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(54) **RAIL VEHICLE BODY AND RAIL VEHICLE PROVIDED WITH A SET OF NON- DEFORMABLE OBSTACLE-REMOVING RAMS**

(57) An end structure (10) of a rail vehicle body (12) comprises a non-deformable structural framework (16) defining a vertical transversal reference plane (100) of the rail vehicle body (12) perpendicular to a longitudinal forward direction (200). A set of non-deformable obstacle-removing rams (42, 44) integral with the non-deformable structural framework (16) protrudes from the vertical transversal reference plane (100) in the longitudinal forward direction (200). The end structure (10) has a set of one or more free spaces (48, 46), each corresponding to a corresponding one of the non-deformable obstacle-removing rams (42, 44). Each of the free spaces (48,

46) has a location and dimensions such as to contain at least a symmetric image (542, 544) of the corresponding non-deformable obstacle-removing ram (42, 44) obtained by rotating an external surface of the corresponding non-deformable obstacle-removing ram (42, 44) by 180° about a vertical line of symmetry (500) located at an intersection between the longitudinal vertical median plane (300) and a forward plane (600) parallel to the vertical transversal reference plane (100) and tangent to a forward end (42F, 44F) of the corresponding non-deformable obstacle removing ram (42, 44).

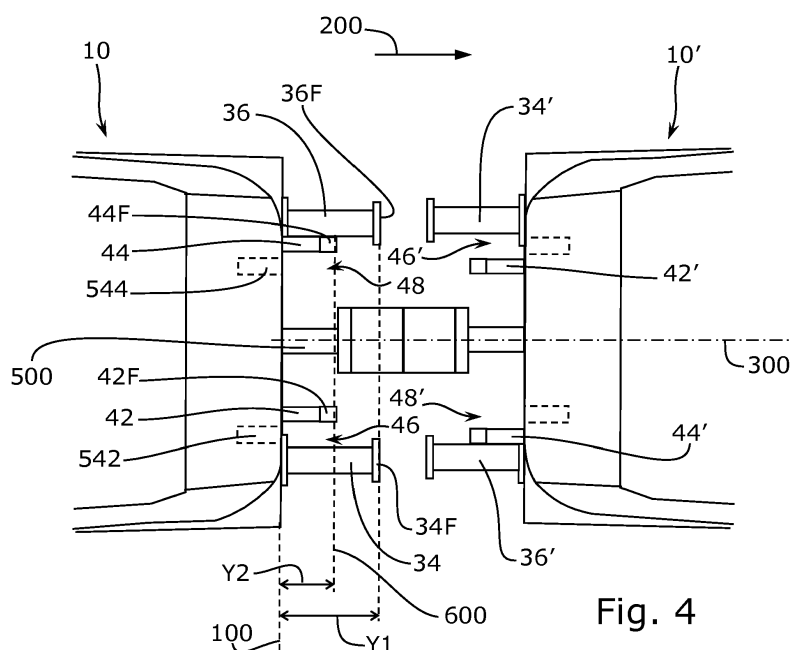


Fig. 4

Description**TECHNICAL FIELD OF THE INVENTION**

[0001] The present invention relates to a rail vehicle body and a rail vehicle with improved crashworthiness.

BACKGROUND ART

[0002] Crashworthiness standards for railway vehicle bodies define a series of collision scenarios and identify common methods of providing passive safety that may be adopted to suit individual vehicle requirements. European Standard EN 15227:2008+A1:2010 also specifies the characteristics of reference obstacles for use in the design collision scenarios. Some of the scenarios deal with rigid or massive obstacles and others with deformable obstacles, leading to potentially conflicting optimisation strategies.

SUMMARY OF THE INVENTION

[0003] The invention aims to provide improved response to a collision scenario dealing with a deformable obstacle without negatively impacting the response to a collision scenario dealing with an identical train unit.

[0004] According to a first aspect of the invention, there is provided a rail vehicle body having a longitudinal vertical median plane and comprising:

- an end structure facing a longitudinal forward direction, wherein the end structure comprises a non-deformable structural framework defining a vertical transversal reference plane of the rail vehicle body perpendicular to the longitudinal forward direction,
- a set of one or more non-deformable obstacle-removing rams integral with the non-deformable structural framework and protruding from the vertical transversal reference plane in the longitudinal forward direction, and
- a set of one or more free spaces, each corresponding to a corresponding one of the non-deformable obstacle-removing rams, wherein each of the free spaces has a location and dimensions such as to contain at least a symmetric image of the corresponding non-deformable obstacle-removing ram obtained by rotating an external surface of the corresponding non-deformable obstacle-removing ram by 180° about a vertical line of symmetry located at an intersection between the longitudinal vertical median plane and the vertical transversal reference plane.

[0005] The non-deformable obstacle-removing rams provide means for removing a deformable obstacle without deforming the end structure of the rail vehicle body. The corresponding free spaces ensure that in a collision scenario involving an identical train unit, the non-deformable obstacle-removing rams will not collide first with the obstacle. In the whole application the terms "non-deformable" with reference to the non-deformable obstacle-removing rams shall mean that the rams are able to withstand without plastic deformation an impact with the specific deformable obstacle defined in the European Standard EN 15227:2008+A1:2010 in the conditions specified in the Standard. More generally, it shall mean that the rams are able to withstand without plastic deformation an impact with an obstacle which has the following characteristics: a mass of 15 000 kg, a centre of mass at 1 750 mm above rail level, no friction to the ground and a stiffness of less than 6430 kN/mm.

