



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
28.04.2021 Bulletin 2021/17

(51) Int Cl.:
B61D 15/06 (2006.01) **B61D 17/06** (2006.01)
B61G 11/14 (2006.01)

(21) Application number: **20199652.7**

(22) Date of filing: **01.10.2020**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(72) Inventors:
• **Geihofer, Philipp**
1140 Vienna (AT)
• **Mieth, Steffen**
02733 Cunewalde (DE)
• **Petto, Michael**
1220 Vienna (AT)

(30) Priority: **22.10.2019 GB 201915238**

(74) Representative: **Zimmermann & Partner**
Patentanwälte mbB
Postfach 330 920
80069 München (DE)

(71) Applicant: **Bombardier Transportation GmbH**
10785 Berlin (DE)

(54) **FRONT END FOR A RAIL VEHICLE**

(57) A front end (13) for a rail vehicle (10) the front end (13) comprising a deformable structure (30), including a frame (31) movable on a chassis (11) and a mechanical protective device (33) mechanically connecting

the frame (31) to the vehicle's chassis (11). The mechanical protective device (33) is adapted to break if a predetermined force F is exceeded, so that the frame (31) may move on the chassis (11).

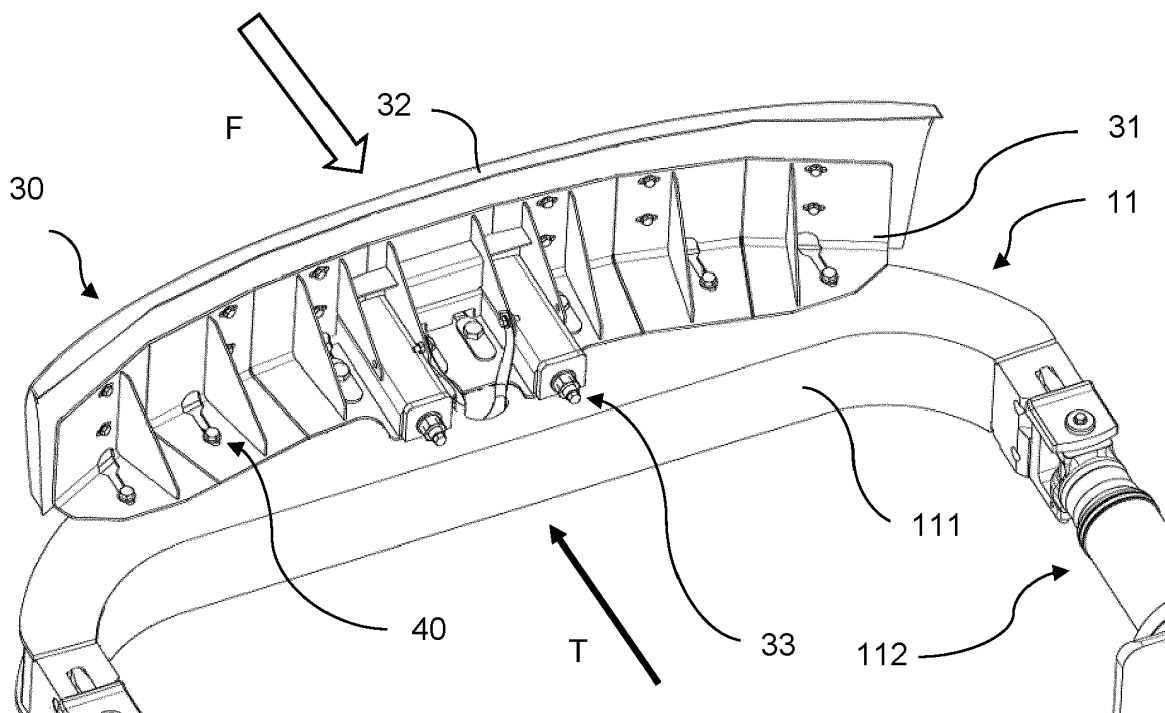


Figure 4

Description

Technical field

[0001] The present invention relates generally to a front end of a railway vehicle. More particularly, the invention relates to a means to shunt a rail vehicle.

Background Art

[0002] Conventional ways of moving trains around within railway depots is to use either shunting vehicles or to couple railway vehicles together. Train couplers are similar to traction rod normally used to connect two adjacent trains mechanically and electrically (sometimes also pneumatically). Couplers are easily visible in front of railway vehicles such as regional trains, and seldom visible on high speed trains (for aerodynamic reasons) or light rail vehicles (for aesthetic reasons). When a shunting operation is required on a light rail vehicle, a staff member, usually the driver himself, must get off the vehicle, raise or remove the front extremity in order to get access to the front coupler and then extend (or unfold) and connect it with the shunting vehicle or an adjacent vehicle's coupler. Such vehicle configuration allowing coupling of light rail vehicles is known from EP2720924.

[0003] Coupling trams is time consuming and often requires extensive manual operations, increasing both maintenance costs for tram operating companies and risks of injuries for the drivers. Similar shunting operation are also sometimes required in the event that a tram in commercial service is out of order and needs assistance to return to the depot.

[0004] Considering the aforementioned drawbacks associated to shunting operations, there is a need for an easier, safer and faster means to shunt railway vehicles.

Summary of invention

[0005] It is an object of the present invention to provide a means to shunt railway vehicles without coupling.

[0006] In the following description, and unless otherwise stated, the word "longitudinal" defines the travelling direction of the rail vehicle, which is also the direction in which the rail track extends, while "transversal" means a direction that is horizontal and perpendicular to the travelling direction.

[0007] According to one aspect of the invention, there is provided a front end of a rail vehicle. The rail vehicle has a shock absorber system designed to cope with impacts on the front of the vehicle and a driver cab structure which has a structural resistance to protect the driver in case of a collision. Both the shock absorber system and the driver cab structure are part of the vehicle's chassis. The front end comprises a deformable structure located preferably at a front extremity of the rail vehicle, so that in most cases the deformable structure collides with an obstacle first, in the event of an impact or a collision. The

deformable structure includes a frame mounted on the vehicle's chassis in such a manner that the frame can move with respect to the chassis.

[0008] As an example, the frame consists in a sheet metal part, and has a main bend of approximately 90°, such that one side of the bent sheet metal part extends substantially horizontally, and is mounted movably on the chassis, and the other side extends substantially vertically. The vertical part is positioned towards the front of the vehicle. In order to provide sufficient rigidity, the frame is provided with ribs welded between the horizontal portion and the vertical portion of the bent sheet metal part.

