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(54) **Rail car underframe assembly and modular car body for a rail vehicle**

Untergestellanordnung für ein Schienenfahrzeug und modulare Karosserie für ein Schienenfahrzeug

Ensemble de châssis de véhicule ferroviaire et carrosserie modulaire pour véhicule ferroviaire

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**EP-A- 0 329 551 EP-A- 0 802 100
EP-A- 0 836 976 EP-A- 0 888 946
DE-A1- 19 956 856 GB-A- 2 411 632**

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Description

TECHNICAL FIELD OF THE INVENTION

[0001] The invention relates to a steel underframe assembly for a modular car body of a rail vehicle, and to a modular car body of a rail vehicle, more particularly an inter-regional or intercity train.

BACKGROUND ART

[0002] A low-loader wagon comprising a box structure is disclosed in EP 0 329 551. The box structure comprises a lower and an upper plates, which are inclined longitudinally. The upper plate has an axial cut-away which is open at least on the side of the large base and receives a casing of horizontal axis, constituting internally a housing for engaging a stop and damping members of an automatic coupling, which casing is integrally connected to the upper plate.

[0003] A driving cabin is disclosed in EP 0 802 100. The cabin has zones of plastic deformation formed by fixed or interchangeable energy absorbers provided at the ends of the vehicle. The zones of deformation have absorbers with varying energy absorption characteristics depending on the extent of deformation. The absorbing zone in the front of the vehicle are formed by an automatic coupling rigidly connected to a first casing mounted in a section of the chassis by a first energy absorbing buffer inserted into the casing and engaging directly on the rear face of the coupling, by at least a second energy absorber connected to the front part of the casing. Several controlled deformation absorbers are provided between the indeformable end of the casing of the vehicle and the actual vehicle body work.

[0004] Another vehicle cabin is disclosed in GB 2 411 632. The cabin comprises an outer frame, the outer frame comprising a plurality of outer frame members defining side, roof and base portions of the vehicle cabin; a front frame comprising a plurality of front frame members defining a front portion of the vehicle cabin where a shock impact is to be expected, wherein the front frame is connected to the outer frame by yieldable connecting means and is of a size whereby, upon application of sufficient force the front frame moves within the outer frame, substantially without disrupting the outer frame.

[0005] A rail vehicle for passenger transportation, especially for local traffic provided with shock absorption units at one of its ends is disclosed in DE 199 56 856. The shock absorber units are supported on a sandwich part containing deformable metallic foam, in the longitudinal direction of the vehicle, said sandwich part forming a partial area of the floor of the driver compartment as a supporting structural element.

[0006] EP 0 836 976 discloses a rail vehicle with a car body made of a tubular main section closed by two opposite end modules. The longitudinal end of the tubular main section is provided with a T-shaped underframe,

which protrudes towards the end module to support the end module.

[0007] A rail vehicle provided with a tubular main section made of aluminium closed by an end module is disclosed in EP 0 888 946. The end module can be a driver's cab or an intercommunication module. The end module is manufactured as a completely equipped, prefabricated unit, quick-release connections being provided for all mechanical and electrical controls and circuits being provided at the vehicle interface. The end module comprises a steel frame, which also supports impact-absorbing buffers designed to undergo plastic deformation and an automatic coupling with its own impact absorber. The steel frame has a U-shaped interface with the main section of the vehicle, extending in a vertical transverse plane. More specifically, the steel frame is attached to the floor and sides of the tubular main section of the vehicle body in a releasable manner. This type of structure makes it possible to use the open end of the tubular main section during assembly of the vehicle to insert the interior outfit before closing the tubular section with the end module. Moreover, after a collision or for refurbishment purposes, it is possible to easily remove the end module.

[0008] The longitudinal forces applied to the end module during a collision are partly transferred to the sides and floor of the tubular main section. In order to avoid deformation of the main section made of aluminium, a large interface area is necessary between the frame of the end module and the sides and floor of the main section. However, the available interface area in a vertical transverse section plane is rather limited. Thus, the whole height of the vehicle sides has to be used as interface, which involves a complex and heavy structure for the steel frame of the end module.

[0009] An end underframe for a rail car having an open box structure forming a rigid unit capable of receiving high torsional or other forces developed in a rail car is disclosed in US 4,235,170. The end underframe includes primary and secondary transverse end sills connected by side buffer members. A coupler is mounted to the primary end sill, which is closer to the end of the rail car. Additional buffer members connect the secondary end sill to a bolster disposed to ride on air or coil springs, which are connected to a bogie. Door openings are accommodated in the space between the primary and secondary end sills. This integral end underframe forms part of the floor supports and is connected to the end of the side girders of the floor. Forces developed at the front of the car and which reach the buffer are further transmitted to the shell of the car and, in particular, the side girders of the floor.

[0010] This structure made of steel is not particularly adapted to a car body manufactured from aluminium alloy profiles. Moreover, it is not adapted to a rail car comprising a tubular module and end modules.

[0011] There is therefore a need for a more appropriate car body structure, adapted to a modular rail vehicle comprising a tubular main section closed by two end modules.

SUMMARY OF THE INVENTION

[0012] According to a first aspect of the invention, there is provided an underframe assembly for a rail vehicle car body comprising a tubular module and an end module, the underframe comprising:

- a steel bolster subassembly provided with an attachment interface for mechanically attaching the steel bolster subassembly to an underside of a floor of the tubular module, a bogie interface for resting on a bogie, and a crossmember ,
- a steel sub-frame provided with interface means for mechanically attaching the steel sub-frame to an underside of a floor of the end module, an inner transverse sill in direct abutment against and bolted or riveted to the crossmember, an outer transverse sill provided with a window , and longitudinal sills connecting the inner and outer transverse sills,
- at least one coupler attached to the crossmember or to the inner transverse sill and protruding outwardly through window of the outer sill.

[0013] Thanks to this structure, longitudinal traction and braking forces applied to the coupler by an adjacent rail car are directly transferred to the bolster subassembly and are transferred from there to the floor of the tubular module. The loads applied to the outer transverse sill of the sub-frame are transferred to the inner transverse sill through the longitudinal sills, and from there directly to the crossmember of the bolster subassembly. Thus, the load applied to the end module is limited. The interface between the bolster subassembly and the underside of the floor benefits from the large available area underneath the floor and can be as large as necessary. The structure is used as interface both for supporting the car body on the bogie and for transmitting longitudinal forces from the coupler and from the end module of the vehicle to the car body.

[0014] The structure is compatible with a modular design of the car body, since the bolster subassembly can be assembled to the tubular module and the sub-frame to the end module before assembly of the end module to the tubular module. The bolt or rivet connection between the sub-frame and the bolster subassembly is releasable, which facilitates repair or refurbishment operations of the car body.

[0015] The window is preferably dimensioned to provide abutments for limiting the pivoting movement of the coupler in a vertical direction and a horizontal direction in order to control the vertical and lateral movement of adjacent cars in case of derailment or collision.

[0016] According to a preferred embodiment, the outer sill is provided with anti-climbers and/or shock absorption means.

[0017] According to a preferred embodiment, the lon-

gitudinal sills and inner and outer transverse sills provide a non-deformable open box structure. Hence, the sub-frame provides the necessary strength to react to coupler lateral damper loads and the overriding reaction forces from the coupler and anti-climbers. The forces transmitted to the upper structure of the end module are minimal to prevent deformation of the upper structure. This arrangement is particularly adapted to an end module provided with side doors, which shall be use to alight from the train in case of collision.

[0018] According to a preferred embodiment, the steel bolster subassembly is provided with a bolster providing the bogie interface and attachment interface and at least a pair of longitudinal girders extending between the bolster and the crossmember. The length of the girders is a function of the distance between the bogie and the second end of the tubular module. The underframe assembly is designed for a single bogie or running gear and has preferably an overall length of less than 6 metres. Two such underframe assemblies can be used at each end of a rail car.

