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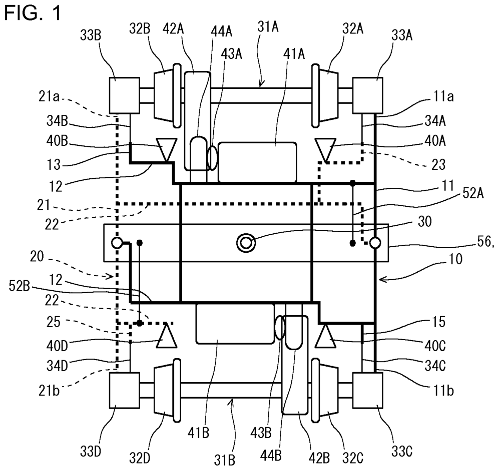
(54) **BOGIE FOR RAILROAD CAR, AND RAILROAD CAR PROVIDED WITH BOGIE**

(57) A bogie includes: a first frame body (10) which includes a right side beam (11) and a first cross beam (12); a second frame body (20) which includes a left side beam (21) and a second cross beam (22); and a bolster (56). The first and second frame bodies (10, 20) support each other in a slidable manner in a longitudinal direction. A center portion of the bolster (56) is supported by a core receiver (30). The bolster (56) and the first cross beam (12) are supported in a flexible manner by a first connecting portion (52A) disposed on the right side of the core receiver (30), and the bolster (56) and the second cross beam (22) are supported in a flexible manner by a second connecting portion (52B) disposed on the left side of the core receiver (30). With such a configuration, fluctuation in lateral force and wheel load at a curved railroad track can be suppressed.

FIG. 1



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Description

TECHNICAL FIELD

[0001] The present invention relates to a railroad car bogie (hereinafter, also simply referred to as "bogie"), and particularly relates to a bogie which allows self-steering of wheelsets on the forward and rearward sides, and a railroad car including the bogie and a car body.

BACKGROUND ART

[0002] A railroad car is formed of a car body and bogies, and the railroad car runs on rails. When the railroad car traverses a curved railroad track, a force with which wheels push the rails in a lateral direction, a so-called lateral force, is generated. Particularly, in a section where a track bends, for example, in transition curve sections at entry and exit of a curved railroad track, it is difficult for the wheelsets to follow the track and hence, the lateral force increases. A large lateral force increases risk of derailment. Accordingly, it is desirable to suppress the lateral force to a low level. Further, the force with which the wheels push the rails in the vertical direction, a so-called wheel load, of the wheels on the outer track side decreases particularly in an exit transition curve section. An excessive decrease in wheel load increases risk of derailment. For this reason, it is desirable to keep a balance between wheel loads on right and left sides while the wheelsets follow the track.

[0003] As a technique of reducing a lateral force at a curved railroad track, and suppressing fluctuation in wheel load, for example, International Application Publication No. WO2016/017103 (Patent Literature 1) discloses a bogie where wheelsets on the forward and rearward sides self-steer corresponding to a curvature of rails on a curved railroad track (hereinafter also referred to as "steering bogie"). A bogie frame of the steering bogie disclosed in Patent Literature 1 is formed of two frame bodies which are joined with each other by way of an elastic element. A first frame body of the two frame bodies includes a right side beam and a first cross beam. A second frame body includes a left side beam and a second cross beam.

[0004] In the case of a bolster-equipped steering bogie, when a railroad car runs through a curved railroad track, relative yawing displacement (rotation about an axis in the vertical direction) occurs between a bolster (car body) and the two frame bodies (bogie frame). Due to such yawing displacement, relative longitudinal movement occurs between the two frame bodies, thus allowing self-steering of the wheelsets on the forward and rearward sides corresponding to such relative longitudinal movement. Accordingly, a lateral force at the curved railroad track is reduced. Further, in a transition curve section, relative rolling displacement (rotation about an axis in the longitudinal direction) occurs between the wheelset on the forward side and the wheelset on the rearward side. The rolling displacement is allowed by relative rotary motion of the two frame bodies (bogie frame) in the pitching direction (rotation about an axis in the lateral direction). Accordingly, fluctuation in wheel load is suppressed in the transition curve section.

[0005] In the case of the bolster-equipped steering bogie disclosed in Patent Literature 1, the bolster is supported by a pair of right and left side bearings. Further, to connect the bolster and each of the two frame bodies with each other, the bolster is also supported by a pair of right and left center plates. In such a configuration, the two side bearings and the two center plates receive a load from the car body. Accordingly, when the steering bogie traverses a curved railroad track, the bolster generates large rotational resistance with respect to the bogie frame (two frame bodies). Therefore, particularly when a railroad car runs through a section from an exit transition curve section to a straight section, it is difficult for the wheelsets to return to a normal orientation. As a result, the wheelsets are deviated from the center position of the track so that the wheel load is unbalanced. Further, the leading wheelset comes into contact with the rails in a state of being directed toward the inner track, thus generating a lateral force.