[0009] According to another aspect, the frame and the chassis can be connected via a guiding means whose function is to guide the deformable structure in a preferred direction. Since collisions happens mostly at the front extremity of the vehicle, the guiding means hinders lateral, ie transversal movements, ensuring that the deformable structure will move mainly backwards, ie along a longitudinal axis of the rail vehicle.

[0010] The person skilled in the art knows many ways to obtain a guiding means, such as roller guide rails, linear bearings or telescopic slides. However, as the deformable structure is likely to be damaged after a collision, it is preferable to have a simple, robust and cheap design for the guiding means. A pin or a screw attached to either the frame of the chassis, sliding in a guiding groove or a guiding slot provided in the other of the frame or the chassis will be preferred to complex and expensive means.

[0011] According to another aspect of the invention, a mechanical protective device such as a mechanical fuse connects the frame to the chassis. The mechanical fuse locks the connection between the frame and the chassis, and is designed to break when a force exceeding a predetermined impact force is exerted onto the deformable structure. The predetermined impact force is calculated based on a desired speed, ie a maximum bumping speed, and the average weight of the vehicles, so that an impact with another rail vehicle at a very low speed is possible without breaking the mechanical fuse. Such very low speed is usually considered to be below 5 km/h, and correspond to the impact speed, for instance the speed of the moving vehicle bumping into the other vehicle, ie the vehicle to be pushed, which is supposedly at a standstill. This feature permits a rail vehicle equipped with a front end according to the invention to push another rail vehicle at very low speed, with limited to no damage to any of the vehicles, and without the need to connect the front couplers. Such feature will be very convenient in a railway depot, as the train drivers will remain safely in their cabin while pushing other vehicles.

[0012] The mechanical fuse can include of one or more break-away bolts arranged longitudinally. Break-away bolts, commonly called fuse-bolts, can be machined bolts containing a smaller or necked section. The diameter at the smaller section is sized to break at a selected traction or tension force, corresponding to the predetermined impact force. Depending on the configuration of the me-

chanical fuse, different types of break-away bolts could be used. It should be noted that other types of mechanical fuses could also be used.

[0013] Whenever a collision occurs at a higher speed, typically above 10km/h, the break-away bolts will break, thus unlocking the movable connection between the frame and the chassis so that the deformable structure can move backward, i.e. from the front extremity towards the driver cab structure.

[0014] An opening is provided in the frame to receive a fuse bolt support dependant or projecting from the chassis. The opening can be a longitudinal slot, extending longitudinally, ie in the direction of travel. The or each break away bolt is connected to one said fuse bolt support and to a fuse bolt interface linked to the frame.

[0015] Alternatively, the mechanical fuse could consist in a bonded connection, in particular an adhesive bonded connection that would be sized/configured to tear off when a force exceeding the predetermined force is exerted on the deformable structure. As a matter of fact, the word "mechanical" is intended in particular to exclude common (electrical) fuses. Adhesives may also be considered as a type of fuse or protective device when connecting the frame to the chassis.

[0016] The driver's cab structure supports most front parts of the bodyshell and the windscreen, and also protects the driver in case of a collision. The mechanical fuse can be used to connect the frame to any part of the shock absorber system or the driver cab structure, that are connected to the vehicle's chassis.

[0017] In another preferred embodiment of the invention the shock absorber system includes a crashbar hidden behind the front lower bodyshell of the vehicle and which is combined in series with hydraulic dampers, the hydraulic dampers that are rigidly attached to the vehicle's chassis. The shock absorber system is preferably located at the front extremity of the rail vehicle. The crashbar is preferably installed at a low level, typically between 300 and 600 millimetres from the top of the rail track, and behind the front bodyshell so that it does not alter the vehicle's aesthetics and is hidden from the public's sight.

[0018] The frame of the deformable structure can be mounted movably on the driver cab structure, or on the crash bar. Preferably the frame is mounted movably on, and connected via the mechanical fuse to the crashbar, so that the deformable structure's is connected in series with the hydraulic dampers.

[0019] In a preferred embodiment of the invention a resilient material, such as an elastomer, is mounted on the frame, preferably in front of the frame and/or covering the vertical portion of the frame and placed adjacent to the bodyshell. It is adapted to deform elastically when the collision force exerted on it remains below a predetermined impact force so that a contact or an impact with another vehicle at very low speed, typically below 5km/h, will cause no permanent damage to the front end.

[0020] Elastomers, either synthetic, natural, or mixed, are common materials. They are easy to produce and

affordable, they can also be moulded to fit almost any shape and dyed to any colour. Elastomers have high elastic properties so that they can deform without being permanently damaged, thereby they are suitable to replace some rail vehicle's bodyshell parts to reduce damages caused by minor impacts. Elastomers' high elasticity is also beneficial in case of collision with pedestrians, reducing significantly injuries severity, compared to more rigid bodyshell materials such as steel, aluminium, glass reinforced plastics (GRP), carbon fibre reinforced plastics (CFRP) or even polyurethane foams.

[0021] Preferably, the resilient material is juxtaposed with the vehicle's front bodyshell parts, thus forming a continuous surface and being almost indistinguishable from other adjacent bodyshell parts.

[0022] According to a further aspect of the invention, upon breakage of the mechanical fuse, the connection between the chassis and the frame is not entirely released, as the guiding means continues to guide the movement of the frame, along the length of the guiding slots.

[0023] When the collision force exceeds the predetermined impact force, and the mechanical fuse breaks because of the excessive force from the impact, it causes the deformable structure to be partly released, thus no longer be operative as a damping device as it is only linked to the chassis by the guiding means. The collided obstacle or vehicle will then most likely bump into the rail vehicle's crashbar and the force will be subsequently transmitted to the hydraulic dampers of the shock absorber system. Accordingly, the break-away bolts sizing as well as the shock absorber system will be specifically configured for the vehicles in question and will need appropriate adaptation.

[0024] According to another aspect of the invention, the frame and the chassis can further be connected via a retaining device. The aim of such a retaining device is to ensure that the deformable structure cannot become loose when the mechanical fuse breaks off, and especially ensure that the deformable structure doesn't detach entirely from the vehicle and fall on the track, where it could cause great damage to vehicles. The retaining device allows for a range of motion within which the mechanical fuse breaks off. In other words, the retaining device does not interfere with the guiding means, nor with the mechanical fuse.

[0025] The retaining device can consist of metallic straps, combining flexibility and strength. Metallic straps can also provide electrical conductivity in case grounding connection of the deformable structure is required (as is required for most metallic parts of a railway vehicle). Any other connection combining the above mentioned mechanical and electrical characteristics could also be used, as long as it does not interfere with the unlocking of the connection provided by the mechanical fuse.

