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(54) VEHICLE STRUCTURE FOR A RAIL VEHICLE

FAHRZEUGSTRUKTUR FÜR EIN SCHIENENFAHRZEUG

STRUCTURE DE VÉHICULE POUR VÉHICULE FERROVIAIRE

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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a vehicle head structure for a rail vehicle, in particular a high-speed rail vehicle, having a head section and a main body section, the vehicle head structure comprising a head interface section for forming a mechanical interface of said vehicle head structure to a mating main body interface section of said main body section, the vehicle head structure defining a longitudinal direction, a transverse direction and a height direction. The present invention further relates to corresponding vehicle body structure, a corresponding rail vehicle comprising such a vehicle body structure and methods for manufacturing a vehicle body structure.

[0002] Vehicle heads of modern rail vehicles, in particular, modern high-speed rail vehicles, have to fulfill a plurality of different, partially contradictory requirements. On the one hand, they have to be as light as possible to reduce the overall weight of the vehicle. On the other hand, according to national or international regulations, such as the so called Technical Specifications for Interoperability (TSI) in Europe, as well as specifications of the respective operator of the vehicle, they have to be designed to exhibit a stiffness sufficient to withstand and properly introduce considerable crash loads into the vehicle structure as it is specified in one or more given crash scenarios. Furthermore, they have to show elaborate aerodynamic properties to reduce, for example, the overall drag of the vehicle and the susceptibility to cross-wind effects while at the same time being required to withstand considerable aerodynamic loads (in particular when entering tunnels, encountering other trains etc.). Hence, typically this results in a highly complex, typically twice curved outer surface of the vehicle head of sufficient stiffness. Finally, despite all these requirements, the head structure has to be manufactured as easily and cheaply as possible.

[0003] It should be noted in this context that the complex, typically twice curved (i.e. having two main curvatures greater than zero) part of the outer surface of the head section often is referred to as the three-dimensionally shaped part of the vehicle's outer surface while the prismatic main body section often is referred to as the two-dimensionally shaped part of the vehicle's outer surface, i.e. the part of the outer surface which may simply be generated by shifting the outer contour (obtained in a cross-section perpendicular to the longitudinal direction) along the longitudinal direction of the vehicle.

[0004] Typically, vehicle head sections are made of a vehicle head structure mounted to an adjacent prismatic main body structure (i.e. the structure of the vehicle body that, apart from cutouts and/or separately mounted containers etc., has an outer shell of identical cross-section along the longitudinal direction). Such a vehicle head structure is disclosed, for example, in US 2008/0309125 A1. Here, a substantially planar interface is formed between the vehicle head structure and the adjacent prismatic main body structure, the interface plane being arranged perpendicular to the longitudinal direction. EP 2 383 161 A1 discloses another type of rail vehicle, in which part of the main body structure is extending under the vehicle head structure along an inclined mating surface.

[0005] A disadvantage, however, of this design is that the vehicle head structure is a comparatively large component of complex three-dimensional design which is comparatively expensive to manufacture. A further disadvantage is that a considerable fraction of the support load has to be taken by the substantially planar and vertically arranged connecting interface between the head structure and the adjacent prismatic main body structure such that corresponding care and expense is necessary for this interface further increasing the overall cost of the vehicle.

SUMMARY OF THE INVENTION

[0006] It is thus an object of the present invention to provide a vehicle head structure, a vehicle body structure, a rail vehicle and methods for manufacturing a vehicle body structure as outlined above that, at least to some extent, overcome the above disadvantages. It is a further object of the present invention to provide a vehicle head structure, a vehicle body structure, a rail vehicle and methods for manufacturing a vehicle body structure that allow simple manufacture and a reduction of the overall expense for the vehicle while at least maintaining the overall performance of the vehicle.

[0007] The above objects are achieved with a rail vehicle having a vehicle head structure according to claim 1, a vehicle body structure of a rail vehicle having a vehicle head structure according to claim 9, and the methods of manufacturing a vehicle body structure according to claims 10 and 15.

[0008] Simple manufacture and a reduction of the overall expense for the vehicle while at least maintaining the overall performance of the vehicle is possible since a bottom part of the main body section, in the longitudinal direction, extends below the vehicle head structure, the interface section between the head section and the main body section preferably being inclined with respect to the height direction of the vehicle. This configuration allowing support of the vehicle head structure from below together with the eventual inclination, compared to the known designs with an interface section extending substantially parallel to the height direction, on the one hand allows facilitating manufacture of the head section.

[0009] This is due to the fact that, typically, at the same longitudinal level (i.e. at the same level along the longitudinal direction) of the vehicle especially in the lower part of the vehicle body the prismatic (two-dimensionally shaped) outer surface of the main body section still continues while, in the upper part of the vehicle body, the complex (three-dimensionally shaped) part of the head section has already begun. The main body section ex-

tending below the vehicle head structure together with the eventual inclined interface in a highly beneficial way allows separating the complex three-dimensionally shaped part of the outer surface and the greatly less complex two dimensionally shaped part of the outer surface such that the head section does not necessarily have any such prismatic areas. By this means, the size of the head section may be reduced and limited only to the complex three-dimensionally shaped part of the outer surface. This greatly facilitates manufacture of the head section. On the other hand, the prismatic areas located at the same longitudinal level may be formed together with the main body section in a way simpler manufacturing process (e.g. even in an extrusion process). Thus, manufacture of the overall structure is greatly facilitated.

[0010] Furthermore, the main body section extending below the vehicle head structure together with the eventual inclined interface section has the advantage that, compared to conventional vertically arranged interfaces, (nonetheless due to the increased interface area and the advantageous special arrangement) it provides a way better support to both loads in the height direction (such as e.g. gravitational loads) and torsional loads of the vehicle body structure about the longitudinal direction. Thus, the overall expense for the interface section may be reduced.

[0011] Hence, the present disclosure relates to a vehicle head structure for a rail vehicle, in particular a high-speed rail vehicle, having a head section and a main body section. The vehicle head structure comprises a head interface section for forming a mechanical interface of the vehicle head structure to a mating main body interface section of the main body section. The vehicle head structure further defines a longitudinal direction, a transverse direction and a height direction. The vehicle head structure is configured such that, in a mounted state, a bottom part of the main body section, in the longitudinal direction, extends below the vehicle head structure, preferably over at least 30%, more preferably over at least 50%, even more preferably over substantially 100%, of a longitudinal dimension of the vehicle head structure. Preferably, the head interface section, in at least one inclined first section, is inclined with respect to the height direction.

[0012] Preferably, the head interface section of the rail vehicle is also inclined with respect to the longitudinal direction, such that, in other words, a split line between the head section and the main body section is formed that, in the inclined first section, extends obliquely to both the longitudinal direction and the height direction.

[0013] It will be appreciated that an arbitrary arrangement of the inclined first section may be chosen depending on the specific outlay of the three-dimensionally shaped part of the head section. For example, it may be provided that an interface surface formed at the vehicle head structure, in the inclined first section, faces upwards. However, with typically shaped vehicle head designs, such an interface surface formed at the vehicle head structure, in the inclined first section, faces downwards (i.e. towards the track the vehicle is running on).

[0014] Furthermore, it will be appreciated that the inclined first section of the interface surface, typically, faces towards the other end of the vehicle (i.e. the end opposite to the vehicle head structure). However, depending on the specific three-dimensional shape of the head section, it may also be the (although rare) case that the inclined first section of the interface surface faces towards the free end of the vehicle head structure.

[0015] It will be further appreciated that the head interface section, in the inclined first section, does not necessarily have to have a substantially planar interface surface (defined by the outer shell structure and eventual further structural components, such as reinforcing ribs, etc. at the respective location). More precisely, the interface surface defined by the interface section may be an at least section wise angled surface and/or an at least section wise curved surface as long as the required inclination with respect to the longitudinal axis is present.

[0016] In this context it should be noted that, in the sense of the present invention, the interface surface as used herein designates the general outlay of the surface of the respective vehicle section contacting the mating surface of the other vehicle section. For the purposes of this application, local irregularities of the surface (such as e.g. local protrusions or indentations), typically in a tolerance range of up to ± 20 mm around the interface surface, are not considered to influence or modify the location and orientation of the interface surface. In other words, the interface surface as used herein designates the median surface defined using such a tolerance range of up to ± 20 mm.

[0017] Preferably, the head interface section defines an interface surface, the interface surface defining a tangential interface plane (i.e. a plane that is tangent to the interface surface). The interface plane, in the at least one inclined first section, has a first inclination with respect to the height direction. Preferably, the first inclination, ranges from 5° to 85°, more preferably from 30° to 80°, even more preferably from 60° to 70°. With such a configuration, highly beneficial designs may be achieved. It will be appreciated that, typically, with high-speed rail vehicles having comparatively long head sections, a larger first inclination may be chosen.

[0018] It will be appreciated that, with respect to the transverse direction, any desired orientation may be chosen for the interface surface and the interface plane, respectively. Preferably, the interface plane is substantially parallel with respect to the transverse direction, thereby providing a very simple, particularly easy to manufacture configuration.

[0019] In addition or as an alternative the interface plane, in at least one second section located adjacent to the inclined first section, is substantially parallel to the height direction or substantially parallel to the longitudinal direction. By this means, for example, a stepped configuration of the interface or split line between the head

section and the main body section may be achieved. Such a stepped configuration may have the advantage of providing the function of appropriately positioning and/or orienting the mating vehicle sections with respect to each other, thereby facilitating assembly of the whole structure. Hence, preferably, the interface surface, in a plane parallel to the height direction and the longitudinal direction, defines a stepped interface contour (or split line, respectively).

[0020] It will be appreciated that the inclined first section may extend over an arbitrary fraction of the total length (i.e. dimension in the longitudinal direction) and/or an arbitrary fraction of the total height (i.e. dimension in the height direction) of the head section. The inclined first section may even extend over the total length and/or total height of the head section.

[0021] However, with preferred embodiments of the vehicle head structure according to the present invention, the rail vehicle in the area of the head section has bottom structure defining an interior floor level and a maximum height dimension above the interior floor level in the height direction. In these cases, the at least one inclined section, in the height direction, extends over 10% to 90% of the maximum height dimension, preferably over 25% to 75% of the maximum height dimension, more preferably over 40% to 65% of the maximum height dimension. With these values particularly beneficial configurations may be achieved which are comparatively easy to manufacture while providing good mechanical properties as outlined above. Depending on inclination of the interface corresponding dimensions in the longitudinal direction result.

[0022] The location of the inclined section may be selected as a function of the outlay of the head section, in particular, the location of the three dimensionally shaped surface area(s). Preferably, the at least one inclined section, in the height direction, extends substantially down to the interior floor level.

[0023] It will be appreciated that a plurality of mutually spaced inclined sections may be provided. These inclined sections may, for example, alternate with one or more intermediate sections extending parallel to the height direction or, eventually, parallel to the longitudinal direction.

[0024] It will be further appreciated that an arbitrary structural design may be chosen for the vehicle head structure. For example, it may be a simple shell structure formed by sufficiently structurally rigid wall elements. Preferably, the vehicle head structure comprises an interior framework structure, thereby providing sufficient structural stability in a very simple way.

[0025] Preferably, the interior framework structure comprises a frontal barrier unit adapted to carry at least one impact energy absorbing device. By this means, a beneficial configuration may be achieved where a frontal impact energy absorbing unit absorbs a considerable fraction up to the entire impact energy to be taken by the vehicle under given crash scenarios (e.g. prescribed according to national, international or operator regulations). The frontal barrier unit may have any desired shape or design, respectively. Preferably, the frontal barrier unit is a substantially plate shaped unit which, in a simple way, provides high structural stability with a high flexibility for locating interfaces for impact energy absorbing devices.

[0026] It will be appreciated that the head section may be designed to undergo a certain amount of deformation under certain crash scenarios. However, with certain preferred embodiments of the invention, the vehicle is adapted to undergo, in a defined maximum frontal crash scenario, a maximum frontal impact load, wherein the interior framework structure is adapted to undergo substantially no plastic deformation in this maximum frontal crash scenario. impact energy is then absorbed at different locations, for example the frontal impact energy absorbing unit as outlined above. Obviously, such a variant is beneficial in terms of protecting a driver and vital components of the vehicle located in the head section in such a crash situation.

[0027] An arbitrary composition of the interior framework structure may be chosen. Preferably, the interior framework structure comprises at least one lateral main pillar element, the lateral main pillar element, in the height direction, protruding beyond the interface section to provide a connector element reaching into the main body section, in particular, down to a bottom structure of the main body section. By this means, a highly structurally stable connection may be obtained between the interior framework structure (hence, ultimately, the head section) and the main body section.

[0028] With further preferred embodiments of the invention, the interior framework structure comprises at least two lateral main pillar elements located in a common plane and connected in the transverse direction via a transverse beam to form an arc shaped main support structure of the interior framework structure. Thereby, particularly structurally stable configurations may be achieved. Preferably, the lateral main pillar elements extend, in the height direction, down to a bottom structure of the main body section, thereby allowing particularly stable support of the interior framework structure.

[0029] In particularly structurally stable variants of the vehicle head structure according to the invention the interior framework structure comprises at least two longitudinal beams extending, in the longitudinal direction, from a front end to a rear end of the interior framework structure. These longitudinal beams may provide proper support of loads acting in the longitudinal direction (such as e.g. impact loads in a crash situation) against the adjacent vehicle body section. Preferably, the two longitudinal beams are located at an upper side of the head structure to beneficially provide structural stability in this area. Furthermore, preferably, the two longitudinal beams are connected via at least one transverse beam to increase structural stability of the configuration. Preferably, the transverse beam and the two longitudinal

beams form part of a front window frame of the head section.

[0030] In addition or as an alternative, the interior framework structure may comprise a plurality of auxiliary framework elements, such as e.g. auxiliary pillar elements and/or a plurality of auxiliary beams, supporting a shell structure forming an outer shell of the head section. By this means, a beneficial support of the outer shell of the vehicle, particularly against high aerodynamic loads (as they occur, for example, particularly in high-speed operations, at the entrance into a tunnel or an encounter with a passing vehicle) may be achieved. Preferably, the shell structure comprises a plurality of elongated reinforcement elements connected to the auxiliary pillar elements and/or the auxiliary beams, thereby beneficially increasing structural stability of the outer shell.