CITATION LIST

PATENT LITERATURE

[0006] Patent Literature 1: International Application Publication No. WO2016/017103

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0007] The present invention has been under such circumstances. It is one objective of the present invention to provide a railroad car bogie and a railroad car which allows self-steering, thus sufficiently reducing a lateral force at a curved railroad track and, at the same time, sufficiently suppressing fluctuation in wheel load.

SOLUTION TO PROBLEM

[0008] A railroad car bogie according to an embodiment of the present invention is a bogie which includes wheelsets on forward and rearward sides of the bogie, and which allows self-steering of the wheelsets. The bogie includes: a first frame body including a side beam on a right side, and a first cross beam integrally formed with the side beam on the right side; a second frame body including a side beam on a left side, and a second cross beam integrally formed with the side beam on the left side; axle boxes respectively attached to right and left end portions of the respective wheelsets; axle box suspensions configured to elastically support the respective axle boxes; and a bolster disposed above the first cross beam or the second cross beam.

[0009] The first frame body and the second frame body support each other, and are slidable in a longitudinal direction. The axle box suspension on a forward right side supports the axle box on the forward right side with a fore end portion of the side beam of the first frame body, and the axle box on the forward right side is joined to the second frame body. The axle box suspension on a forward left side supports the axle box on the forward left side with a fore end portion of the side beam of the second frame body, and the axle box on the forward left side is joined to the first frame body. The axle box suspension on a rearward right side supports the axle box on the rearward right side with a rear end portion of the side beam of the first frame body, and the axle box on the rearward right side is joined to the first frame body. The axle box suspension on a rearward left side supports the axle box on the rearward left side with a rear end portion of the side beam of the second frame body, and the axle box on the rearward left side is joined to the second frame body.

[0010] The bogie further includes: a core receiver configured to support a center portion of the bolster, the core receiver being provided on an upper surface of the first cross beam or the second cross beam; a first connecting portion configured to connect the first cross beam and the bolster with each other, the first connecting portion being disposed on a right side of the core receiver; and a second connecting portion configured to connect the second cross beam and the bolster with each other, the second connecting portion being disposed on a left side of the core receiver. The first connecting portion includes a first shaft portion and a first hole portion, the first shaft portion protruding in a vertical direction from either one of the first cross beam or the bolster, and the first hole portion being formed on the other of the first cross beam or the bolster, and accommodating a distal end portion of the first shaft portion. The second connecting portion includes a second shaft portion and a second hole portion, the second shaft portion protruding in the vertical direction from either one of the second cross beam or the bolster, and the second hole portion being formed on the other of the second cross beam or the bolster, and accommodating a distal end portion of the second shaft portion.

[0011] A railroad car according to the embodiment of the present invention includes: the above-mentioned bogie; a car body; and a pair of right and left air springs disposed on the bolster, and configured to support the car body.

ADVANTAGEOUS EFFECTS OF INVENTION

[0012] The railroad car bogie and the railroad car of the present invention allow self-steering, thus sufficiently reducing a lateral force at a curved railroad track and, at the same time, sufficiently suppressing fluctuation in wheel load.

BRIEF DESCRIPTION OF DRAWINGS

[0013]

FIG. 1 is a top plan view schematically showing one example of a railroad car provided with a bogie according to an embodiment of the present invention.
FIG. 2 is a top plan view showing a specific example of a bogie frame used for the railroad car shown in FIG. 1.
FIG. 3A is a right side view of the bogie shown in FIG. 1.
FIG. 3B is a left side view of the bogie shown in FIG. 1.
FIG. 4 is a cross-sectional view of the railroad car shown in FIG. 1 as viewed from a forward surface side.
FIG. 5A is a top plan view schematically showing a situation where the railroad car of this embodiment runs through a left-turning curved railroad track.
FIG. 5B is a top plan view schematically showing a situation where the railroad car of this embodiment runs through a right-turning curved railroad track.
FIG. 6 is a view showing fluctuation in lateral force at the curved railroad track.
FIG. 7 is a view showing displacement in a lateral direction of a wheelset at the curved railroad track.

DESCRIPTION OF EMBODIMENTS

[0014] To solve the above-mentioned problems, inventors of the present invention have made extensive studies by performing numerical analysis supposing that a railroad car runs through a curved railroad track consisting of five sections (an entry straight section, an entry transition curve section, a steady curve section, an exit transition curve section, and an exit straight section). As a result, the inventors of the present invention acquired the following findings.