[0026] It will become obvious for a person skilled in the art that such a front end could also be used on a rail guided vehicle which has no driver's cab, such as a driv-

erless metro, or an Automated People Mover (APM).

[0027] The applicants have found that by using a front end according to the invention, it is safer, faster and more economic to shunt another railway vehicle.

[0028] Other features and advantages of the present invention will become apparent from the following detailed description. It should be understood, however, that the specific embodiments in the detailed description are given by way of illustration only, since various changes and modifications within the scope of the invention will become apparent to those skilled in the art.

Brief description of drawings

[0029]

Figure 1: Side view of a typical light railway vehicle

Figure 2: Side view of two railway vehicles having their front extremities raised, their couplers extended and connected.

Figure 3: Side view of two railway vehicles, one vehicle using a front end according to the invention to push the other vehicle.

Figure 4: Partial perspective view of the back of a front end according to the invention, including the crash absorber system.

Figure 5: Enlarged view of a region of Figure 4, showing details of the mechanical fuse. Some parts have been removed for clarity purpose.

Figure 6: Partial perspective view of a front end of a railway vehicle, showing the deformable structure and bodyshell parts.

Figure 7: Perspective view of the front end and its proximate environment consisting of the crash absorber system and the folded coupler.

Figure 8: Alternative embodiment of the mechanical fuse (resilient material not shown).

Figure 9: Illustration of a fuse bolt support.

Description of embodiments

[0030] Referring to Figure 1, a rail vehicle 10 is traveling on a track 200. The track 200 defines the longitudinal direction. The front end 13 of the rail vehicle 10 is located below the windscreen 14. The front extremity 20 is the portion located the farthest away along the longitudinal direction, in the direction of travel T of the rail vehicle 10, ie towards the left of Figure 1.

[0031] Coupled rail vehicles are shown on Figure 2. The depicted vehicles are two different models of light

rail vehicles 10, 100. Both vehicles have their front extremity 20, 120 raised, so that the front couplers 114, 115 are made accessible to the drivers, and can be unfolded and connected to each other.

[0032] A folded coupler 114 can be seen from Figure 7 located behind the crashbar 111.

[0033] Inside depots, railway vehicles circulate at low speed, typically below 10 km/h. As can be seen from Figure 3, the present invention makes no use of the front couplers 114, 115 but instead the vehicle 10 uses its front end 13 to push the other vehicle 100. The front end 13 contacts the vehicle 100 at a low level, typically 500-600 millimetres above the track level.

[0034] Figure 4 shows an expanded view of a front end 13 of a rail vehicle 10 having a chassis 11, the front end 13 comprises a deformable structure 30. The deformable structure 30 includes a frame 31, which consists mainly in a bended metal plate, mounted on the chassis 11 in a movable manner. A mechanical fuse 33 is attached directly or indirectly on one end to the frame 31 and on the other end to the chassis 11. The mechanical fuse 33 is adapted to break past or above a predetermined force so that the frame 31 may move backwards on the chassis 11. A resilient material 32 having elastomeric properties, such as rubber, can be mounted onto the frame 31.

[0035] The resilient material 32 is designed to resist to low speed impacts, typically below 5km/h, preferably equal or lower than 3 km/h, without suffering any plastic deformation. For vehicle such as light rail vehicles, an impact speed of 3 km/h induces impact forces on the front end 13 of approximately 150 kN. Values of 150 kN causes no plastic deformation on the mechanical fuse 33 either, as they are designed to break at a significantly higher force.

[0036] The mechanical fuse 33 attached between the frame 31 and the rail vehicle's chassis 11 is designed to break when a predetermined impact force is exerted onto the deformable structure 30. An impact or a collision occurring at a speed above 10km/h will break the mechanical fuse 33 and release the front end 13. The predetermined impact force resulting from this impact is approximately 300kN.

[0037] According to one embodiment of the invention, the part of the chassis 11 to which the frame 31 is movably attached comprises a crashbar 111.

[0038] As can be seen on Figure 5, the connection between the frame 31 and the crashbar 111 also comprises a retaining device 50 comprising metallic straps, attached on one end to the frame 31, and on the other end to the crashbar 111. The retaining device 50 allows for a range of motions within which the mechanical fuse 33 breaks off. In other words, the retaining device 50 is operative to retain the deformable structure 30 attached to the chassis 11 when the mechanical fuse 33 breaks off

[0039] The front end 13 also includes a guiding means 40 inserted between the frame 31 of the deformable structure 30 and the vehicle. Such guiding means 40 will hinder lateral movements and ensure that the deformable

structure 30 moves in a preferred direction upon failure of the mechanical fuse 33.

[0040] Preferably, the guiding means 40 allows for a longitudinal movement of the deformable structure 30, ie along the direction of travel T of the rail vehicle, which should be the main direction of the impact force resulting from a collision between two adjacent rail vehicles on the same track, or between the rail vehicle and an obstacle.

[0041] An example of a mechanical fuse 33 can be seen on Figure 5, implementing one or more fuse bolts 331 installed longitudinally, parallel to the vehicle travelling direction. Such arrangement is best suited for the use of traction fuse bolts, which will break past or above a selected traction force. The fuse bolts 331 contain a smaller section which is the location where the bolt will break. The fuse bolts 331 are rigidly connected on one end to a fuse bolt support 332 rigidly connected to the crashbar 111 and bolted on the other end to a fuse bolt interface 333. An opening 31a in the frame 31 receives the fuse bolt support 332. The opening 31a is a longitudinal slot, extending from the fuse bolt 332 towards the front of the vehicle, ie in the direction of travel T. A collision on the deformable structure 30 will push the frame 31 backwards which in turn will push the fuse bolt interface 333. The fuse bolt interface 333 is connected to the frame 31, in particular rigidly connected, or part of the frame 31, and comprises a vertical steel plate provided with an opening in its centre. The fuse bolt 331 is inserted into the opening from one side of the steel plate and bolted on the other side. The fuse bolt interface 333 thus induces a traction force on the fuse bolt 331 thanks to the bolted connection, when the frame 31 moves backwards. An impact force F greater than 300kN will break the mechanical fuse 33, unlocking the connection between the frame 31 and the chassis 11. The fuse bolt support 332 will slide inside the opening 31a until the fuse bolt support 332 reaches the vertical portion of the frame 31 and goes through a vertical slot of the opening 31a.

[0042] Referring to Figure 6, the resilient material 32, made of rubber, is juxtaposed with the vehicle's front bodyshell 12. The benefit of this configuration is that the bodyshell and the resilient material form a continuous surface so that the resilient material 32 is almost not distinguishable from the front bodyshell 12.

[0043] As can be seen on Figure 7, the coupler 114 is located behind the crashbar 111, so that the front extremity 20 must be raised in order to extend the coupler 114.