[0031] With further preferred embodiments of the invention, the interior framework structure comprises a plurality of main framework elements and a plurality of auxiliary framework elements supporting an outer shell structure. The outer shell structure comprises an outer shell element forming an outer shell of the head section and a plurality of elongated reinforcement elements connected to the outer shell element. The reinforcement elements are connected to the auxiliary framework elements, while the outer shell element is connected directly to the main framework elements thereby achieving a very beneficial introduction of loads into the shell structure and, ultimately, a highly structurally stable configuration.

[0032] With certain preferred embodiments of the invention, during manufacture, an opening within the outer shell of the head section is used for introducing large and heavy components into the vehicle interior prior to closing the outer shell of the head section, thereby facilitating overall assembly and manufacture of the vehicle. Hence, with preferred embodiments of the vehicle head structure according to the invention, the two longitudinal beams and the transverse beam confine a mounting access opening located, in the longitudinal direction, between the transverse beam and the rear end of the interior framework structure, the mounting access opening being usable during manufacture of the vehicle for inserting large interior equipment components into an interior of the head section.

[0033] The mounting access opening may be closed later on by any suitable means. Preferably, the mounting access opening is partially closed or divided by a further transverse beam connected to the longitudinal beams in a cold joining process, in particular, in a riveting process. By this means, overall structural stability of the interior frame structure may be increased (the cold joining process beneficially avoiding distortion of the structure due to the introduction of heat). Furthermore, preferably, the mounting access opening is finally closed by a cover unit forming part of an outer shell of the vehicle head structure.

[0034] Any desired manufacturing technique or combination of manufacturing techniques may be used for producing the vehicle head structure. Preferably, the vehicle head structure is formed as a differential structure composed of a plurality of mutually mechanically connected components, thereby facilitating manufacture of the overall structure.

[0035] Preferably, at least a fraction of the components are connected at least partially in a fusion process, in particular, in a welding process. Such configurations, typically, facilitate repair of damaged sections.

[0036] Furthermore, preferably, at least a fraction of the components are made from a material comprising a light metal alloy, in particular, comprising aluminum. Such configurations, typically, allow very lightweight structures.

[0037] The present invention further relates to a vehicle body structure for a rail vehicle, in particular a high-speed rail vehicle, comprising a vehicle head structure according to the invention forming a head section of the vehicle body structure and a main body section of the vehicle body structure. With such a vehicle body structure the advantages and variants as outlined above in the context of the vehicle head structure may be achieved to the same extent. Hence, in this respect, it is here referred to only to the explanations given above.

[0038] It will be appreciated that the main body section may have any desired shape. Preferably, the main body section has a substantially prismatic outer surface along the longitudinal direction, thereby greatly facilitating manufacture of the main body section.

[0039] Preferably, the main body section comprises a bottom structure defining an interior floor level and reaching, in the longitudinal direction, into the head section. By this means, a beneficial configuration may be achieved, wherein a stable and reliable connection between the head section and the main body section is achieved in an additional connection via this bottom structure.

[0040] The present invention further relates to a rail vehicle comprising a vehicle body structure according to the invention. With such a rail vehicle the advantages and variants as outlined above in the context of the vehicle head structure and the vehicle structure, respectively, may be achieved to the same extent. Hence, in this respect, it is here referred to only to the explanations given above.

[0041] It will be appreciated that the present invention may be used in combination with arbitrary rail vehicles. The beneficial effects of the present invention are particularly useful in high-speed applications. Hence, preferably, the rail vehicle is adapted to be used for high-speed operation at nominal operating speeds above 250 km/h, preferably above 300 km/h, more preferably above 350 km/h.

[0042] The present invention further relates to a method of manufacturing the vehicle body structure according to the invention. The method comprises, in a first step of a sidewall forming step (more precisely, a sidewall segment forming step) using at least a first connecting tech-

nique, forming a first head sidewall framework (more precisely, a first head sidewall segment framework structure) of the head section, the first head sidewall framework comprising a first longitudinal beam and/or a first main pillar element and/or a plurality of first auxiliary framework elements.

[0043] Subsequently, in a vehicle body assembly step using at least a second connecting technique, a first vehicle sidewall (more precisely, a first vehicle sidewall segment) is connected to a bottom structure of the main body section and, in particular, to a roof structure of the main body section to form a vehicle body.

[0044] It will be appreciated that the first and/or second connecting technique may comprise any desired connecting technique or arbitrary combinations of different connecting techniques. Preferably, at least one of the first connecting technique and the second connecting technique comprises a fusion process, in particular, a welding process.

[0045] It will be appreciated that the first head sidewall framework may be integrated into the first vehicle sidewall prior to or within said vehicle body assembly step. Hence, with preferred variants of the invention, in a second step of the sidewall forming step using at least a third connecting technique, the first head sidewall framework is connected to a main body sidewall (more precisely, a main body sidewall structure) of the main body section to form the first vehicle sidewall. Subsequently, the first vehicle sidewall is connected to the bottom structure.

[0046] As an alternative, in the vehicle body assembly step using at least a third connecting technique, a main body sidewall of the main body is connected to the bottom structure and, subsequently, the first head sidewall framework is connected to the main body sidewall (to integrate the first head sidewall framework into the first vehicle sidewall).

[0047] It will be appreciated that, in both cases, the third connecting technique may comprise any desired connecting technique or arbitrary combinations of different connecting techniques. Preferably, the third connecting technique may again comprise a fusion process, in particular, a welding process.

[0048] With further preferred variants of the invention, in the vehicle body assembly step using a fourth connecting technique, a second longitudinal beam of a second head sidewall framework (i.e. a second head sidewall segment framework structure) is connected to the first longitudinal beam via a first transverse beam extending in the transverse direction, thereby achieving a firm and rigid connection between the two head sidewalls or sidewall segments, respectively.

[0049] Preferably, the first longitudinal beam and the second longitudinal beam are located at an upper side of the head structure as it has been outlined above. Furthermore, preferably, the first longitudinal beam, the second longitudinal beam and the first transverse beam form part of a front window frame of a front window opening of the head section.

[0050] In addition or as an alternative, preferably, the first longitudinal beam, the second longitudinal beam and the first transverse beam confine a mounting access opening located, in the longitudinal direction, between the transverse beam and a rear end of the head section, the mounting access opening being usable for inserting large interior equipment components into an interior of the head section as it also has been described above.

[0051] Finally, as outlined above, preferably, the first transverse beam is located in a substantially common plane with a first lateral main pillar element connected to the first longitudinal beam and a second lateral main pillar element connected to the second longitudinal beam to form an arc shaped main support structure. Preferably, the first lateral main pillar element and the second lateral main pillar element, in the height direction, extend down to the bottom structure and, in particular, are connected to the bottom structure to achieve a particularly stable configuration.

[0052] It will be appreciated that, again, the fourth connecting technique may comprise any desired connecting technique or arbitrary combinations of different connecting techniques. Preferably, it comprises a fusion process, in particular, a welding process.

[0053] With further preferred embodiments of the invention, in the vehicle body assembly step, at least one large interior equipment component is inserted into the interior of the head section via the mounting access opening and/or the front window opening, the interior equipment component, in particular, being one of a driver's board, an electrical equipment cabinet and a cable duct. Subsequently, in the vehicle body assembly step, after inserting the interior equipment component and using a fifth connecting technique, the mounting access opening, preferably, is partially closed by a second transverse beam connected to the first longitudinal beam and the second longitudinal beam.

[0054] Furthermore, preferably, in the vehicle body assembly step, after inserting the interior equipment component and using a sixth connecting technique, the front window opening, in particular, is closed by a front window unit. Finally, preferably, in the vehicle body assembly step, after inserting the interior equipment component and using a seventh connecting technique, the mounting access opening, in particular, is closed by a cover unit forming part of an outer shell of the vehicle head section.

[0055] It will be appreciated that, either one of the fifth to seventh connecting technique may comprise any desired connecting technique or arbitrary combinations of different connecting techniques. Preferably, the fifth connecting technique comprises a cold joining process, in particular, a riveting process. Furthermore, preferably, at least one of the sixth connecting technique and the seventh connecting technique comprises a bonding process, in particular, an adhesive bonding process such as, preferably, a gluing process.

[0056] It will be appreciated that the outer shell of the respective sidewall segment may be formed prior to the

vehicle body assembly step, during the vehicle body assembly step or even after the vehicle body assembly step. Hence, with certain embodiments of the invention, in the sidewall forming step, a head shell structure forming part of an outer shell of the head section is connected to the first head sidewall framework. With further preferred embodiments of the invention, in an outer shell forming step, after said sidewall forming step, a head shell structure forming part of an outer shell of the head section is connected to the first vehicle sidewall. As mentioned, the outer shell forming step may occur at any time prior to, during or after the vehicle body assembly step.

[0057] The head shell structure may have any desired design and composition, respectively. Preferably, the head shell structure comprises a plurality of elongated reinforcement elements connected to auxiliary elements of the first head sidewall framework to achieve a particularly stable structure as it has been outlined above.

[0058] The present invention further relates to a method of manufacturing a vehicle structure for a rail vehicle, in particular, the vehicle structure according to the invention, having a head section and a main body section. The method comprises partially forming the head section and the main body section leaving at least one mounting access opening within the head section for inserting large interior equipment components into an interior of the head section. Subsequently, at least one such large interior equipment component is inserted into the interior of the head section via the at least one mounting access opening. Finally, the at least one mounting access opening is closed using a cover unit forming part of an outer shell of the vehicle head section.

[0059] Such a method has the advantage that large and/or heavy components of the vehicle may introduced into and mounted in the interior of the vehicle at a very late stage of the manufacturing process of the vehicle without having to transport the respective component over a long distance along the longitudinal direction. This greatly facilitates manufacture of the vehicle. Moreover, connecting techniques may be used for closing the respective mounting access which do not introduce a considerable amount of heat into the structure which might otherwise cause distortion of the structure.

[0060] 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

[0061]

Figure 1 is a schematic side view of a preferred embodiment of a rail vehicle according to the present invention comprising a preferred embodiment of a vehicle structure according to the present invention including a preferred embodiment of a vehicle head structure according to the present invention manufactured with a preferred embodiment of a method according to the present invention;

Figure 2 is a schematic perspective representation of a part of the vehicle head structure of Figure 1 (with the outer shell structure and parts of a roof framework structure removed);

Figure 3 is a further schematic perspective representation of a part of the vehicle head structure of Figure 1 (with only the outer shell structure removed);

Figure 4 is a further schematic perspective representation of a part of the vehicle structure of Figure 1 (including the vehicle head structure of Figure 3);

Figure 5 is a further schematic perspective representation of the vehicle structure of Figure 1 (including parts of the outer shell structure of the vehicle head structure);

Figure 6 is a schematic sectional representation of a detail of the vehicle structure of Figure 5 (in a section along line VI-VI of Figure 4 and 5).

DETAILED DESCRIPTION OF THE INVENTION

[0062] With reference to Figures 1 to 4 a preferred embodiment of a rail vehicle 101 according to the present invention comprising a preferred embodiment of a vehicle structure according to the invention including a preferred embodiment of a vehicle head structure 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 vehicle 101, the y-axis designates the transverse direction of the vehicle 101and the z-axis designates the height direction of the vehicle 101. The vehicle 101 is a high-speed rail vehicle with a nominal operating speed above 250 km/h, more precisely above 300 km/h, namely 380 km/h.

[0063] As can be seen from Figure 1 the vehicle 101 comprises a vehicle structure in the form of a wagon body 102 supported in a conventional manner, in the region both of its ends, on running gears 103 (located in suitable running gear cutouts of the wagon body 102). It will be appreciated however that, with other embodiments of the invention, any other type of support of the wagon body on suitable running gears may be chosen.

[0064] The wagon body 102 comprises a head section 104 and a main body section 105 connected via an interface 106 comprising a head interface section 106.1 of the head section 104 and a mating main body interface section 106.2 of the main body section 105. The head

section 104 is located at the free end of the vehicle 101 which may form a leading or trailing end of a train the vehicle 101 forms part of. In a conventional manner, the head section 104 houses a driver's compartment receiving a driver stand and further large and/or heavy equipment (not shown in greater detail) for controlling and operating the vehicle 101.

[0065] The head section 104 has a complex three-dimensionally shaped outer surface to fulfill specific aerodynamic requirements, while the main body section 105 has a substantially prismatic or two-dimensionally shaped outer surface as it has been outlined above.

[0066] The head section 104 comprises a vehicle head structure 104.1 which in turn comprises an interior head framework structure in the form of a head framework 104.2 (see Figure 2, 3 and 4) and an outer head shell structure in the form of an outer head shell 104.3 (see Figure 5). As can be seen best from Figure 2 and 3 (showing the vehicle head structure 104.1 in different views with different parts of the vehicle 101 removed), the interior head framework 104.2 comprises two main longitudinal beams 104.4 extending, in the longitudinal direction (x-direction), from a front end to a rear end of the head framework 104.2. These main longitudinal beams 104.4 provide proper support of loads acting in the longitudinal direction (such as e.g. impact loads in a crash situation) against the adjacent main body section 105.

[0067] The two main longitudinal beams 104.4 are located at an upper side of the vehicle head structure 104.1 to provide structural stability in this area. The two main longitudinal beams 104.4, in the mounted state of the vehicle head structure 104.1, are connected in the transverse direction (y-direction) via a plurality of transverse beams including a frontal first transverse beam 104.5 (carrying a wiper box receiving the drive unit for a wiper for the front window of the head section 104) and a second transverse beam 104.6, all welded to the main longitudinal beams 104.4 to provide good structural stability of the configuration.

[0068] The first and second transverse beam 104.5, 104.6 and the two longitudinal beams 104.4 form part of a front window frame for a front window unit 107 (see Figure 5) of the head section 104.

[0069] Furthermore, the head framework 104.2 comprises at a plurality of lateral main pillar elements including two center main pillar elements 104.8 as well as two rearward main pillar elements 104.9, all welded to the main longitudinal beams 104.4 to provide good structural stability of the configuration. The two center main pillar elements 104.8 are located in a substantially common plane (parallel to the yz-plane) with the second transverse beam 104.6 such that an arc shaped structure is formed.