(a) In a conventional steering bogie disclosed in Patent Literature 1, a bolster which receives a load from a car body is supported by a pair of right and left side bearings. That is, the bolster is supported by a bogie frame formed of two frame bodies (a first frame body and a second frame body) at positions separated from the center of yawing rotation. Accordingly, when a conventional car traverses a curved railroad track, large rotational resistance of the bolster is generated with respect to the bogie frame. In view of the above, to reduce rotational resistance of the bolster, the bolster should be supported at the position of the center of yawing rotation. The position of the center of yawing rotation corresponds to a center portion of the bolster in the lateral direction (that is, a center portion of the bogie frame).
(b) In the conventional steering bogie, to realize steering function from relative longitudinal movement of the two frame bodies which occurs with yawing of the bolster, the bolster is coupled to each of the two frame bodies by center plates. The center plates cannot allow relative displacement between the bolster and the frame body in a flexible manner. Accordingly, when a conventional car runs through a section from an exit transition curve section to a straight section, relative longitudinal movement of the two frame bodies is restrained. As a result, it is difficult for the wheelsets to return to a normal orientation. In view of the above, to make the relative longitudinal movement of the two frame bodies smooth, the relative displacement between the bolster and the frame body should be allowed in a flexible manner. That is, a coupled state between the bolster and each of the two frame bodies should be loosened.

[0015] The present invention has been completed based on the above-mentioned finding.

[0016] The railroad car bogie according to an embodiment of the present invention is a bogie which includes wheelsets on forward and rearward sides of the bogie, and which allows self-steering of the wheelsets. The bogie includes a first frame body, a second frame body, four axle boxes, four axle box suspensions, and a bolster. The first frame body includes a side beam on a right side and a first cross beam integrally formed with the right side beam. The second frame body includes a side beam on a left side and a second cross beam integrally formed with the left side beam. The axle boxes are respectively attached to right and left end portions of the respective wheelsets. The axle box suspensions elastically support the respective axle boxes. The bolster is disposed above the first cross beam or the second cross beam.

[0017] The first frame body and the second frame body support each other, and are slidable in a longitudinal direction. The axle box suspension on the forward right side supports the axle box on the forward right side with a fore end portion of the side beam of the first frame body, and the axle box on the forward right side is joined to the second frame body. The axle box suspension on the forward left side supports the axle box on the forward left side with a fore end portion of the side beam of the second frame body, and the axle box on the forward left side is joined to the first frame body. The axle box suspension on the rearward right side supports the axle box on the rearward right side with a rear end portion of the side beam of the first frame body, and the axle box on the rearward right side is joined to the first frame body. The axle box suspension on the rearward left side supports the axle box on the rearward left side with a rear end portion of the side beam of the second frame body, and the axle box on the rearward left side is joined to the second frame body.

[0018] The bogie further includes a core receiver, a first connecting portion, and a second connecting portion. The core receiver is provided on an upper surface of the first cross beam or the second cross beam, and supports a center portion of the bolster. The first connecting portion is disposed on the right side of the core receiver, and connects the first cross beam and the bolster with each other. The second connecting portion is disposed on the left side of the core receiver, and connects the second cross beam and the bolster with each other. The first connecting portion includes a first shaft portion and a first hole portion. The first shaft portion protrudes in a vertical direction from either one of the first cross beam or the bolster. The first hole portion is formed on the other of the first cross beam or the bolster, and accommodates a distal end portion of the first shaft portion. The second connecting portion includes a second shaft portion, and a second hole portion. The second shaft portion protrudes in the vertical direction from either one of the second cross beam or the bolster. The second hole portion is formed on the other of the second cross beam or the bolster, and accommodates a distal end portion of the second shaft portion.

[0019] In a typical example, each axle box suspension includes a link extending from the axle box along a longitudinal direction. The first cross beam includes a first extending portion extending toward the fore end portion of the side beam of the second frame body. The second cross beam includes a second extending portion extending toward the fore end portion of the side beam of the first frame body. In this case, the axle box suspension on the forward right side supports the axle box on the forward right side with the fore end portion of the side beam of the first frame body, and the link extending from the axle box on the forward right side is joined to the second extending portion of the second frame body. The axle box suspension on the forward left side supports the axle box on the forward left side with the fore end portion of the side beam of the second frame body, and the link extending from the axle box on the forward left side is joined to the first extending portion of the first frame body. The axle box suspension on the rearward right side supports the axle box on the rearward right side with the rear end portion of the side beam of the first frame body, and the link extending from the axle box on the rearward right side is joined to the side beam of the first frame body. The axle box suspension on the rearward left side supports the axle box on the rearward left side with the rear end portion of the side beam of the second frame body, and the link extending from the axle box on the rearward left side is joined to the side beam of the second frame body.