[0019] According to a second aspect of the invention, there is provided a rail vehicle car body of a given overall length measured along a longitudinal axis of the car body, comprising:

- a tubular module having a first and a second longitudinal open ends and comprising a floor made of longitudinal aluminium alloy extruded profiles welded together along their length,
- a first and a second independent steel bolster subassemblies each mechanically attached to an underside of the floor of the tubular module towards a respective one of the first and second longitudinal ends of the tubular module and each provided with a bogie interface for resting on a bogie, wherein at least the second steel bolster subassembly is provided with a crossmember ,
- a first end module mechanically fastened to the first end of the tubular module and/or to the first steel bolster subassembly,
- a second end module comprising an upper structure provided with a floor and a steel sub-frame mechanically attached to an underside of the floor of the end module, an inner transverse sill in direct abutment against and bolted or riveted to the crossmember, an outer transverse sill provided with a window , and longitudinal sills connecting the inner and outer transverse sills, the upper structure being mechanically fastened in a releasable manner to the second end of the tubular module,
- at least one coupler attached to the crossmember or to the inner transverse sill and protruding outwardly through window of the outer sill.

[0020] Bolts or rivets or a combination of bolts or rivets and of an adhesive substance can be used for attaching the upper structure of the end module to the second end of the tubular module. Thus, the end module including the sub-frame can be assembled to or removed from the tubular module as a single unit, which provides the full advantages of a modular design.

[0021] The longitudinal aluminium alloy profiles confer the required rigidity to the tubular module, and keep the overall weight of the rail car body low. Similarly, the absence of bolts or rivets to join the longitudinal profiles contributes to a lighter floor.

[0022] Advantageously, the longitudinal extrusion profiles can form double skinned walls.

[0023] The longitudinal profiles are preferably welded to one another edge to edge without overlapping, to save weight.

[0024] The upper structure of the second end module can be manufactured from welded aluminium alloy elements, including panels and/or extruded profiles.

[0025] According to a preferred embodiment, the upper structure of the second end module comprises at least one lateral access door opening and a gangway opening. In such a case, the structure of the end module shall be designed so as to avoid any substantial deformation in case of collision. The rigidity of the frame of the sub-frame is paramount.

[0026] The invention applies to intermediate cars, in which case the first end module can be identical to the second end module. It also applies to end cars, in which case the first end module may constitute a driver's cab.

[0027] According to a preferred embodiment, the tubular module is not provided with any side door. All the exit areas are concentrated in the end modules, or at least one of them.

[0028] The tubular module also comprises a roof and two opposite side walls. The floor, roof and opposite side wall may each comprise aluminium alloy extruded profiles extending from the first longitudinal open end to the second longitudinal open end of the tubular module. The tubular module may further be provided with a strengthening diaphragm welded at least to the longitudinal profiles extending from the first longitudinal open end to the second longitudinal open end of the tubular module, the strengthening diaphragm being provided with holes for receiving bolts or rivets for fastening the upper structure of the second end module to the tubular module.

[0029] According to another aspect of the invention, there is provided a rail vehicle car body of a given overall length measured along a longitudinal axis of the car body, comprising:

- a tubular module having two longitudinal ends and comprising longitudinal aluminium alloy extruded profiles welded together along their length, at least some of the longitudinal profiles extending from one of the two longitudinal ends of the tubular module to the other, the longitudinal distance between the ends

of the tubular module being greater than 75% of the overall length of the car body, each of the two longitudinal ends being provided with a strengthening annular diaphragm extending in a plane perpendicular to the longitudinal axis and welded at least to the extruded profiles extending from one of the two longitudinal ends of the tubular module to the other,

- two independent steel bolster subassemblies each mechanically attached to the tubular module towards a respective one of the two longitudinal ends of the tubular module and providing a bogie interface for a bogie,
- two end modules each comprising a steel sub-frame and an upper structure bolted or riveted onto the steel sub-frame, the upper structure being mechanically fastened in a releasable manner to the strengthening diaphragm, the steel sub-frame being mechanically fastened in a releasable manner to the steel bolster subassembly,
- at least one coupler extending through the sub-frame of one of the two end modules and pivotally attached to one of the two steel bolster subassemblies.

[0030] Thanks to this structure, traction and braking forces applied to the couplers by an adjacent rail car are directly transferred to the corresponding subassembly and are transferred from one subassembly to the other through the tubular module. The longitudinal aluminium alloy profiles and singularly those extending from one longitudinal end of the tubular module to the other confer the required rigidity to the tubular module, and keep the overall weight of the rail car body low. Similarly, the absence of bolts or rivets to join the longitudinal profiles contributes to a lighter shell.

[0031] The end modules can be mounted to the tubular module after completion of the welding operations on the tubular module. Thus, the interior outfit of the rail car, which may include the insulation, cabling, ceiling, flooring, interior panels, lighting, seats, toilet module and other equipment, can be installed through one of the open ends of the tubular module after the longitudinal profiles have been welded together and painted. The upper structure of the end modules can preferably be bolted or riveted to strengthening diaphragms of the tubular module. Alternatively or additionally, an adhesive substance may be used at the interface between the upper structure and the end of the tubular module.

[0032] Similarly, refurbishment is simplified, since one of the end modules can be removed to give access to the interior of the tubular module.

[0033] The length of the tubular module is preferably more than 75% of the total length of the car body, the remaining less than 25% being allocated to the two end modules. If one of the end module is a driver's cab, the length of the tubular module may be about 70% of the

overall length of the car body.

[0034] Each bolster subassembly is preferably a welded and machined assembly, manufactured from steel and attached to the aluminium tube e.g. using bolts bolted into tapping bars inserted in a diaphragm welded to the car body extruded profiles. The material selection provides the necessary strength and stiffness with a minimised vertical cross section to ensure that the passenger area of the vehicle has as low a walking floor height as possible.

[0035] Advantageously, the upper structure of at least one of the two end modules be manufactured from welded aluminium alloy panels. Preferably, the upper structure of both end modules is manufactured from welded aluminium alloy panels.

[0036] The upper structure of at least one of the two end modules, and preferably of the two end modules, may comprise at least one lateral access door opening and a gangway opening. In such a case, the structure of the end module shall be designed so as to avoid any substantial deformation in case of collision. The tubular module does not need to be provided with any side door. All the exit areas are concentrated in the end modules, or at least one of them.

[0037] According to another embodiment, one of the two end modules can constitute a driver's cab.

[0038] The tubular module may further comprise one or more intermediate structural diaphragms extending in a plane perpendicular to the longitudinal axis and welded at least to the extruded profiles extending from one of the two longitudinal ends of the tubular module to the other. The diaphragms are preferably closed rings. They can also be U shaped open diaphragms opening upwards or downwards.

[0039] According to a preferred embodiment, each strengthening annular diaphragm is provided with holes for receiving bolts or rivets for fastening the end modules to the tubular module.

[0040] The tubular module includes a floor, two opposite side walls and a roof made of longitudinal profiles. According to a preferred embodiment, the longitudinal profiles extending from one of the two longitudinal ends of the tubular module to the other include two sole bars joining the floor to each of the two side walls and two upper rails joining the roof to each of the two side walls.

[0041] The profiles extending from one of the two longitudinal ends of the tubular module to the other may further include two upper body side profiles each welded to one of the two upper rails edge to edge without overlapping and two lower body side profiles each welded to one of the two sole bars edge to edge without overlapping. The floor can also be made of longitudinal profiles extending from one of the two longitudinal ends of the tubular module to the other welded to one another edge to edge without overlapping.

[0042] Preferably, the two sole bars and the two upper rails are thicker than the other profiles so as to provide additional rigidity.

[0043] In order to control the movement vertical and lateral movement of adjacent cars in case of a derailment, the pivoting movement of the at least one coupler in a vertical direction and a horizontal direction is limited by abutments provided on at least one of the two subframes. The sub-frame provides the necessary strength to react to coupler lateral damper loads and the overriding reaction forces from the coupler and anti-climbers.

[0044] According to a preferred embodiment, each of the two steel sub-frames comprises an interface extending perpendicularly to the longitudinal axis and in direct abutment against and bolted or riveted to a respective one of the two steel bolster subassemblies. This simplifies the assembly of the end modules.