[0006] Preferably, each of the free spaces has a width measured perpendicularly to the longitudinal vertical median plane, which is greater than a width of the symmetric image of the corresponding non-deformable obstacle-removing ram, preferably with a transverse clearance greater than 100mm, most preferably greater than 200mm. The transverse clearance will compensate potential misalignments between two identical colliding rail vehicles on a straight track. Such misalignment may result, in particular, from the lateral clearance between the car body and the running gear and from the lateral clearance between the wheels and the track.

[0007] According to one embodiment, the non-deformable structural framework includes a set of non-deformable beams extending in the vertical transversal reference plane and supporting the set of one or more non-deformable obstacle-removing rams, and the set of non-deformable beams preferably includes a transverse beam and one or more vertical beams extending between a subframe of the non-deformable structural framework and the transverse beam, each of the one or more vertical beams supporting one of the non-deformable obstacle-removing rams.

[0008] According to one embodiment, the forward end of each of the one or more non-deformable obstacle-removing rams has a slanted shape.

[0009] Preferably, a set of shock absorbing elements in a non-deformed state, which protrudes from the vertical transversal reference plane in the longitudinal forward direction at a vertical distance Z below the set of one or more non-

deformable obstacle-removing rams, wherein the shock absorbing elements are deformable in a deformed state upon impact with an obstacle. In the collision scenario against an identical train unit, the shock-absorbing elements will be the first to collide with the obstacle.

[0010] The shock-absorbing elements should preferably not be involved in the collision scenario against the deformable obstacle and should therefore preferably be at a substantial distance below the non-deformable obstacle-removing rams. Preferably, the vertical distance Z is more than 400 mm, preferably more than 500 mm, most preferably more than 600 mm. Preferably, the shock absorbing elements have a front end which, in the deformed state of the shock absorbing elements, is tangent to a rearward vertical transverse plane, which is in front of, or coplanar with, the vertical transversal reference plane.

[0011] The shock-absorbing elements should preferably be dimensioned such as to absorb a significant part of the collision energy in the collision scenario with an identical train. Preferably, the rail vehicle body has a mass M and the shock absorbing elements are such as to absorb an energy greater than $\frac{1}{2} MV^2$ with $V=110\text{km/h}$ when deformed from the non-deformed state to the deformed state.

[0012] The non-deformable obstacle removing rams should preferably be dimensioned such that, in a collision scenario with a 80t wagon provided with elastomeric buffers as defined in the European Standard EN 15227:2008+A1:2010, they never contact the obstacle. Therefore, the shock absorbing elements have a front end which, in the non-deformed state of the shock absorbing elements, is at a predetermined distance Y_1 in front of the vertical transversal reference plane, and

$$Y_1 \leq 105\text{mm}$$

[0013] The non-deformable obstacle removing rams should preferably be dimensioned such that they contact and possibly remove the deformable obstacle before it reaches the shock-absorbing elements. According to one embodiment, the forward end of the obstacle-removing rams is located at a predetermined distance Y_2 from the vertical transversal reference plane, and

$$Y_1 - Y_2 \leq 350\text{mm}$$

[0014] Referring to the specific deformable obstacle defined in the European Standard EN 15227:2008+A1:2010, the following inequality holds true:

$$(Y_1 - Y_2) \leq \sqrt{2,56 - (Z - 1,2)^2} - 1,05$$

[0015] According to another aspect of the invention, there is provided a rail vehicle comprising the rail vehicle body as described hereinbefore and a set of running gears for carrying and guiding the rail vehicle body along a track, wherein the running gears define a track level, wherein the set of one or more non-deformable obstacle-removing rams protrudes from the vertical transversal reference plane in the longitudinal forward direction at a predetermined height Z_2 above the track level and the set of shock absorbing elements protrudes from the vertical transversal reference plane in the longitudinal forward direction at a predetermined height Z_1 above the track level, wherein:

$$\begin{cases} 1,2\text{m} < Z_2 \\ Z_1 \leq 1,2\text{m} \end{cases}$$

[0016] The obstacle-removing rams are specifically located at a height that will collide with a deformable obstacle, whereas the shock absorbing elements are located below the deformable part of the obstacle. Preferably:

$$0,800\text{ m} \leq Z_1$$

[0017] According to a most preferred embodiment, [CLAIM13].

$$1,70\text{m} \leq Z_2 \leq 2,20\text{m}$$

[0018] In order to ensure that the non-deformable obstacle removing rams contact and possibly remove the deformable obstacle before it reaches the shock-absorbing elements, the following should preferably hold true:

$$(Y_1 - Y_2) \leq \sqrt{2,56 - (Z_2 - 2,2)^2} - 1,05 \text{ (in meters)}$$

[0019] According to a another aspect of the invention, there is provided a rail vehicle comprising the rail vehicle body as described hereinbefore and a set of running gears for carrying and guiding the rail vehicle body along a track, in particular a rail vehicle as described hereinbefore, wherein the running gears are such that the vehicle body has a given lateral clearance relative to a mid-path defined by the track in a transverse direction perpendicular to the longitudinal vertical median plane, and each of the free spaces has a location and dimensions such as to contain a second image of the corresponding non-deformable obstacle-removing ram which results from a translation of the symmetric image in the transverse direction with an amplitude equal to the lateral clearance.