[0020] As a typical example, the first cross beam of the first frame body and the second cross beam of the second frame body are made to overlap each other in the vertical direction in a non-contact manner. However, either of the first cross beam or the second cross beam may be disposed on the upper side. Further, the first cross beam and the second cross beam may be disposed adjacent to each other in the longitudinal direction.

[0021] As a typical example, a distal end portion of the first cross beam is inserted into an opening formed in the side beam of the second frame body. A distal end portion of the second cross beam is inserted into an opening formed in the side beam of the first frame body. With such a configuration, the first frame body and the second frame body can support each other in a slidable manner in the longitudinal direction. The first frame body and the second frame body may be supported each other such that the distal end portion of the first cross beam is placed on the side beam of the second frame body, and the distal end portion of the second cross beam is placed on the side beam of the first frame body.

[0022] The railroad car according to the embodiment of the present invention includes the above-mentioned bogie, a car body, and a pair of right and left air springs disposed on the bolster, and support the car body.

[0023] According to the bogie and the car provided with the bogie of this embodiment, when the car runs through a curved railroad track, relative yawing displacement occurs between the bolster (car body) and the bogie frame (the first frame body and the second frame body) according to the curved railroad track. Due to such relative yawing displacement, relative longitudinal movement occurs between the first frame body and the second frame body, thus allowing self-steering of the wheelsets on the forward and rearward sides corresponding to the relative longitudinal movement. Further, the bolster is supported at one point by the core receiver and hence, the bolster can smoothly rotate with respect to the bogie frame in the yawing direction. Accordingly, a lateral force at a curved railroad track can be sufficiently reduced.

[0024] The respective axle boxes are elastically supported on the bogie frame (the first frame body and the second frame body) by the respective corresponding axle box suspensions. Further, the first frame body and the second frame body are allowed to relatively rotate in the pitching direction. Accordingly, in a transition curve section, relative rolling displacement between the wheelset on the forward side and the wheelset on the rearward side which occurs with the bending of the track can be allowed. Therefore, it is possible to suppress fluctuation in wheel load in the transition curve section. Particularly, the bolster and the bogie frame are connected with each other in a flexible manner by the first connecting portion and the second connecting portion and hence, when the railroad car runs through a section from an exit transition curve section to a straight section, the bolster does not restrain relative longitudinal movement between the first frame body and the second frame body. For this reason, the wheelset on the forward side and the wheelset on the rearward side can smoothly return to normal orientation. Accordingly, generation of a lateral force and fluctuation in wheel load in a transition curve section can be sufficiently suppressed.

[0025] It is preferable that the above-mentioned bogie include: a first elastic member disposed in a gap formed between the distal end portion of the first shaft portion and the first hole portion; and a second elastic member disposed in a gap formed between the distal end portion of the second shaft portion and the second hole portion. In this case, generation of a lateral force and fluctuation in wheel load can be sufficiently suppressed. In a typical example, the first elastic member may be a first rubber bush, and the second elastic member may be a second rubber bush.

[0026] It is preferable that, the above-mentioned bogie further includes side bearings respectively provided on an upper surface of the side beam of the first frame body and an upper surface of the side beam of the second frame body, the side bearings opposedly facing right and left end portions of the bolster with gaps formed between the side bearings and the bolster. In this case, when the bolster rotates in the rolling direction about the core receiver, the rotation of the bolster can be restricted.

[0027] The above-mentioned bogie may adopt the following configuration. The above-mentioned bogie includes tread brake devices which correspond to the respective right and left wheels of the respective wheelsets, and traction motors and gear units configured to drive the respective wheelsets. The tread brake device on the forward left side and the tread brake device on the rearward right side are held by the first cross beam, and the tread brake device on the forward right side and the tread brake device on the rearward left side are held by the second cross beam. The traction motor and the gear unit on the forward are held by either one of the first cross beam or the second cross beam, and the traction motor and the gear unit on the rearward sides are held by either one of the first cross beam or the second cross beam. In this case, the above-mentioned bogie may be utilized as a drive bogie.

[0028] Hereinafter, an embodiment of a railroad car bogie and a railroad car according to the present invention is described in detail.

[0029] FIG. 1 is a top plan view schematically showing one example of the railroad car provided with a bogie according to the embodiment of the present invention. FIG. 2 is a top plan view showing a specific example of a bogie frame used for the railroad car shown in FIG. 1. FIG. 3A is a right side view of the bogie shown in FIG. 1, and FIG. 3B is a left side view of the bogie. FIG. 4 is a cross-sectional view of the railroad car shown in FIG. 1 as viewed from a forward surface side.

