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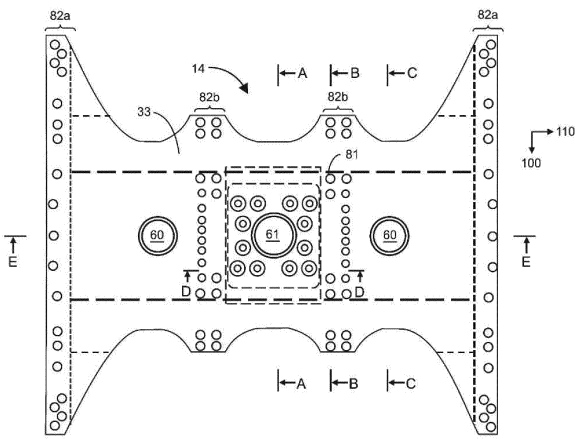
(54) BODY BOLSTER AND RAILROAD VEHICLE STRUCTURE PROVIDED WITH SAME

(57) Provided are a lightweight bolster having high reliability and capable of reducing a life cycle energy and a railway car structure body including this bolster. According to the invention, the above-mentioned problems can be solved by a bolster (14) including a core (50) made of metal and composite materials (33 and 35) sealing this core (50) or a railway car structure body including this bolster.

FIG. 3



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Description

Technical Field

[0001] The present invention relates to a plate-shaped bolster that constitutes an underframe forming a floor surface of a railway car structure body and is provided on a lower surface of the underframe in a railroad tie direction and a railway car structure body including the same.

Background Art

[0002] Generally, a railway car structure body (hereinafter, referred to as "structure body") is a hexahedron structure including an underframe forming a floor surface, side structures erected on both end portions in a width direction of the underframe, end structures erected on both end portions in a longitudinal direction of the underframe, and a roof structure provided on top end portions of the side structures and end structures. In the following production steps, a bogie for running on a railway is provided on lower surfaces of both end portions in a longitudinal direction of this structure body, and interior equipment, such as various kinds of electrical components that supply power for driving the bogie, seats, and lighting devices, is provided.

[0003] The underframe mainly includes side beams provided in the longitudinal direction of the underframe on both the end portions in the width direction of the underframe, end sills connecting both end portions in a longitudinal direction of the side beams, bolsters provided along the end sills and separately disposed in a predetermined dimension on a center side in the longitudinal direction of the structure body, and center sills connecting the end sills and the bolsters in the longitudinal direction of the structure body and including a coupler for coupling cars.

[0004] A center pin provided on a lower surface of each bolster forming the structure body (underframe) so as to hang downward is connected to a bogie frame forming a bogie via a traction device including a coupling link. Driving force of a railway car at the time of acceleration and brake force thereof at the time of deceleration are transmitted to the bolster of the underframe forming the structure body from the bogie via the traction device and the center pin. Therefore, the bolster needs to have high strength and rigidity. PTL 1 discloses a railroad car structure body having the above-mentioned structure.

Citation List

Patent Literature(s)

[0005] [PTL 1] WO 2013/157464

Summary of Invention

Technical Problem(s)

[0006] Because of a growing interest in environmental problems, reduction in life cycle energy that is a sum total of energy amounts at stages of procurement, production, use (operation), and reuse is strongly required. Reduction in weight of a structure body contributes to saving of resources and reduction in energy used at the time of operation, and therefore it is possible to reduce energy regarding use that occupies most of the life cycle energy, procurement, and production.

[0007] Further, a shock to the railway generated when the railway car runs is alleviated because of reduction in weight, and therefore it is possible to reduce a maintenance cost of the railway.

[0008] In order to promote reduction in weight, the structure body has been produced from a hollow extruded shape material made of an aluminum alloy. However, a current hollow extruded shape material having two face plates and a plurality of ribs connecting those face plates is thinned to near limits of an extrusion ability, and further reduction in weight is becoming difficult.

[0009] An object of the invention is to provide a lightweight bolster having high reliability and capable of reducing a life cycle energy and a railway car structure body including this bolster.

Solution to Problem(s)

[0010] In order to solve the above problems, a bolster constituting an underframe of a representative railway car structure body of the invention includes: a core made of metal; and a composite material provided along the core, and the above-mentioned problems can be solved by a railway car structure body including this bolster.

Advantageous Effects of Invention

[0011] According to the invention, it is possible to provide a lightweight bolster having high reliability and capable of reducing a life cycle energy and a railway car structure body including this bolster.

[0012] Problems, configurations, and effects other than those described above will be described by the following description of embodiments.

Brief Description of Drawings

[0013]

[Fig. 1] Fig. 1 is a side view of a railroad car.
[Fig. 2] Fig. 2 is a perspective view of a railroad car structure body seen from below.
[Fig. 3] Fig. 3 is a plan view of a bolster.
[Fig. 4] Fig. 4 is a plan view of a panel constituting the bolster illustrated in Fig. 3.

[Fig. 5] Fig. 5 is a plan view of a center pin mounting seat provided on a core illustrated in Fig. 4.
[Fig. 6] Fig. 6 is an A-A cross-sectional view of the bolster illustrated in Fig. 3.
[Fig. 7] Fig. 7 is a B-B cross-sectional view of the bolster illustrated in Fig. 3.
[Fig. 8] Fig. 8 is a C-C cross-sectional view of the bolster illustrated in Fig. 3.
[Fig. 9] Fig. 9 is a D-D cross-sectional view of the bolster illustrated in Fig. 3.
[Fig. 10] Fig. 10 is an enlarged view of an F portion of the B-B cross-section of the bolster illustrated in Fig. 7.
[Fig. 11] Fig. 11 is an E-E cross-sectional view (see Fig. 3) of the bolster constituting an underframe.

Description of Embodiments

[0014] A railway car is a general term of a car operated along a laid railway and means a railroad car, a monorail car, a car for a new transportation system, a streetcar, and the like.

[0015] Further, an example disclosed herein relates to a bolster made up of a core made of metal and a composite material provided on both upper and lower surfaces of this core and also relates to a structure body in which this bolster is provided on side beams and center sills constituting an underframe by mechanical fastening means such as rivets or bolts.

[0016] Hereinafter, an example of the invention will be described with reference to the drawings by using a railroad car as a representative example of the railway cars.

[0017] Note that directions regarding the railroad car for use in the following description are defined as a longitudinal direction (rail direction) 100 of the railroad car, a width direction (railroad tie direction) 110 of the railroad car, and a height direction 120 of the railroad car crossing the longitudinal direction 100 and the width direction 110. Hereinafter, those directions will be simply referred to as the longitudinal direction 100, the width direction 110, and the height direction 120.

[0018] Fig. 1 is a side view of the railroad car. The railroad car is made up of a railroad car structure body (hereinafter, referred to as "structure body 1"), a bogie 5, electrical components, interior equipment, and the like. The structure body 1 is a hexahedron including an underframe 10 (see Fig. 2) forming a floor surface, side structures 20 erected on both end portions in a width direction of the underframe 10, end structures 30 erected on both end portions in a longitudinal direction of the underframe 10, and a roof structure 40 supported by top end portions of the side structures 20 and top end portions of the end structures 30. Each side structure 20 includes window portions 22 for lighting and ventilation, a side exit/entrance 21 via which passengers and the like get on/off the railroad car, and the like.

[0019] Both end portions in the longitudinal direction 100 of the structure body 1 are supported by the bogie 5 so as to be movable on a railway. Plate-shaped bolsters 14 are provided in the width direction of the underframe 10 on parts of a lower surface of the underframe forming the floor surface of the structure body 1, the parts being parts on which the bogie 5 is provided. The structure body 1 is elastically supported by a pair of air springs 8 (only one thereof is illustrated) provided at a center portion in the longitudinal direction 100 of a bogie frame 6 of the bogie 5 provided under the bolsters 14. The air springs 8 have a function of restraining vibration and the like of the bogie 5 caused by irregularity of the railway and the like from being transmitted to the structure body 1 and a function of maintaining a constant floor surface height of the structure body 1 changing in the height direction 120 in accordance with an increase and decrease in the number of passengers.