[0044] Another embodiment of a mechanical fuse 33 is represented in Figure 8, where the mechanical fuse 33 connects the frame 31 and the rail vehicle's chassis 11 and where the chassis 11 comprises the driver's cab structure 113.

[0045] Figure 9 shows the fuse bolt support 332 bolted to the driver's cab structure 113, and the fuse bolts 331 are inserted transversally through both the fuse bolt support 332 and the fuse bolt interface 333. The fuse bolt interface 333 includes a tube forming the fuse bolt inter-

face longitudinal member 3331, a fuse bolt interface front end 3333 and a fuse bolt interface rear end 3332, the fuse bolt interface front end 3333 is connected to the frame 331 while the fuse bolt interface rear end 3332 is connected to the fuse bolt support 332 via the fuse bolts 331. An inclined notch 98 has been machined on the fuse bolt interface rear end 3332 and a corresponding chamfer 99 machined in the fuse bolt support 332, facing the notch 98, the chamfer 99 and the notch 98 preferably being parallel. In the event of a collision on the front end 13, the frame 31 will push backwards and thus will apply a mainly longitudinal force on the mechanical fuse 33. The longitudinal force transmitted to the fuse bolt interface front end 3333, the fuse bolt interface longitudinal member 3331 and the fuse bolt interface rear end 3332 will become a shear force in the fuse bolt(s) 331, which will break if the force exceeds a predetermined shear force. Upon failure of the fuse bolts 331, the fuse bolt interface 333 will move backwards (towards the rear of the vehicle) and the notch 98 in the fuse bolt interface rear end 3332 will meet the chamfer 99 of the fuse bolt support 332, thus forcing the fuse bolt interface 333 to move downwards. This safety measure ensure that the fuse bolts interface will be fully released so that it does not interfere with the shock absorber system 112 and that it moves in a preferred direction, ie towards the bottom or downwardly. The mechanical fuse 33 further includes its own retaining device, consisting also of a metallic strap connected to the fuse bolt support 332, to ensure that no part can fall on the track.

[0046] Figure 4 also shows an example of a guiding means 40 consisting of longitudinal slots 42 which have been laser-cut in the frame 31. The slots 42 extend mainly in the horizontal portion of the frame 31, and also slightly in the vertical portion. Bolts 41 extend through the slots 42 and are bolted to the crashbar 111. The slots 42 in the frame 31 are slightly larger than the nominal diameter of the bolts 41, but smaller than the bolt heads. In the vertical portion of the frame 31, the slots 42 are larger than the bolt heads and extend slightly higher than the bolt heads so that the bolts 41 will not retain the frame 31 when the fuse bolt(s) 331 breaks. The tightening of the bolts 41 is such that the effort applied to the frame does not interfere with the function of the mechanical fuse 33. The orientation of the slots 42 will ensure that the frame will move in a direction essentially parallel to the longitudinal direction.

Reference signs list

[0047]

10	Rail vehicle
11	Chassis
111	Crashbar
112	Shock absorber system
113	Driver cab structure
114	Front coupler of other rail vehicle

12	Bodyshell
13	Front end
14	Windshield
20	Front extremity of vehicle 10
30	Deformable structure
31	Frame
31a	Opening
32	Resilient material
33	Mechanical fuse
331	Fuse bolt
331a	Smaller section
332	Fuse bolt support
333	Fuse bolt interface
3331	Fuse bolt interface longitudinal member
3332	Fuse bolt interface rear end
3333	Fuse bolt interface front end
40	Guiding means
41	Bolt
42	Slot
50	Retaining device
98	Notch
99	Chamfer
100	Other rail vehicle
115	Front coupler of other rail vehicle 100
120	Front extremity of other rail vehicle 100
200	Track

Claims

1. Rail vehicle (10), the rail vehicle (10) having a front end (13) and a chassis (11), said front end (13) comprising a deformable structure (30), wherein said deformable structure (30) includes:
 - a frame (31) movable on the chassis (11); and
 - a mechanical protective device (33) mechanically connecting the frame (31) to the chassis (11), the mechanical protective device (33) being adapted to break if a predetermined impact force (F) is exceeded, so that the frame (31) may move on the chassis (11).
2. Rail vehicle (10) according to claim 1, wherein a resilient material (32) is mounted on the frame (31), the resilient material (32) being adapted to elastically deform under an impact force below 150 kN.
3. Rail vehicle (10) according to claim 2, wherein the resilient material (32) comprises an elastomer.
4. Rail vehicle (10) according to any of the previous claims, wherein the predetermined impact force (F) corresponds to an impact speed above 10 km/h.
5. Rail vehicle (10) according to any of the previous claims, wherein the chassis (11) includes a driver cab structure (113) and a shock absorber system

(112) and in that the mechanical protective device (33) mechanically connects the frame (31) to the driver cab structure (113) or to the shock absorber system (112).

6. Rail vehicle (10) according to any of the previous claims, wherein the frame (31) and the chassis (11) are connected via a guiding means (40) operative to guide the deformable structure (30) in a predetermined direction when the mechanical protective device (33) breaks.
7. Rail vehicle (10) according to any of the previous claims, wherein the mechanical protective device (33) includes one or more break-away bolts (34).
8. Rail vehicle (10) according to any of the previous claims, wherein the frame (31) and the chassis (11) are further connected via a retaining device operative (50) to retain the deformable structure (30) attached to the chassis (11) when the mechanical protective device (33) breaks.
9. Rail vehicle (10) according to claim 8, wherein the retaining device (50) consists of one or more flexible straps.

10. Rail vehicle according to any of the previous claims, wherein the resilient material (32) is juxtaposed with a bodyshell (12) of the rail vehicle (10) and together with the bodyshell (12) presents a continuous surface.

11. Method for moving a rail vehicle, wherein the rail vehicle (10) is shunted with another rail vehicle (100) using a front end (13) according to any of the previous claims.