[0030] The railroad car shown in FIG. 1 to FIG. 4 is a car which uses bolster-equipped bogies each of which includes a bolster 56 between a car body 50 and the bogie. The car includes one bogie each on the forward and rearward sides of the car body 50.

[0031] Referring to FIG. 1 and FIG. 2, the bogie of this embodiment includes a first frame body 10 and a second frame body 20, which are separately independent from each other, as a bogie frame. The bogie frame is formed by combining the first frame body 10 and the second frame body 20 with each other. In FIG. 1, to facilitate the understanding of the configurations of the first frame body 10 and the second frame body 20, constitutional elements of the first frame body 10 are indicated by bold solid lines, and constitutional elements of the second frame body 20 are indicated by bold dotted lines.

[0032] The first frame body 10 includes a right side beam 11 and a first cross beam 12. The right side beam 11 and the first cross beam 12 are firmly joined with each other by welding, thus formed into an integral body. On the other hand, the second frame body 20 includes a left side beam 21 and a second cross beam 22. The left side beam 21 and the second cross beam 22 are firmly joined with each other by welding, thus formed into an integral body.

[0033] The first cross beam 12 of the first frame body 10 includes a first extending portion 13 which extends toward a fore end portion 21a of the side beam 21 of the second frame body 20 (see FIG. 1 and FIG. 3B). The first extending portion 13 extends around to an area below the side beam 21 of the second frame body 20, and is disposed behind the fore end portion 21a of the side beam 21. That is, the first extending portion 13, which extends from the first cross beam 12 integrally formed with the right side beam 11, reaches the position of the left side beam 21 disposed on the side opposite to the right side beam 11. On the other hand, the second cross beam 22 of the second frame body 20 includes a second extending portion 23 which extends toward a fore end portion 11a of the side beam 11 of the first frame body 10 (see FIG. 1 and FIG. 3A). The second extending portion 23 extends around to an area below the side beam 11 of the first frame body 10, and is disposed behind the fore end portion 11a of the side beam 11. That is, the second extending portion 23, which extends from the second cross beam 22 integrally formed with the left side beam 21, reaches the position of the right side beam 11 disposed on the side opposite to the left side beam 21.

[0034] The first frame body 10 and the second frame body 20 support each other, and are slidable in a longitudinal direction. To be more specific, referring to FIG. 1 to FIG. 4, the first cross beam 12 of the first frame body 10 and the second cross beam 22 of the second frame body 20 are made to overlap each other in the vertical direction in a non-contact manner. FIG. 2 shows a mode where the first cross beam 12 is disposed above the second cross beam 22.

[0035] Referring to FIG. 3B, an opening 21c is formed in the side beam 21 (left side beam 21) of the second frame body 20 at a center portion in the longitudinal direction, and the opening 21c penetrates the side beam 21 in the lateral direction. A distal end portion of the first cross beam 12 of the first frame body 10 is inserted into the opening 21c. A wearing plate 37 made of metal is provided in the opening 21c. The distal end portion of the first cross beam 12 is placed on the wearing plate 37. Referring to FIG. 3A, an opening 11c is formed in the side beam 11 (right side beam 11) of the first frame body 10 at a center portion in the longitudinal direction, and the opening 11c penetrates the side beam 11 in the lateral direction. A distal end portion of the second cross beam 22 of the second frame body 20 is inserted into the opening 11c. A wearing plate 37 made of metal is provided in the opening 11c. The distal end portion of the second cross beam 22 is placed on the wearing plate 37. With such a configuration, the first frame body 10 and the second frame body 20 support each other at two points, that is, right and left points, and can move slidably each other in the longitudinal direction. Further, the first frame body 10 and the second frame body 20 are allowed to rotate in a pitching direction about an axis which connects two supporting points. In FIG. 1, the points at which the first frame body 10 and the second frame body 20 support each other are indicated by circles.

[0036] Such a bogie frame, formed by combining the first frame body 10 and the second frame body 20 with each other, includes wheelsets 31A and 31B respectively disposed on the forward and rearward sides of the bogie frame. The wheelset 31A includes wheels 32A and 32B on the right and left sides thereof, and the wheelset 31B includes wheels 32C and 32D on the right and left sides thereof. Further, axle boxes 33A and 33B are attached to both right and left end portions of the wheelset 31A, and axle boxes 33C and 33D are attached to both right and left end portions of the wheelset 31B. The respective axle boxes 33A, 33B, 33C and 33D are elastically supported on the bogie frame (the first frame body 10 and the second frame body 20) by the respective corresponding axle box suspensions.