BRIEF DESCRIPTION OF THE DRAWINGS

[0045] Other advantages and features of the invention will become more clearly apparent from the following description of specific embodiments of the invention given as non-restrictive examples only and represented in the accompanying drawings in which:

- figure 1 is a side view of a car body of rail vehicle in accordance with the invention,
- figure 2 illustrates an exploded view of the car body of figure 1,
- figure 3 illustrates a cross-section of a tubular module of the car body of figure 1,
- figure 4 illustrates a bolster subassembly of the car body of figure 1,
- figure 5 illustrates an end module of the car body of figure 1,
- figure 6 illustrates a subframe of the end module of figure 5,
- figure 7 illustrates the underside of the vehicle of figure 1,
- figure 8 illustrates the interior layout of the car body of figure 1,
- figure 9 illustrates a detail of a second embodiment of the invention;
- figure 10 illustrates an isometric view of a third embodiment of the invention; and
- figure 11 illustrates an exploded view of the third embodiment of figure 10.

DETAILED DESCRIPTION OF VARIOUS EMBODIMENTS

[0046] Referring to figure 1, the car body 10 of passenger rail vehicle 12 consists of two end modules 14 and one tubular module 18 extending from one of the two end modules to the other. As illustrated, the tubular module 18 constitutes the major part of the car body 1. Its length amounts to more than 75%, and preferably more than 85% of the overall length of the car body. For a typical car body length of 25,500 mm, the length of the tubular module is preferably more than 19,125 mm and, in the specific example of figure 1, equal to 22,350 mm.

[0047] As illustrated in figure 2, the tubular module 18 comprises a roof 20, left and right doorless side walls 22 and a floor 26. These panels extend from one of the two end modules to the other and are longitudinally welded together, i.e. in a direction parallel to the longitudinal axis of the tubular module.

[0048] More specifically, and as illustrated in figure 3, each of the roof, floor and side walls is composed of a plurality of extruded profiles cut to the appropriate length, which are welded along their length and machined as far as necessary. In this particular embodiment, the roof 20 includes a roof plank 201 flanked by two cant rails 202, 203. The roof plank 201 and cant rails 202, 203 are longitudinally welded together to form the roof before they are assembled to the side walls 22. Similarly, each side wall 22 includes an upper body side 221, a centre body side 222 and a lower body side 223, which are welded together along their length before the side wall 22 itself is welded to the roof 20 and floor 26. In case a side wall 22 requires window and/or other openings, the cutting out and/or other machining operations are carried out before welding the side wall 22 to the roof 20 and floor 26. The floor 26 includes a planar wall section made of a centre floor plank 261, flanked by two inner floor planks 262 and two outer floor planks 263. The plan wall section itself is flanked by two sole bars 264. These extruded elements are longitudinally welded together and machined before the floor is welded to the side walls 22. One or more jigs (not shown) may be used to temporarily maintain the extruded elements in position during welding.

[0049] While some of the extruded profiles may be interrupted to accommodate window openings or roof recesses for electrical equipment, at least some of the extruded profiles, and singularly the cant rails 202, upper body sides 221, lower body sides 223, sole bars 264 and outer floor planks 263 located at the upper and lower edges of the car body shell as well as the centre and inner floor planks 261, 262 extend from one end of the tubular module to the other and are welded to one another along the full length of the tubular module without interruption.

[0050] As can be seen on figure 3, the cant rails 202 are thicker than the roof plank 201, to provide additional rigidity to the corners of the shell structure cross-section.

The floor planks 261, 262, 263, sole bars 264, body sides 221, 222, 223, roof planks 201 and cant rails 202 are all double skinned extrusion profiles to ensure a lightweight self-supporting tube design whilst meeting all necessary strength and stiffness requirements. Additional stiffness is provided at the edges of the car body shell by the sole bar 264 and cant rail 202 extrusion elements, which are larger in section than the other extrusion elements.

[0051] All the extruded elements are pre-drilled so that no machining is required during the final assembly of the car body. C-shaped slots 30, 32 are provided on the bottom of the sole bar and other floor-related extrusion elements for mounting underfloor equipment and inside the car body, protruding from the floor planks, body sides and/or roof planks for the mounting of seats, interior installation and trim, providing a high degree of flexibility in the interior layout.

[0052] One or more structural ring-shaped diaphragms 34 can be welded or otherwise secured at the centre and/or at intermediate positions of the tubular module 18 to increase body shell stiffness and to provide a channel for air ducts between the floor and roof space. Similarly, two annular end diaphragms 38 are welded at the ends of the tubular structure to reinforce the stiffness of the tubular structure and reduce the major modes of vibration of the tubular module. The two annular end diaphragms are also provided with holes in and constitute an attachment interface for each of the end modules.

[0053] A steel bolster subassembly 40 is attached underneath the tubular module 18 to an underside of the floor 26 and comprises a bolster 42 providing an interface for the bogie 44, a crossmember 46 projecting towards the adjacent end of the tubular module and a pair of girders 47 extending from the crossmember to the bolster and the coupler. As illustrated in figure 4, the bolster subassembly 40 is a rigid welded and machined assembly, manufactured from steel. This subassembly is attached to the underside of the floor using bolts and tapping bars inserted in the car body extrusion elements. The number of bolts is adapted to the longitudinal shear loads and vertical loads applied to the subassembly in several scenarios, including collision. The material selection provides the necessary strength and stiffness with a minimised vertical cross-section to ensure that the passenger area of the vehicle has as low a walking floor height as possible.

[0054] Referring to figures 5 to 7, each end module 14 includes an upper structure 140 manufactured from formed internal and external aluminium panels and/or extruded elements, which are welded together to create a stiff, lightweight design. This upper structure 140 includes a roof 140A, side walls 140B provided with passenger door openings 142 and end wall 140C provided with a gangway opening 143, a floor 140D as well as an annular diaphragm 138 extending in a vertical transverse plane to provide rigidity and form an interface with the tubular module. The aluminium upper structure is bolted to a steel sub-frame 144. As illustrated in figure 5, energy

absorbing anti-climbers 145 are mounted at floor level at the ends of the sub-frame for absorbing the crash energy associated with the collision scenarios detailed in the High Speed TSI revision. They are specified to work in conjunction with the energy absorbing intermediate coupler system. Since the end module houses the passenger doors, it is not designed to deform during the specified collision scenarios, in order to preserve the doors as a means of emergency exit. Therefore, the sub-frame includes a square-shaped non-deformable open box structure with an inner transverse sill 146, an outer transverse sill 147 connected by a series of longitudinal sills 148, and a series of additional elements 149 which provide an interface for fixing the sub-frame 144 to the upper structure 140. The inner transverse sill 146 of this structure also provides an attachment interface extending in a vertical plane and bolted to the crossmember 46 at the end of the bolster subassembly 40 when the end module is mechanically fastened to the tubular module. The coupler 60 shown in figure 6 has an inner end 62 directly connected to the crossmember 46 of the bolster subassembly or to the transverse sill 146 and a coupling end 64 protruding from the sub-frame through a window 150 formed in the transverse sill 147, which provides lateral and vertical abutments to the coupler. The coupler is provided with a telescopic shock absorbing structure 66 as is well known in the art. The sub-frame 144 provides the necessary strength to react to coupler lateral damper loads and to the overriding reaction forces from the coupler, while the longitudinal loads are directly transmitted to the crossmember 46 of the bolster subassembly 40 or to the transverse sill 146. Thus, loads applied during collision are distributed between the transverse sill 147, the sub-frame 144 and the bolster subassembly 140.

[0055] The interior outfit of the end module 140 can be manufactured after the end module has been bolted to the tubular module. In a preferred embodiment of the invention, however, the end modules are painted, completely equipped with interior outfit and technical equipment like door systems, lighting, control equipment, passenger information modules, etc. and pre-tested before being bolted to the tubular end module

[0056] The interior layout of the car body is shown in figure 8. The interior outfit 50 including ceiling, flooring, interior panels, air ducts, cabling, lighting, seats 52, passenger information and entertainment modules, tables, 54, toilets 56 and insulation is installed in the tubular module 18 from one open end of the module after completion of the welding operations including the welding of the end diaphragms 38 and after the shell of the tubular module has been painted. Finally, the end modules 14 are positioned so that bolts can be inserted through the holes of the inner transverse sill 146 and crossmember 46 and through the holes of the end diaphragms 38 and of the diaphragm 138 of the end modules to mechanically attach the end modules to the tubular modules in a releasable manner. Additionally, an adhesive substance can be used for attaching the upper structure 140 of the end

module to the end diaphragm 38. Refurbishment of the car can also be efficiently carried out from the open ends of the tubular modules after removal of one of the end modules.