[0070] Furthermore, the head framework 104.2 comprises a plurality of auxiliary pillar elements 104.10 (firmly connected to the main longitudinal beams 104.4 to provide proper support to the outer shell 104.3 of the head section 104) and auxiliary beams 104.11 as well as further elements such as side window frames etc. In the present example, the auxiliary pillar elements 104.10 are mutually interconnected and connected to adjacent main pillar elements 104.8, 104.9, among others, by auxiliary longitudinal beam elements 104.12 to provide an overall structurally stable framework. As will be explained in more detail below, the auxiliary beams 104.11 are firmly connected, e.g. welded, to a (generally quadrangular) frame element 104.7 which itself is firmly connected, e.g. glued, to the main longitudinal beams 104.4, the second transverse beam 104.6 and the main body section 105 to provide proper support to the outer shell 104.3 in the top part of the head section 104.

[0071] As can be seen from Figure 3 and 4, in the mounted state of the wagon body 102, a third transverse beam 104.13 (sitting underneath one of the auxiliary beams 104.11) is located in a substantially common plane (parallel to the yz-plane) with the rearward lateral main pillar elements 104.9 and connected to the main longitudinal beams 104.4 such that, here as well, an arc shaped structure is formed. Contrary to the first to second transverse beam 104.5 and 104.6, the third transverse beam 104.13 is connected to the longitudinal beams 104.4 by a cold joining process, such as riveting. It will be appreciated however that, with other embodiments of the invention, any other cold joining technique may be used, such as e.g. screwing, clamping but also gluing etc.

[0072] In the present example, in an intermediate manufacturing state during manufacture of the vehicle 101 (in a similar configuration as shown in Figure 2), a mounting access opening 108 within the head framework 104.2 and the outer head shell 104.3 of the head section is used for introducing large and heavy components into the vehicle interior prior to closing the outer head shell 104.3 of the head section 104, thereby facilitating overall assembly and manufacture of the vehicle. The mounting access opening 108 is delimited by the main longitudinal beams 104.4, the second transverse beam 104.6 and an interface profile (not shown in greater detail) of the main body section 105 (forming an interface for the frame 104.7).

[0073] After the required equipment has been inserted into the vehicle interior the mounting access opening 108 is partially closed (or separated in two parts) by the third transverse beam 104.13. A cover unit 104.15 including the frame 104.7, the auxiliary transverse beams 104.11 and the outer shell element 104.14 (as well as, for example, a head light module as indicated in Figure 3 to 5) may be inserted (as a pre-assembled module) and connected to the main longitudinal beams 104.4, the second transverse beam 104.6 and the rear transverse interface (not shown in greater detail) of the main body section 105 forming the interface for frame 104.7. A cold joining process is used to avoid distortion of the structure due to heat (as it would be the case, for example, if a welding process was used). Preferably, the frame 104.7 of the cover unit 104.15 is glued onto the respective interfaces to firmly connect the cover unit 104.15 to the structure.

[0074] It will be appreciated that, in a similar manner, the opening provided by the front window frame (formed by the two longitudinal beams 104.4 and the first and second transverse beam 104.5, 104.6) may also be used for inserting equipment into the vehicle interior prior to mounting the front window unit 107. Here as well, connection of the front window unit 107 is preferably executed in a cold joining process. Preferably, the front window unit 107 is glued into the front window frame.

[0075] As can be seen from Figure 1 and 4, the main body section 105 comprises a bottom structure 105.1 protruding, in the longitudinal direction, into the head section 104. The front end of the bottom structure 105.1 carries a substantially plate shaped frontal barrier unit in the form of the so-called barrier plate 109. The plane of main extension of the barrier plate 109 is arranged to be substantially parallel to the yz-plane. The barrier plate 109 (which is at least connected to the main body section 105 but can additionally cover the front of the internal head framework) is adapted to carry an impact energy absorbing unit comprising one or more impact energy absorbing devices (as is indicated by the dashed contour 110 in Figure 1). The impact energy absorbing unit, as will be explained in further detail below, serves to absorb impact energy in a crash situation with a crash partner (e.g. another vehicle or an obstacle).

[0076] As can be seen from Figure 1 and 4, the mechanical interface 106 between the head section 104 and the main body section 105 is formed by the head interface section 106.1 and the mating main body interface section 106.2 partially extending obliquely to both the longitudinal direction and the height direction. To this end, the head interface section 106.1 forms a stepped interface which, in an inclined, downward facing first section 106.3, is inclined with respect to the height direction (z-axis) and the longitudinal direction (x-axis). A second section 106.4 and a third section 106.5 of the interface section 106.1, both located adjacent to the first section 106.3 are substantially parallel to the height direction (z-axis), while a fourth section 106.6 of the interface section 106.1 located adjacent to the third section 106.5 is inclined with respect to the height direction (z-axis) but parallel to the longitudinal direction (x-axis).

[0077] The respective sections 106.3 to 106.6 of the head interface section 106.1 define substantially planar interface surfaces. With certain embodiments, the interface surfaces may be substantially parallel with respect to the transverse direction (y-direction) leading to fully planar interface surfaces. However, in the present example, the interface surface is selected such that, at each edge point of the interface edge formed at the intersection of the outer shell 104.3 and the interface surface, the tangential plane of interface surface (i.e., the plane tangent to the interface surface at this edge point) contains the surface normal of the outer shell 104.3 at the respective edge point as well as the tangent line (tangent to the interface edge at this edge point). This, leads to a slight distortion of the interface surface (depending on the curvature of the outer shell 104.3 and the inclination of the interface section) but guarantees that identical joint dimensions are present at each the edge point thereby facilitating connection between the head section 104 and the main body section 105

[0078] (e.g. in a welding process) and, hence, providing a very simple, particularly easy to manufacture configuration.

[0079] It will thus be appreciated that, with certain embodiments of the invention, the head interface section, in any of its sections, in particular, in the inclined first section, does not necessarily have to show a substantially planar interface surface. More precisely, the interface surface defined by the respective interface section may be an at least section wise angled surface and/or an at least section wise curved surface.

[0080] In this context it is furthermore once again explicitly referred to the explanations given above regarding local irregularities (such as e.g. local protrusions or indentations) of the interface surface of the interface section 106.1.

[0081] Given the substantially planar interface surface of the head interface section 106.1 (and, consequently, also of the mating main body interface section 106.2) a tangential interface plane (i.e. a plane that is tangent to the interface surface), in the present example, coincides with the respective interface surface.

[0082] In the present example, the interface surface and the interface plane, respectively, in the obliquely inclined first section 106.3, has a first inclination of about $a = 68°$ with respect to the height direction. It will be appreciated however that, with other embodiments of the invention, any other inclination may be chosen, preferably in the limits as specified above.

[0083] This partially oblique interface 106 has the advantage that the split line between the head section 104 and the main body section 105, at the individual longitudinal level, may be placed at the height level where, for example, the part of the vehicle outer shell located below this height level still continues the prismatic (two-dimensionally shaped) outer surface of the main body section while, the part of the vehicle outer shell located above this height level already forms part of a complex (three-dimensionally shaped) part of the head section. The (at least partially) inclined or oblique interface 106, in other words, in a highly beneficial way allows separating the complex three-dimensionally shaped part of the outer surface and the greatly less complex two dimensionally shaped part of the outer surface such that the head section 104 does not necessarily have any such prismatic areas. By this means, the size of the head section 104 may be reduced and limited only to the complex three-dimensionally shaped part of the outer surface. This greatly facilitates manufacture of the head section 104. On the other hand, the prismatic areas located at the same longitudinal level may be formed together with the main body section 105 in a way simpler manufacturing process (e.g. even in an extrusion process). Thus, man-

ufacture of the overall structure is greatly facilitated.

[0084] Furthermore, the at least partially inclined or oblique interface 106 has the advantage that, compared to conventional vertically arranged interfaces, (nonetheless due to the increased interface area and the advantageous special arrangement) it provides a way better support to both loads in the height direction (such as e.g. gravitational loads) and torsional loads of the vehicle body structure 102 about the longitudinal direction. Thus, the overall expense for the interface section 106 may be reduced compared to conventional designs.

[0085] More precisely, as can be seen from Figure 1, in the present example, a bottom part of the main body section 105, in the longitudinal direction, extends below the vehicle head structure 104.1 over 75% to 95%, more precisely about 85%, of the longitudinal dimension of the vehicle head structure 104.1 (between the end plate 109 and the second interface section 106.4).

[0086] It will be appreciated however that, with other embodiments of the invention, in particular, depending on the interface design, the bottom part of the main body section 105 may extend over different fractions of the longitudinal dimension of the vehicle head structure 104.1. Preferably, the bottom part of the main body section 105 extends below the vehicle head structure 104.1 over at least 30%, more preferably over at least 50%, even more preferably over substantially 100%, of the longitudinal dimension of the vehicle head structure 104.1.

[0087] It will be appreciated that, generally, the inclined first section 106.3 may extend over an arbitrary fraction of the total length (i.e. dimension in the longitudinal direction) and/or an arbitrary fraction of the total height (i.e. dimension in the height direction) of the head section 104. The inclined first section 106.3 may even extend over the total length and/or total height of the head section 104. In an alternative embodiment, the inclined first section 106.3 may extend (either from the upper vertex of the head section 104 or, in an angled split line configuration, from an upper split line section similar to second section 106.4) down to the bottom structure 105.1, in particular, in some cases reaching up to the forward end of the bottom structure 105.1 (i.e. up to the end plate 109).

[0088] As outlined above, the location and dimension of the inclined section 106.3 may be selected as a function of the outlay of the head section 104, in particular, at the transition between the prismatic, two-dimensionally shaped outer surface areas and the complex three dimensionally shaped outer surface areas. In the present example, the obliauelv inclined section 106.3, in the height direction, extends substantially down to the interior floor level defined by the bottom structure 105.1.

[0089] It will be appreciated that, with other embodiments of the invention, a plurality of mutually spaced inclined sections may be provided. These inclined sections may, for example, alternate with one or more intermediate sections extending parallel to the height direction or, eventually, parallel to the longitudinal direction.

[0090] As can be seen from Figure 3 and 4, the lateral main pillar elements104.8 and 104.9, in the height direction, protrude beyond the interface 106.1 to provide a connector element reaching into the main body section 105. In the present example, the lateral main pillar elements104.8 and 104.9 reach down to the bottom structure 105.1 of the main body section 105 and are firmly connected to the bottom structure 105.1. By this means, the arc shaped structure formed by the coplanar center main pillar elements 104.8 and the second transverse beam 104.6 is closed via the bottom structure 105.1 ultimately yielding a ring-shaped, highly stable structure. The same applies to the arc shaped structure formed by the third transverse beam 104.13 and the rearward lateral main pillar elements 104.9.

[0091] In the present example the frontal impact energy absorbing unit 110 is adapted to absorb the entire maximum impact energy to be taken by the vehicle 101 under given crash scenarios (e.g. prescribed according to national, international or operator regulations). Furthermore, the head framework 104.2 is adapted to undergo substantially no plastic deformation in this maximum frontal crash scenario. Obviously, this is beneficial in terms of protecting a driver and vital components of the vehicle 101 located in the head section in such a crash situation.

[0092] As can be seen best from Figure 5 and 6, in the present example, the auxiliary framework elements (such as the auxiliary pillar element 104.10 shown in Figure 6) and the main framework elements (such as the main pillar element 104.8 shown in Figure 6) support a head shell structure 104.16 forming part of an outer shell of the head section. By this means, a beneficial support of the outer shell of the vehicle, particularly against high aerodynamic loads (as they occur, for example, particularly in high-speed operations, at the entrance into a tunnel or an encounter with a passing vehicle) is achieved.

[0093] As can be seen from Figure 6, the head shell structure 104.16 comprises a plurality of elongated reinforcement elements 104.17 connected and extending transverse to the auxiliary pillar elements 104.10 and connected to an outer shell element 104.18, thereby beneficially increasing structural stability of the outer shell. It will be appreciated that the reinforcement elements 104.17 preferably are monolithically formed with the outer shell element 104.18 (e.g. both generated in a common extrusion process). However, any other connecting technique, preferably cold bonding technique (to avoid heat induced distortion), may also be used. At the level of the main head framework elements, such as the main pillar element 104.8, the outer shell element 104.18 is connected directly to the main head framework element, thereby achieving a very beneficial introduction of loads into the head shell structure 104.16 and, ultimately, a highly structurally stable configuration.

[0094] As can be seen from Figure 1, a nose section 111 of the wagon body 102 covers the impact energy absorbing unit 110 as well as connectors (not shown) for providing mechanical, energy and/or data transfer con-

nection with respect to another vehicle. It will be appreciated that the nose section 111 may be formed as a separate component mechanically connected to the head section 104. However, with certain embodiments of the invention, the nose section 111 may also be part of the head section 104. In particular, the nose section may be formed in a similar manner as the head section 104.

[0095] It will be appreciated that any desired manufacturing technique or combination of manufacturing techniques may be used for producing the vehicle head structure 104.1. Preferably, as in the present example, the vehicle head structure 104.1 is formed as a differential structure composed of a plurality of mutually mechanically connected components, thereby facilitating manufacture of the overall structure.

[0096] As in the present example, preferably, at least a fraction of the components are connected at least partially in a fusion process, in particular, in a welding process. Such configurations, typically, facilitate repair of damaged sections. Furthermore, as in the present example, preferably, at least a fraction of the components, in particular, the components of the head framework structure 104.2 as well as the components of the outer shell structure 104.3, are made from a material comprising a light metal alloy, in particular, comprising aluminum. Such configurations, typically, allow very lightweight structures.

[0097] In the following, preferred embodiments of a method of manufacturing the vehicle 101 will be described with reference to Figure 1 to 6. In an initial step of this method all the components as outlined above are manufactured and provided, respectively.

[0098] In a first step of a sidewall forming step, a first head sidewall framework located on one side of the head section 104 is formed in a separate manufacturing station, the first head sidewall framework comprising one of the longitudinal beams 104.4, the main pillar elements 104.8 and 104.9, the auxiliary framework elements 104.10 for this first head sidewall framework and the auxiliary longitudinal framework element 104.12. At the same time the second head sidewall framework located on the other side of the head section 104 and comprising the corresponding components may be formed.

