzeugeinheit (102) nach einem der Ansprüche 1 bis 11.

Revendications

1. Une unité de véhicule ferroviaire, comprenant

- un premier composant de véhicule (104),
 - un deuxième composant de véhicule (111), et
 - un dispositif de support de roulement (112);
 - ledit dispositif de support de roulement (112) empêchant le mouvement de roulement entre ledit premier composant de véhicule (104) et ledit deuxième composant de véhicule (111) autour d'un axe de roulement;
 - ledit dispositif de support de roulement (112) comportant une barre de torsion (112.1), un premier bras de torsion (112.2) et un deuxième bras de torsion (112.3);
 - ledit premier bras de torsion (112.2) étant relié de manière rigide et en rotation avec une première section d'extrémité de ladite barre de torsion (112.1) et étant articulé audit premier composant de véhicule (104);
 - ledit deuxième bras de torsion (112.3) étant relié de manière rigide et en rotation avec une deuxième section d'extrémité de ladite barre de torsion (112.1) et étant articulé audit premier composant de véhicule (104);
 - ladite barre de torsion (112.1) étant montée de manière pivotable sur ledit deuxième composant de véhicule (111) via un premier élément de support (113.1) et un deuxième élément de support (113.2), ledit premier élément de support (113.1) et ledit deuxième élément de support (113.2) étant mutuellement espacés d'une distance de support le long d'un axe longitudinal de barre de torsion (112.6) de ladite barre de torsion (112.1);
caractérisé en ce que
 - au moins un élément intermédiaire (114.1, 114.2) est installé;
 - ledit élément intermédiaire (114.1, 114.2) étant relié audit deuxième composant de véhicule (111) et coopérant avec ladite barre de torsion (112.1);
 - ledit élément intermédiaire (114.1, 114.2) étant situé entre le premier élément de support (113.1) et ledit deuxième élément de support (113.2);
 - ledit élément intermédiaire (114.1, 114.2) comporte un élément d'amortissement (114.3);
 - ledit élément d'amortissement (114.3) coopérant avec ladite barre de torsion (112.1) pour amortir les vibrations de flexion de ladite barre

de torsion (112.1) autour d'un axe de flexion orienté de manière transversale audit axe de barre de torsion (112.6).

2. L'unité de véhicule ferroviaire selon la revendication 1, dans laquelle

- ledit élément d'amortissement (114.3) comporte un élément polymérique;
 - ledit élément polymérique, en particulier, étant fait d'un polymère compressible, en particulier un élastomère polyuréthane cellulaire,
 - ledit polymère compressible, en particulier, montrant, lors d'une compression dans une direction de compression, un allongement relatif dans une direction transversale à ladite direction de compression de moins de 10%, préférablement de moins de 5%, plus préférablement de sensiblement 0%.

3. L'unité de véhicule ferroviaire selon l'une des revendications 1 ou 2, dans laquelle ledit élément d'amortissement (114.3) est conçu pour être efficace à une fréquence desdites vibrations de flexion au-dessus de 1 Hz, préférablement entre 1 Hz et 15 Hz, plus préférablement entre 3 Hz et 10 Hz.

4. L'unité de véhicule ferroviaire selon l'une quelconque des revendications 1 à 3, dans laquelle

- ledit élément intermédiaire (114.1, 114.2) comprend un élément de maintien (114.4) et un élément de douille (114.3);
 - ledit élément de maintien (114.4) étant relié audit deuxième composant de véhicule (111);
 - ledit élément de douille (114.3) entourant ladite barre de torsion (112.1) et étant maintenu, à sa circonférence extérieure, dans un réceptacle dudit élément de maintien (114.4);
 - ledit élément de douille (114.3), en particulier, étant sous contrainte de compression dans un état d'absence de charge dudit dispositif de support de roulement (112).