[0057] While a preferred embodiment of the invention has been described, it is to be understood by those skilled in the art that the invention is naturally not limited to this embodiment. Many variations are possible.

[0058] Additional strengthening extrusions may be provided at the sole bar and cant rail to strengthen the structure to react crash loads associated with the High Speed TSI revision collision scenarios.

[0059] Similarly, an additional U-shaped or ring-shaped diaphragm 238, illustrated in figure 9, can be sandwiched between the end diaphragms 38 of the tubular module 18 and the diaphragm 138 of the respective end module 14 to further reinforce the structure of the car body.

[0060] The car body shell structure can also be adapted to a driving car as illustrated in figures 10 and 11, in which case one of the end modules is a driver's cab 214.

Claims

1. An underframe assembly for a rail vehicle car body (10) comprising a tubular module and an end module, the underframe comprising:
 - a steel bolster subassembly (40) provided with an attachment interface for mechanically attaching the steel bolster subassembly to an underside of a floor of the tubular module, a bogie interface for resting on a bogie, and a crossmember (46),
 - a steel sub-frame (144) provided with interface means (149) for mechanically attaching the steel sub-frame to an underside of a floor of the end module, an inner transverse sill (146) in direct abutment against and bolted or riveted to the crossmember, an outer transverse sill (147) provided with a window (150), and longitudinal sills (148) connecting the inner and outer transverse sills,
 - at least one coupler (60) attached to the crossmember or to the inner transverse sill and protruding outwardly through the window of the outer sill.
2. The underframe assembly of claim 1, wherein the window is dimensioned to provide abutments for limiting the pivoting movement of the coupler in a vertical direction and a horizontal direction.
3. The underframe assembly of claim 1 or claim 2, wherein the outer sill is provided with anti-climbers (145) and/or shock absorption means.

4. The underframe assembly of any one of the foregoing claims, wherein the longitudinal sills and inner and outer transverse sills provide a non-deformable open box structure.
5. The underframe assembly of any one of the foregoing claims, wherein the steel bolster subassembly is provided with a bolster (42) providing the bogie interface and attachment interface and at least a pair of longitudinal girders (47) extending between the bolster and the crossmember.
6. The underframe assembly of any one of the foregoing claims, having an overall length of less than 6 metres.
7. A rail vehicle car body (10) of a given overall length measured along a longitudinal axis of the car body, comprising:
 - a tubular module (18) having a first and a second longitudinal open ends and comprising a floor made of longitudinal aluminium alloy extruded profiles (261, 262, 263) welded together along their length,
 - a first and a second independent steel bolster subassemblies (40) each mechanically attached to an underside of the floor of the tubular module towards a respective one of the first and second longitudinal ends of the tubular module and each provided with a bogie interface for resting on a bogie, wherein at least the second steel bolster subassembly (40) is provided with a crossmember (46),
 - a first end module mechanically fastened to the first end of the tubular module and/or to the first steel bolster subassembly,
 - a second end module comprising an upper structure provided with a floor and a steel sub-frame (144) mechanically attached to an underside of the floor of the end module, an inner transverse sill (146) in direct abutment against and bolted or riveted to the crossmember, an outer transverse sill (147) provided with a window (150), and longitudinal sills (148) connecting the inner and outer transverse sills, the upper structure being mechanically fastened in a releasable manner to the second end of the tubular module,
 - at least one coupler attached to the crossmember or to the inner transverse sill and protruding outwardly through window of the outer sill.
8. The rail vehicle car body of claim 7, wherein the steel sub-frame of the second end module and the second bolster subassembly form an underframe according to any one of claims 2 to 6.
9. The rail vehicle car body claim 7 or claim 8, wherein the upper structure of the second end module is manufactured from welded aluminium alloy elements.
10. The rail vehicle car body of any one of claims 7 to 9, wherein the upper structure of the second end module comprises at least one lateral access door opening (142) and a gangway opening.
11. The rail vehicle car body of any one of claims 7 to 10, wherein the first end module is identical to the second end module.
12. The rail vehicle of any one of claims 7 to 11, wherein the first end module constitutes a driver's cab.
13. The rail vehicle car body of claims 7 to 12, wherein the tubular module is not provided with any side door.
14. The rail vehicle car body of claims 7 to 13, wherein the tubular module comprises a roof and two opposite side walls, the floor, roof and opposite side wall each comprising aluminium alloy extruded profiles extending from the first longitudinal open end to the second longitudinal open end of the tubular module.
15. The rail vehicle car body of any one of claim 14, wherein the second end of the tubular module is provided with a strengthening diaphragm welded at least to the longitudinal profiles extending from the first longitudinal open end to the second longitudinal open end of the tubular module, the strengthening diaphragm being provided with holes for receiving bolts or rivets for fastening the upper structure of the second end module to the tubular module.

Patentansprüche

1. Untergestellanordnung für die Karosserie eines Schienenfahrzeugs (10), umfassend ein rohrförmiges Modul und ein Endmodul, wobei das Untergerüst Folgendes umfasst:
 - eine Stahlwiegen-Unteranordnung (40), ausgestattet mit einer Befestigungsschnittstelle zur mechanischen Befestigung der Stahlwiegen-Unteranordnung an eine Unterseite eines Bodens des rohrförmigen Moduls, eine Drehgestell-Schnittstelle, um auf einem Drehgestell zu ruhen, und einen Querträger (46),
 - einen Stahl-Unterrahmen (144), ausgestattet mit Schnittstellenmitteln (149), zur mechanischen Befestigung des Stahl-Unterrahmens an eine Unterseite eines Bodens des Endmoduls, einen inneren Längsträger (146) in direktem Anschlag gegen den und verbolt oder vernietet mit dem Querträger, einen äußeren Quer-