[0037] The respective axle box suspensions are general-purpose components. Referring to FIG. 1, FIG. 3A and FIG. 3B, the respective axle box suspensions include links 34A, 34B, 34C and 34D which extend along the longitudinal direction from the respective corresponding axle boxes 33A, 33B, 33C and 33D. Each axle box suspension shown in FIG. 3A and FIG. 3B is a so-called mono-link type axle box suspension. The mono-link type axle box suspension is an axle box suspension of a type which joins an axle box and a bogie frame with each other by one link having both end portions thereof into which rubber bushes are inserted.

[0038] Particularly referring to FIG. 3A, the axle box suspension on the forward right side supports the axle box 33A on the forward right side with the fore end portion 11a of the side beam 11 of the first frame body 10. A coil spring 35 is disposed between the axle box 33A and the fore end portion 11a of the side beam 11. A laminated rubber may be disposed in addition to the coil spring 35, or in place of the coil spring 35. The laminated rubber is a component formed by alternately laminating a thin rubber sheet and a steel plate. The link 34A of the axle box suspension includes rubber bushes 36a and 36b at both fore and rear end portions. The fore end portion of the link 34A is coupled to the axle box 33A by way of the rubber bush 36a, and the rear end portion of the link 34A is coupled to the second extending portion 23 of the second frame body 20 by way of the rubber bush 36b.

[0039] On the other hand, particularly referring to FIG. 3B, the axle box suspension on the forward left side supports the axle box 33B on the forward left side with the fore end portion 21a of the side beam 21 of the second frame body 20. The support structure, where the axle box 33B is supported by the fore end portion 21a of the side beam 21, is substantially equal to that in the above-mentioned axle box suspension on the forward right side. The link 34B of the axle box suspension on the forward left side includes rubber bushes 36a and 36b at both fore and rear end portions. The fore end portion of the link 34B is coupled to the axle box 33B by way of the rubber bush 36a, and the rear end portion of the link 34B is coupled to the first extending portion 13 of the first frame body 10 by way of the rubber bush 36b.

[0040] Particularly referring to FIG. 3A, the axle box suspension on the rearward right side supports the axle box 33C on the rearward right side with a rear end portion 11b of the side beam 11 of the first frame body 10. The support structure, where the axle box 33C is supported by the rear end portion 11b of the side beam 11, is substantially equal to that in the above-mentioned axle box suspension on the forward right side. In this embodiment, a first protruding portion 15 is formed on a lower surface of the side beam 11 of the first frame body 10. The first protruding portion 15 protrudes from a position in front of the rear end portion 11b of the side beam 11. The link 34C of the axle box suspension on the rearward right side includes rubber bushes 36a and 36b at both fore and rear end portions. The rear end portion of the link 34C is coupled to the axle box 33C by way of the rubber bush 36a, and the fore end portion of the link 34C is coupled to the first protruding portion 15 of the first frame body 10 by way of the rubber bush 36b.

[0041] On the other hand, particularly referring to FIG. 3B, the axle box suspension on the rearward left side supports the axle box 33D on the rearward left side with a rear end portion 21b of the side beam 21 of the second frame body 20. The support structure, where the axle box 33D is supported by the rear end portion 21b of the side beam 21, is substantially equal to that in the above-mentioned axle box suspension on the forward right side. In this embodiment, a second protruding portion 25 is formed on a lower surface of the side beam 21 of the second frame body 20. The second protruding portion 25 protrudes from a position in front of the rear end portion 21b of the side beam 21. The link 34D of the axle box suspension on the rearward left side includes rubber bushes 36a and 36b at both fore and rear end portions. The rear end portion of the link 34D is coupled to the axle box 33D by way of the rubber bush 36a, and the fore end portion of the link 34D is coupled to the second protruding portion 25 of the second frame body 20 by way of the rubber bush 36b.

[0042] In the case of the bogie shown in FIG. 1, the above-mentioned bogie frame (the first frame body 10 and the second frame body 20) includes tread brake devices 40A and 40B which respectively correspond to the right and left wheels 32A and 32B of the wheelset 31A, and tread brake devices 40C and 40D which respectively correspond to the right and left wheels 32C and 32D of the wheelset 31B. The respective tread brake devices 40A, 40B, 40C and 40D include brake shoes which opposedly face treads of the respective corresponding wheels 32A, 32B, 32C and 32D.