[0099] Furthermore, a first and second three-dimensionally shaped parts of the head shell structure 104.16 as outlined above (i.e. comprising the reinforcement elements 104.17 and the outer shell element 104.18) for the respective side of the head section 104 is formed in a separate manufacturing station.

[0100] Subsequently, the first part of the head shell structure 104.16 is connected to the associated first head sidewall framework (i.e. components 104.4, 104.8, 104.9, 104.10, 104.12) to form a first head sidewall while the second part of the head shell structure 104.16 is connected to the second head sidewall framework (i.e. components 104.4, 104.8, 104.9, 104.10, 104.12) to form a second head sidewall, respectively, to provide the configuration as described above in the context of Figure 6.

[0101] After an adjustment and calibration step of the first and second head sidewalls, in a second step of the sidewall forming step, each one of the first and second sidewalls is connected via the respective part of the interface 106 to an adjacent third and fourth (prismatic) main body sidewall (more precisely, a main body sidewall segment) of the main body section 105 to form a first and second vehicle side wall (more precisely, a first and second vehicle sidewall segment), respectively.

[0102] Subsequently, in a vehicle body assembly step, the first and second vehicle sidewalls are connected to the bottom structure 105.1 of the main body section 105 and to a roof structure 105.2 of the main body section to form the vehicle body 102.

[0103] In a further step of the vehicle body assembly step, the longitudinal beams 104.1 are connected via the barrier plate 109 and the transverse beams 104.5 and 104.6 to provide the configuration as described above, thereby achieving a firm and rigid connection between the two vehicle sidewalls.

[0104] It will be appreciated that, with other embodiments of the invention, the respective head sidewall framework may be connected to the associated main body sidewall after the main body sidewall has been connected to the bottom structure 105.1 and to the roof structure 105.2 of the main body section 105. In these cases, the first and second head sidewall framework (i.e. components 104.4, 104.8, 104.9, 104.10, 104.12) may be mounted individually to the assembled main body segment 105 and connected via the transverse beams 104.5 and to 104.6. As an alternative, the head framework 104.2 (as shown in Figure 2, excluding frame 104.7) may be pre-assembled (either alone or already with parts of the outer shell structure 104.3 mounted thereon) and then connected as a whole unit via the interface 106 to the main body section 105.

[0105] It will be appreciated that, with other embodiments of the invention, the respective outer shell structure of the head segments and/or the main body segments may be mounted at any desired point in time prior to or after connecting the respective (head and/or main body) sidewall frameworks to each other, to the bottom structure 105.1 and/or to the roof structure 105.2.

[0106] It will be appreciated that the connecting techniques used in any of these steps may comprise any desired connecting technique or arbitrary combinations of different connecting techniques. Preferably, at least one of these connecting techniques comprises a fusion process, in particular, a welding process.

[0107] After further adjustment, calibration, conditioning and equipment steps, the large and/or heavy components are inserted into the vehicle interior via the manufacturing access opening 108 as it has been outlined above.

[0108] Finally, the third transverse beam 104.14 is mounted in the way it has been described above. Subsequently, the frame 104.7 with the auxiliary transverse

beams 104.11 and the outer shell element 104.14 forming the corresponding part of the outer shell closing the mounting access opening 108 are installed in the way it has been described above. As mentioned, this may happen by mounting a (previously manufactured) cover unit 104.15 including the frame 104.7, the auxiliary transverse beams 104.11 and the outer shell element 104.14.

[0109] Similar applies with respect to the closing of further openings. Hence, the opening of the front window frame is closed by mounting the front window unit 107 as it has been described above. Similar applies to all further closing components such as side windows etc. 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 and economic solution for manufacturing the wagon body.

Claims

1. A rail vehicle, in particular a high-speed rail vehicle, having a head section (104) and a main body section (105), wherein

- a vehicle head structure (104.1) of said head section (104) has a head interface section (106.1) forming a mechanical interface to a mating main body interface section of said main body section (105);
- said vehicle head structure (104.1) defines a longitudinal direction, a transverse direction and a height direction;
- said vehicle head structure (104.1) is configured such that, in a mounted state, a bottom part of said main body section (105), in said longitudinal direction, extends below said vehicle head structure (104.1),

characterized in that

- said vehicle head structure (104.1) has an interior framework structure (104.2) comprising at least two longitudinal beams (104.4) extending, in said longitudinal direction, from a front end to a rear end of said interior framework structure (104.2) and being connected via at least one transverse beam (104.6),
- said two longitudinal beams (104.4) and said transverse beam (104.6) confine a mounting access opening (108) located, in said longitudinal direction, between said transverse beam (104.6) and said rear end of said interior framework structure (104.2),
- said mounting access opening (108) being usable during manufacture of said vehicle for inserting large interior equipment components into an interior of said head section (104);
- said mounting access opening (108) being partially closed by a further transverse beam (104.13) connected to said longitudinal beams (104.4) in a cold joining process, in particular, in a riveting process;
- said mounting access opening (108) being closed by a cover unit (104.15) forming part of an outer shell of said vehicle head structure (104.1).

2. The rail vehicle according to claim 1, wherein

- said head interface section (106.1) comprises at least one inclined first section (106.3), which is inclined with respect to said height direction and said longitudinal direction,
wherein
- said head interface section (106.1), in particular, defines an interface surface, said interface surface defining a tangential interface plane, said tangential interface plane being tangent to said interface surface;
- said interface plane, in said at least one inclined first section (106.3), having a first inclination with respect to said height direction, said first inclination, in particular, ranging from 5° to 85°, preferably from 30° to 80°, more preferably from 60° to 70°;
and/or
- said interface surface, in said height direction, facing downwards towards a track said vehicle is running on.

3. The rail vehicle according to claim 2, wherein

- said interface plane is substantially parallel with respect to said transverse direction
and/or
- said interface plane, in at least one second section located adjacent to said inclined first section (106.3), is substantially parallel to said height direction or substantially parallel to said longitudinal direction
and/or
- said interface surface, in a plane parallel to said height direction and said longitudinal direction, defines a stepped interface contour.

4. The rail vehicle according to one of claims 2 or 3, wherein

- said rail vehicle in the area of said head section (104) has bottom structure (105.1) defining an interior floor level and a maximum height dimension above said interior floor level in said height direction;
- said at least one inclined section, in said height

direction, extending over 10% to 90% of said maximum height dimension, preferably over 25% to 75% of said maximum height dimension, more preferably over 40% to 65% of said maximum height dimension;
and/or
- said at least one inclined first section (106.3), in said height direction, extending substantially down to said interior floor level.

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

- -said interior framework structure (104.2) comprises a frontal barrier unit (109) adapted to carry at least one impact energy absorbing device (110), said frontal barrier unit (109), in particular, being a substantially plate shaped unit;
and/or
- said vehicle is adapted to undergo, in a defined maximum frontal crash scenario, a maximum frontal impact load, said interior framework structure (104.2) being adapted to undergo substantially no plastic deformation in said maximum frontal crash scenario;
and/or
- said interior framework structure (104.2) comprises at least one lateral main pillar element (104.8, 104.9), said lateral main pillar element (104.8, 104.9), in said height direction, protruding beyond said interface section (106.3) to provide a connector element reaching into said main body section (105), in particular, down to a bottom structure (105.1) of said main body section (105);
and/or
- said interior framework structure (104.2) comprises at least two lateral main pillar elements (104.8, 104.9) located in a common plane and connected in said transverse direction via a transverse beam (104.6, 104.13) to form an arc shaped main support structure of said interior framework structure (104.2), said lateral main pillar elements (104.8, 104.9), in particular, extending, in said height direction, down to a bottom structure (105.1) of said main body section (105);
and/or
- said two longitudinal beams (104.4) are located at an upper side of said head structure;
and/or
- said transverse beam (104.6) and said two longitudinal beams (104.4) form part of a front window frame of said head section (104);
and/or
- said interior framework structure (104.2) comprises a plurality of auxiliary pillar elements (104.10) and/or a plurality of auxiliary beams (104.11) supporting a shell structure (104.3) forming an outer shell of said head section (104), said shell structure (104.3), in particular, comprising a plurality of elongated reinforcement elements (104.17) connected to said auxiliary pillar elements (104.10) and/or said auxiliary beams (104.11);
and/or
- said interior framework structure (104.2) comprises a plurality of main framework elements (104.4, 104.6, 104.8, 104.9, 104.13) and a plurality of auxiliary framework elements (104.10, 104.11) supporting an outer shell structure (104.3) comprising an outer shell element (104.18) forming an outer shell of said head section (104) and a plurality of elongated reinforcement elements (104.17) connected to said outer shell element (104.18), said reinforcement elements (104.17) being connected to said auxiliary framework elements (104.10, 104.11), said outer shell element (104.18) being connected directly to said main framework elements (104.4, 104.6, 104.8, 104.9, 104.13).

6. The rail vehicle according to one of claims 1 to 5, wherein

- in said mounted state, said bottom part of said main body section (105), in said longitudinal direction, extends over at least 30%, more preferably over at least 50%, even more preferably over substantially 100%, of a longitudinal dimension of said vehicle head structure (104.1),

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

- said vehicle head structure (104.1) is formed as a differential structure composed of a plurality of mutually mechanically connected components (104.4 to 104.18);
- at least a fraction of said components (104.4 to 104.12, 104.16 to 104.18) being connected at least partially in a fusion process, in particular, in a welding process;
and/or
- at least a fraction of said components (104.4 to 104.18) being made from a material comprising a light metal alloy, in particular, comprising aluminum.

8. The rail vehicle according to one of claims 1 to 7, wherein said rail vehicle is adapted to be used for high-speed operation at nominal operating speeds above 250 km/h, preferably above 300 km/h, more preferably above 350 km/h.

9. A vehicle body structure of a rail vehicle, in particular,

of the rail vehicle according to one of claims 1 to 7, comprising

- a vehicle head structure (104.1) forming a head section (104) of said vehicle body structure and a main body structure forming a main body section (105) of said vehicle body structure;
- said main body section (105), in particular, having a substantially prismatic outer surface along said longitudinal direction;

wherein

- said vehicle head structure (104.1) of said head section (104) has a head interface section (106.1) forming a mechanical interface to a mating main body interface section of said main body section (105);
- said vehicle head structure (104.1) defines a longitudinal direction, a transverse direction and a height direction;
- said vehicle head structure (104.1) is configured such that, in a mounted state, a bottom part of said main body section (105), in said longitudinal direction, extends below said vehicle head structure (104.1),
- said main body section (105), in particular, comprising a bottom structure (105.1) defining an interior floor level and reaching, in said longitudinal direction, into said head section (104),

characterized in that

- said vehicle head structure (104.1) has an interior framework structure (104.2) comprising at least two longitudinal beams (104.4) extending, in said longitudinal direction, from a front end to a rear end of said interior framework structure (104.2) and being connected via at least one transverse beam (104.6),
- said two longitudinal beams (104.4) and said transverse beam (104.6) confine a mounting access opening (108) located, in said longitudinal direction, between said transverse beam (104.6) and said rear end of said interior framework structure (104.2),
- said mounting access opening (108) being usable during manufacture of said vehicle for inserting large interior equipment components into an interior of said head section (104);
- said mounting access opening (108) being partially closed by a further transverse beam (104.13) connected to said longitudinal beams (104.4) in a cold joining process, in particular, in a riveting process;
- said mounting access opening (108) being closed by a cover unit (104.15) forming part of an outer shell of said vehicle head structure (104.1).

10. A method of manufacturing the vehicle body structure according to claim 9, comprising,

- in a first step of a sidewall forming step using at least a first connecting technique, forming a first head sidewall framework of said head section (104), said first head sidewall framework comprising a first longitudinal beam (104.4) and/or a first main pillar element (104.8, 104.9) and/or a plurality of first auxiliary framework (104.10, 104.12) elements,
- in a vehicle body assembly step using at least a second connecting technique, connecting a first vehicle sidewall to a bottom structure (105.1) of said main body section (105) and, in particular, to a roof structure of said main body section (105) to form a vehicle body;
- said first head sidewall framework being integrated into said first vehicle sidewall prior to or within said vehicle body assembly step;
- at least one of said first connecting technique and said second connecting technique, in particular, comprising a fusion process, in particular, a welding process.

11. The method according to claim 10, wherein

- in a second step of said sidewall forming step using at least a third connecting technique, connecting said first head sidewall framework to a main body sidewall of said main body section (105) to form said first vehicle sidewall and connecting said first vehicle sidewall to said bottom structure (105.1);
or
- in said vehicle body assembly step using at least a third connecting technique, connecting a main body sidewall of said wagon body to said bottom structure (105.1) and subsequently connecting said first head sidewall framework to said main body sidewall to form said first vehicle sidewall;
- said third connecting technique, in particular, comprising a fusion process, in particular, a welding process.

12. The method according to claim 10 or 11, wherein

- in said vehicle body assembly step using a fourth connecting technique, a second longitudinal beam (104.4) of a second head sidewall framework is connected to said first longitudinal beam (104.4) via a first transverse beam (104.6) extending in said transverse direction;
- said first longitudinal beam (104.4) and said second longitudinal beam (104.4), in particular,

being located at an upper side of said head structure;
- said first longitudinal beam (104.4), said second longitudinal beam (104.4) and said first transverse beam (104.6), in particular, forming part of a front window frame of a front window opening of said head section (104);
- said first longitudinal beam (104.4), said second longitudinal beam (104.4) and said first transverse beam (104.6), in particular, confining a mounting access opening (108) located, in said longitudinal direction, between said transverse beam (104.6) and a rear end of said head section (104), said mounting access opening (108) being usable for inserting large interior equipment components into an interior of said head section (104);
- said first transverse beam (104.6), in particular, being located in a substantially common plane with a first lateral main pillar element (104.8) connected to said first longitudinal beam (104.4) and a second lateral main pillar element (104.8) connected to said second longitudinal beam (104.4) to form an arc shaped main support structure, said first lateral main pillar element (104.8) and said second lateral main pillar element (104.8), in particular, extending, in said height direction, down to said bottom structure (105.1) and, in particular, being connected to said bottom structure (105.1);
- said fourth connecting technique, in particular, comprising a fusion process, in particular, a welding process.