[0020] Fig. 2 is a perspective view of the railroad car structure body seen from below. The underframe 10 forming the floor surface of the structure body 1 has high rigidity because the underframe 10 supports a weight of a passenger and a device provided under a floor and receives a compressive load and a tensile load from cars coupled to the own car. The underframe 10 includes side beams 11 that extend from the side structure 20 to both end portions in the width direction 110 and includes end sills 13 on both the end portions in the longitudinal direction 100. Further, two center sills 12 are provided to extend in the longitudinal direction 100 of the underframe 10 from a center portion in the width direction 110 of the end sills 13. Each center sill 12 includes a coupler (not illustrated) for coupling cars.

[0021] Each plate-shaped bolster 14 that connects one side beam 11 to the other side beam 11 is provided in the width direction 110 of the underframe 10 at a position having a predetermined distance from the end sill 13 toward the center in the longitudinal direction 100 of the underframe 10. The bolster 14 is connected to the side beams 11 by mechanical fastening means such as bolts at fastening portions 82a (see Fig. 3) on both end portions in the width direction 110 thereof and is also fastened to the two center sills 12 by mechanical fastening means such as bolts at fastening portions 82b (see Fig. 3) near the center in the width direction 110 thereof.

[0022] Fig. 3 is a plan view of the bolster, and Fig. 4 is a plan view of a panel 51 constituting the bolster illustrated in Fig. 3. The bolster 14 is a plate-shaped component and has a shape symmetrical to an imaginary line showing an E-E cross-section. Both the end portions in the width direction 110 of the bolster 14 serve as the fastening portions 82a on both the end portions, which are fastened to the side beams 11. Further, the fastening portions 82b near the center, which are fastened to the center sills 12, project in the longitudinal direction 100 from a center portion in the width direction 110 of the bolster 14.

[0023] The bolster 14 in this example is made up of a core 50 made of metal and a composite material provided along this core 50. That is, at least part of a surface of

the core 50 made of metal and part of a surface of the composite material exist substantially in parallel to each other. The core 50 is made up of the panel 51 made of metal and a center pin mounting seat 75 (see Fig. 5) made of metal and connected to a center portion of the panel 51.

[0024] With such a configuration, it is possible to promote reduction in weight of the bolster in this example, as compared to a conventional bolster made up of only metal components.

[0025] Further, the bolster 14 is preferably made up of the core 50 (see Fig. 6) made of metal, a first composite material 33 provided on an upper surface in the height direction 120 of this core 50, and a second composite material 35 provided on a lower surface thereof.

[0026] With such a configuration, even in a case where a bending load is applied to the bolster 14, the above-mentioned composite materials having high tensile strength and compressive strength mainly bear the load, and therefore it is possible to promote reduction in weight of the bolster in this example and the bolster can have high bending strength and rigidity.

[0027] Further, the bolster 14 is preferably such that substantially the whole core 50 is wrapped in and sealed with the first composite material 33 covering the upper surface of the core 50 and the second composite material 35 covering the lower surface of the core 50 (see Fig. 6). In other words, the composite materials are a cylindrical body including the core 50 thereinside.

[0028] With such a configuration, the bolster in this example can have high strength, rigidity, and durability (weather resistance) of a metal component, and it is possible to provide a railway car capable of reducing a life cycle cost.

[0029] Further, the bolster 14 has a hybrid structure including the core 50 made of metal, the first composite material 33, and the second composite material 35. Therefore, even in a case where mechanical strength of the composite materials is lost due to degradation over time and the like, the metallic core 50 can secure residual strength, and thus the bolster 14 can have high reliability.

[0030] Note that, although not illustrated, the bolster 14 may be formed by inserting the core 50 through an opening of a cylindrical portion obtained by weaving fibers in a cylindrical shape, then closing this opening, impregnating this cylindrical body including the core 50 thereinside with resin, and curing the cylindrical body, instead of using the first composite material 33 and the second composite material 35.

[0031] Fig. 4 is a plan view of the panel 51 constituting the bolster 14. The panel 51 is made of, for example, an aluminum alloy and includes a first member 53 having a rectangular shape and having a long side disposed in the width direction 110 at the center portion, second members 55 provided along both edges in the longitudinal direction 100 of the first member 53, third members 57 provided in the longitudinal direction 100 on both edges in the width direction 110 of the first member 53 and the second members 55, and fourth members 58 connected to the second members 55 and the third members 57. Note that an integrated member in which the second members 55 and the third members 57 are integrally provided may be prepared, instead of using the second members 55 and the third members 57 which are individually prepared.

[0032] A center portion in the width direction of the first member 53 constituting the panel 51 has an opening 61 in which the center pin mounting seat 75 (see Fig. 5) is provided. Further, in order to elastically support the structure body 1, openings 60 are provided on parts on which the air springs provided on an upper surface of the bogie 5 abut.

[0033] Fig. 5 is a plan view of the center pin mounting seat 75 provided on the core illustrated in Fig. 4. The center pin mounting seat 75 is, for example, a rectangular plate-shaped member that is produced by being cut off from an aluminum alloy and has a dimension in the longitudinal direction 100 larger than a dimension in the width direction 110. Flanges 75b provided in the longitudinal direction and flanges 75c provided in the width direction 110 are provided on a circumference of the center pin mounting seat 75.

[0034] The center pin mounting seat 75 has an opening 75e at a center portion thereof, and a plurality of cylindrical portions 75d having axes in the height direction 120 are cut off around the opening 75e. The center pin mounting seat 75 is fastened to the bolster 14 by bolts to be inserted through the cylindrical portions 75d (see Fig. 9).

[0035] Fig. 6 is a cross-sectional view of the bolster taken along the line A-A of Fig. 3. The reference sign 50 in Fig. 6 denotes a range of the core 50. The core 50 in this cross-section is made up of the panel 51 including the first member 53 and the second members 55, the center pin mounting seat 75 provided on this panel 51, and the like. In addition, the reference sign 75 in Fig. 6 denotes a range of the center pin mounting seat 75. Further, the reference sign 61 in Fig. 6 denotes an opening.

[0036] Further, the whole surface of the core 50 including the panel 51, the center pin mounting seat 75, and the like is sealed with the first composite material 33 and the second composite material 35 having a shell structure and divided in the height direction 120.

[0037] Fig. 7 is a cross-sectional view of the bolster 14 taken along the line B-B of Fig. 3. In this cross-section, the bolster 14 is such that whole surfaces of the first member 53 and the second members 55 forming the core 50 are sealed with the first composite material 33 and the second composite material 35 having a shell structure and divided in the height direction 120.

[0038] In other words, the bolster 14 has a hybrid structure in which both surfaces in a vertical direction (height direction 120) of a metallic member (core 50) disposed as a core are interposed between composite materials (first composite material 33 and second composite material 35) and is such that two composite materials (33

and 35) are separately disposed via the core 50 in the height direction 120.

[0039] Further, cylindrical bodies 59 penetrating in the height direction 120 are provided in the first composite material 33, the second composite material 35, and the first member 53 or the second members 55 which are part of the core 50.

[0040] Fig. 8 is a cross-sectional view taken along the line C-C of Fig. 3. Also in this cross-section, the bolster 14 is provided by sealing the whole surface of the assembled core 50 with the first composite material 33 and the second composite material 35 having a shell structure and divided in the height direction 120.