- Schwellbalken (147), ausgestattet mit einem Fenster (150) und Längs-Schwellbalken (148), die die inneren und die äußeren Quer-Schwellbalken miteinander verbinden,
 - mindestens einen Verbinder (60), der mit dem Querträger oder mit dem inneren Quer-Schwellbalken verbunden ist und durch das Fenster des äußeren Schwellbalkens nach außen hervorsteht.
2. Untergestellanordnung nach Anspruch 1, wobei das Fenster abgemessen ist, um Anschläge bereitzustellen, um die Schwenkbewegung des Verbinders in einer vertikalen Richtung und in einer horizontalen Richtung zu begrenzen.
3. Untergestellanordnung nach Anspruch 1 oder Anspruch 2, wobei der äußere Schwellbalken mit Überpufferungsschutzvorrichtungen (145) und/oder Stossdämpfungsmitteln ausgestattet ist.
4. Untergestellanordnung nach einem der vorhergehenden Ansprüche, wobei die Längs-Schwellbalken und die inneren und die äußeren Quer-Schwellbalken eine nicht verformbare offene Kastenstruktur bereitstellen.
5. Untergestellanordnung nach einem der vorhergehenden Ansprüche, wobei die Stahlwiegen-Unteranordnung mit einer Wiege (42) ausgestattet ist, die die Drehgestell-Schnittstelle und die Befestigungsschnittstelle und mindestens ein Paar längsgerichteter Balken (47) bereitstellt, die sich zwischen der Wiege und dem Querträger erstrecken.
6. Untergestellanordnung nach einem der vorhergehenden Ansprüche, mit einer gesamten Länge von weniger als 6 Metern.
7. Karosserie eines Schienenfahrzeugs (10) mit einer bestimmten gesamten Länge, gemessen entlang einer Längsachse der Karosserie, umfassend:
- ein rohrförmiges Modul (18) mit einem ersten und einem zweiten längsgerichteten offenen Ende, und umfassend einen Boden, hergestellt aus längsgerichteten Extrusionsprofilen (261, 262, 263) aus Aluminiumlegierung, die auf ihrer gesamten Länge zusammengeschweißt sind.
 - eine erste und eine zweite unabhängige Stahlwiegen-Unteranordnung (40), die jeweils mechanisch an eine Unterseite des Bodens des rohrförmigen Moduls hin zu einem entsprechenden des ersten und des zweiten längsgerichteten Endes des rohrförmigen Moduls befestigt sind, und die jeweils mit einer Drehgestell-Schnittstelle ausgestattet sind, um auf einem Drehgestell zu ruhen, wobei mindestens die
- zweite Stahlwiegen-Unteranordnung (40) mit einem Querträger (46) ausgestattet ist,
 - ein erstes Endmodul, das mechanisch an das erste Ende des rohrförmigen Moduls und/oder an die erste Stahlwiegen-Unteranordnung befestigt ist.
 - ein zweites Endmodul, umfassend eine obere Struktur, die mit einem Boden und einen Stahl-Unterrahmen (144) ausgestattet ist, der mechanisch an eine Unterseite des Bodens des Endmoduls befestigt ist, einen inneren Längsträger (146) in direktem Anschlag gegen den und verbolzt oder vernietet mit dem Querträger, einen äußeren Quer-Schwellbalken (147), ausgestattet mit einem Fenster (150) und Längs-Schwellbalken (148), die die inneren und die äußeren Quer-Schwellbalken miteinander verbinden, wobei die obere Struktur mechanisch auf eine lösbare Weise mit einem zweiten Ende des rohrförmigen Moduls verbunden ist,
 - mindestens einen Verbinder, der mit dem Querträger oder mit dem inneren Quer-Schwellbalken verbunden ist und durch das Fenster des äußeren Schwellbalkens nach außen hervorsteht.
8. Karosserie eines Schienenfahrzeugs nach Anspruch 7, wobei der Stahl-Unterrahmen des zweiten Endmoduls und die zweite Stahlwiegen-Unteranordnung einen Unterrahmen nach einem der Ansprüche 2 bis 6 bilden.
9. Karosserie eines Schienenfahrzeugs nach Anspruch 7 oder Anspruch 8, wobei die obere Struktur des zweiten Endmoduls aus geschweißten Aluminiumlegierungs-Elementen hergestellt ist.
10. Karosserie eines Schienenfahrzeugs nach einem der Ansprüche 7 bis 9, wobei die obere Struktur des zweiten Endmoduls mindestens eine seitliche Zugangstüröffnung (142) und eine Übergangsöffnung umfasst.
11. Karosserie eines Schienenfahrzeugs nach einem der Ansprüche 7 bis 10, wobei das erste Endmodul identisch mit dem zweiten Endmodul ist.
12. Schienenfahrzeug eines der Ansprüche 7 bis 11, wobei das erste Endmodul eine Fahrerkabine darstellt.
13. Karosserie eines Schienenfahrzeugs nach Anspruch 7 bis 12, wobei das rohrförmige Modul nicht mit einer Seitentür ausgestattet ist.
14. Karosserie eines Schienenfahrzeugs nach Anspruch 7 bis 13, wobei das rohrförmige Modul ein Dach und zwei gegenüber liegende Seitenwände umfasst, wobei der Boden, das Dach und die gegen-

über liegenden Seitenwände jeweils Extrusionsprofile aus einer Aluminiumlegierung umfassen, die sich vom ersten längsgerichteten offenen Ende zum zweiten längsgerichteten offenen Ende des rohrförmigen Moduls erstrecken.

15. Karosserie eines Schienenfahrzeugs nach Anspruch 14, wobei das zweite Ende des rohrförmigen Moduls mit einer Verstärkungsmembran ausgestattet ist, die mindestens an die längsgerichteten Profile geschweißt ist, die sich vom ersten längsgerichteten offenen Ende zum zweiten längsgerichteten offenen Ende des rohrförmigen Moduls erstrecken, wobei die Verstärkungsmembran mit Löchern zur Aufnahme von Bolzen oder Nieten ausgestattet ist, um die obere Struktur des zweiten Endmoduls an das rohrförmige Modul zu befestigen.

Revendications

1. Ensemble de châssis pour une carrosserie de voiture ferroviaire (10) comprenant un module tubulaire et un module d'extrémité, le châssis comprenant :

- un sous-ensemble de traverse pivot en acier (40) pourvu d'une interface de fixation pour attacher mécaniquement le sous-ensemble de traverse pivot en acier à une partie de dessous d'un plancher du module tubulaire, d'une interface de bogie pour reposer sur un bogie, et d'un élément transversal (46),
- un faux cadre en acier (144) pourvu de moyens formant interface (149) pour attacher mécaniquement le faux cadre en acier à une partie de dessous d'un plancher du module d'extrémité, d'une traverse inférieure intérieure (146) directement en butée contre l'élément transversal et boulonnée ou rivetée à celui-ci, d'une traverse inférieure extérieure (147) pourvue d'une fenêtre (150), et de longerons longitudinaux (148) reliant les traverses inférieures intérieure et extérieure,
- au moins un élément d'accouplement (60) attaché à l'élément transversal ou à la traverse inférieure intérieure et faisant saillie à l'extérieur à travers la fenêtre de la traverse inférieure extérieure.

2. Ensemble de châssis selon la revendication 1, dans lequel la fenêtre est dimensionnée pour fournir des butées pour limiter le déplacement de pivotement de l'élément d'accouplement dans une direction verticale et une direction horizontale.

3. Ensemble de châssis selon la revendication 1 ou la revendication 2, dans lequel la traverse inférieure extérieure est pourvue de dispositifs anti-chevauchement

(145) et/ou de moyens d'absorption des chocs.

4. Ensemble de châssis selon l'une quelconque des revendications précédentes, dans lequel les longerons longitudinaux et les traverses inférieures intérieure et extérieure réalisent une structure en forme de boîte ouverte non déformable.

5. Ensemble de châssis selon l'une quelconque des revendications précédentes, dans lequel le sous-ensemble de traverse pivot en acier est pourvu d'une traverse pivot (42) réalisant l'interface de bogie et l'interface de fixation et d'au moins une paire de poutrelles longitudinales (47) s'étendant entre la traverse pivot et l'élément transversal.

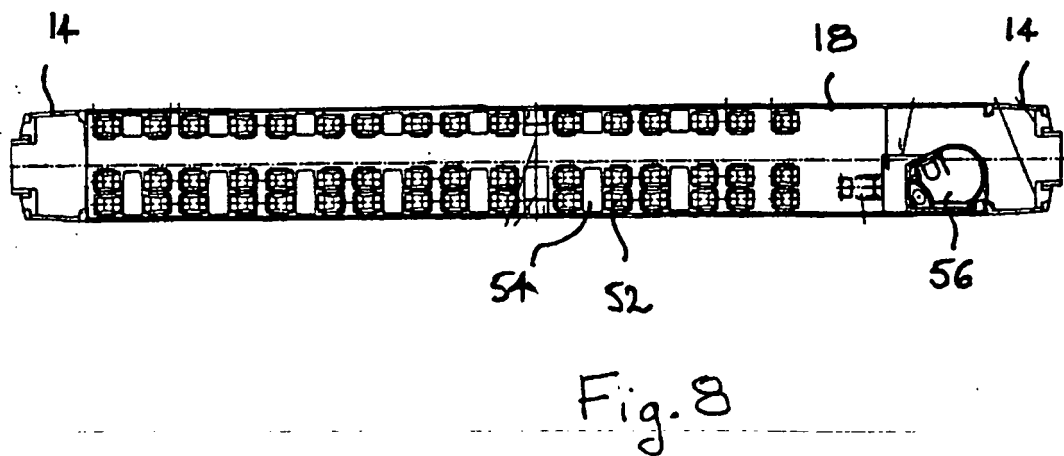
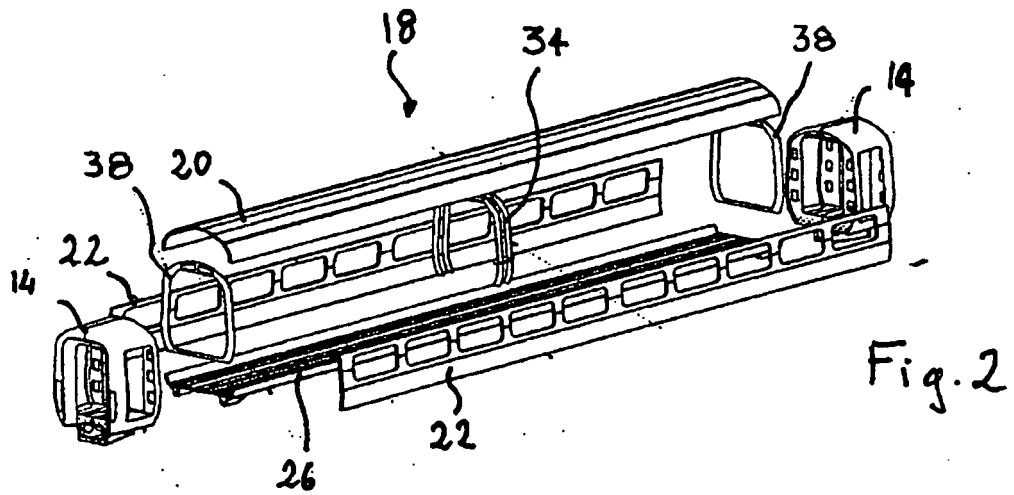
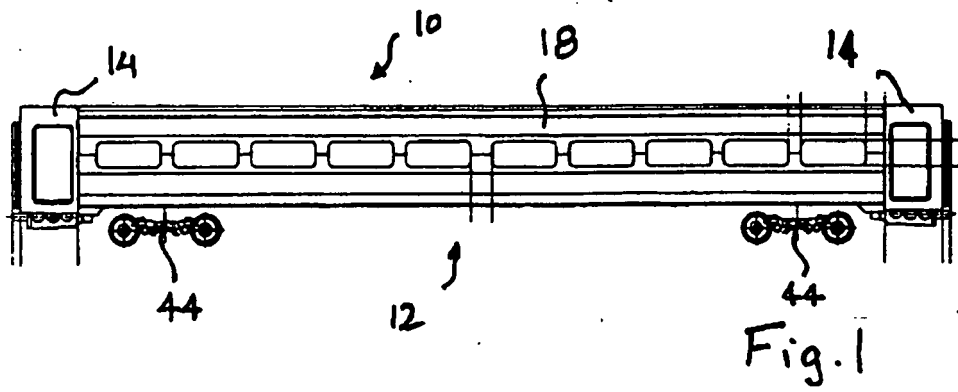
6. Ensemble de châssis selon l'une quelconque des revendications précédentes, ayant une longueur globale inférieure à 6 mètres.