13. The method according to claim 12, wherein

- in said vehicle body assembly step, at least one large interior equipment component is inserted into said interior of said head section (104) via said mounting access opening (108) and/or said front window opening, said interior equipment component, in particular, being one of a driver's board, an electrical equipment cabinet and a cable duct;
- in said vehicle body assembly step, after inserting said interior equipment component and using a fifth connecting technique, said mounting access opening (108), in particular, is partially closed by a second transverse beam (104.13) connected to said first longitudinal beam (104.4) and said second longitudinal beam (104.4);
- in said vehicle body assembly step, after inserting said interior equipment component and using a sixth connecting technique, said front window opening, in particular, is closed by a front window unit (107);
- in said vehicle body assembly step, after inserting said interior equipment component and using a seventh connecting technique, said mounting access opening (108), in particular, is closed by a cover unit (104.15) forming part of an outer shell of said vehicle head section (104);
- said fifth connecting technique, in particular, comprising a cold joining process, in particular, a riveting process;
- at least one of said sixth connecting technique and said seventh connecting technique, in particular, comprising a fusion process, in particular, an adhesive bonding process, preferably a gluing process.

14. The method according to one of claims 10 to 13, wherein

- in said sidewall forming step, a head shell structure (104.3) forming part of an outer shell of said head section (104) is connected to said first head sidewall framework;
or
- in an outer shell forming step, after said sidewall forming step, a head shell structure (104.3) forming part of an outer shell of said head section (104) is connected to said first vehicle sidewall;
- said head shell structure (104.3), in particular, comprising a plurality of elongated reinforcement elements (104.17) connected to auxiliary elements of said first head sidewall framework;

15. A method of manufacturing the vehicle body structure according to claim 9, comprising

- partially forming said head section (104) and said main body section (105) leaving said mounting access opening (108) within said head section (104) open for inserting large interior equipment components into an interior of said head section (104);
- inserting said large interior equipment components into said interior of said head section (104) via said mounting access opening (108); and
- closing said at least one mounting access opening (108) using said cover unit (104.15) to form said part of said outer shell of said vehicle head section (104).

Patentansprüche

1. Schienenfahrzeug, insbesondere ein Hochgeschwindigkeits-Schienenfahrzeug, mit einem Kopfabschnitt (104) und einem Hauptkörperabschnitt (105), wobei

- eine Fahrzeugkopfstruktur (104.1) des Kopfabschnitts (104) einen Kopfschnittstellenab-

schnitt (106.1) aufweist, der eine mechanische Schnittstelle zu einem passenden Hauptkörperschnittstellenabschnitt des Hauptkörperabschnitts (105) bildet;
- die Fahrzeugkopfstruktur (104.1) eine Längsrichtung, eine Querrichtung und eine Höhenrichtung definiert;
- die Fahrzeugkopfstruktur (104.1) derart ausgebildet ist, dass sich, in einem montierten Zustand, ein Bodenteil des Hauptkörperabschnitts (105) in der Längsrichtung unterhalb der Fahrzeugkopfstruktur (104.1) erstreckt,

dadurch gekennzeichnet, dass

- die Fahrzeugkopfstruktur (104.1) eine Innenrahmenstruktur (104.2) aufweist, die wenigstens zwei Längsträger (104.4) umfasst, die sich in der Längsrichtung von einem vorderen Ende zu einem hinteren Ende der inneren Rahmenstruktur (104.2) erstrecken und über wenigstens einen Querträger (104.6) verbunden sind,
- die beiden Längsträger (104.4) und der Querträger (104.6) eine Montagezugangsöffnung (108) begrenzen, die, in Längsrichtung, zwischen dem Querträger (104.6) und dem hinteren Ende der Innenrahmenstruktur (104.2) angeordnet ist,
- wobei die Montagezugangsöffnung (108) während der Herstellung des Fahrzeugs zum Einsetzen großer Innenausstattungskomponenten in einen Innenraum des Kopfteils (104) verwendbar ist;
- wobei die Montagezugangsöffnung (108) teilweise durch einen weiteren Querträger (104.13) verschlossen ist, der mit den Längsträgern (104.4) in einem Kaltfügeverfahren, insbesondere in einem Nietverfahren, verbunden ist;
- wobei die Montagezugangsöffnung (108) durch eine Abdeckeinheit (104.15) verschlossen ist, die einen Teil einer Außenschale der Fahrzeugkopfstruktur (104.1) bildet.

2. Schienenfahrzeug nach Anspruch 1, wobei

- der Kopfschnittstellenabschnitt (106.1) wenigstens einen geneigten ersten Abschnitt (106.3) umfasst, der in Bezug auf die Höhenrichtung und die Längsrichtung geneigt ist,
wobei
- der Kopfschnittstellenabschnitt (106.1) insbesondere eine Schnittstellenfläche definiert, wobei die Schnittstellenfläche eine tangentiale Schnittstellenebene definiert, wobei die tangentiale Schnittstellenebene tangential zu der Schnittstellenfläche ist;
- wobei die Schnittstellenebene, in dem wenigstens einen geneigten ersten Abschnitt (106.3), eine erste Neigung in Bezug auf die Höhenrichtung aufweist, wobei die erste Neigung insbesondere im Bereich von 5° bis 85°, vorzugsweise von 30° bis 80°, weiter vorzugsweise von 60° bis 70° liegt;
und/oder
- die Schnittstellenfläche in der Höhenrichtung nach unten in Richtung einer Spur, auf der das Fahrzeug fährt, weist.

3. Schienenfahrzeug nach Anspruch 2, wobei

- die Schnittstellenebene im Wesentlichen parallel zur Querrichtung verläuft;
und/oder
- die Schnittstellenebene, in wenigstens einem zweiten Abschnitt, der an den geneigten ersten Abschnitt (106.3) angrenzt, im Wesentlichen parallel zu der Höhenrichtung oder im Wesentlichen parallel zu der Längsrichtung verläuft;
und/oder
- die Schnittstellenfläche, in einer Ebene parallel zu der Höhenrichtung und der Längsrichtung, eine abgestufte Schnittstellenkontur definiert.

4. Schienenfahrzeug nach einem der Ansprüche 2 oder 3, wobei

- das Schienenfahrzeug im Bereich des Kopfabschnitts (104) eine Bodenstruktur (105.1) aufweist, die ein Innenraumbodenniveau und eine maximale Höhenabmessung über dem Innenraumbodenniveau in der Höhenrichtung definiert;
- wobei sich der wenigstens eine geneigte Abschnitt, in der Höhenrichtung, über 10 % bis 90 % der maximalen Höhenabmessung, vorzugsweise über 25 % bis 75 % der maximalen Höhenabmessung, weiter vorzugsweise über 40 % bis 65 % der maximalen Höhenabmessung erstreckt;
und/oder
- wobei sich der wenigstens eine geneigte erste Abschnitt (106.3), in der Höhenrichtung, im Wesentlichen bis zu dem Innenraumbodenniveau erstreckt.

5. Schienenfahrzeug nach einem der Ansprüche 1 bis 4, wobei

- die Innenrahmenstruktur (104.2) eine Frontalbarriereeinheit (109) umfasst, die ausgelegt ist, wenigstens eine Aufprallenergieabsorptionsvorrichtung (110) zu tragen, wobei die Frontalbarriereeinheit (109) insbesondere eine im Wesentlichen plattenförmige Einheit ist;
und/oder

- das Fahrzeug derart ausgelegt ist, dass es in einem definierten maximalen Frontalcrashszenario eine maximale Frontalaufprallbelastung erfährt, wobei die innere Rahmenstruktur (104.2) derart ausgelegt ist, dass sie in dem maximalen Frontalcrashszenario im Wesentlichen keine plastische Verformung erfährt;
und/oder
- die Innenrahmenstruktur (104.2) wenigstens ein seitliches Hauptsäulenelement (104.8, 104.9) umfasst, wobei das seitliche Hauptsäulenelement (104.8, 104.9), in der Höhenrichtung, über den Schnittstellenabschnitt (106.3) hinausragt, um ein Verbindungselement bereitzustellen, das in den Hauptkörperabschnitt (105) hineinreicht, insbesondere bis zu einer Bodenstruktur (105.1) des Hauptkörperabschnitts (105);
und/oder
- die Innenrahmenstruktur (104.2) wenigstens zwei seitliche Hauptsäulenelemente (104.8, 104.9) aufweist, die in einer gemeinsamen Ebene angeordnet und in der Querrichtung über einen Querträger (104.6, 104.13) verbunden sind, um eine bogenförmige Hauptstützstruktur der inneren Rahmenstruktur (104.2) zu bilden, wobei sich die seitlichen Hauptsäulenelemente (104.8, 104.9) insbesondere in der Höhenrichtung bis zu einer Bodenstruktur (105.1) des Hauptkörperabschnitts (105) erstrecken;
und/oder
- die beiden Längsträger (104.4) an einer Oberseite der Kopfstruktur angeordnet sind;
und/oder
- der Querträger (104.6) und die beiden Längsträger (104.4) einen Teil eines Frontscheibenrahmens des Kopfteils (104) bilden;
und/oder
- die Innenrahmenstruktur (104.2) eine Vielzahl von Hilfssäulenelementen (104.10) und/oder eine Vielzahl von Hilfsträgern (104.11) umfasst, die eine Schalenstruktur (104.3) tragen, die eine äußere Schale des Kopfteils (104) bildet, wobei die Schalenstruktur (104.3) insbesondere eine Vielzahl von länglichen Verstärkungselementen (104.17) umfasst, die mit den Hilfssäulenelementen (104.10) und/oder den Hilfsträgern (104.11) verbunden sind;
und/oder
- die Innenrahmenstruktur (104.2) eine Vielzahl von Hauptrahmenelementen (104.4, 104.6, 104.8, 104.9, 104.13) und eine Vielzahl von Hilfsrahmenelementen (104.10, 104.11) umfasst, die eine äußere Schalenstruktur (104.3) tragen, die ein äußeres Schalenelement (104.18), das eine äußere Schale des Kopfabschnitts (104) bildet, und eine Vielzahl von länglichen Verstärkungselementen (104. 17), die mit dem Außenschalenelement (104.18) verbunden sind, wobei die Verstärkungselemente (104.17) mit den Hilfsrahmenelementen (104.10, 104.11) verbunden sind und das Außenschalenelement (104.18) direkt mit den Hauptrahmenelementen (104.4, 104.6, 104.8, 104.9, 104.13) verbunden ist.

6. Schienenfahrzeug nach einem der Ansprüche 1 bis 5, wobei

- im montierten Zustand, der Bodenteil des Hauptkörperabschnitts (105), in der Längsrichtung, über wenigstens 30 %, vorzugsweise über wenigstens 50 %, weiter vorzugsweise über im Wesentlichen 100 % einer Längsabmessung der Fahrzeugkopfstruktur (104.1) verläuft.

7. Schienenfahrzeug nach einem der Ansprüche 1 bis 6, wobei

- die Fahrzeugkopfstruktur (104.1) als eine Differentialstruktur ausgebildet ist, die aus einer Vielzahl von mechanisch miteinander verbundenen Komponenten (104.4 bis 104.18) besteht;
- wobei wenigstens ein Teil der Komponenten (104.4 bis 104.12, 104.16 bis 104.18) zumindest teilweise in einem Schmelzverfahren, insbesondere in einem Schweißverfahren, verbunden ist;
und/oder
- wenigstens ein Teil der Komponenten (104.4 bis 104.18) aus einem Material hergestellt ist, das eine Leichtmetalllegierung, insbesondere Aluminium, umfasst.

8. Schienenfahrzeug nach einem der Ansprüche 1 bis 7, wobei das Schienenfahrzeug für einen Hochgeschwindigkeitsbetrieb mit Nennbetriebsgeschwindigkeiten über 250 km/h, vorzugsweise über 300 km/h, weiter vorzugsweise über 350 km/h, ausgelegt ist.

9. Wagenkastenstruktur eines Schienenfahrzeugs, insbesondere des Schienenfahrzeugs nach einem der Ansprüche 1 bis 7, umfassend

- eine Fahrzeugkopfstruktur (104.1), die einen Kopfabschnitt (104) der Fahrzeugkörperstruktur bildet, und eine Hauptkörperstruktur, die einen Hauptkörperabschnitt (105) der Fahrzeugkörperstruktur bildet;
- wobei der Hauptkörperabschnitt (105) insbesondere eine im Wesentlichen prismatische Außenfläche entlang der Längsrichtung aufweist;
wobei
- eine Fahrzeugkopfstruktur (104.1) des Kopfabschnitts (104) einen Kopfschnittstellenab-

schnitt (106.1) aufweist, der eine mechanische Schnittstelle zu einem passenden Hauptkörperschnittstellenabschnitt des Hauptkörperabschnitts (105) bildet;
- die Fahrzeugkopfstruktur (104.1) eine Längsrichtung, eine Querrichtung und eine Höhenrichtung definiert;
- die Fahrzeugkopfstruktur (104.1) derart ausgebildet ist, dass sich, in einem montierten Zustand, ein Bodenteil des Hauptkörperabschnitts (105) in der Längsrichtung unterhalb der Fahrzeugkopfstruktur (104.1) erstreckt,
- wobei der Hauptkörperabschnitt (105) insbesondere eine Bodenstruktur (105.1) umfasst, die ein Innenbodenniveau definiert und, in der Längsrichtung, in den Kopfabschnitt (104) hineinreicht

dadurch gekennzeichnet, dass

- die Fahrzeugkopfstruktur (104.1) eine Innenrahmenstruktur (104.2) aufweist, die wenigstens zwei Längsträger (104.4) umfasst, die sich in der Längsrichtung von einem vorderen Ende zu einem hinteren Ende der Innenrahmenstruktur (104.2) erstrecken und über wenigstens einen Querträger (104.6) verbunden sind,
- die beiden Längsträger (104.4) und der Querträger (104.6) eine Montagezugangsöffnung (108) begrenzen, die, in Längsrichtung, zwischen dem Querträger (104.6) und dem hinteren Ende der Innenrahmenstruktur (104.2) angeordnet ist,
- wobei die Montagezugangsöffnung (108) während der Herstellung des Fahrzeugs zum Einsetzen großer Innenausstattungskomponenten in einen Innenraum des Kopfteils (104) verwendbar ist;
- wobei die Montagezugangsöffnung (108) teilweise durch einen weiteren Querträger (104.13) verschlossen ist, der mit den Längsträgern (104.4) in einem Kaltfügeverfahren, insbesondere in einem Nietverfahren, verbunden ist;
- wobei die Montagezugangsöffnung (108) durch eine Abdeckeinheit (104.15) verschlossen ist, die einen Teil einer Außenschale der Fahrzeugkopfstruktur (104.1) bildet.