[0041] Fig. 9 is a cross-sectional view of the bolster taken along the line D-D of Fig. 3. The reference sign 75 in Fig. 9 denotes a range of the center pin mounting seat 75. In the center pin mounting seat 75, the flanges 75b are fitted into openings of a face plate 53c under the first member 53. In addition, as well as in other cross-sectional views, the whole surface is sealed with the first composite material 33 and the second composite material 35 having a shell structure, except for the cylindrical portions 75d.

[0042] Fig. 10 is an enlarged view of an F portion of the B-B cross-section of the bolster illustrated in Fig. 7. A cross-sectional structure in Fig. 10 is a structure in which an insulating material 36 (glass fiber layer or GFRP) is provided on a surface of the core 50 (panel 51, center pin mounting seat 75, and the like) and outer sides of those insulating layers are sealed with composite materials (first composite material 33 and second composite material 35).

[0043] With this configuration, it is possible to restrain the core 50 made of an aluminum alloy from being deteriorated due to electric corrosion. This makes it possible to provide a railway car including the bolster 14 having high reliability.

[0044] Next, the first composite material 33 and the second composite material 35 covering the core 50 will be described. The first composite material 33 and the second composite material 35 are made of a carbon-fiber reinforced plastic (hereinafter, referred to as "CFRP") in which a carbon fiber is selected as a reinforced fiber and epoxy resin is selected as matrix resin. Note that the reinforced fiber is not limited to a carbon fiber, and a glass fiber, an aramid fiber, or the like may be selected as the reinforced fiber. Similarly, the matrix resin is not limited to epoxy resin, and unsaturated polyester resin, vinylester resin, phenol resin, or the like may be selected as the matrix resin.

[0045] Further, in order to equalize an elastic modulus of CFRP with that of the core made of an aluminum alloy, CFRP may have a quasi-isotropic laminate configuration without having an anisotropy or may have a laminate configuration having an anisotropy in order to apply strength based on a load condition (load direction) to the CFRP.

[0046] Hereinafter, production steps of the bolster 14 will be described. First, the panel 51 forming the core 50 is produced. The first member 53, the second members 55, the third members 57, and the fourth members 58 forming the panel 51 are prepared.

[0047] The first member 53 and the second members 55 are a hollow extruded shape material having two face plates 53a(55a) and 53c(55c) facing each other and a rib 53b(55b) connecting the face plates and are extruded and molded in the width direction 110. The panel 51 is produced by positioning four types of members, i.e., the first member 53, the second members 55, the third members 57, and the fourth members 58 and then joining those members by welding (or friction stir joining) along joining lines 71, 72, and 73.

[0048] Then, a part into which the center pin mounting seat 75 described below is fitted is processed in the panel 51. The face plate 53c under the center portion of the first member 53 (panel 51) is removed in accordance with a rectangular shape of the center pin mounting seat 75 (a rectangular shape having the dimension in the longitudinal direction 100 larger than the dimension in the width direction 110). Further, a plurality of holes 80 into which the plurality of cylindrical portions 75d provided on the center pin mounting seat 75 are fitted are processed in the upper face plate 53a facing the removed lower face plate (see Fig. 3, Fig. 4, and Fig. 9).

[0049] Next, an aluminum alloy is cut out to produce the center pin mounting seat 75. The center pin mounting seat 75 is shaped to have a rectangular shape having the dimension in the longitudinal direction 100 larger than the dimension in the width direction 110, and the opening 75e is processed at the center portion thereof. The flanges 75b provided in the longitudinal direction 100 and the flanges 75c provided in the width direction 110 are cut out on the whole circumference of the center pin mounting seat 75, and the plurality of cylindrical portions 75d to which a center pin 15 is fastened are cut out around the opening 75e so as to have an axis direction in the height direction 120.

[0050] Then, the center pin mounting seat 75 is connected to the panel 51 to produce the core 50. First, the center pin mounting seat 75 is fitted into the processed part of the panel 51 (first member 53). The flanges 75b(75c) provided on the circumference of the center pin mounting seat 75 are fitted until the flanges 75b(75c) abut on the face plate 53a of the first member 53, and the plurality of cylindrical portions 75d of the center pin mounting seat 75 are fitted into the plurality of holes 80 processed in the panel 51 (first member 53). At this time, superimposition of the joining lines 71 of the first member 53 and the second members 55 on the flanges 75c of the center pin mounting seat 75 is confirmed, and then the first member 53 and the center pin mounting seat 75 are welded. By performing attachment as described above, it is possible to firmly fix the center pin mounting seat 75 to the panel 51.

[0051] Next, the first composite material 33 and the second composite material 35, which have been subject-

ed to a prepreg step in which a carbon fiber is impregnated with epoxy resin in advance and then have been subjected to autoclave molding, and the core 50 are put together by being bonded with a cold-setting adhesive so as to prevent a residual stress from being generated due to a difference between linear expansion coefficients. At this time, the thin insulating material 36 (glass fiber layer or GFRP; see Fig. 10) which achieves electrical insulation to restrain electric corrosion is provided on the surfaces of the composite materials (first composite material 33 and second composite material 35) which are in contact with the core 50 (panel 51, center pin mounting seat 75, and the like) made of an aluminum alloy. Further, in order to obtain a firm bonding surface, screws (small screws) and the like may be additionally provided at intervals of several hundreds of millimeters to secure a surface pressure at the time of bonding.

[0052] Note that the producing method in which autoclave molding is performed after a prepreg step has been described as an example of a producing method of composite materials. However, instead of this producing method, members that have been molded by a continuous molding method such as press molding, a resin transfer molding (RTM) method, a reaction injection molding (RIM) method, or a pultrusion method may be cut in an appropriate dimension and then those members may be joined to be put together. Further, there may also be employed, for example, an integrally molding method (SCRIMP method) in which a dispersing agent of matrix resin to be injected is disposed at the same time when a molded portion is decompressed.

[0053] After assembly is completed, holes 81 through which the cylindrical bodies 59 (bushes; see Fig. 7) are inserted are machined, and then the cylindrical bodies 59 that penetrate the first composite material 33, the second composite material 35, and the core 50 in the height direction 120 to bind those members in the vertical direction are fixed. In this way, the bolster 14 is finished.

[0054] As illustrated in Fig. 7, an axial-direction dimension t1 of each cylindrical body 59 is set to be slightly larger than a dimension between the upper surface of the first composite material 33 and the lower surface of the second composite material 35. The cylindrical body 59 is fixed to the bolster 14 so that a top end portion of the cylindrical body 59 projects upward (direction of the underframe 10) from the upper surface of the first composite material 33 and a bottom end portion of the cylindrical body 59 projects downward from the lower surface (surface facing the railway) of the second composite material 35.

[0055] Further, although not illustrated, recessed portions suitable for a shape of abutting surfaces of the cylindrical bodies 59 may be processed on parts of the side beams 11 and the center sills 12 on which the cylindrical bodies 59 (bolster 14) abut and the bolster 14 may be mechanically fastened to the side beams 11 and the center sills 12 in a state in which abutting portions of the cylindrical bodies 59 are fitted into the recessed portions provided on the side beams 11 and the center sills 12.

[0056] Note that the recessed portions may be provided on the side beams 11 and the center sills 12 on which all the cylindrical bodies 59 abut, or the recessed portions may be provided only on parts on which selected cylindrical bodies 59 abut.

[0057] When the recessed portions are provided on the side beams 11 and the center sills 12 in accordance with the shape of the cylindrical bodies 59 that project from the upper surface of the first composite material 33 and the surface of the second composite material 35 as described above, it is possible to maintain fastening without the bolster 14 sliding on the side beams 11 or the center sills 12 even in a case where traction force or brake force is applied to the bolster 14 from the bogie 5. Further, because the recessed portions are provided, it is possible to reduce the number of mechanical fastening portions and the number of cylindrical bodies 59, and therefore it is possible to reduce a production cost and promote reduction in weight.