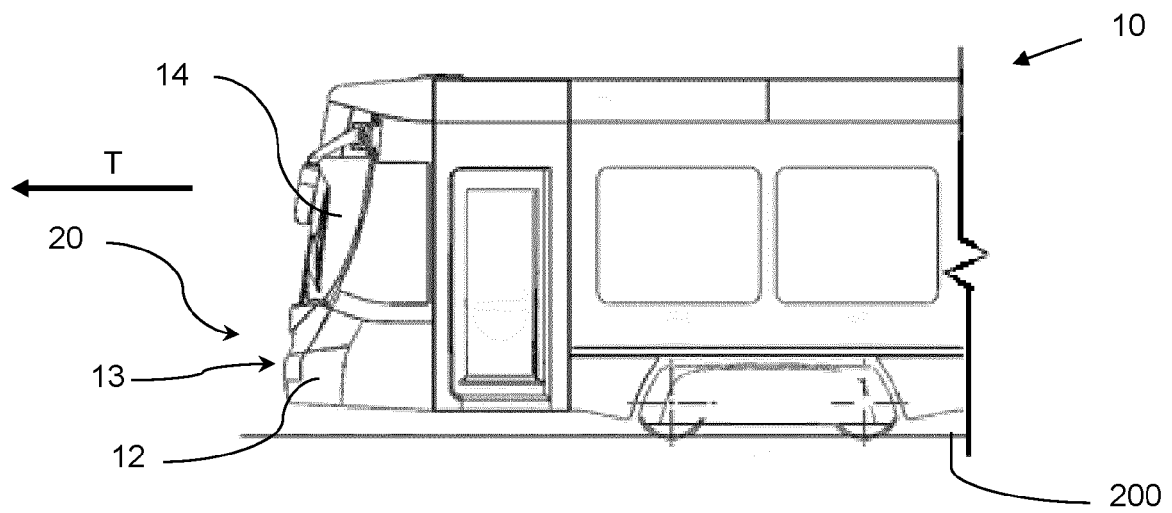


Figure 1

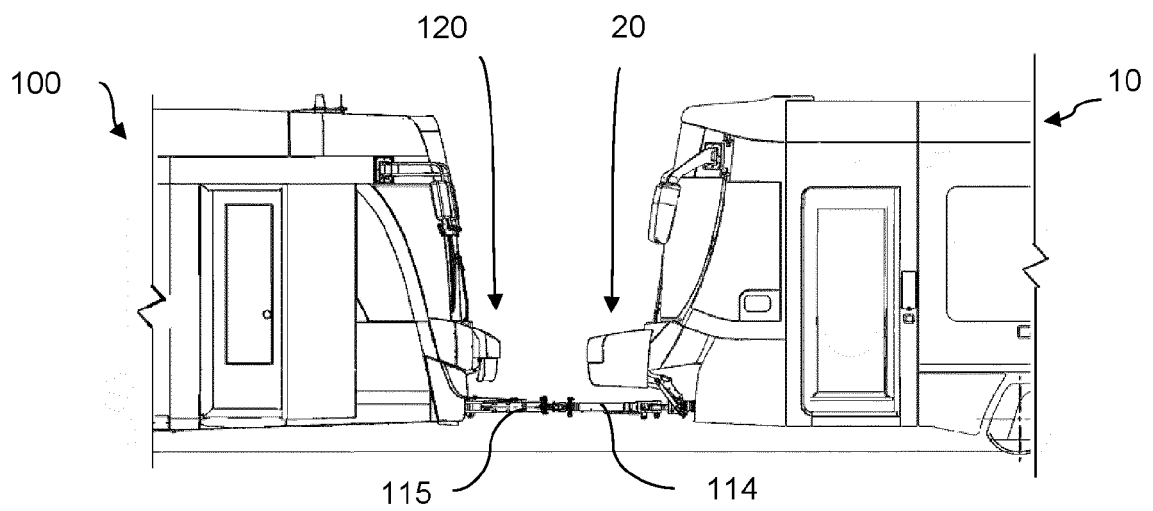


Figure 2

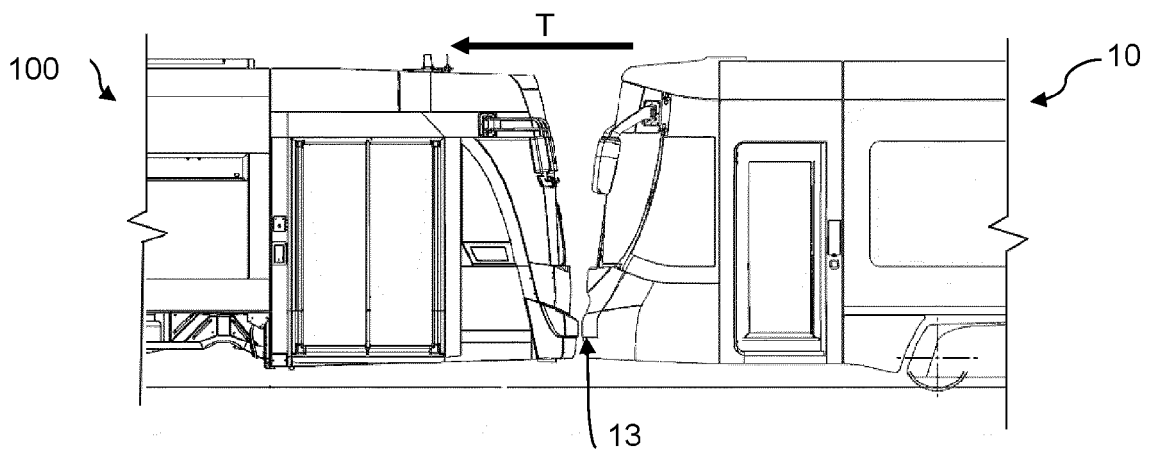


Figure 3

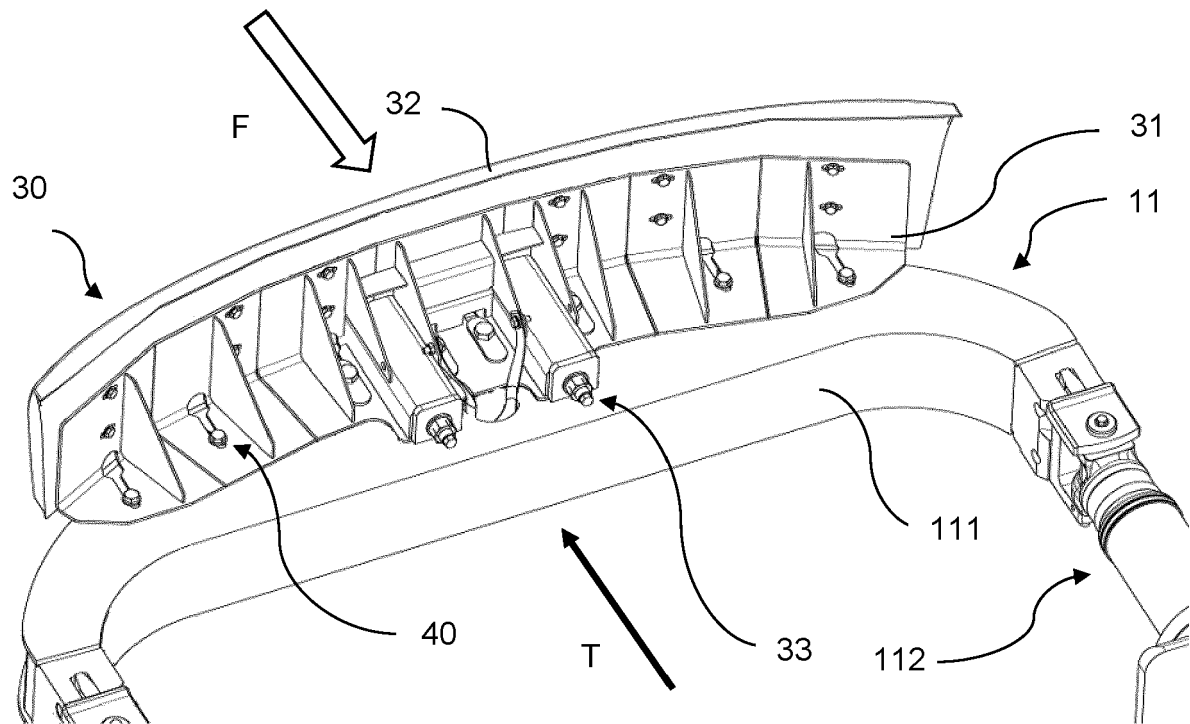


Figure 4

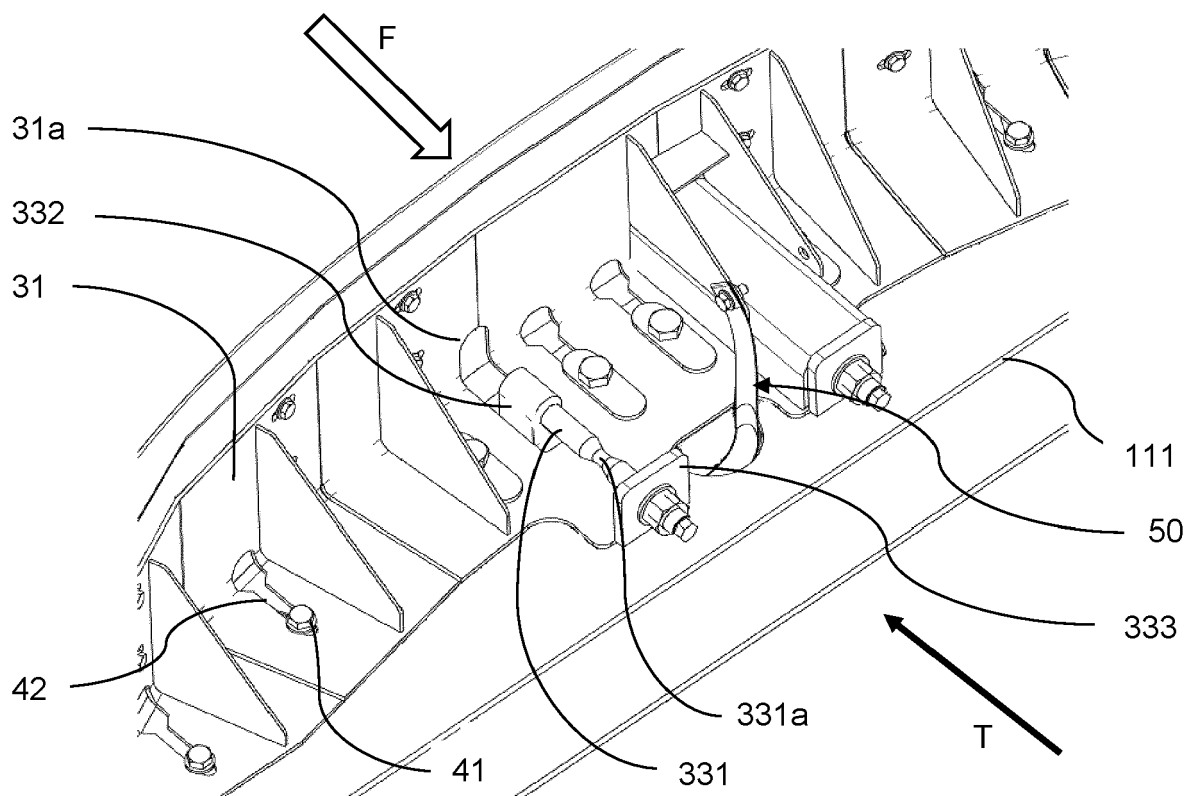


Figure 5

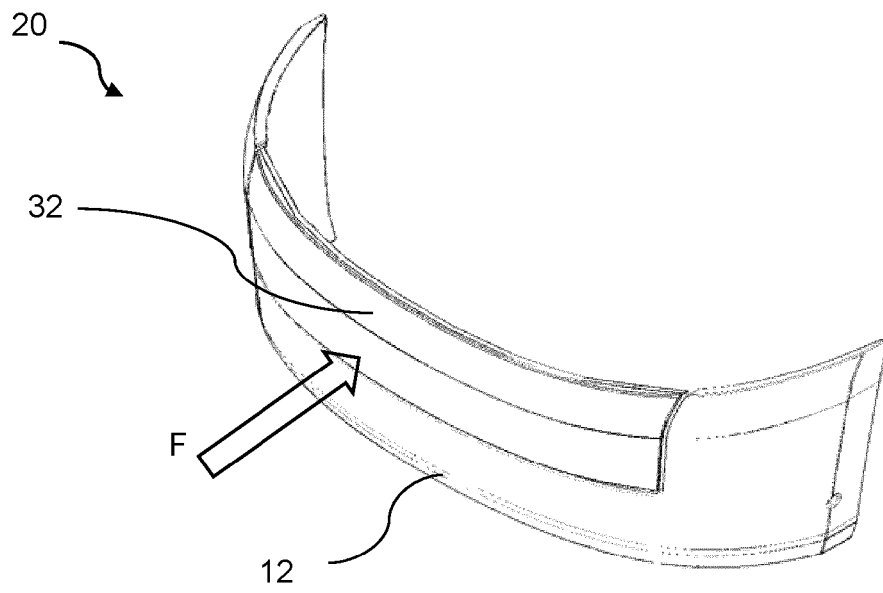


Figure 6

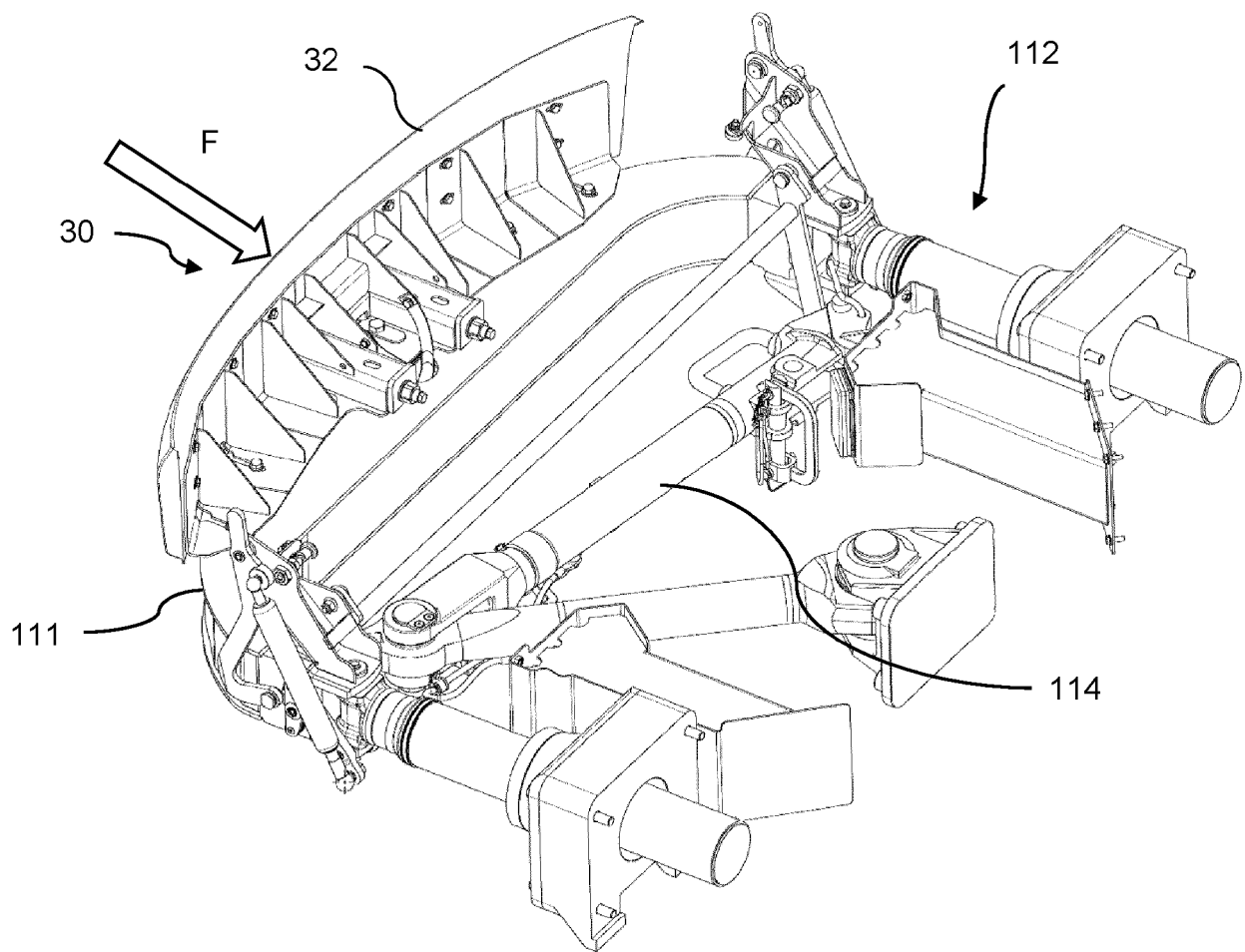


Figure 7

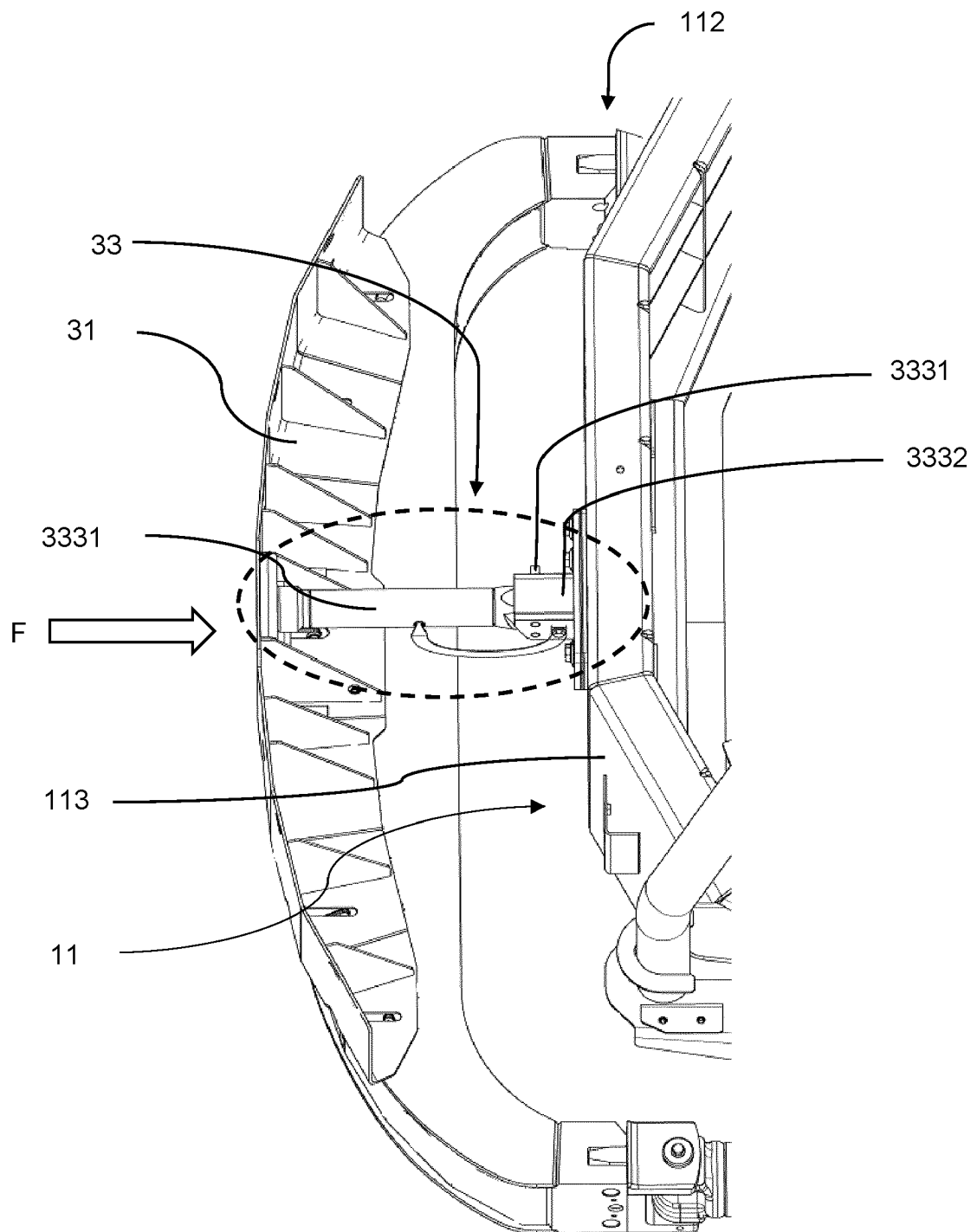


Figure 8

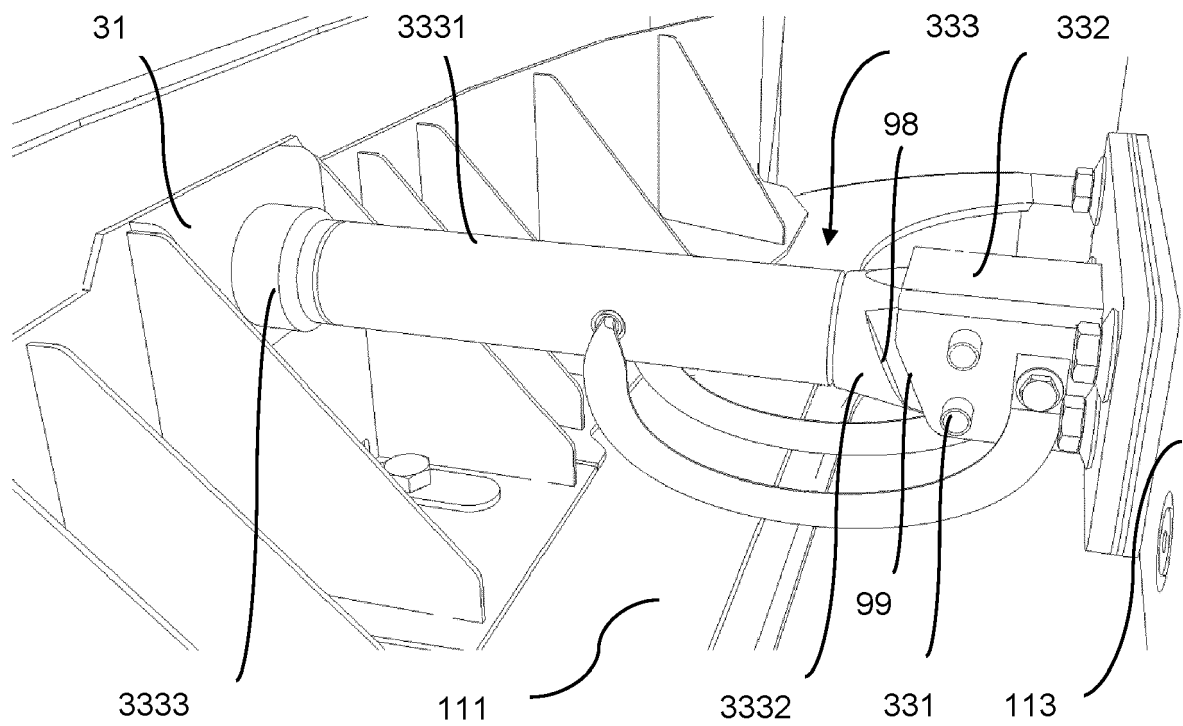


Figure 9



EUROPEAN SEARCH REPORT

 Application Number
 EP 20 19 9652

5

10

15

20

25

30

35

40

45

50

55

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 2005/028275 A1 (SIEMENS TRANSPORTATION SYSTEMS [US]; GOUGH GLEN [US]) 31 March 2005 (2005-03-31)	1-5,10,11	INV. B61D15/06 B61D17/06 B61G11/14