10. Verfahren zur Herstellung der Fahrzeugkörperstruktur nach Anspruch 9, umfassend,

- in einem ersten Schritt eines Seitenwandbildungsschritts unter Verwendung wenigstens einer ersten Verbindungstechnik einen ersten Kopfseitenwandrahmen des Kopfabschnitts (104) gebildet wird, wobei der erste Kopfseitenwandrahmen einen ersten Längsträger (104.4) und/oder ein erstes Hauptsäulenelement (104.8, 104.9) und/oder eine Vielzahl von ersten Hilfsrahmenelementen (104.10, 104.12) umfasst,
- in einem Fahrzeugkörper-Montageschritt unter Verwendung wenigstens einer zweiten Verbindungstechnik, Verbinden einer ersten Fahrzeugseitenwand mit einer Bodenstruktur (105.1) des Hauptkörperabschnitts (105) und insbesondere mit einer Dachstruktur des Hauptkörperabschnitts (105), um einen Fahrzeugkörper zu bilden;
- wobei der erste Kopfseitenwandrahmen in die erste Fahrzeugseitenwand vor oder innerhalb des Fahrzeugkörper-Montageschritts integriert wird;
- wobei wenigstens eine aus der ersten Verbindungstechnik und der zweiten Verbindungstechnik insbesondere ein Schmelzverfahren, insbesondere ein Schweißverfahren, umfasst.

11. Verfahren nach Anspruch 10, wobei

- in einem zweiten Schritt des Seitenwandbildungsschritts unter Verwendung wenigstens einer dritten Verbindungstechnik der erste Kopfseitenwandrahmen mit einer Hauptkörperseitenwand des Hauptkörperabschnitts (105) verbunden wird, um die erste Fahrzeugseitenwand zu bilden, und die erste Fahrzeugseitenwand mit der Bodenstruktur (105.1) verbunden wird; oder
- in Fahrzeugkörper-Montageschritt unter Verwendung wenigstens einer dritten Verbindungstechnik, Verbinden einer Hauptkörperseitenwand des Wagenkörpers mit der Bodenstruktur (105.1) und anschließendes Verbinden des ersten Kopfseitenwandrahmens mit der Hauptkörperseitenwand, um die erste Fahrzeugseitenwand zu bilden;
- wobei die dritte Verbindungstechnik insbesondere ein Schmelzverfahren, insbesondere ein Schweißverfahren, umfasst.

12. Verfahren nach Anspruch 10 oder 11, wobei

- in dem Fahrzeugkörper-Montageschritt unter Verwendung einer vierten Verbindungstechnik ein zweiter Längsträger (104.4) eines zweiten Kopfseitenwandrahmens mit dem ersten Längsträger (104.4) über einen ersten Querträger (104.6) verbunden wird, der sich in der Querrichtung erstreckt;
- wobei der erste Längsträger (104.4) und der zweite Längsträger (104.4) insbesondere an einer Oberseite der Kopfstruktur angeordnet sind;
- wobei der erste Längsträger (104.4), der zweite Längsträger (104.4) und der erste Querträger (104.6) insbesondere einen Teil eines Front-

scheibenrahmens einer Frontscheibenöffnung des Kopfteils (104) bilden;
- wobei der erste Längsträger (104.4), der zweite Längsträger (104.4) und der erste Querträger (104.6) insbesondere eine Montagezugangsöffnung (108) begrenzen, die in der Längsrichtung zwischen dem Querträger (104.6) und einem hinteren Ende des Kopfabschnitts (104) angeordnet ist, wobei die Montagezugangsöffnung (108) zum Einsetzen großer Innenausstattungskomponenten in einen Innenraum des Kopfabschnitts (104) verwendbar ist;
- wobei der erste Querträger (104.6) insbesondere in einer im Wesentlichen gemeinsamen Ebene mit einem ersten seitlichen Hauptsäulenelement (104.8), das mit dem ersten Längsträger (104.4) verbunden ist, und einem zweiten seitlichen Hauptsäulenelement (104.8), das mit dem zweiten Längsträger (104. 4) verbunden ist, um eine bogenförmige Hauptstützstruktur zu bilden, wobei sich das erste seitliche Hauptsäulenelement (104.8) und das zweite seitliche Hauptsäulenelement (104.8) insbesondere in der Höhenrichtung bis zu der Bodenstruktur (105.1) erstrecken und insbesondere mit der Bodenstruktur (105.1) verbunden sind;
- wobei die vierte Verbindungstechnik insbesondere ein Schmelzverfahren, insbesondere ein Schweißverfahren, umfasst.

13. Verfahren nach Anspruch 12, wobei

- in dem Fahrzeugkörper-Montageschritt, wenigstens eine große Innenausstattungskomponente über die Montagezugangsöffnung (108) und/oder die Frontscheibenöffnung in den Innenraum des Kopfteils (104) eingesetzt wird, wobei es sich bei der Innenausstattungskomponente insbesondere um ein Fahrerpult, einen Schaltschrank für elektrische Geräte oder einen Kabelkanal handelt;
- in dem Fahrzeugkörper-Montageschritt, nach dem Einsetzen der Innenausstattungskomponente und unter Verwendung einer fünften Verbindungstechnik, die Montagezugangsöffnung (108) insbesondere teilweise durch einen zweiten Querträger (104.13) verschlossen wird, der mit dem ersten Längsträger (104.4) und dem zweiten Längsträger (104.4) verbunden ist;
- in dem Fahrzeugkörper-Montageschritt, nach dem Einsetzen der Innenausstattungskomponente und unter Verwendung einer sechsten Verbindungstechnik, die Frontscheibenöffnung, insbesondere durch eine Frontscheibeneinheit (107), geschlossen wird;
- in dem Fahrzeugkörper-Montageschritt, nach dem Einsetzen der Innenausstattungskomponente und unter Anwendung einer siebten Verbindungstechnik, die Montagezugangsöffnung (108) insbesondere durch eine Abdeckeinheit (104.15) verschlossen wird, die einen Teil einer Außenschale des Fahrzeugkopfabschnitts (104) bildet;
- wobei die fünfte Verbindungstechnik insbesondere ein Kaltfügeverfahren, insbesondere ein Nietverfahren, umfasst;
- wenigstens eine aus die sechste Verbindungstechnik und die siebte Verbindungstechnik, insbesondere ein Fügeverfahren, insbesondere ein adhäsives Verbindungsverfahren, vorzugsweise ein Klebeverfahren, umfasst.

14. Verfahren nach einem der Ansprüche 10 bis 13, wobei

- in dem Seitenwandbildungsschritt eine Kopfschalenstruktur (104.3), die einen Teil einer Außenschale des Kopfabschnitts (104) bildet, mit dem ersten Kopfseitenwandrahmen verbunden wird;
oder
- in einem Außenschalenbildungsschritt, nach dem Seitenwandbildungsschritt, eine Kopfschalenstruktur (104.3), die einen Teil einer Außenschale des Kopfabschnitts (104) bildet, mit der ersten Fahrzeugseitenwand verbunden wird;
- wobei die Kopfschalenstruktur (104.3) insbesondere eine Vielzahl von länglichen Verstärkungselementen (104.17) umfasst, die mit Hilfselementen des ersten Kopfseitenwandrahmens verbunden sind;

15. Verfahren zur Herstellung der Fahrzeugkörperstruktur nach Anspruch 9, umfassend

- teilweises Formen des Kopfabschnitts (104) und des Hauptkörperabschnitts (105), wobei die Montagezugangsöffnung (108) innerhalb des Kopfabschnitts (104) offen gelassen wird, um große Innenausstattungskomponenten in einen Innenraum des Kopfabschnitts (104) einzuführen;
- Einführen der großen Innenausstattungskomponenten in das Innere des Kopfabschnitts (104) über die Montagezugangsöffnung (108); und
- Schließen der wenigstens einen Montagezugangsöffnung (108) unter Verwendung der Abdeckeinheit (104.15), um den Teil der Außenschale des Fahrzeugkopfabschnitts (104) zu bilden.

Revendications

1. Véhicule ferroviaire, en particulier un véhicule ferro-

viaire à grande vitesse, ayant une section de tête (104) et une section de corps principal (105) dans lequel:

- une structure de tête de véhicule (104.1) de ladite section de tête (104) a une section d'interface de tête (106.1) formant une interface mécanique avec une section d'interface de corps principal correspondante de ladite section de corps principal (105) ;
- ladite structure de tête de véhicule (104.1) définissant une direction longitudinale, une direction transversale et une direction de hauteur ;
- ladite structure de tête de véhicule (104.1) est configurée de telle sorte que, dans un état monté, une partie inférieure de ladite section de corps principal (105), dans ladite direction longitudinale, s'étend en dessous de ladite structure de tête de véhicule (104.1),

caractérisé en ce que

- ladite structure de tête de véhicule (104.1) a une structure d'ossature intérieure (104.2) comprenant au moins deux poutres longitudinales (104.4) s'étendant, dans ladite direction longitudinale, d'une extrémité avant à une extrémité arrière de ladite structure d'ossature intérieure (104.2), et étant reliées par au moins une poutre transversale (104.6) ;
- lesdites deux poutres longitudinales (104.4) et ladite poutre transversale (104.6, 104.13) confinent une ouverture d'accès de montage (108) située, dans ladite direction longitudinale, entre ladite poutre transversale (104.6) et ladite extrémité arrière de ladite structure d'ossature intérieure (104.2),
- ladite ouverture d'accès de montage (108) étant utilisable pendant la fabrication dudit véhicule pour insérer de grands composants d'équipement intérieur dans un intérieur de ladite section de tête (104) ;
- ladite ouverture d'accès au montage (108) étant partiellement fermée par une autre poutre transversale (104.13) reliée auxdites poutres longitudinales (104.4) dans un processus d'assemblage à froid, en particulier, dans un processus de rivetage ;
- ladite ouverture d'accès au montage (108) étant fermée par une unité de couvercle (104.15) faisant partie d'une coque extérieure de ladite structure de tête de véhicule (104.1).

2. Véhicule ferroviaire selon la revendication 1, dans lequel

- ledit tronçon d'interface de tête (106.1) comprend au moins un premier tronçon incliné (106.3), qui est incliné par rapport à ladite direction de hauteur et à ladite direction longitudinale, dans lequel
- ladite section d'interface de tête (106.1), en particulier, définit une surface d'interface, ladite surface d'interface définissant un plan d'interface tangentiel, ledit plan d'interface tangentiel étant tangentiel à ladite surface d'interface;
- ledit plan d'interface, dans ledit au moins un premier tronçon incliné (106.3), ayant une première inclinaison par rapport à ladite direction de hauteur, ladite première inclinaison, notamment, allant de 5° à 85°, de préférence de 30° à 80°, plus préférentiellement de 60° à 70° ;
et/ou
- ladite surface d'interface, dans ladite direction de hauteur, étant tournée vers le bas en direction d'une voie sur laquelle roule ledit véhicule.

3. Véhicule ferroviaire selon la revendication 2, dans lequel

- ledit plan d'interface est sensiblement parallèle à ladite direction transversale
et/ou
- ledit plan d'interface, dans au moins un deuxième tronçon situé à côté dudit premier tronçon incliné (106.3), est sensiblement parallèle à ladite direction de hauteur ou sensiblement parallèle à ladite direction longitudinale
et/ou
- ladite surface d'interface, dans un plan parallèle à ladite direction de hauteur et à ladite direction longitudinale, définit un contour d'interface escalier.

4. Véhicule ferroviaire selon l'une des revendications 2 ou 3, dans lequel

- ledit véhicule ferroviaire dans la zone de ladite section de tête (104) a une structure inférieure (105.1) définissant un niveau de sol intérieur et une dimension de hauteur maximale au-dessus dudit niveau de sol intérieur dans ladite direction de hauteur ;
- ladite au moins une section inclinée, dans ladite direction de hauteur, s'étendant sur 10 % à 90 % de ladite dimension de hauteur maximale, de préférence sur 25 % à 75 % de ladite dimension de hauteur maximale, plus préférentiellement sur 40 % à 65 % de ladite dimension maximale dimension en hauteur ;
et/ou
- ladite au moins une première section inclinée (106.3), dans ladite direction de hauteur, s'étendant vers le bas sensiblement jusqu'audit niveau du sol intérieur.

5. Véhicule ferroviaire selon l'une des revendications 1 à 4, dans lequel

- ladite structure d'ossature intérieure (104.2) comprend une unité de barrière frontale (109) adaptée pour porter au moins un dispositif d'absorption d'énergie de choc (110), ladite unité de barrière frontale (109), en particulier, étant une unité sensiblement en forme de plaque ;
et/ou
- ledit véhicule est adapté pour subir, dans un scénario de collision frontale maximal défini, une charge maximale de choc frontal, ladite structure d'ossature intérieure (104.2) étant adapté pour ne subir sensiblement aucune déformation plastique dans ledit scénario de collision frontale maximale ;
et/ou
- ladite structure d'ossature intérieure (104.2) comprend au moins un élément de pilier principal latéral (104.8, 104.9), ledit élément de pilier principal latéral (104.8, 104.9), dans ladite direction de la hauteur, faisant saillie au-delà de ladite section d'interface (106.3) pour fournir un élément connecteur atteignant ladite section de corps principal (105), en particulier, vers le bas jusqu'à une structure de sol (105.1) de ladite section de corps principal (105);
et/ou
- ladite structure d'ossature intérieure (104.2) comprend au moins deux éléments de pilier principal latéraux (104.8, 104.9) situés dans un plan commun et reliés dans ladite direction transversale par l'intermédiaire d'une poutre transversale (104.6, 104.13) pour former une structure de support principale en forme d'arc de ladite structure de cadre intérieure (104.2), lesdits éléments de pilier principal latéraux (104.8, 104.9), en particulier, s'étendant, dans ladite direction de hauteur, ver le bas jusqu'à une structure de sol (105.1) de ladite section de corps principal (105);
et/ou
- lesdites deux poutres longitudinales (104.4) sont situées sur un côté supérieur de ladite structure de tête ;
et/ou
- ladite structure d'ossature intérieure (104.2) comprend une pluralité d'éléments de pilier auxiliaires (104.10) et/ou une pluralité de poutres auxiliaires (104.11) supportant une structure de coque (104.3) formant une coque externe de ladite section de tête (104), ladite structure de coque (104.3), en particulier, comprenant une pluralité d'éléments de renforcement allongés (104.17) connectés auxdits éléments de pilier auxiliaires (104.10) et/ou auxdites poutres auxiliaires (104.11);
et/ou
- ladite structure d'ossature intérieure (104.2) comprend une pluralité d'éléments d'ossature principale (104.4, 104.6, 104.8, 104.9, 104.13) et une pluralité d'éléments d'ossature auxiliaire (104.10, 104.11) supportant une structure de coque externe (104.3) comprenant un élément de coque externe (104.18) formant une coque externe de ladite section de tête (104) et une pluralité d'éléments de renforcement allongés connectés audit élément de coque externe (104.18), lesdits éléments de renforcement (104.17) étant connectés auxdits éléments de d'ossature auxiliaire (104.10, 104.11), ledit élément de coque externe (104.18) étant relié directement auxdits éléments d'ossature principale (104.4, 104.6, 104.8, 104.9, 104.13).