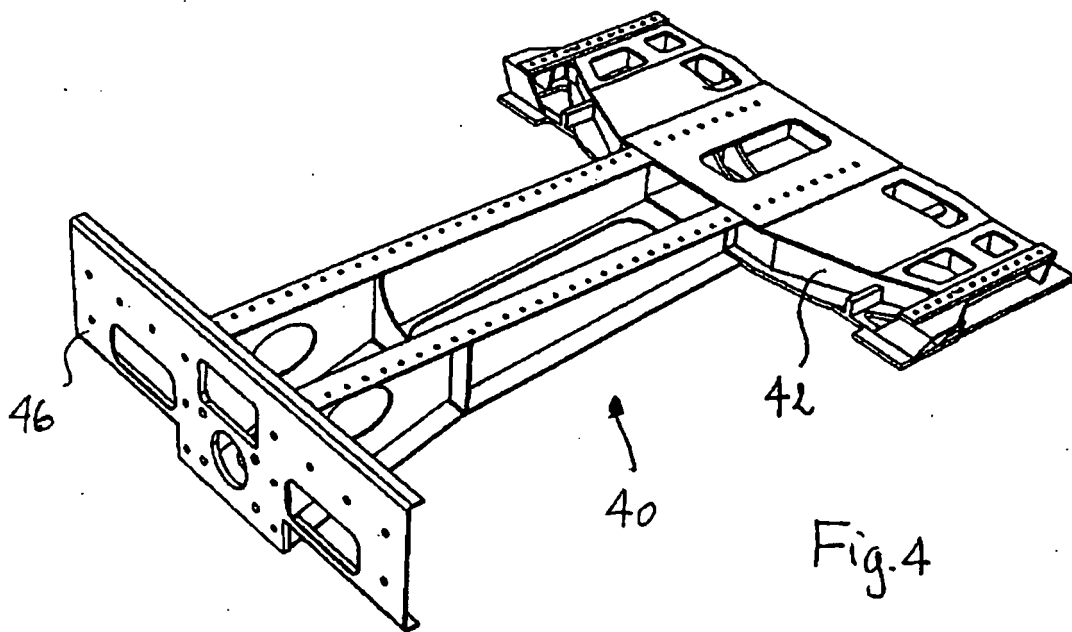
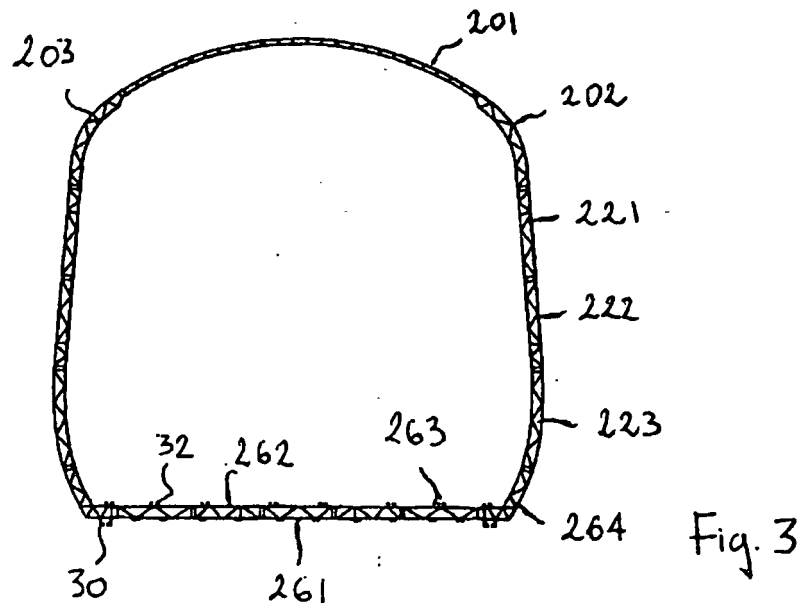
7. Carrosserie de voiture ferroviaire (10) d'une longueur globale donnée mesurée le long d'un axe longitudinal de la carrosserie de voiture, comprenant :