[0058] The bolster 14 is mechanically fastened to the side beams 11 and the center sills 12 constituting the underframe 10 by bolts inserted through the cylindrical bodies 59. Further, the center pin 15 is mechanically fastened to the bolster 14 by bolts inserted through the cylindrical portions 75d. The cylindrical bodies 59 are components provided to prevent buckling caused by a bearing surface pressure generated due to fastening force of the bolts and do not necessarily need to be made of an aluminum alloy and may be made of, for example, iron having high buckling strength.

[0059] Further, when the cylindrical bodies 59 are made of an electroconductive material, it is possible to provide a railway car having high reliability and capable of restraining an electric device from being broken or reset in a case where a current caused by a large voltage (hereinafter, surge current) is generated.

[0060] For example, when a power collector (pantograph) is brought into contact with an overhead line or is separated from the overhead line or when a vacuum circuit breaker (VCB) provided in a circuit connecting the power collector and a main transformer is switched on/off, an extremely large voltage is momentarily generated and a surge current is generated due to this large voltage in some cases.

[0061] This surge current causes breakage of electric devices such as a main converter, an auxiliary power supply device, and an air conditioner mounted on the railway car and causes reset operation of those electric devices in some cases. Therefore, in order to protect the electric devices from a surge current, there is provided a grounded circuit that electrically connects the structure body 1 and the bogie 5 and is grounded on the railway (railroad) via a wheel set 7 (including wheels on both end portions of an axle) provided in the bogie 5.

[0062] In other words, by providing an electroconductive or high electroconductive member that penetrates the upper surface and lower surface in the height direc-

tion 120 of the bolster covered with the composite materials, it is possible to form a grounded circuit (see Fig. 11) that extends to the bogie 5 from the structure body 1 (the center sills 12 and the side beams 11 forming the underframe 10) via the bolster 14. Therefore, even when the bolster 14 is covered with composite materials having lower electroconductivity than that of a metal or the like, it is possible to provide a railway car having high reliability and capable of restraining electric devices from being broken or reset due to a surge current.

[0063] Fig. 11 is an E-E cross-sectional view (see Fig. 3) of the bolster constituting the underframe. The bolster 14 is connected to the side beams 11 and the center sills 12 constituting the underframe of the structure body 1 by mechanical fastening means such as bolts. The cylindrical bodies 59 (bushes) provided in the bolster 14, which are used for the above fastening, are provided in two rows or a row in the longitudinal direction 100 of the structure body 1.

[0064] The center pin 15 serving as center of revolution of the bogie 5 is provided on a center portion in the width direction 110 of the lower surface (a surface on which the bogie 5 is provided) of the bolster 14. The center pin 15 and the bogie are coupled by a traction device, and traction force and brake force are transmitted to the structure body 1 from the bogie 5 via the traction device. Further, the pair of air springs 8 are provided on a center portion in the longitudinal direction 100 of the bolster 14 so as to be provided in the width direction 110 thereof and interposes the center pin 15 therebetween.

[0065] A sufficient space exists between the lower surface of the underframe 10 and the upper surface of the bolster 14, and a piping (wiring) module 9 obtained by bundling a plurality of wires and pipes is provided on the lower surface of the underframe 10 in the longitudinal direction 100 of the structure body 1 from end portions thereof to a center portion thereof without interfering with the bolster 14. Further, an air tank may also be provided in the above-mentioned space.

[0066] As described above, by employing the configuration in this example, it is possible to promote reduction in weight of the bolster 14 because the bolster 14 in this example is not made up of only metal components. Further, because the first composite material 33 and the second composite material 35 are provided on both the surfaces in the vertical direction (height direction) of the plate-shaped core 50 made of metal, and therefore, even in a case where a bending load is applied to the bolster 14, the above-mentioned composite materials having high tensile strength and compressive strength mainly bear the load. Thus, it is possible to promote reduction in weight of the bolster 14 and the bolster 14 can have high bending strength and rigidity.

[0067] Further, because both the whole surfaces in the vertical direction (height direction) of the plate-shaped core 50 made of metal is sealed with the first composite material 33 and the second composite material 35, the bolster 14 in this example can have high strength, rigidity, and durability (weather resistance) of a metal component, and it is possible to provide a railway car capable of reducing a life cycle cost.

[0068] Further, the bolster 14 in this example has a hybrid structure including the core 50 made of metal, the first composite material 33, and the second composite material 35. Therefore, even in a case where mechanical strength of the composite materials is lost due to degradation over time and the like, the metallic core 50 can secure residual strength, and thus the bolster 14 can have high reliability.

[0069] Further, with the configuration in which recessed portions are provided on the side beams 11 and the center sills 12 and the bolster 14 and the side beams 11 and the center sills 12 are mechanically fastened to each other in a state in which the cylindrical bodies 59 forming the bolster 14 are fitted into those recessed portions, it is possible to maintain fastening without the bolster 14 sliding on the side beams 11 or the center sills 12 even in a case where traction force or brake force is applied to the bolster 14 from the bogie 5. Furthermore, because the recessed portions are provided, it is possible to reduce the number of mechanical fastening portions and the number of cylindrical bodies 59, and therefore it is possible to reduce a production cost and promote reduction in weight.

[0070] Further, the bolster 14 in this example is assembled by a metallic core and composite materials with an adhesive and therefore has a high attenuation rate. Thus, when vibration is input to the bolster 14 from the bogie 5 via the traction device and the center pin 15, the vibration is attenuated in a process of transmitting the vibration through the inside of the bolster 14, and therefore the vibration is hardly transmitted to the underframe 10. Accordingly, it is possible to reduce in-car noise and vibration which are generated due to vibration of the structure body 1 from the bogie 5. This makes it possible to provide a comfortable railway car.

[0071] Further, as a modification example of this example, a state monitor system that includes an accelerometer 90 and monitors a vibration level of the bolster 14 that is in an operation state may be mounted on the upper surface (surface facing the lower surface of the underframe 10) of the bolster 14 constituting the underframe 10. When the first (second) composite material 33(35) constituting the bolster 14 is deteriorated or bonding surfaces of the core 50 and the composite materials constituting the bolster 14 are peeled off, the vibration level and a natural oscillation frequency of the bolster 14 monitored by the accelerometer 90 are changed. By monitoring those changes in the vibration level and the like, normality of the bolster 14 can be always monitored. This makes it possible to provide a railway car having high reliability.

[0072] Further, the bolster 14 includes a glass fiber layer (see Fig. 10) serving as the insulating material 36 on boundary surfaces between the core 50 made of an aluminum alloy and the composite materials (first composite

material 33 and second composite material 35). With this configuration, it is possible to restrain the core 50 made of an aluminum alloy from being deteriorated due to electric corrosion. This makes it possible to provide a railway car including the bolster 14 having high reliability.

[0073] Further, the bolster 14 includes the electroconductive cylindrical bodies 59, and therefore it is possible to easily form the grounded circuit (see Fig. 11) that extends to the bogie 5 from the structure body 1 (center sills 12 and side beams 11 forming underframe 10) via the bolster 14 through those cylindrical bodies 59. This makes it possible to provide a railway car having high reliability and capable of restraining electric devices from being broken or reset due to a surge current.

[0074] With the above configuration, it is possible to provide a lightweight bolster having high reliability and capable of reducing a life cycle energy and a railway car structure body including this bolster.

[0075] Note that the invention is not limited to the above-mentioned examples and includes various modification examples. For example, the above-mentioned examples have been described in detail to easily change the invention, and therefore the invention is not necessarily limited to the examples having all the configurations described above. Further, a part of a configuration of an example can be replaced with another configuration, and another configuration can be added to a configuration of an example. Further, a configuration can be added to, removed from, or replaced with a part of the configuration in an example.