6. Véhicule ferroviaire selon l'une des revendications 1 à 5, dans lequel

- dans ledit état monté, ladite partie inférieure de ladite section de corps principal (105), dans ladite direction longitudinale, s'étend sur au moins 30 %, plus préférentiellement sur au moins 50 %, encore plus préférentiellement sur sensiblement 100 %, d'une dimension longitudinale de ladite structure de tête de véhicule (104.1).

7. Véhicule ferroviaire selon l'une des revendications 1 à 6, dans lequel

- ladite structure de tête de véhicule (104.1) est formée comme une structure différentielle composée d'une pluralité de composants reliés mécaniquement (104.4 à 104.18);
- au moins une fraction desdits composants (104.4 à 104.12, 104.16 à 104.18) étant connectée au moins partiellement dans un procédé de fusion, en particulier, dans un procédé de soudage ;
et/ou
- au moins une fraction desdits composants (104.4 à 104.18) étant constituée d'un matériau comprenant un alliage métallique léger, notamment, comprenant de l'aluminium.

8. Véhicule ferroviaire selon l'une des revendications 1 à 7, dans lequel ledit véhicule ferroviaire est adapté pour être utilisé pour un fonctionnement à grande vitesse à des vitesses de fonctionnement nominales supérieures à 250 km/h, de préférence supérieures à 300 km/h, plus préférablement supérieures 350 km/h.

9. Structure de carrosserie de véhicule pour un véhicule ferroviaire, en particulier dudit véhicule ferro-

viaire selon l'une des revendications 1 à 7, comprenant

- une structure de tête de véhicule (104.1) formant une section de tête (104) de ladite structure de carrosserie de véhicule et une structure de corps principal formant une section de corps principal (105) de ladite structure de carrosserie de véhicule ;
- ladite section de corps principal (105), en particulier, ayant une surface extérieure qui est sensiblement prismatique le long ladite direction longitudinale ;

dans lequel

- ladite structure de tête de véhicule (104.1) a une section d'interface de tête (106.1) formant une interface mécanique avec une section d'interface de corps principal correspondante de ladite section de corps principal (105) ;
- ladite structure de tête de véhicule (104.1) définissant une direction longitudinale, une direction transversale et une direction de hauteur ;
- ladite structure de tête de véhicule (104.1) est configurée de telle sorte que, dans un état monté, une partie inférieure de ladite section de corps principal (105), dans ladite direction longitudinale, s'étend en dessous de ladite structure de tête de véhicule (104.1),
- ladite section de corps principal (105), en particulier, comprend une structure de sol (105.1) définissant un niveau de sol intérieur et s'étendant, dans ladite direction longitudinale, dans ladite section de tête (104),

caractérisé en ce que

- ladite structure de tête de véhicule (104.1) a une structure d'ossature intérieure (104.2) comprenant au moins deux poutres longitudinales (104.4) s'étendant, dans ladite direction longitudinale, d'une extrémité avant à une extrémité arrière de ladite structure d'ossature intérieure (104.2), et étant reliées par au moins une poutre transversale (104.6) ;
- lesdites deux poutres longitudinales (104.4) et ladite poutre transversale (104.6, 104.13) confinent une ouverture d'accès de montage (108) située, dans ladite direction longitudinale, entre ladite poutre transversale (104.6) et ladite extrémité arrière de ladite structure d'ossature intérieure (104.2),
- ladite ouverture d'accès de montage (108) étant utilisable pendant la fabrication dudit véhicule pour insérer de grands composants d'équipement intérieur dans un intérieur de ladite section de tête (104) ;
- ladite ouverture d'accès au montage (108) étant partiellement fermée par une autre poutre transversale (104.13) reliée auxdites poutres longitudinales (104.4) dans un processus d'assemblage à froid, en particulier, dans un processus de rivetage ;
- ladite ouverture d'accès au montage (108) étant fermée par une unité de couvercle (104.15) faisant partie d'une coque extérieure de ladite structure de tête de véhicule (104.1).

10. Procédé de fabrication de la structure de carrosserie de véhicule selon la revendication 8, comprenant

- dans une première étape d'une étape de formation de flanc, utilisant au moins un premier technique de liaison, formant une première ossature de flanc de tête de ladite section de tête (104), ladite première ossature de flanc de tête comprenant une première poutre longitudinale (104.4) et/ou un premier élément de pilier principal (104.8, 104.9) et/ou une pluralité de premiers éléments d'ossature auxiliaire (104.10, 104.12),
- dans une étape d'assemblage de caisse de véhicule utilisant au moins une deuxième technique de liaison, former la liaison d'un premier flanc de véhicule à une structure de sol (105.1) de ladite section de caisse principale (105) et, en particulier, à une structure de toit de ladite section de caisse principale (105) pour former une carrosserie de véhicule ;
- ladite première ossature de flanc de tête étant intégrée dans ledit premier flanc de véhicule avant ou pendant ladite étape d'assemblage de carrosserie de véhicule ;
- au moins l'une de ladite première technique de liaison et de ladite deuxième technique de liaison, notamment, comprenant un procédé de fusion, notamment un procédé de soudage.

11. Procédé selon la revendication 10, dans lequel

- dans une deuxième étape de ladite étape de formation de flanc, en utilisant au moins une troisième technique de liaison, connectant ladite première ossature de flanc de tête à un flanc de corps principal de ladite section de corps principal (105) pour former ledit premier flanc de véhicule et connecter ledit premier flanc de véhicule à ladite structure de sol (105.1);

ou

- dans ladite étape d'assemblage de carrosserie de véhicule, en utilisant au moins une troisième technique de liaison, connectant un flanc de corps principal dudit corps de wagon à ladite structure de sol (105.1) et ensuite connectant ladite première ossature de flanc de tête audite flanc de corps principal pour former ledit premier flanc de véhicule;

- ladite troisième technique de liaison comprenant notamment un procédé de fusion, notamment un procédé de soudage.

12. Procédé selon la revendication 10 ou 11, dans lequel

- dans ladite étape d'assemblage de carrosserie de véhicule, utilisant une quatrième technique de liaison, une deuxième poutre longitudinale (104.4) d'une deuxième ossature de flanc de tête est reliée à ladite première poutre longitudinale (104.4) par l'intermédiaire d'une première poutre transversale (104.6) s'étendant dans ladite direction transversale ;
- ladite première poutre longitudinale (104.4) et ladite seconde poutre longitudinale (104.4), en particulier, étant situées sur un côté supérieur de ladite structure de tête ;
- ladite première poutre longitudinale (104.4), ladite deuxième poutre longitudinale (104.4) et ladite première poutre transversale (104.6), en particulier, faisant partie d'un cadre de vitre avant d'une ouverture de vitre avant dudit tronçon de tête (104) ;
- ladite première poutre longitudinale (104.4), ladite deuxième poutre longitudinale (104.4) et ladite première poutre transversale (104.6), en particulier, confinant une ouverture d'accès de montage (108) située, dans ladite direction longitudinale, entre ladite poutre transversale (104.6) et une extrémité arrière de ladite section de tête (104), ladite ouverture d'accès de montage (108) étant utilisable pour insérer de grands composants d'équipement intérieur dans un intérieur de ladite section de tête (104);
- ladite première poutre transversale (104.6), en particulier, étant située dans un plan sensiblement commun avec un premier élément de pilier principal latéral (104.8) connecté à ladite première poutre longitudinale (104.4) et un deuxième élément de pilier principal latéral (104.8) connecté à ladite deuxième poutre longitudinale (104.4) pour former une structure de support principale en forme d'arc, ledit premier élément de pilier principal latéral (104.8) et ledit deuxième élément de pilier principal latéral (104.8), en particulier, s'étendant, dans ladite direction de hauteur, vers le bas jusqu'à ladite structure de sol (105.1) et, en particulier, étant reliée à ladite structure de sol (105.1);
- ladite quatrième technique de liaison, notamment, comprenant un procédé de fusion, notamment un procédé de soudage.

13. Procédé selon la revendication 12, dans lequel

- dans ladite étape d'assemblage de la carrosserie du véhicule, au moins un grand composant d'équipement intérieur est inséré dans ledit intérieur de ladite section de tête (104) via ladite ouverture d'accès de montage (108) et/ou ladite ouverture de fenêtre avant, ledit composant d'équipement intérieur, en particulier, étant l'un d'un tableau de bord, d'une armoire d'équipement électrique et d'un gaine de câble;
- dans ladite étape d'assemblage de la carrosserie du véhicule, après insertion dudit composant d'équipement intérieur et en utilisant une cinquième technique de liaison, ladite ouverture d'accès de montage (108), en particulier, est partiellement fermée par une deuxième poutre transversale (104.13) reliée à ladite première poutre longitudinale (104.4) et ladite seconde poutre longitudinale (104.4);
- dans ladite étape d'assemblage de la carrosserie du véhicule, après insertion dudit composant d'équipement intérieur et en utilisant une sixième technique de liaison, ladite ouverture de fenêtre avant, notamment, est fermée par une unité de fenêtre avant (107) ;
- dans ladite étape d'assemblage de la carrosserie du véhicule, après insertion dudit composant d'équipement intérieur et en utilisant une septième technique de liaison, ladite ouverture d'accès de montage (108), en particulier, est fermée par une unité de couvercle (104.15) faisant partie d'une coque extérieure de ladite section de tête de véhicule (104) ;
- ladite cinquième technique d'assemblage comprenant notamment un procédé d'assemblage à froid, notamment un procédé de rivetage ;
- au moins l'une de ladite sixième technique de liaison et de ladite septième technique de liaison, notamment, comprenant un procédé de fusion, notamment un procédé de bondage adhésif, de préférence un procédé de collage.

14. Procédé selon l'une des revendications 10 à 13, dans lequel

- dans ladite étape de formation de flanc, une structure de coque de tête (104.3) faisant partie d'une coque externe de ladite section de tête (104) est connectée à ladite première structure de flanc de tête ;
ou
- dans une étape de formation de coque externe, après ladite étape de formation de flanc, une structure de coque de tête (104.3) faisant partie d'une coque externe de ladite section de tête (104) est connectée audit premier flanc de véhicule ;
- ladite structure de coque de tête (104.3), en particulier, comprenant une pluralité d'éléments de renforcement allongés (104.17) reliés à des

éléments auxiliaires de ladite première ossature de flanc de tête ;

15. Procédé de fabrication de ladite structure de carrosserie de véhicule selon la revendication 9, comprenant

- former partiellement ladite section de tête (104) et ladite section de corps principal (105) laissant au moins une ouverture d'accès de montage (108) dans ladite section de tête (104) pour insérer de grands composants d'équipement intérieur dans un intérieur de ladite section de tête (104);
- insérer lesdits grands composants d'équipement intérieur dans ledit intérieur de ladite section de tête (104) via ladite au moins une ouverture d'accès de montage (108) ; et
- fermer ladite au moins une ouverture d'accès au montage (108) en utilisant une unité de couvercle (104.15) faisant partie d'une coque extérieure de ladite section de tête de véhicule (104).