[0043] The tread brake device 40A on the forward right side is held by the second cross beam 22 of the second frame body 20 at a position immediately rearward of the wheel 32A on the forward right side. The tread brake device 40B on the forward left side is held by the first cross beam 12 of the first frame body 10 at a position immediately rearward of the wheel 32B on the forward left side. The tread brake device 40C on the rearward right side is held by the first cross beam 12 of the first frame body 10 at a position immediately forward of the wheel 32C on the rearward right side. The tread brake device 40D on the rearward left side is held by the second cross beam 22 of the second frame body 20 at a position immediately forward of the wheel 32D on the rearward left side.

[0044] In an actual bogie, the tread brake device 40A on the forward right side and the tread brake device 40D on the rearward left side are immobilized to brake device seats (not shown in the drawing) which are respectively formed on the second cross beam 22 of the second frame body 20. The tread brake device 40B on the forward left side and the tread brake device 40C on the rearward right side are immobilized to brake device seats (not shown in the drawing) which are respectively formed on the first cross beam 12 of the first frame body 10.

[0045] In the case of the bogie shown in FIG. 1, the above-mentioned bogie frame (the first frame body 10 and the second frame body 20) includes a traction motor 41A, a gear unit 42A, and a joint 43A so as to drive the wheelset 31A, and includes a traction motor 41B, a gear unit 42B, and a joint 43B so as to drive the wheelset 31B. All of the traction motors 41A and 41B, the gear units 42A and 42B, and the joints 43A and 43B are general-purpose components. The gear unit 42A, 42B includes a gear fitted on an axle of the wheelset 31A, 31B, and a pinion which meshes with the gear. The joints 43A, 43B are gear couplings or flexible couplings. The joint 43A, 43B respectively connects a main shaft of the traction motor 41A, 41B and a pinion shaft of the gear unit 42A, 42B with each other, and transmits a rotation torque of the main shaft of the traction motor 41A, 41B to the pinion shaft of the gear unit 42A, 42B. Also, the joint 43A, 43B respectively absorbs relative displacement between the main shaft of the traction motor 41A, 41B and the pinion shaft of the gear unit 42A, 42B.

[0046] The gear unit 42A on the forward side is disposed on the wheelset 31A on the forward side at a position adjacent to the wheel 32B on the forward left side. A suspension tool 44A is provided on the first cross beam 12 of the first frame body 10 at a position adjacent to the tread brake device 40B on the forward left side. The gear unit 42A on the forward side is suspended by the suspension tool 44A, thus being held in a swingable manner. The gear unit 42B on the rearward side is disposed on the wheelset 31B on the rearward side at a position adjacent to the wheel 32C on the rearward right side. A suspension tool 44B is provided on the first cross beam 12 of the first frame body 10 at a position adjacent to the tread brake device 40C on the rearward right side. The gear unit 42B on the rearward side is suspended by the suspension tool 44B, thus being held in a swingable manner.

[0047] Specifically, referring to FIG. 2, the gear unit 42A on the forward side is mounted on a suspension tool seat 17a, which extends forward from the first cross beam 12 of the first frame body 10, by way of the suspension tool 44A. The gear unit 42B on the rearward side is mounted on a suspension tool seat 17b, which extends rearward from the first cross beam 12 of the first frame body 10, by way of the suspension tool 44B.

[0048] The traction motor 41A is held on the first cross beam 12 of the first frame body 10 at a position adjacent to the suspension tool 44A on the forward side, and the traction motor 41B is held on the first cross beam 12 of the first frame body 10 at a position adjacent to the suspension tool 44B on the rearward side. Specifically, referring to FIG. 2, the traction motor 41A on the forward side is mounted on a traction motor seat 16a extending forward from the first cross beam 12 of the first frame body 10. The traction motor 41B on the rearward side is mounted on a traction motor seat 16b extending rearward from the first cross beam 12 of the first frame body 10.

[0049] Referring to FIG. 1, FIG. 2 and FIG. 4, the bogie includes the bolster 56 above the first cross beam 12 of the first frame body 10. A core receiver 30 is disposed on an upper surface of the first cross beam 12 at the center portion in the lateral direction. The center portion of the bolster 56 in the lateral direction is supported by the core receiver 30. The core receiver 30 is formed of a pedestal 30a which has a frusto-conical shape, and a projecting portion 30b which opposedly faces the pedestal 30a and has an inverted frusto-conical shape. The pedestal 30a is immobilized to the upper surface of the first cross beam 12, and the projecting portion 30b is immobilized to a lower surface of the bolster 56. The projecting portion 30b and the pedestal 30a are simply in contact with each other. With such a configuration, the bolster 56 is allowed to rotate with respect to the bogie frame (first cross beam 12) in the yawing direction about the core receiver 30. The bolster 56 is also allowed to rotate with respect to the bogie frame (first cross beam 12) in the rolling direction about the core receiver 30.