Reference Signs List

[0076]

1 ... structure body
5 ... bogie
6 ... bogie frame
7 ... wheel set
8 ... air spring
9 ... piping (wiring) module
10 ... underframe
11 ... side beam
12 ... center sill
13 ... end sill
14 ... bolster
15 ... center pin
20 ... side structure
21 ... side exit/entrance
22 ... window portion
50 ... core
30 ... end structure
40 ... roof structure
33 ... first composite material
35 ... second composite material
36 ... insulating material
51 ... panel
53 ... first member
55 ... second member
57 ... third member
58 ... fourth member
59 ... cylindrical body
60, 61 ... opening
71, 72, 73 ... joining line
75 ... center pin mounting seat
75b, 75c ... flange
75d ... cylindrical portion
75e ... opening
80, 81 ... hole
82a, 82b ... fastening portion
90 ... accelerometer
100 ... longitudinal direction
110 ... width direction
120 ... height direction

Claims

1. A bolster forming an underframe of a railway car structure body, the bolster comprising:

   a core made of metal; and
   a composite material provided along the core.

2. The bolster according to claim 1, wherein
the composite material is a cylindrical body including the core.

3. The bolster according to claim 1, wherein
the composite material includes
a first composite material provided on an upper surface of the core, and
a second composite material provided on a lower surface of the core.

4. The bolster according to claim 3, further comprising an electroconductive member penetrating the first composite material, the core, and the second composite material in a height direction of the railway car structure body.

5. The bolster according to claim 4, wherein
the core includes
a panel made of metal, and
a center pin mounting seat provided on a center portion of the panel.

6. The bolster according to claim 5, wherein
the panel is an extruded shape material made of an aluminum alloy and having two face plates facing each other and a rib connecting the face plates.

7. The bolster according to claim 5, wherein
the panel includes
a first member provided in a width direction on a center portion in a longitudinal direction of the bolster, and

second members joined to the first member along both end portions in a longitudinal direction of the first member.

8. The bolster according to claim 5, wherein the center pin mounting seat is a rectangular plate-shaped member having a dimension in a longitudinal direction larger than a dimension in a width direction, and has a flange to abut on and be welded to one of the face plates on a circumference of the plate-shaped member and a plurality of cylindrical portions through which bolts for fixing the center pin to the center pin mounting seat are inserted.

9. The bolster according to claim 8, wherein the center pin mounting seat is welded to the panel so that the flange is superimposed on a joining line.

10. The bolster according to claim 4, wherein the bolster includes an insulating material on boundary surfaces between the core and the first composite material and the second composite material.

11. The bolster according to claim 4, wherein the electroconductive member has a cylindrical body, and a top end portion of the electroconductive member projects from an upper surface of the first composite material.