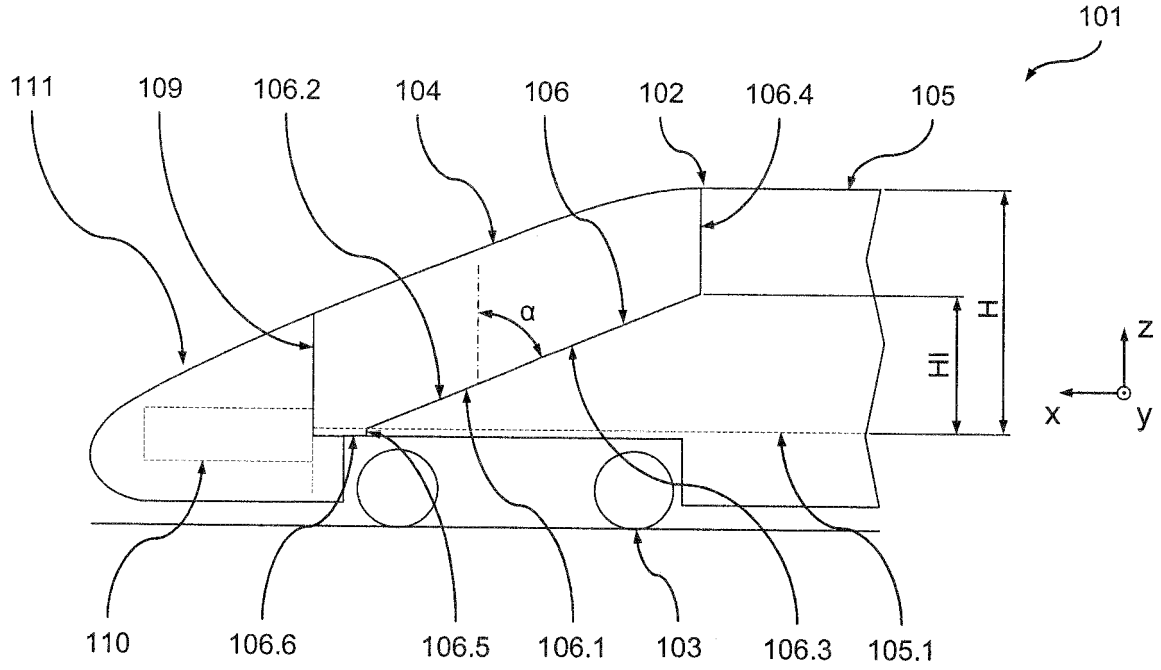

101
111
109
106.2
104
106
102
106.4
105
α
H
HI
z
x
y
110
106.6
106.5
106.1
103
106.3
105.1

Fig. 1

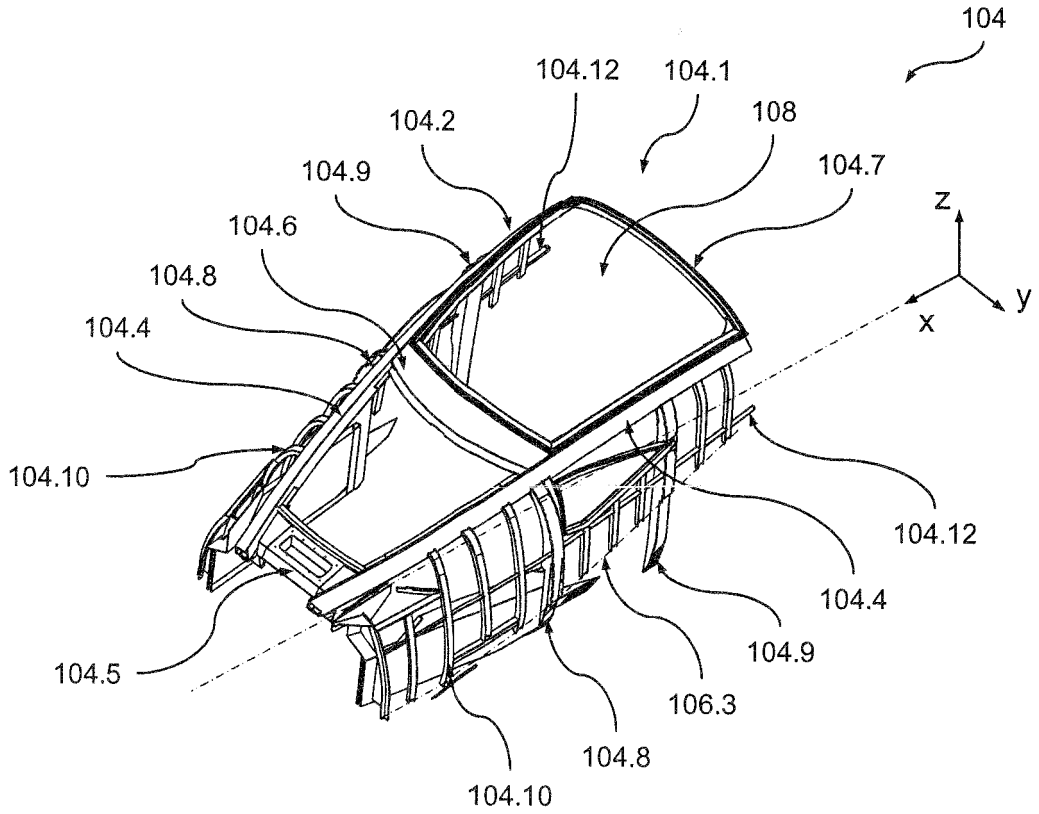

104
104.12
104.1
104.2
108
104.9
104.7
104.6
104.8
104.4
z
y
x
104.10
104.12
104.4
104.9
104.5
106.3
104.8
104.10

Fig. 2

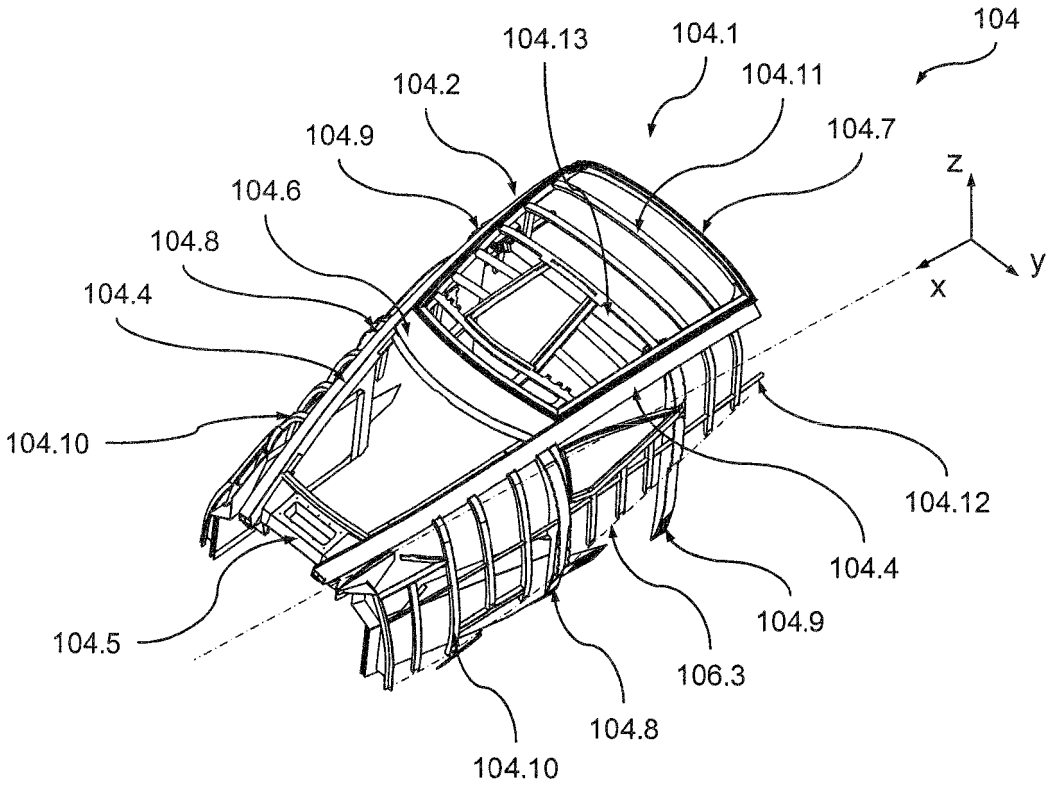

104
104.13
104.1
104.11
104.2
104.9
104.7
104.6
104.8
104.4
104.10
104.12
104.4
104.9
104.5
106.3
104.8
104.10
z
y
x

Fig. 3

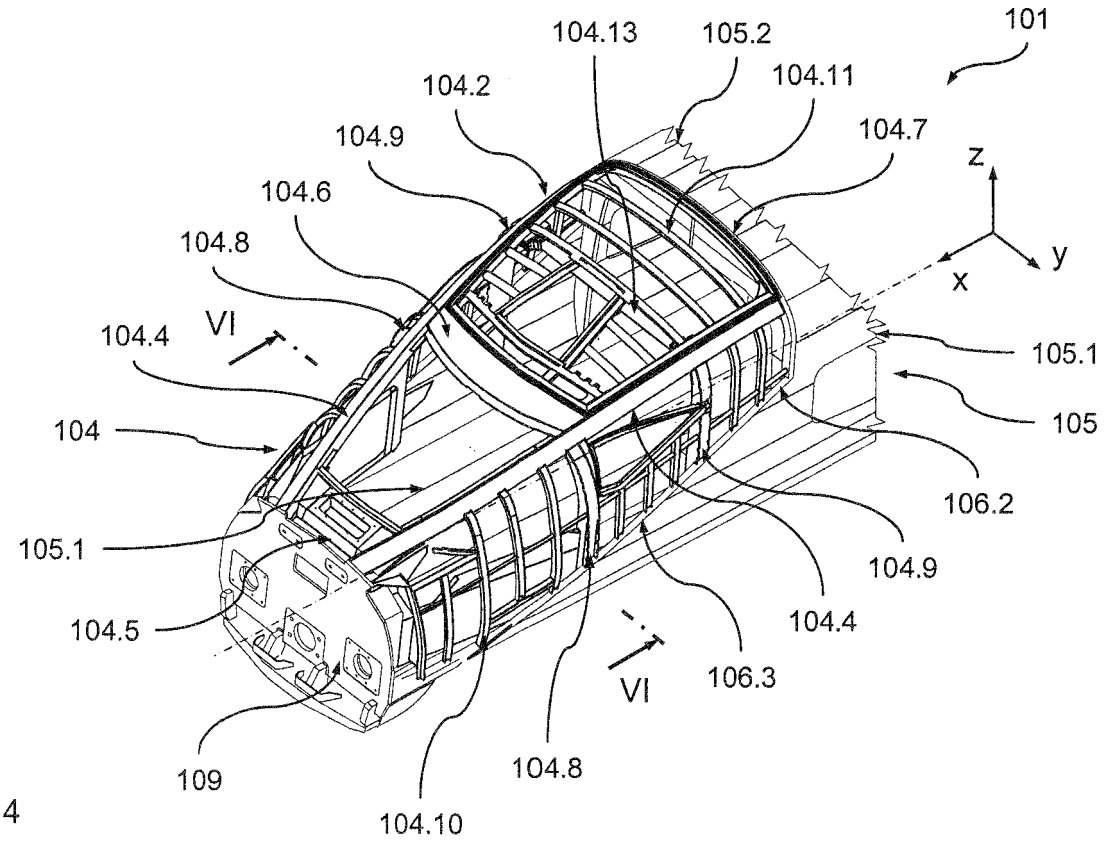

101
104.13
105.2
104.11
104.2
104.9
104.7
104.6
104.8
VI
104.4
105.1
104
105
106.2
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104.5
106.3
VI
109
104.8
104.10
z
y
x

Fig. 4

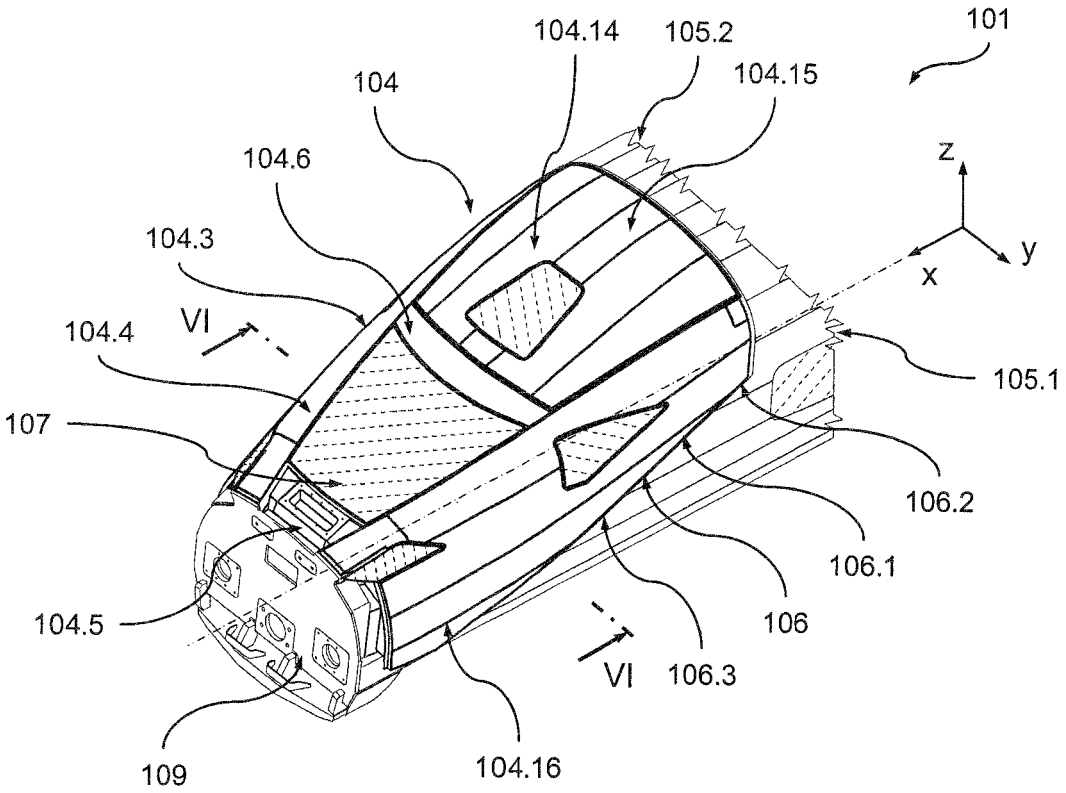

101
104.14
105.2
104.15
104
104.6
104.3
104.4
VI
107
105.1
106.2
106.1
106
104.5
VI
106.3
109
104.16
z
y
x

Fig. 5

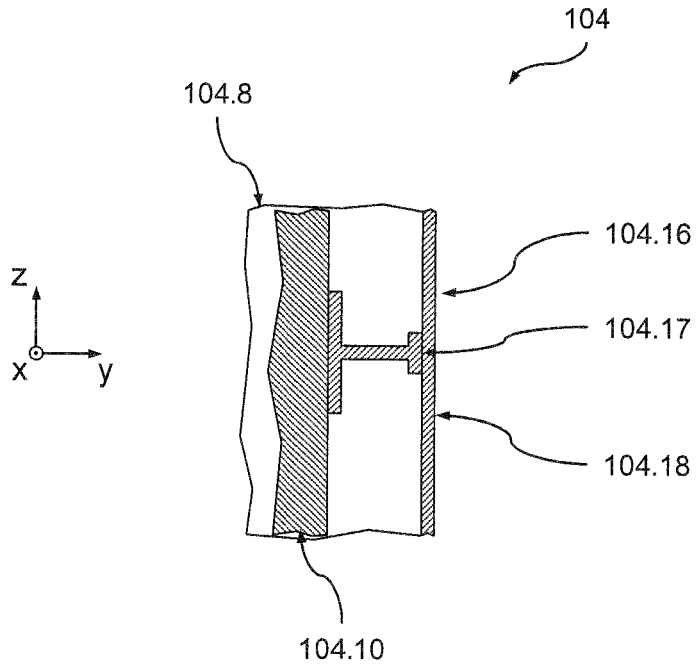

104
104.8
104.16
104.17
104.18
104.10
z
x
y

Fig. 6

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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