BRIEF DESCRIPTION OF THE FIGURES

[0020] Other advantages and features of the invention will then become more clearly apparent from the following description of a specific embodiment of the invention given as non-restrictive examples only and represented in the accompanying drawings in which:

- figure 1 is an isometric view of an end structure of a vehicle body of a rail vehicle according to one embodiment of the invention;
- figure 2 is a side view of the end structure of figure 1 in front of a deformable obstacle;
- figure 3 is a side view of the end structure of figure 1 after collision with the deformable obstacle;
- figure 4 is a top view of illustrating two end structures of two vehicle bodies according to the embodiment of figure 1, facing one another;
- figure 5 is a top view of illustrating one end structure of a vehicle body according to the embodiment of figure 1, after a frontal collision with a similar vehicle.

[0021] Corresponding reference numerals refer to the same or corresponding parts in each of the figures.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0022] With reference to Figures 1, 2 and 4, an end structure 10 of a vehicle body 12 of a rail vehicle 14 comprises a non-deformable structural framework 16 defining a vertical transversal reference plane 100 of the rail vehicle body 12 perpendicular to a longitudinal forward direction 200, and to a longitudinal vertical median plane 300 of the vehicle body 12. The non-deformable structural framework 16 includes a subframe 18, a transverse beam 20, which constitutes a window sill for a windshield opening 22 of the rail vehicle 16, vertical beams 24, 26 extending in the vertical transversal reference plane 100 between the subframe 18 and the transverse beam 20 and slanted side posts 28, 30 extending between the transverse beam 20 and a roof structure 32 of the vehicle body 12. Remarkably, the longitudinal vertical median plane 300 is not a plane of symmetry for the vertical beams 24, 26, i.e. the vertical beam 24 on one side of the longitudinal vertical median plane is not at the same distance from the plane 300 as the vertical beam 26 on the other side.

[0023] The rail vehicle body 12 further comprises a set of shock absorbing elements 34, 36 protruding from the vertical transversal reference plane 100 in the longitudinal forward direction 200. The shock absorbing elements 34, 36 are such as to absorb an energy greater than $\frac{1}{2} MV^2$ when crushed from the non-deformed state to a crushed state, where $V=110\text{km/h}$ and M is the mass of rail vehicle body. The shock absorbing elements 34, 36 have a front end 34F, 36F, which, in a non-deformed state of the shock absorbing elements, is at a predetermined distance Y_1 in front of the vertical transversal reference plane 100. Each shock absorbing element 34 on one side of the longitudinal vertical median plane 300 as a corresponding symmetric shock absorbing element 36 on the other side of the longitudinal vertical median plane.

[0024] As illustrated in figure 2, the rail vehicle 14 comprises a set of running gears 38 for carrying and guiding the rail vehicle body 12 along a track 40. The running gears 38 define a track level 400, and the set of shock absorbing elements are at a predetermined height Z_1 above the track level 400. Preferably,

$$0,800 \text{ m} \leq Z_1 \leq 1,200 \text{ m}$$

[0025] The rail vehicle body **12** further comprises a set of two non-deformable obstacle-removing rams **42, 44** integral with the non-deformable structural framework **16** and protruding from the vertical transversal reference plane **100** in the longitudinal forward direction **200**. The non-deformable obstacle-removing rams **42, resp. 44** are supported at their rear end by one of the vertical beams **24, resp. 26** and have a protruding slanted front end **42F, resp. 44F**. As best illustrated in figure **4**, the two non-deformable obstacle-removing rams **42, 44** are at different distances from the longitudinal vertical median plane **300**. As a result, the rail vehicle body **12** further comprises two free spaces **46, resp. 48**, one on each side of the longitudinal vertical median plane **300**, each at the same distance from the longitudinal vertical median plane **300** as the non-deformable obstacle-removing ram **44, resp. 42** on the other side of the longitudinal vertical median plane **300**.

[0026] The non-deformable obstacle-removing rams **42, 44** protrude from the vertical transversal reference plane **100** in the longitudinal forward direction **200** at a predetermined height Z_2 above the track level and above the shock absorbing elements **36, 38**, such that:

$$1,20 \text{ m} < Z_2$$

[0027] Preferably, the height Z_2 is such that:

$$1,70 \text{ m} \leq Z_2 \leq 2,20 \text{ m}$$

[0028] As best depicted in Figure 4, each of the free spaces **46, resp. 48** has a location and dimensions such as to contain a symmetric image **544, resp. 542** of the corresponding non-deformable obstacle-removing ram **44, resp. 42** obtained by rotating an external surface of the corresponding non-deformable obstacle-removing ram by 180° about a vertical line of symmetry **500** located at an intersection between the longitudinal vertical median plane **300** and a forward plane **600** parallel to the vertical transversal reference plane **100** and tangent to the forward end **44F, 42F** of the corresponding non-deformable obstacle removing ram **44, resp. 42**.