5. L'unité de véhicule ferroviaire selon l'une quelconque des revendications 1 à 4, dans laquelle

- ladite barre de torsion (112.1), dans une configuration de référence, et dans un état opérationnel de ladite unité de véhicule ferroviaire, possède un mode de vibration de flexion présentant au moins un maximum relatif de flexion en un point de flexion maximale;
 - ledit élément intermédiaire (114.1, 114.2), le long dudit axe de barre de torsion (112.6), étant situé à une distance, par rapport audit point de flexion maximale, qui est inférieure à 10% de ladite distance de support, préférablement

- moins de 5% de ladite distance de support, plus
préféablement de 3% à 0% de ladite distance
de support;
- ladite configuration d'état de référence étant
une configuration dans laquelle, en omettant le-
dit au moins un élément intermédiaire (114.1,
114.2), ladite barre de torsion (112.1) est exclu-
sivement reliée audit deuxième composant de
véhicule (111) via ledit premier élément de sup-
port (113.1) et ledit deuxième élément de sup-
port (113.2);
 - ledit état opérationnel de ladite unité de véhi-
cule ferroviaire, en particulier, étant un état dans
lequel ladite unité de véhicule ferroviaire est mi-
se en fonctionnement à sa vitesse opérationnel-
le nominale.
6. L'unité de véhicule ferroviaire selon la revendication
5, dans laquelle ledit élément intermédiaire (114.1,
114.2) est conçu pour effectuer, par comparaison
avec ladite configuration de référence, une réduction
d'une amplitude maximale desdites vibrations de
flexion d'au moins 80%, préféablement d'au moins
90%, plus préféablement au moins 95%.
7. L'unité de véhicule ferroviaire selon l'une quelcon-
que des revendications 1 à 6, dans laquelle
- deux éléments intermédiaires (114.1, 114.2)
sont mis en oeuvre;
 - chacun desdits éléments intermédiaires
(114.1, 114.2) étant situé, le long dudit axe de
barre de torsion (112.6), à une distance d'élé-
ment intermédiaire par rapport au plus proche
dudit premier élément de support (113.1) et du-
dit deuxième élément de support (113.2);
 - la distance d'élément intermédiaire (114.1,
114.2) étant de 25% à 45% de ladite distance
de support, préféablement de 30% à 40% de
ladite distance de support, plus préféablement
de 33% à 37% de ladite distance de support.
8. L'unité de véhicule ferroviaire selon l'une quelcon-
que des revendications 1 à 7, dans laquelle
- l'unité comporte un train de roulement (102);
 - ledit premier composant de véhicule, en parti-
culier, étant un châssis de train de roulement
(104) dudit train de roulement;
 - ledit deuxième composant de véhicule, en parti-
culier, étant une traverse (111) ou une caisse
de wagon supportée sur ledit châssis de train
de roulement (104) par le biais d'un dispositif de
ressort secondaire (106).
9. L'unité de véhicule ferroviaire selon la revendication
8, dans laquelle
- ledit deuxième composant de véhicule est une
traverse (111) s'étendant dans une direction
transversale à ladite unité de véhicule ferroviai-
re;
 - ledit premier élément de support (113.1) et ledit
deuxième élément de support (113.2) étant si-
tués dans la région d'extrémités transversale-
ment opposées de ladite traverse (111).
10. L'unité de véhicule ferroviaire selon l'une quelcon-
que des revendications 1 à 9, dans laquelle
- l'unité comprend une unité de roue (103) défi-
nissant une largeur de voie;
 - ladite distance de support étant au moins de
120% de ladite largeur de voie, préféablement
au moins 150% de ladite largeur de voie, plus
préféablement de 160% à 180% de ladite lar-
geur de voie.
11. L'unité de véhicule ferroviaire selon l'une quelcon-
que des revendications 1 à 10, dans laquelle ladite
unité est conçue pour une vitesse de fonctionnement
nominal supérieure à 250 km/h, préféablement su-
périeure à 300 km/h, plus préféablement supérieure
à 350 km/h.
12. Un véhicule ferroviaire avec une unité de véhicule
ferroviaire (102) selon l'une quelconque des reven-
dications 1 à 11.