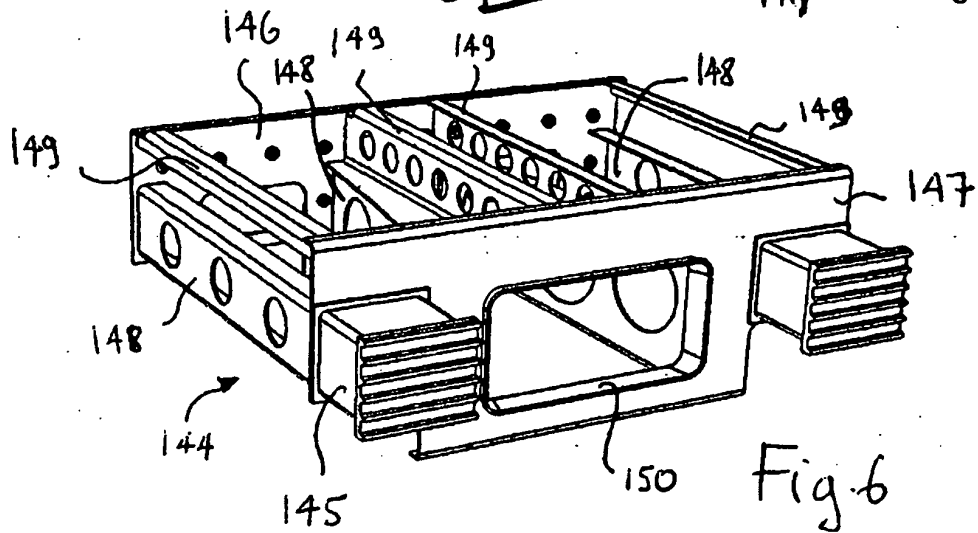
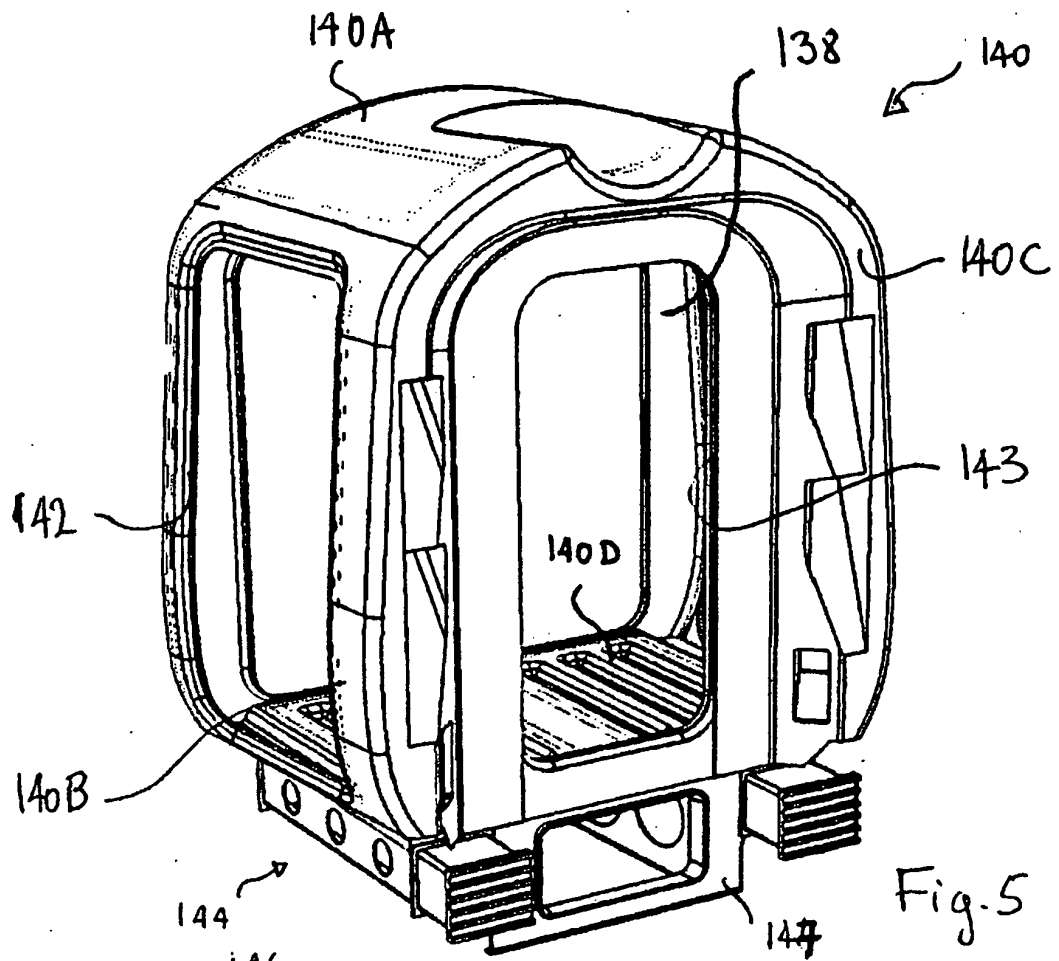
- un module tubulaire (18) comportant des première et deuxième extrémités ouvertes longitudinales et comprenant un plancher réalisé en des profilés extrudés en alliage d'aluminium longitudinaux (261, 262, 263) soudés les uns aux autres le long de leur longueur,
- des premier et deuxième sous-ensembles de traverse pivot en acier (40) indépendants attachés chacun mécaniquement à une partie de dessous du plancher du module tubulaire vers une extrémité respective parmi les première et deuxième extrémités longitudinales du module tubulaire et pourvus chacun d'une interface de bogie pour reposer sur un bogie, dans laquelle au moins le deuxième sous-ensemble de traverse pivot en acier (40) est pourvu d'un élément transversal (46),
- un premier module d'extrémité fixé mécaniquement à la première extrémité du module tubulaire et/ou au premier sous-ensemble de traverse pivot en acier,
- un deuxième module d'extrémité comprenant une structure supérieure pourvue d'un plancher et d'un faux cadre en acier (144) attaché mécaniquement à une partie de dessous du plancher du module d'extrémité, une traverse inférieure intérieure (146) directement en butée contre l'élément transversal et boulonnée ou rivetée à celui-ci, une traverse inférieure extérieure (147) pourvue d'une fenêtre (150), et des longerons longitudinaux (148) reliant les traverses inférieures intérieure et extérieure, la structure supérieure étant fixée mécaniquement d'une manière

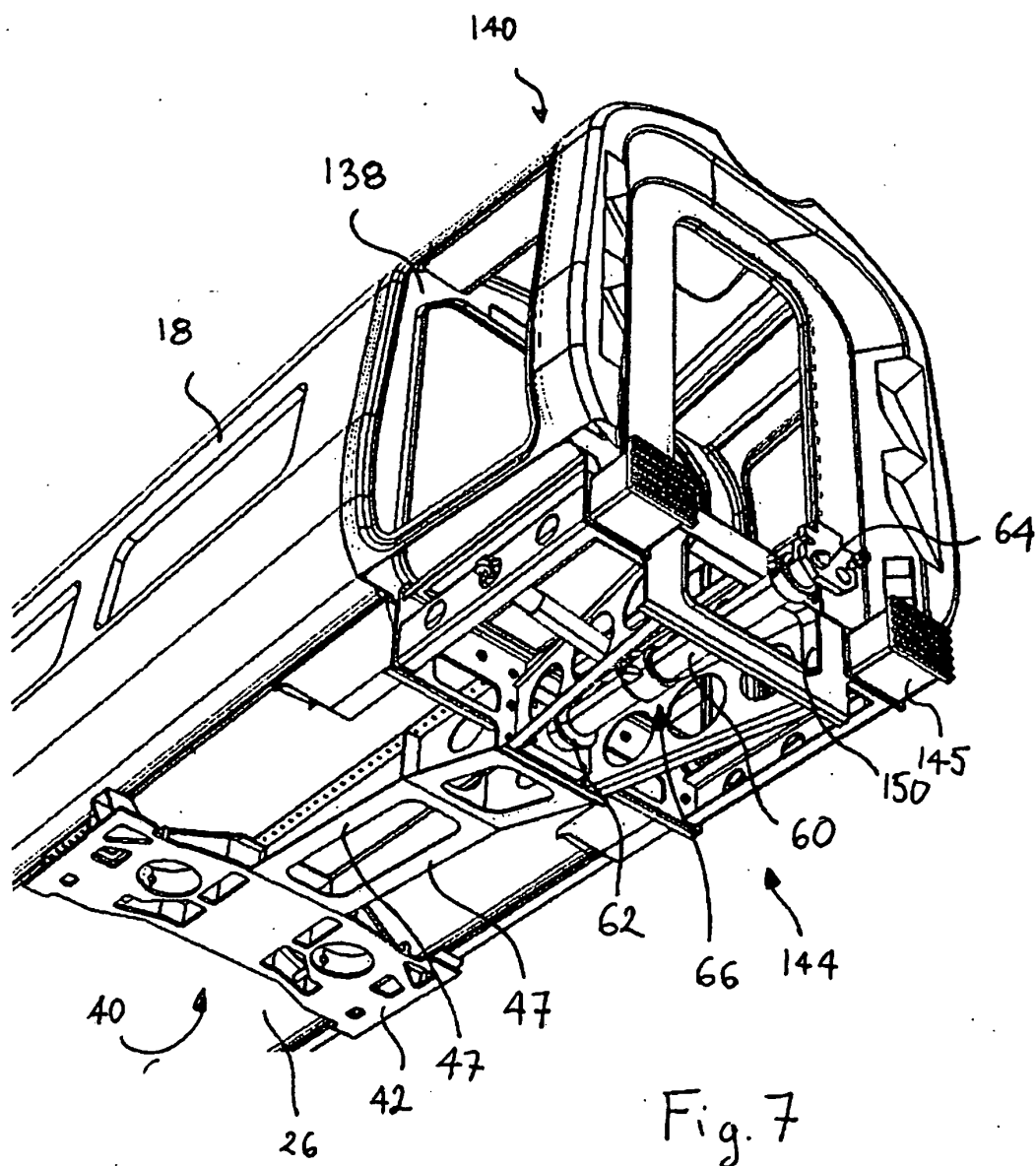
- re libérable à la deuxième extrémité du module tubulaire,
 - au moins un élément d'accouplement attaché à l'élément transversal ou à la traverse inférieure intérieure et faisant saillie à l'extérieur à travers la fenêtre de la traverse inférieure extérieure. 5
8. Carrosserie de voiture ferroviaire selon la revendication 7, dans laquelle le faux cadre en acier du deuxième module d'extrémité et le deuxième sous-ensemble de traverse pivot forment un châssis selon l'une quelconque des revendications 2 à 6. 10
9. Carrosserie de voiture ferroviaire selon la revendication 7 ou la revendication 8, dans laquelle la structure supérieure du deuxième module d'extrémité est fabriquée à partir d'éléments en alliage d'aluminium soudés. 15
10. Carrosserie de voiture ferroviaire selon l'une quelconque des revendications 7 à 9, dans laquelle la structure supérieure du deuxième module d'extrémité comprend au moins une ouverture de porte d'accès latérale (142) et une ouverture d'intercirculation. 20 25
11. Carrosserie de voiture ferroviaire selon l'une quelconque des revendications 7 à 10, dans laquelle le premier module d'extrémité est identique au deuxième module d'extrémité. 30
12. Véhicule ferroviaire selon l'une quelconque des revendications 7 à 11, dans lequel le premier module d'extrémité constitue une cabine du conducteur. 35
13. Carrosserie de voiture ferroviaire selon les revendications 7 à 12, dans laquelle le module tubulaire n'est pas pourvu d'une porte latérale.
14. Carrosserie de voiture ferroviaire selon les revendications 7 à 13, dans laquelle le module tubulaire comprend un toit et deux parois latérales opposées, le plancher, le toit et les parois latérales opposées comprenant chacun des profilés extrudés en alliage d'aluminium s'étendant de la première extrémité ouverte longitudinale jusqu'à la deuxième extrémité ouverte longitudinale du module tubulaire. 40 45
15. Carrosserie de voiture ferroviaire selon la revendication 14, dans laquelle la deuxième extrémité du module tubulaire est pourvue d'une membrane de renforcement soudée au moins aux profilés longitudinaux s'étendant de la première extrémité ouverte longitudinale jusqu'à la deuxième extrémité ouverte longitudinale du module tubulaire, la membrane de renforcement étant pourvue de trous pour recevoir des boulons ou des rivets pour fixer la structure supérieure du deuxième module d'extrémité au module 50 55