[0029] In other words, assuming that the end structure **10** of the rail vehicle **14** faces an identical end structure **10'** of another rail vehicle as depicted in figure **4**, each non-deformable obstacle-removing ram **42, 44, 42', 44'** faces one of the free spaces **48', 46', resp. 48, 46** of the opposite end structure **10'**. If the two end structures **10, 10'** collide, each non-deformable obstacle-removing ram **42, 44, resp. 42', 44'** will enter the opposite free space **48', 46', resp. 48, 46**. In a collision scenario involving two identical train units, the shock absorbing elements **36, 38, 36', 38'** will start collapsing before the non-deformable obstacle-removing rams **42, 44, resp. 42', 44'** collide with the non-deformable structural framework **16', 16** of the opposite vehicle.

[0030] Taking now into consideration the deformation of the shock absorbing elements **34, 36** of the end structure **10** in a collision scenario with a vehicle having a similar end structure **10'**, a reward vertical transverse plane **600'** tangent to the front end **34F, 36F** of the shock absorbing elements **34, 36** in their deformed state has been illustrated in figure **5**. In Figure 5, only the end structure **10** has been shown. The reward vertical transverse plane **600'** is located slightly in front of the vertical transversal reference plane **100**, which ensures that in a collision scenario involving two identical train units, the shock absorbing elements **36, 38, 36', 38'** will have completely collapsed before the non-deformable obstacle-removing rams **42, 44, resp. 42', 44'** collide with the non-deformable structural framework **16', 16** of the opposite vehicle.

[0031] The set of running gears **38** for carrying and guiding the rail vehicle body **12** along the track **40** are such that the vehicle body **12** has a given lateral clearance relative to a mid-path defined by the track in a transverse direction perpendicular to the longitudinal vertical median plane **300**. This lateral clearance is partly related to the freedom of motion of the rail vehicle body **12** relative to the wheelsets of the running gear **38** allowed by the suspension, and partly related to the hunting oscillation of the wheelsets. Preferably, each of the free spaces **46, 48**, has a location and dimensions such as to contain a second image of the corresponding non-deformable obstacle-removing ram which results from a translation of the symmetric image in the transverse direction with an amplitude equal to the lateral clearance. Preferably, each of the free spaces **46, 48** has a width measured perpendicularly to the longitudinal vertical median plane, which is greater than a width of the symmetric image of the corresponding non-deformable obstacle-removing ram, preferably with a transverse clearance greater than 100mm, most preferably greater than 200mm.

[0032] The non-deformable obstacle-removing rams **42, 44** are located at a vertical distance Z above the shock absorbing elements, which is more than 400 mm, preferably more than 500 mm, most preferably more than 600 mm. The obstacle-removing rams **42, 44** have a front end **42F, 44F**, which is located at a predetermined distance Y_2 from

the vertical transversal reference plane, such that in a collision scenario with a standardised equivalent deformable obstacle **700** depicted in figure **3**, they will collide with the obstacle **700** before the shock absorbing elements **34**, **36** do.

[0033] The equivalent obstacle **700** of figure **3** is defined by the European Standard EN 15227:2008+A1:2010 and is representative of a large heavy obstacle at a level crossing. During the impact, the upper protruding part **710** of the deformable obstacle **700** collapses and absorbs a substantial part of the kinetic energy, as illustrated in figure **3**. The lower part **720** of the deformable obstacle **700** starts moving together with the upper part **710** in the forward direction **200** of the rail vehicle **14** even before it is pushed by the shock absorbing elements **34**, **36**. When, finally, the contact between the shock absorbing elements **34**, **36** and the lower part **720** of the standard deformable obstacle **700** takes place, a substantial amount of energy has already been absorbed by the deformation and acceleration of the upper part **710** of the obstacle **700**.

[0034] To achieve the desired sequence of events, the distance Y_1 between the vertical transverse plane **100** and the front end **34F**, **36F** of the shock absorbing elements **34**, **36**, i.e. the operative length of the shock absorbing elements **34**, **36**, and the distance Y_2 between the vertical transversal reference plane **100** and the front end **42F**, **44F** of the obstacle removing rams **42**, **44** are preferably such that:

$$Y_1 - Y_2 \leq 350\text{mm}$$

[0035] Preferably, the distances Y_1 and Y_2 are related to the height Z_1 of the shock absorbing elements **34**, **36** above the track **40** as follows:

$$(Y_1 - Y_2) \leq \sqrt{2,56 - (Z_1 - 1,2)^2} - 1,05 \text{ (in meters)}$$

[0036] Preferably, the distances Y_1 and Y_2 are related to the height Z_2 of the non-deformable obstacle-removing rams **42**, **44** above the track as follows:

$$(Y_1 - Y_2) \leq \sqrt{2,56 - (Z_2 - 2,2)^2} - 1,05 \text{ (in meters)}$$

[0037] Remarkably, the stiffness of the non-deformable beams **20**, **24**, **26** should be such that the non-deformable structural framework **16** does not substantially deform upon impact with the standard equivalent deformable obstacle **700**, as illustrated in figure **3**.

[0038] The rail vehicle body **12** further comprises a train coupler **50**, which is centrally located between the shock absorbing elements **34**, **36**, at a height Z_3 above the track, which is in the same range as the height Z_1 of the shock absorbing elements **34**, **36**, i.e. such that:

$$0,800 \text{ m} \leq Z_3 \leq 1,200 \text{ m}$$

[0039] However, the influence of the train coupler **50** in the collision scenarios discussed hereinbefore can be omitted. It is therefore not relevant whether the train coupler **50** will reach the standard equivalent deformable obstacle **700** before or after the non-deformable obstacle-removing rams **42**, **44**. This is the reason why the train coupler **50** was not illustrated in figures **2** and **3**.