12. A railway car structure body, comprising the bolster according to any one of claims 1 to 11.

FIG. 1

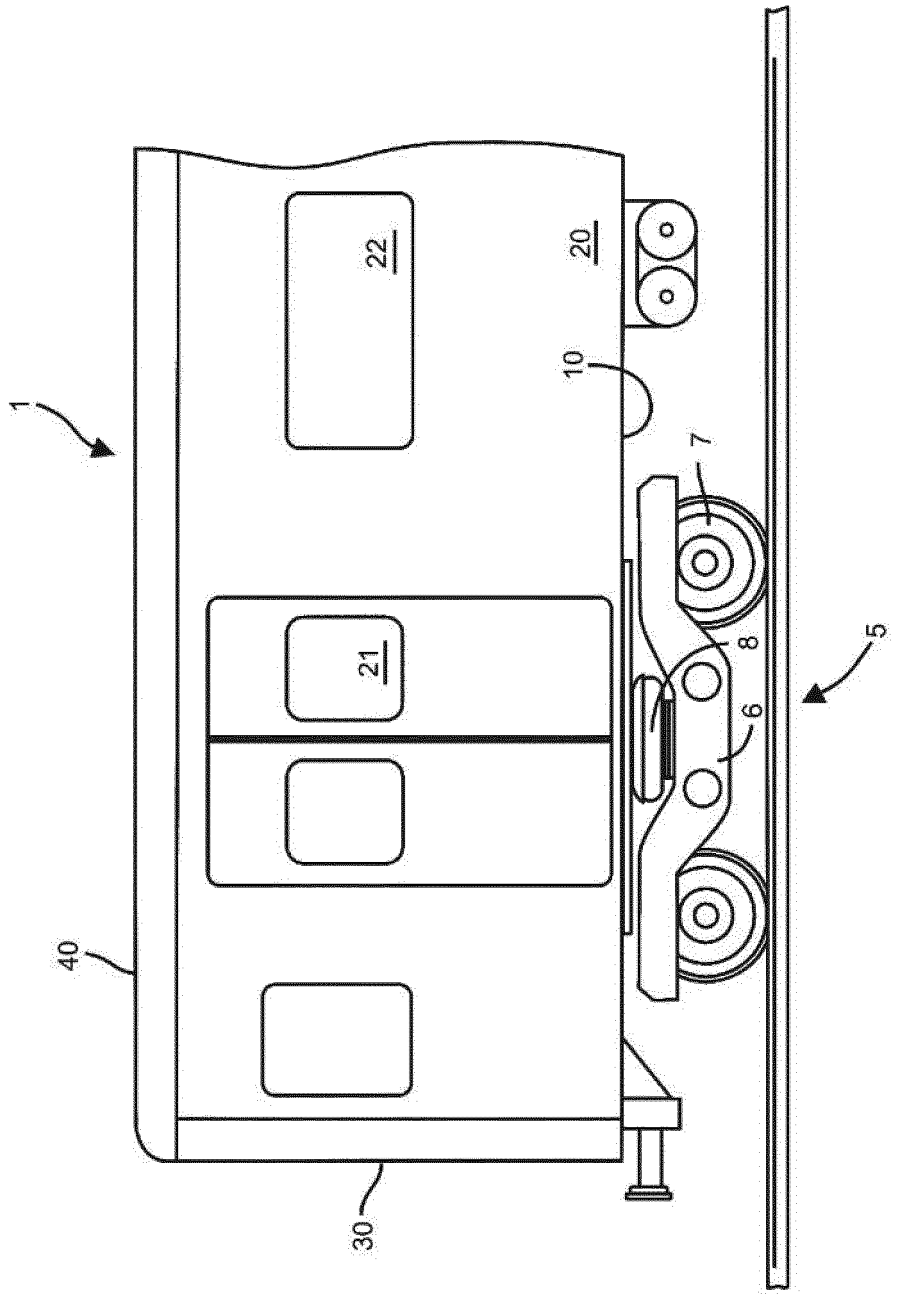


FIG. 2

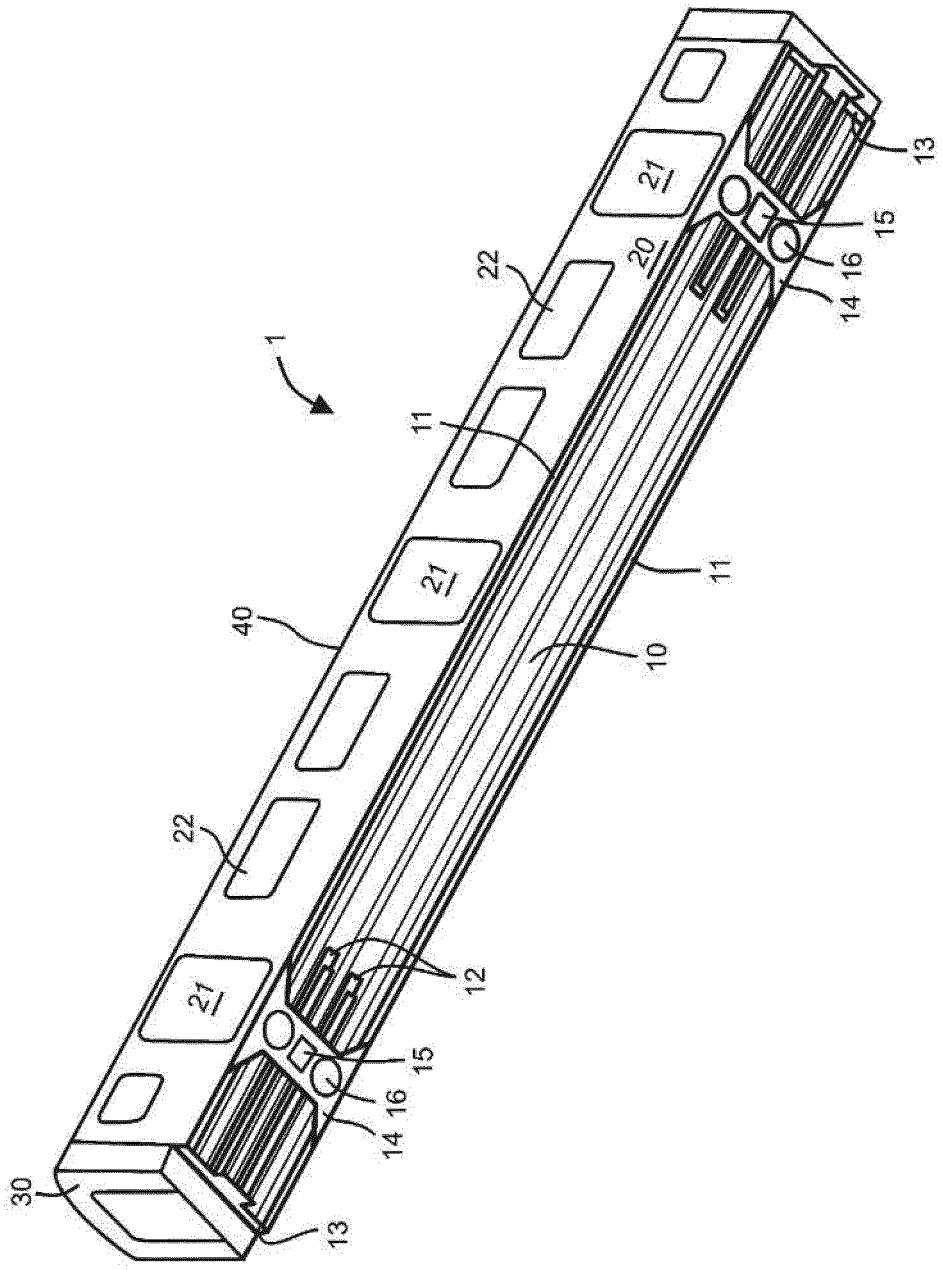


FIG. 3

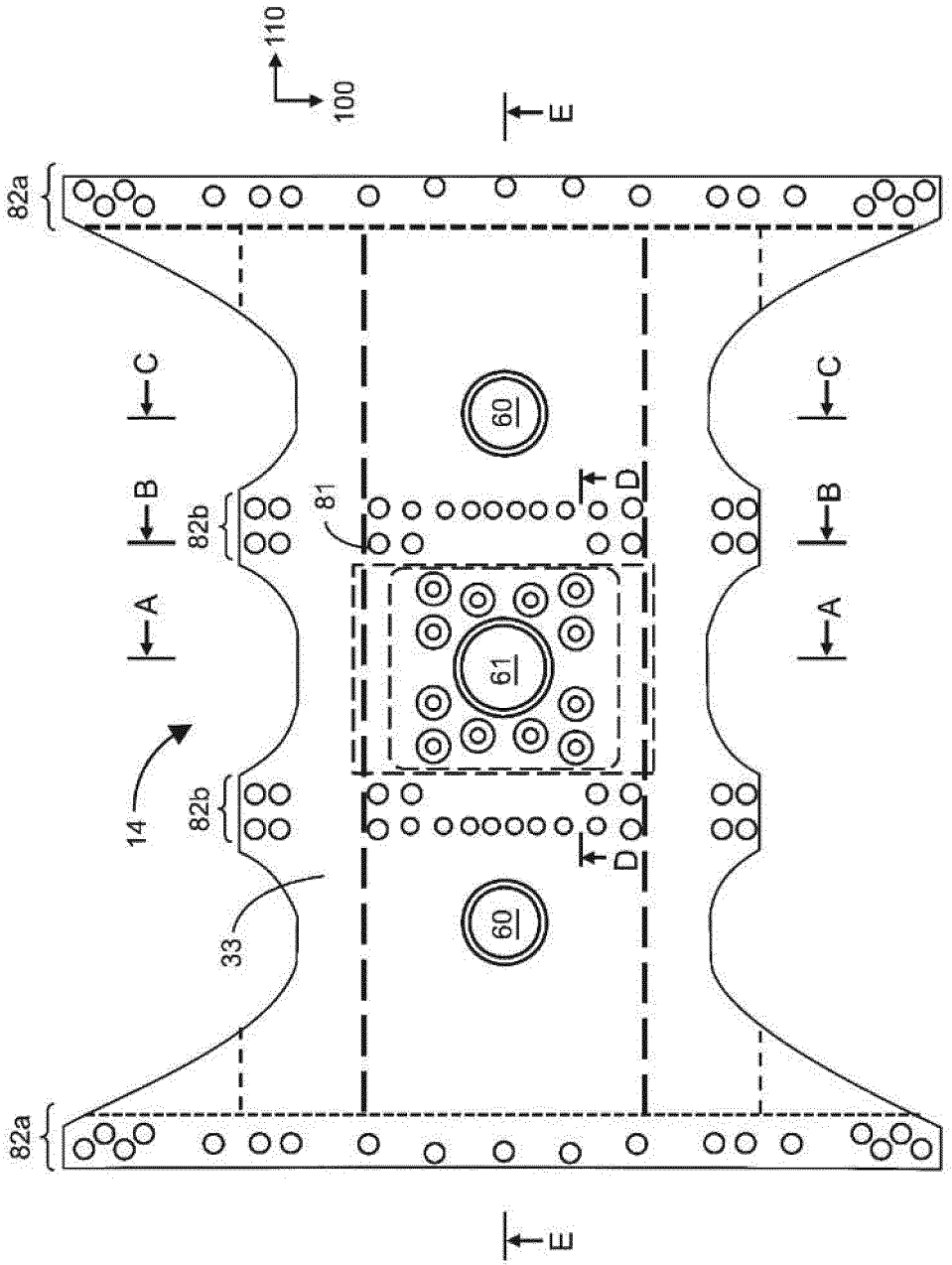


FIG. 4

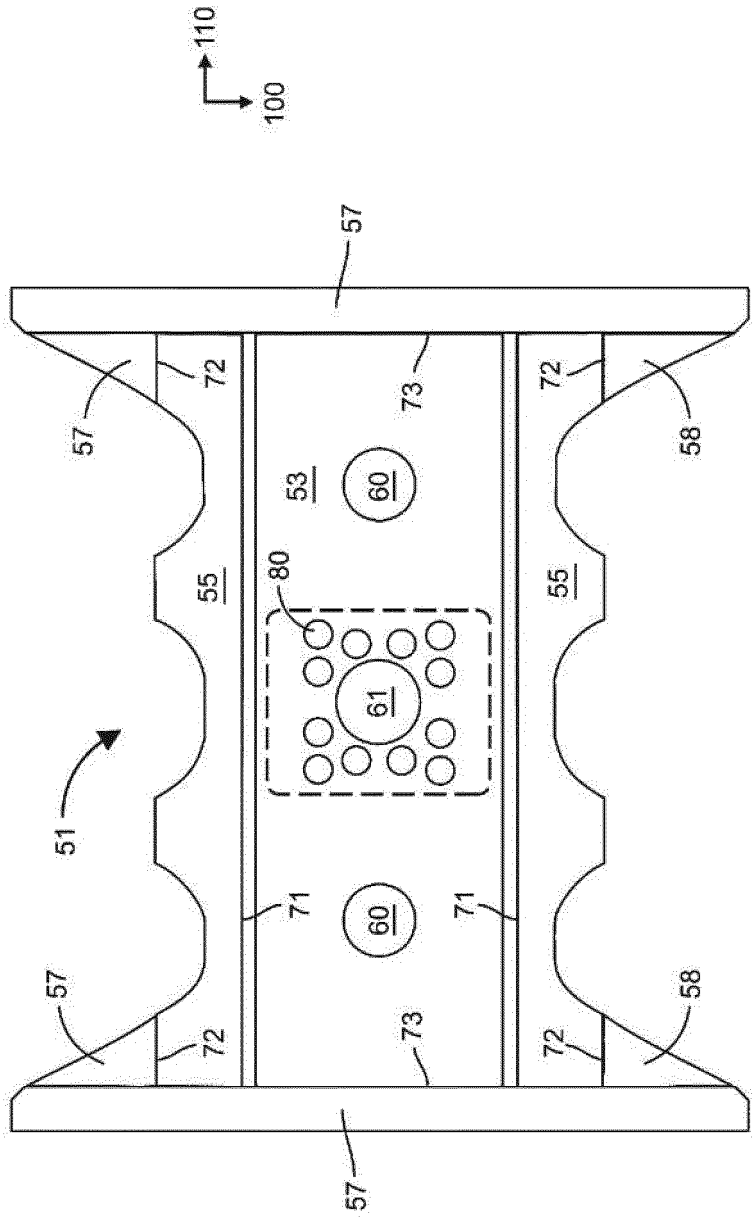


FIG. 5

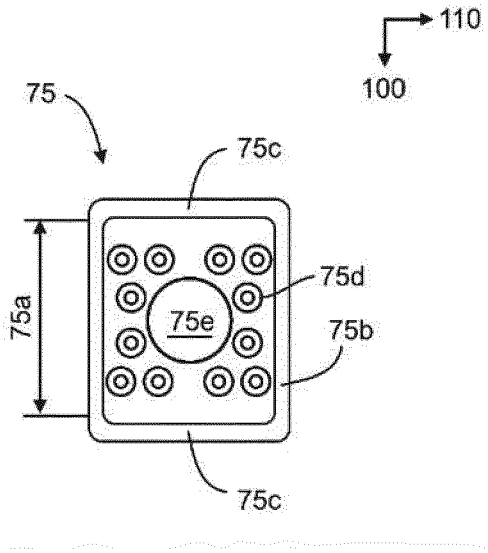


FIG. 6

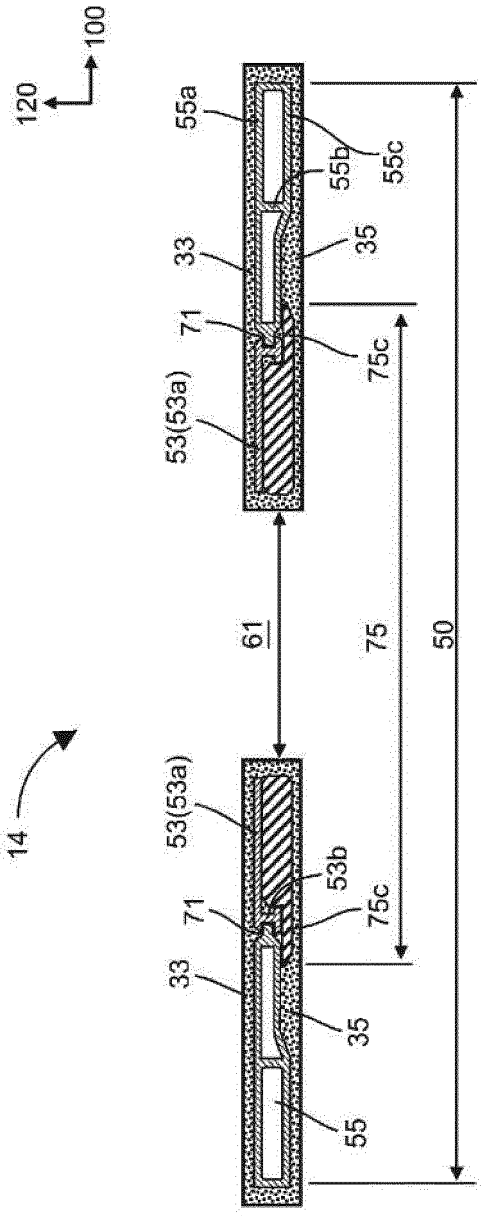

100
120
55a
55b
55c
33
35
71
75c
53(53a)
61
75
50
14
53(53a)
53b
71
75c
33
35
55

FIG. 7

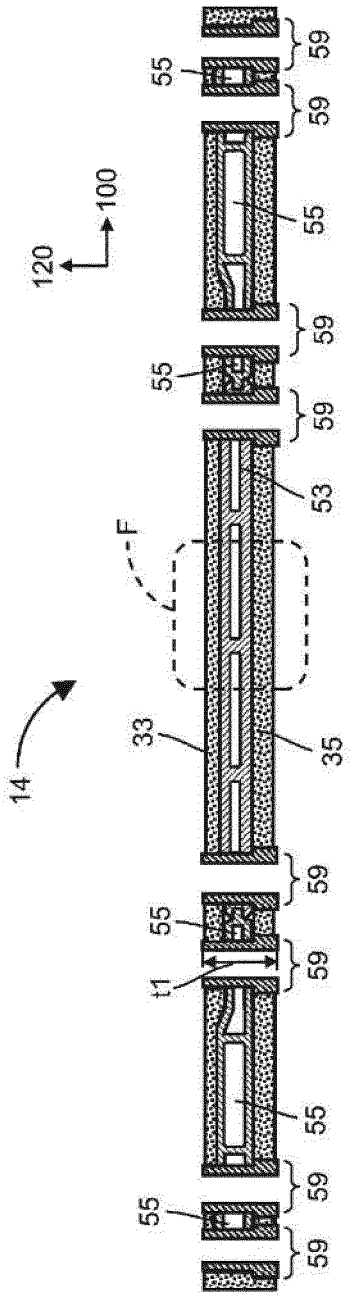


FIG. 8

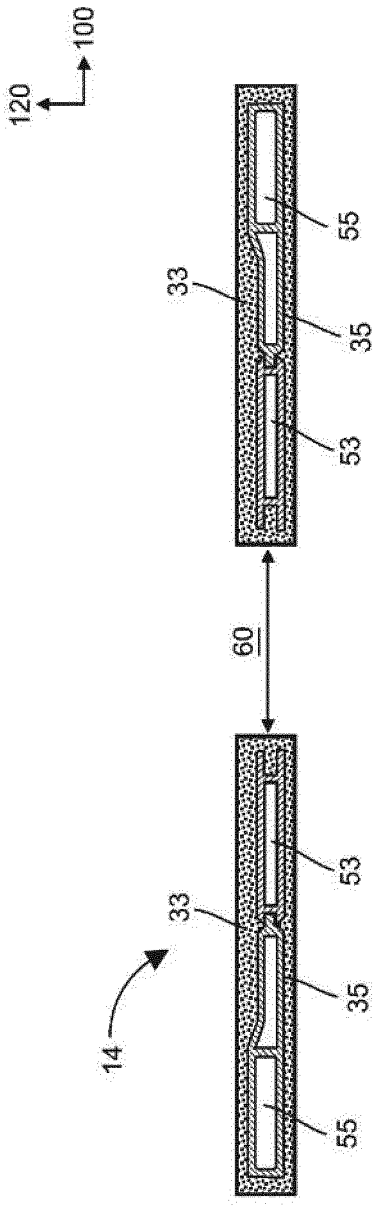


FIG. 9

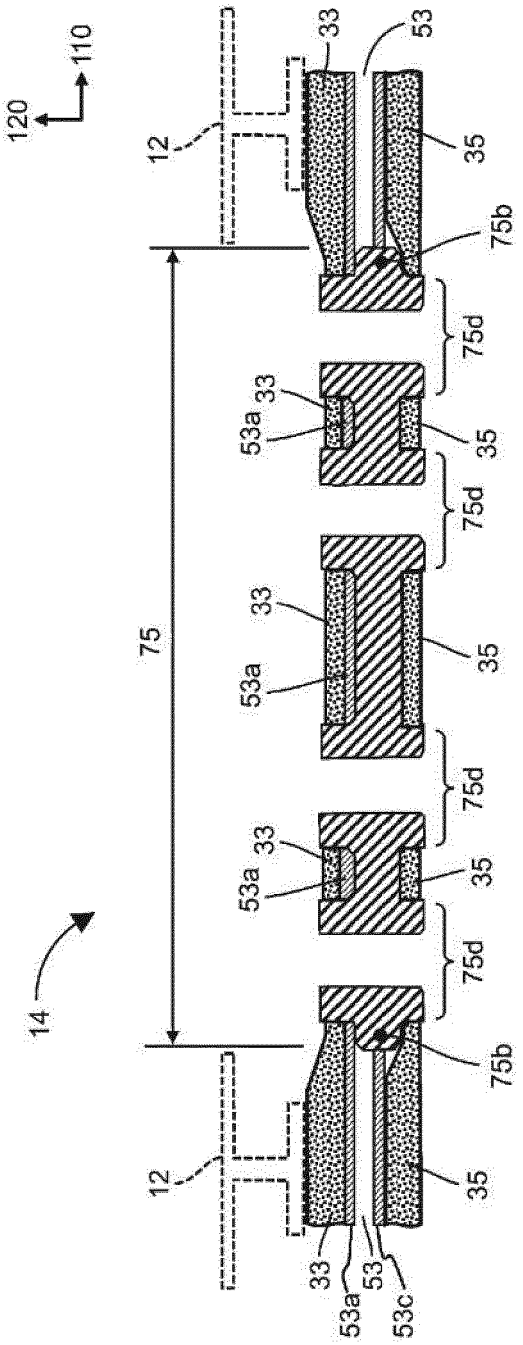


FIG. 10

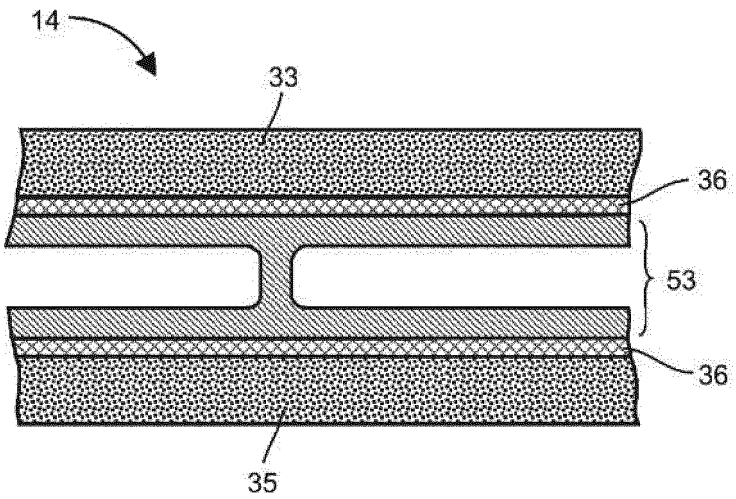