tubulaire.









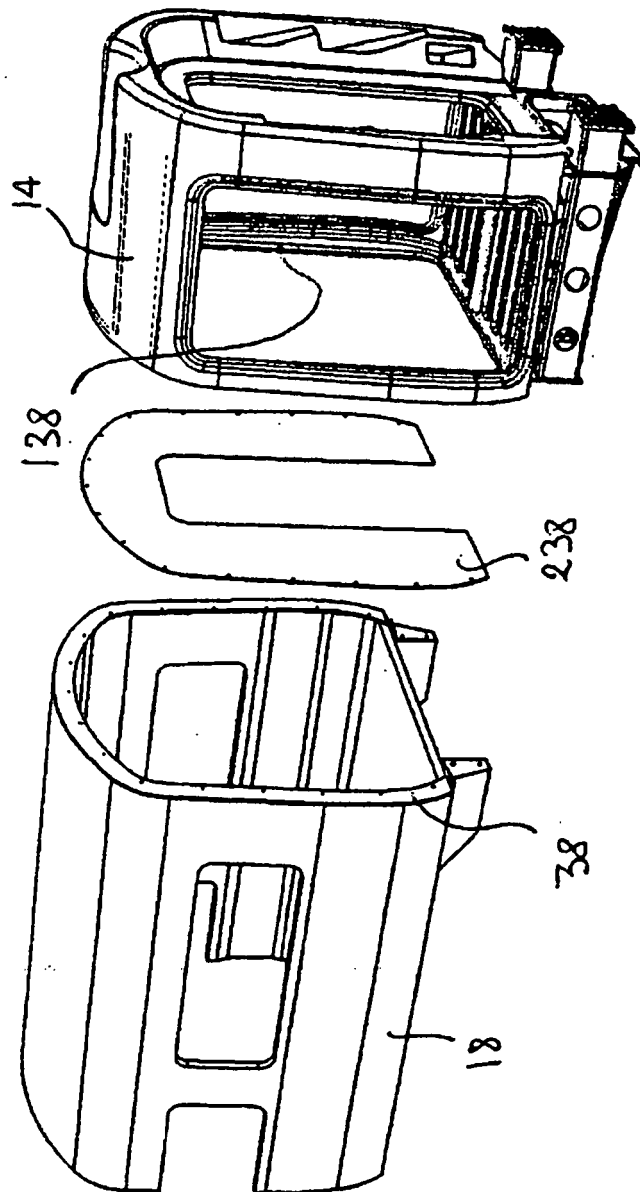
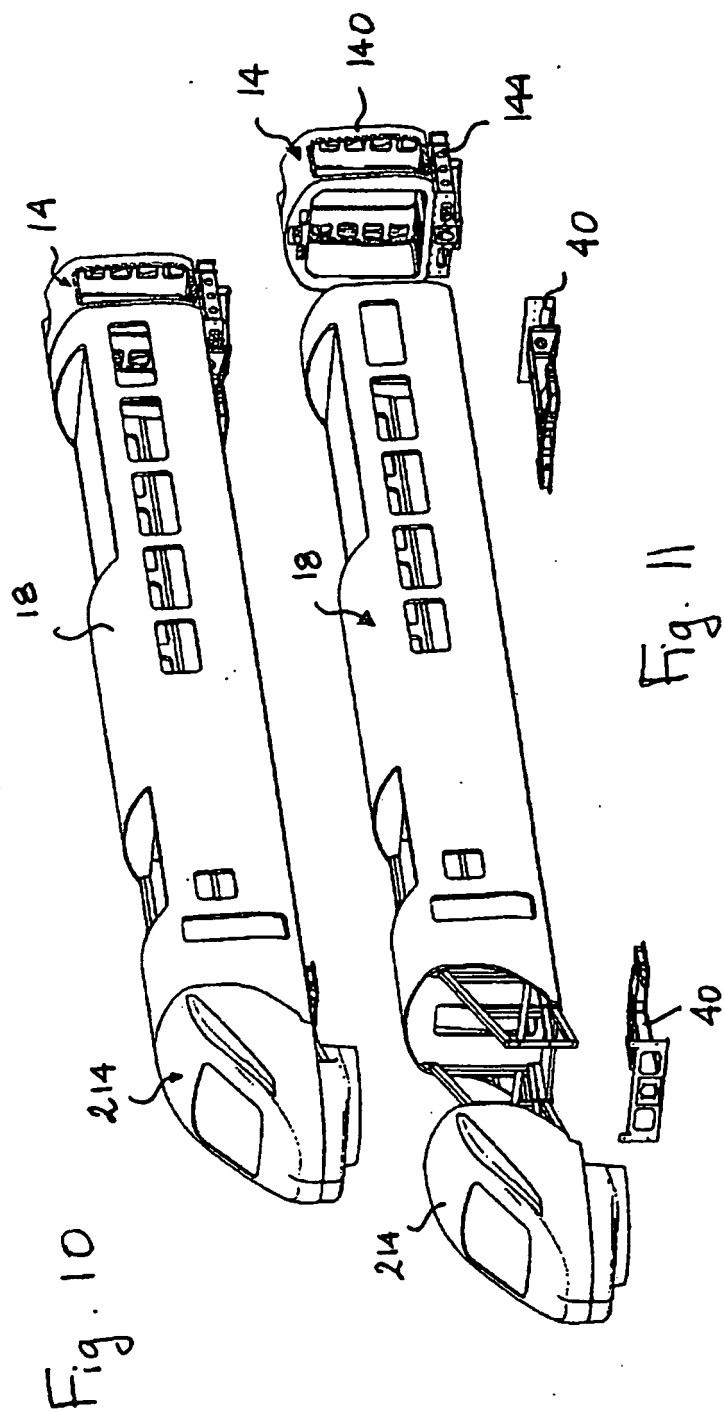


Fig. 9



REFERENCES CITED IN THE DESCRIPTION

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