[0040] Obviously, the invention can be generalised to structural framework with more than two non-deformable obstacle-removing rams **42**, **44**.

Claims

1. A rail vehicle body (12) having a longitudinal vertical median plane (300) and comprising an end structure (10) facing a longitudinal forward direction (200), wherein the end structure (10) comprises a non-deformable structural framework (16) defining a vertical transversal reference plane (100) of the rail vehicle body (12) perpendicular to the longitudinal forward direction (200), **characterised in that** the rail vehicle body (12) further comprises

- a set of one or more non-deformable obstacle-removing rams (42, 44) integral with the non-deformable structural framework (16) and protruding from the vertical transversal reference plane (100) in the longitudinal forward

direction (200), and

- a set of one or more free spaces (48, 46), each corresponding to a corresponding one of the non-deformable obstacle-removing rams (42, 44), wherein each of the free spaces (48, 46) has a location and dimensions such as to contain at least a symmetric image (542, 544) of the corresponding non-deformable obstacle-removing ram (42, 44) obtained by rotating an external surface of the corresponding non-deformable obstacle-removing ram (42, 44) by 180° about a vertical line of symmetry (500) located at an intersection between the longitudinal vertical median plane (300) and the vertical transversal reference plane (100).

2. The rail vehicle body of claim 1, wherein each of the free spaces (48, 46) has a width measured perpendicularly to the longitudinal vertical median plane (300), which is greater than a width of the symmetric image (542, 544) of the corresponding non-deformable obstacle-removing ram (42, 44), preferably with a transverse clearance greater than 100mm, most preferably greater than 200mm.

3. The rail vehicle body of any one of the preceding claims, wherein the non-deformable structural framework (16) includes a set of non-deformable beams (20, 24, 26) extending in the vertical transversal reference plane (100) and supporting the set of one or more non-deformable obstacle-removing rams (42, 44), and the set of non-deformable beams (20, 24, 26) preferably includes a transverse beam (20) and one or more vertical beams (24, 26) extending between a subframe (18) of the non-deformable structural framework (16) and the transverse beam (20), each of the one or more vertical beams (24, 26) supporting one of the non-deformable obstacle-removing rams (42, 44).

4. The rail vehicle body of any one of the preceding claims, wherein the forward end (42F, 44F) of each of the one or more non-deformable obstacle-removing rams (42, 44) has a slanted shape.

5. The rail vehicle body of any one of the preceding claims, further comprising a set of shock absorbing elements (34, 36) in a non-deformed state, which protrudes from the vertical transversal reference plane (100) in the longitudinal forward direction (200) at a vertical distance Z below the set of one or more non-deformable obstacle-removing rams (42, 44), wherein the shock absorbing elements (34, 36) are deformable in a deformed state upon impact with an obstacle.

6. The rail vehicle body of claim 5, wherein the shock absorbing elements (34, 36) have a front end (34F, 36F) which, in the deformed state of the shock absorbing elements (34, 36), is tangent to a rearward vertical transverse plane (600'), which is in front of, or coplanar with, the vertical transversal reference plane (100).

7. The rail vehicle body of any one of claims 5 to 6, wherein the rail vehicle body (12) has a mass M and the shock absorbing elements (34, 36) are such as to absorb an energy greater than $\frac{1}{2} MV^2$ with V=110km/h when deformed from the non-deformed state to the deformed state.

8. The rail vehicle body of any one of claims 5 to 7, wherein the shock absorbing elements (34, 36) have a front end (34F, 36F) which, in the non-deformed state of the shock absorbing elements (34, 36), is at a predetermined distance Y_1 in front of the vertical transversal reference plane (100), and

$$Y_1 \leq 105mm$$

9. The rail vehicle body of claim 8, wherein the forward end (42F, 46F) of the obstacle-removing rams (42, 44) is located at a predetermined distance Y_2 from the vertical transversal reference plane (100), and

$$Y_1 - Y_2 \leq 350mm$$

10. The rail vehicle body of claim 9, wherein

$$(Y_1 - Y_2) \leq \sqrt{2,56 - (Z - 1,2)^2} - 1,05$$

11. A rail vehicle comprising the rail vehicle body of any one of claims 5 to 10 and a set of running gears (38) for carrying and guiding the rail vehicle body (12) along a track (40), wherein the running gears (38) define a track level (40),

wherein the set of one or more non-deformable obstacle-removing rams (42, 44) protrudes from the vertical transversal reference plane (100) in the longitudinal forward direction at a predetermined height Z_2 above the track level and the set of shock absorbing elements (34, 36) protrudes from the vertical transversal reference plane (100) in the longitudinal forward direction at a predetermined height Z_1 above the track level, wherein:

$$\begin{cases} 1,2m < Z_2 \\ Z_1 \leq 1,2m \end{cases}$$

12. The rail vehicle of claim 11, wherein

$$0,800\text{ m} \leq Z_1$$

13. The rail vehicle of any one of claims 11 to 12, wherein:

$$1,70m \leq Z_2 \leq 2,20m$$

14. The rail vehicle of any one of claims 11 to 13, wherein the rail vehicle body (100) is according to any one of claims 8 to 10 and