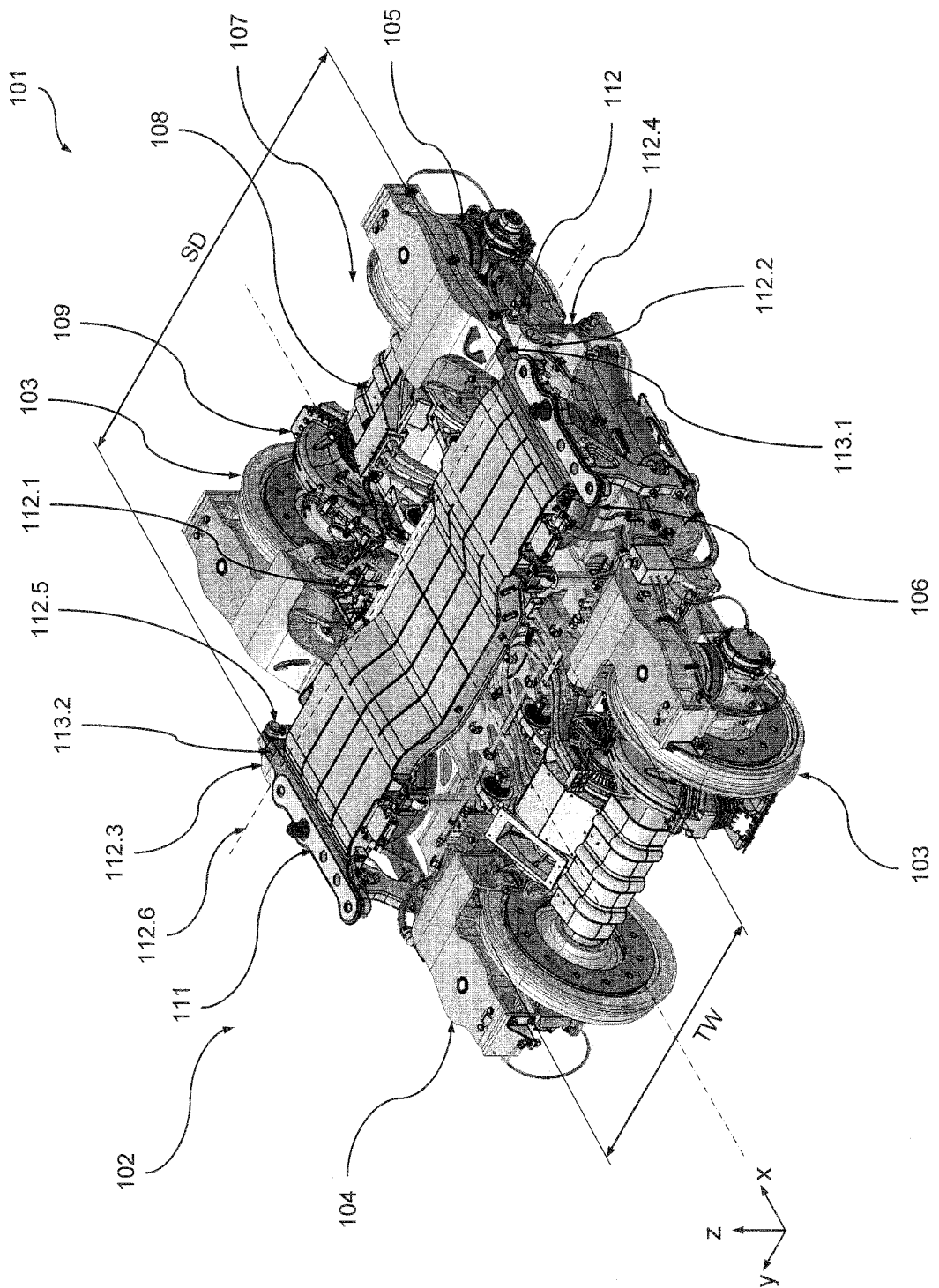


Fig. 1

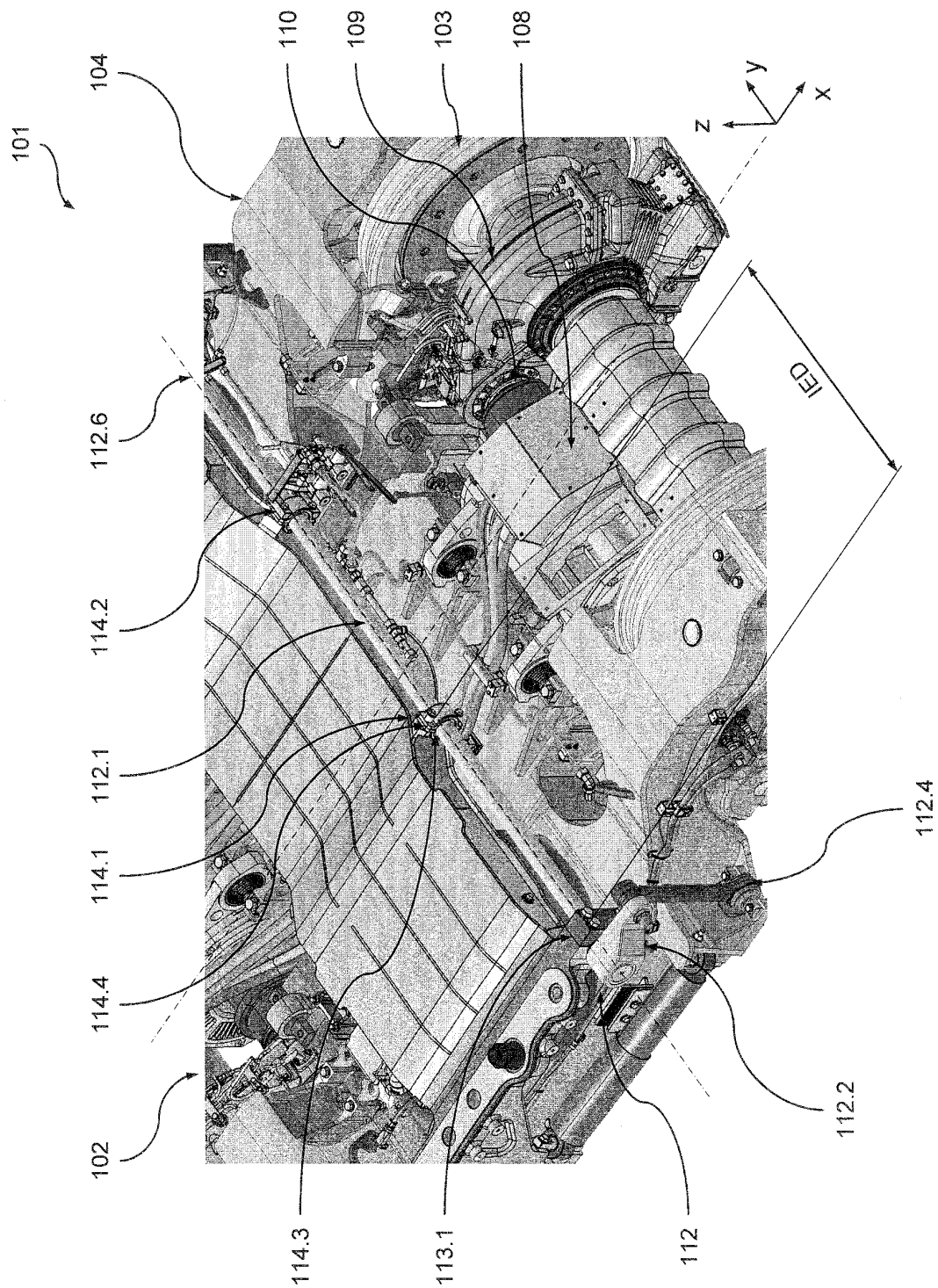


Fig. 2

REFERENCES CITED IN THE DESCRIPTION

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