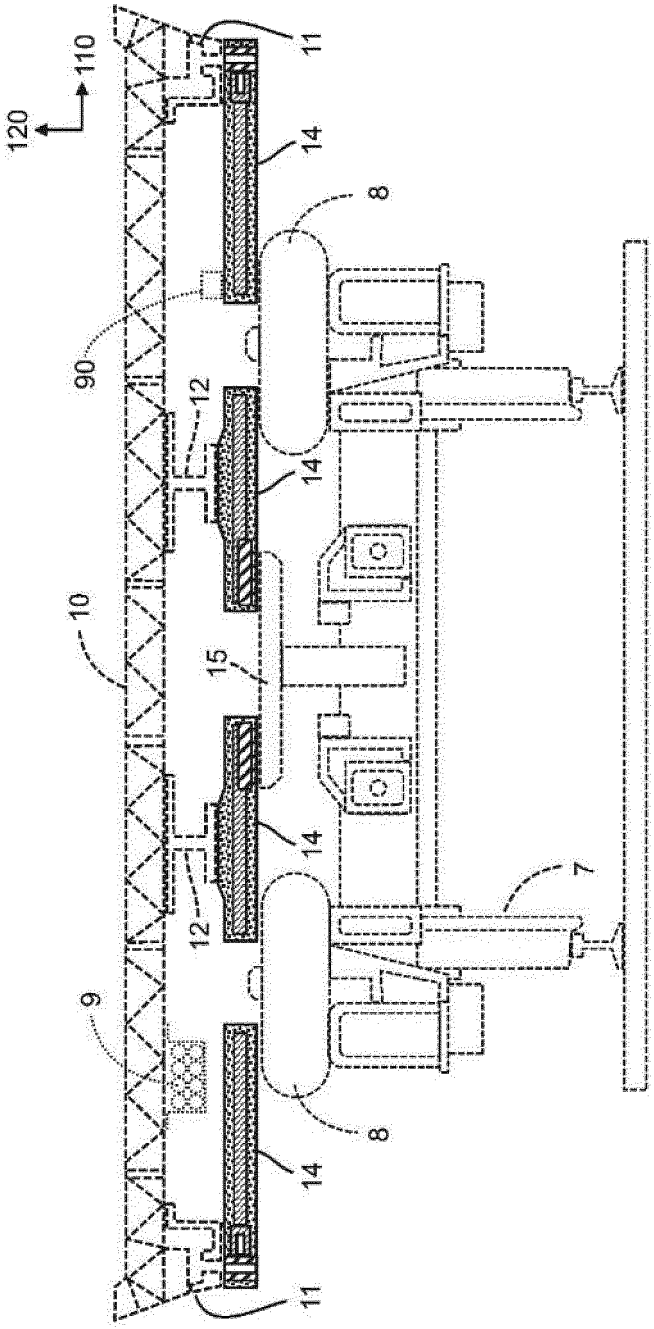


FIG. 11



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2015/085374

A. CLASSIFICATION OF SUBJECT MATTER
B61F1/12(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B61F1/12

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2016
Kokai Jitsuyo Shinan Koho 1971-2016 Toroku Jitsuyo Shinan Koho 1994-2016

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2013-1198 A (Hitachi, Ltd.), 07 January 2013 (07.01.2013), paragraphs [0026] to [0030]; fig. 1 to 8 & WO 2012/172925 A1 & EP 2722246 A1 paragraphs [0031] to [0036]; fig. 1 to 8	1-3,12 4-11
Y	WO 1999/010168 A1 (Toray Industries, Inc.), 04 March 1999 (04.03.1999), page 15, line 11 to page 16, line 7; fig. 5, 9 & US 6468613 B1 column 12, lines 4 to 54; fig. 5, 9 & EP 938969 A1 & DE 69836259 T2 & AU 8747898 A & CA 2269353 A1 & KR 10-2000-0068796 A	1-3,12

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 February 2016 (18.02.16)	01 March 2016 (01.03.16)
Name and mailing address of the ISA/ Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2015/085374

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 4-292258 A (Hitachi, Ltd.), 16 October 1992 (16.10.1992), paragraphs [0021], [0024], [0026] to [0027]; fig. 15 to 17, 20, 24 to 29 (Family: none)	1-12

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 2013157464 A **[0005]**