A	* page 5, line 13 - page 11, line 6; figures 2-6B *	6-9	
A	----- US 6 820 759 B1 (SCHINDLER CHRISTIAN [DE] ET AL) 23 November 2004 (2004-11-23) * column 1, line 54 - column 2, line 44; figures 1-10 *	1-11	
A	----- EP 2 277 762 A2 (BOMBARDIER TRANSP GMBH [DE]) 26 January 2011 (2011-01-26) * paragraph [0027] - paragraph [0051]; figures 1-8 *	1-11	
A	----- WO 02/096734 A1 (SCHARFENBERGKUPPLUNG GMBH & CO [DE]) 5 December 2002 (2002-12-05) * page 3, line 7 - page 6, line 12; figure 1 *	1-11	TECHNICAL FIELDS SEARCHED (IPC)
A	----- US 2008/250965 A1 (CLARK PETER [US] ET AL) 16 October 2008 (2008-10-16) * paragraph [0022] - paragraph [0038]; figures 1-10 *	1-11	B61D B61G
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 3 March 2021	Examiner Lendfers, Paul
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 20 19 9652

5

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

03-03-2021

10

15

20

25

30

35

40

45

50

55

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2005028275 A1	31-03-2005	AT 377538 T CA 2539383 A1 DE 602004009942 T2 EP 1663754 A1 ES 2300829 T3 US 2007186802 A1 WO 2005028275 A1	15-11-2007 31-03-2005 16-10-2008 07-06-2006 16-06-2008 16-08-2007 31-03-2005
US 6820759 B1	23-11-2004	AT 240860 T CA 2389499 A1 DE 19956856 A1 EP 1232083 A1 ES 2199887 T3 PT 1232083 E US 6820759 B1 WO 0138153 A1	15-06-2003 31-05-2001 31-05-2001 21-08-2002 01-03-2004 31-10-2003 23-11-2004 31-05-2001
EP 2277762 A2	26-01-2011	DE 102009034682 A1 EP 2277762 A2 ES 2541593 T3 PL 2277762 T3	10-02-2011 26-01-2011 22-07-2015 31-08-2015
WO 02096734 A1	05-12-2002	AT 365662 T AU 2002317168 B2 CN 1463235 A DE 10126483 A1 DK 1390245 T3 EP 1390245 A1 ES 2288191 T3 KR 20030022875 A MX PA03000871 A PL 358612 A1 PT 1390245 E US 2002178967 A1 WO 02096734 A1	15-07-2007 03-08-2006 24-12-2003 05-12-2002 24-09-2007 25-02-2004 01-01-2008 17-03-2003 05-04-2004 09-08-2004 05-09-2007 05-12-2002 05-12-2002
US 2008250965 A1	16-10-2008	CA 2628874 A1 US 2008250965 A1 US 2010199881 A1	12-10-2008 16-10-2008 12-08-2010

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- EP 2720924 A [0002]