$$(Y_1 - Y_2) \leq \sqrt{2,56 - (Z_2 - 2,2)^2} - 1,05 \text{ (in meters)}$$

15. A rail vehicle comprising the rail vehicle body (12) of any one of claims 1 to 10 and a set of running gears (38) for carrying and guiding the rail vehicle body (12) along a track (40), preferably the rail vehicle of any one of claims 11 to 14, wherein the running gears (38) are such that the vehicle body (12) has a given lateral clearance relative to a mid-path defined by the track (40) in a transverse direction perpendicular to the longitudinal vertical median plane (300), and each of the free spaces (48, 46) has a location and dimensions such as to contain a second image of the corresponding non-deformable obstacle-removing ram (32, 34) which results from a translation of the symmetric image in the transverse direction with an amplitude equal to the lateral clearance.

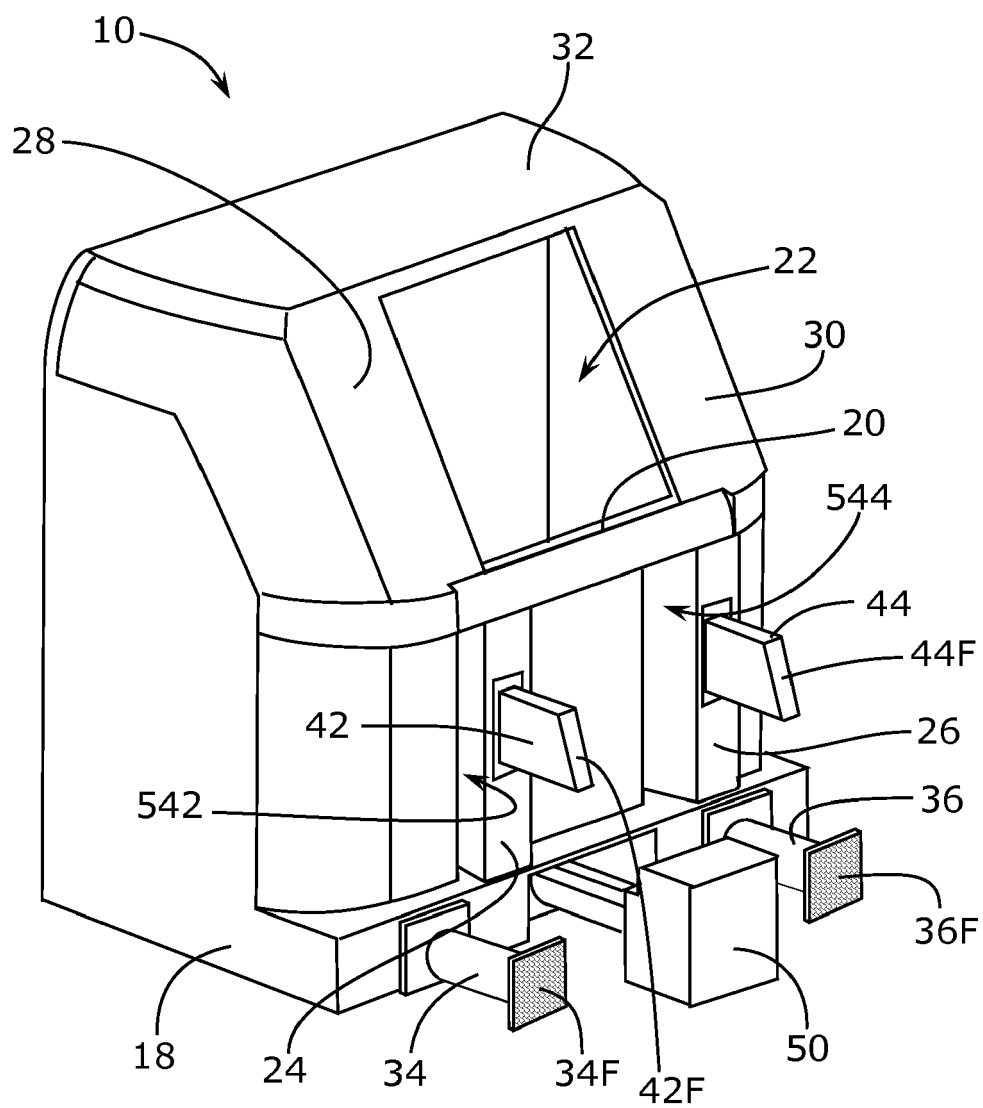


Fig. 1

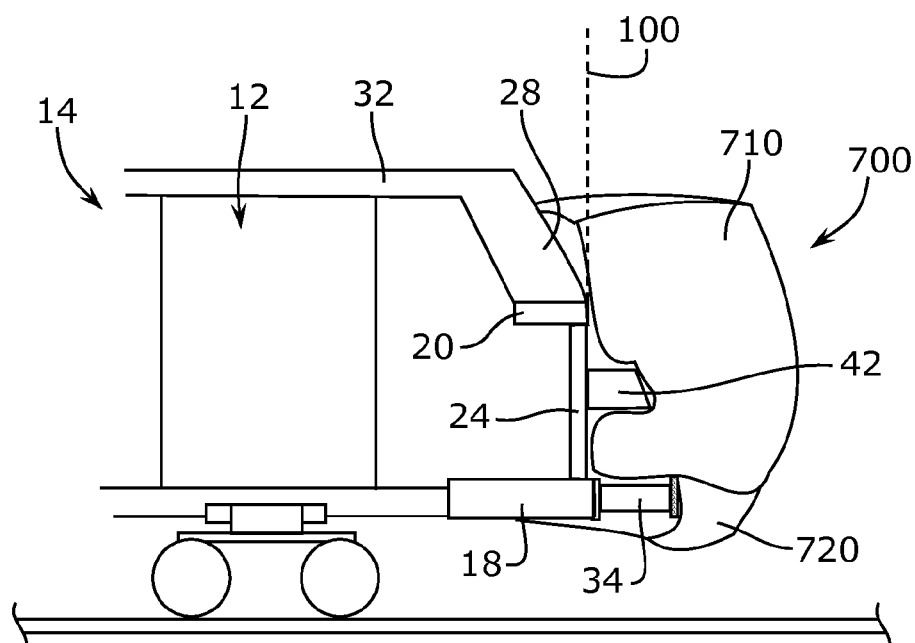
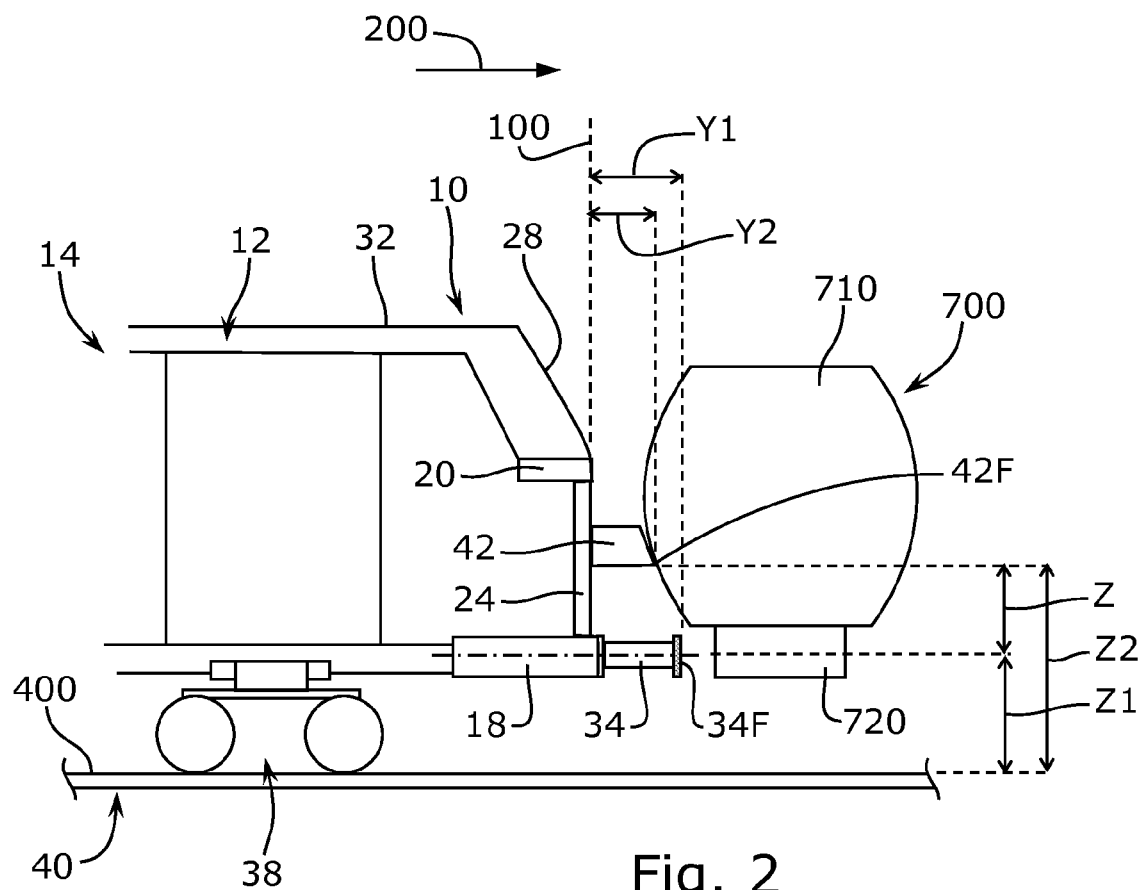
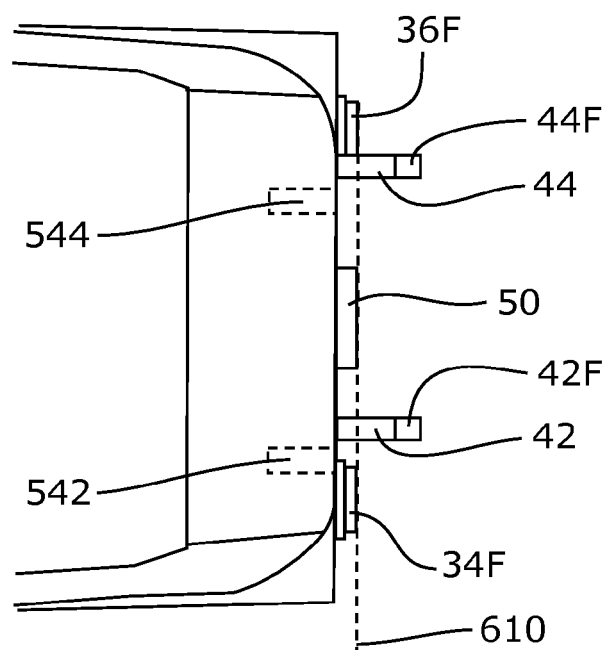
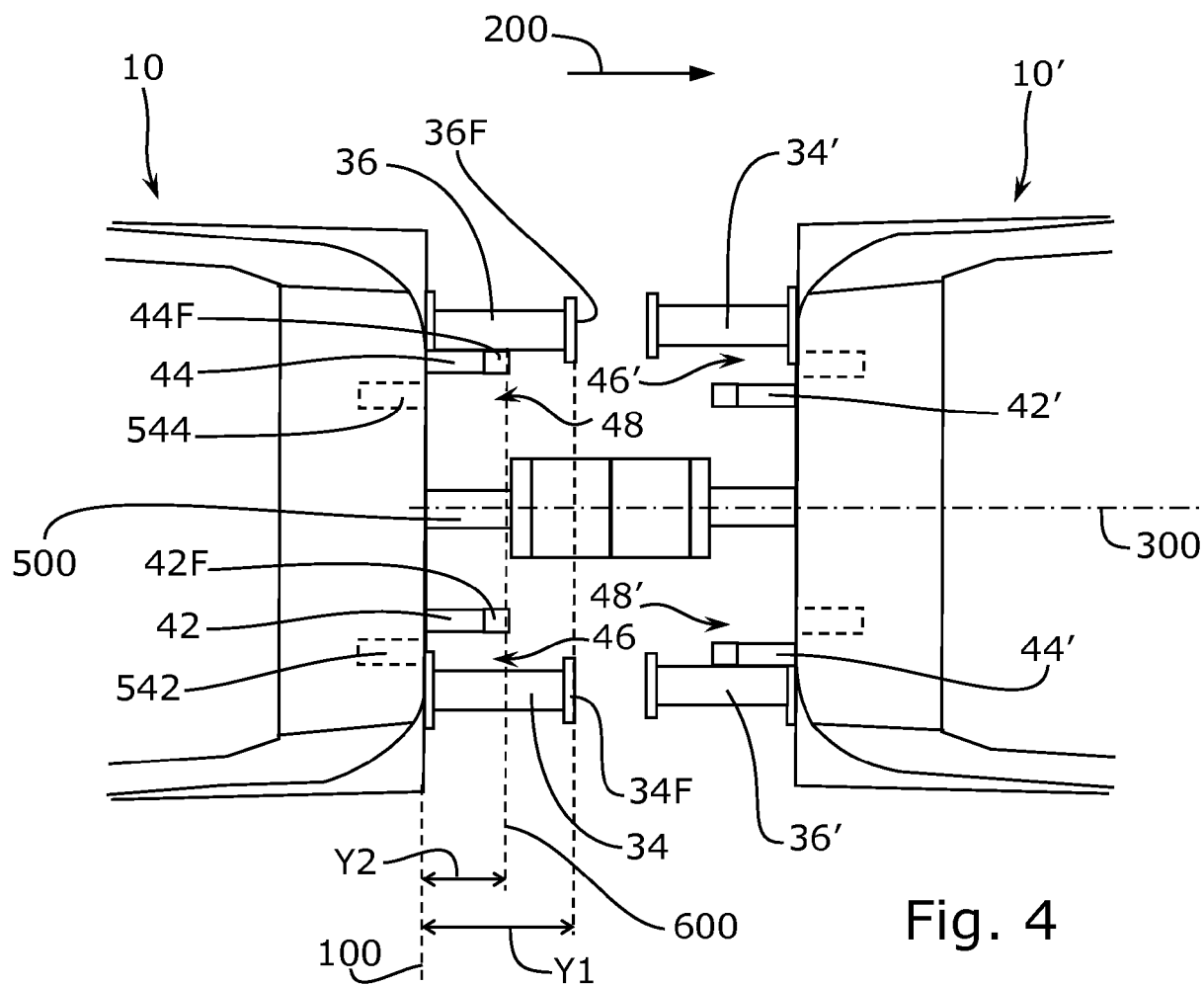


Fig. 3





EUROPEAN SEARCH REPORT

 Application Number
 EP 17 17 5836

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EPO FORM 1503 03.82 (P04C01)

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	EP 1 215 098 A1 (ALSTOM [FR]) 19 June 2002 (2002-06-19) * column 3, paragraph 0010 - column 5, paragraph 0023; figures 1-4 *	1-15	INV. B61D15/06
A	WO 2010/029188 A1 (VOITH PATENT GMBH [DE]) 18 March 2010 (2010-03-18) * page 15, line 9 - page 24, line 30; figures 1-19 *	1-15	
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A	EP 0 888 946 A1 (ALSTOM DDF [FR]) 7 January 1999 (1999-01-07) * column 3, line 6 - column 5, line 58; figures 1-4 *	1-15	
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