[0050] The bogie of this embodiment includes a pair of right and left side bearings 57, 57 between the bogie frame (the first frame body 10 and the second frame body 20) and the bolster 56. The side bearings 57, 57 are respectively disposed on the side beam 11 of the first frame body 10 and on the side beam 21 of the second frame body 20. Each side bearing 57 is formed of a pedestal 57a which has a truncated pyramid shape, and a projecting portion 57b which opposedly faces the pedestal 57a and has an inverted truncated pyramid shape. The pedestals 57a, 57a are immobilized on upper surfaces of the side beams 11 and 21, respectively, and the projecting portions 57b, 57b are immobilized on a lower surface of the bolster 56. The projecting portion 57b, 57b and the pedestal 57a, 57a are not in contact with each other. However, when the bolster 56 rotates in the rolling direction about the core receiver 30, the projecting portion 57b and the pedestal 57a for one of the side bearing 57 on the right side or the side bearing 57 on the left side come into contact with each other, thus restricting further rotation of the bolster 56.

[0051] Referring to FIG. 4, a pair of right and left air springs 51, 51 are disposed on an upper surface of the bolster 56. The car body 50 is joined to the bolster 56 by these air springs 51, 51. That is, the car body 50 and the bolster 56 are formed into an integral body by way of the air springs 51, 51.

[0052] In this embodiment, referring to FIG. 1 and FIG. 4, a pair of right and left connecting portions 52A and 52B are disposed between the bolster 56 and the bogie frame (the first frame body 10 and the second frame body 20). The first connecting portion 52A of the two connecting portions 52A and 52B is disposed on the right side of the core receiver 30, and connects the first cross beam 12 and the bolster 56 with each other. The second connecting portion 52B is disposed on the left side of the core receiver 30, and connects the second cross beam 22 and the bolster 56 with each other.

[0053] To be more specific, the first connecting portion 52A includes a first shaft portion 53A and a first hole portion 54A. The first shaft portion 53A protrudes downward from the lower surface of the bolster 56. The first hole portion 54A is formed in the first cross beam 12 at the position on an extension of the first shaft portion 53A. A distal end portion of the first shaft portion 53A is accommodated in the first hole portion 54A. In this embodiment, a first rubber bush 55A having a ring shape is fitted in a gap which has a toroidal shape and is formed between the distal end portion of the first shaft portion 53A and the first hole portion 54A. That is, the bolster 56 is connected to the first cross beam 12 (first frame body 10) by way of the first shaft portion 53A and the first rubber bush 55A.

[0054] On the other hand, the second connecting portion 52B includes a second shaft portion 53B and a second hole portion 54B. The second shaft portion 53B protrudes downward from the lower surface of the bolster 56. The second cross beam 22 includes a second projecting piece portion 24 which extends to the upper surface of the first cross beam 12. The second hole portion 54B is formed in the second projecting piece portion 24 at the position on an extension of the second shaft portion 53B. A distal end portion of the second shaft portion 53B is accommodated in the second hole portion 54B. In this embodiment, a second rubber bush 55B having a ring shape is fitted in a gap which has a toroidal shape and is formed between the distal end portion of the second shaft portion 53B and the second hole portion 54B. That is, the bolster 56 is connected to the second cross beam 22 (second frame body 20) by way of the second shaft portion 53B and the second rubber bush 55B.

[0055] With such a configuration, the bolster 56 receives a load from the car body 50 by way of the air springs 51 and 51. The core receiver 30 which supports the bolster 56 receives the load from the bolster 56. Further, the first connecting portion 52A and the second connecting portion 52B, which connect the bolster 56 (car body 50) and the bogie frame (the first frame body 10 and the second frame body 20) with each other, allow relative displacement between the bolster 56 and the bogie frame in a flexible manner.

[0056] FIG. 5A and FIG. 5B are top plan views schematically showing situations where the railroad car of this embodiment shown in FIG. 1 to FIG. 4 runs through curved railroad tracks. Of these drawings, FIG. 5A shows the case of a left-turning curved railroad track, and FIG. 5B shows the case of a right-turning curved railroad track. Referring to FIG. 5A and FIG. 5B, behavior of the respective constitutional elements when the car of this embodiment runs through a curved railroad track is as follows.

[0057] When the car runs through the curved railroad track, relative yawing displacement occurs between the bolster 56 (car body 50) and the bogie frame (the first frame body 10 and the second frame body 20). For example, when the car runs through the left-turning curved railroad track, referring to FIG. 5A, the bolster 56 assumes a state where the bolster 56 yaws rightward with respect to the bogie frame, that is, with respect to the advancing direction of the car. Conversely, when the car runs through the right-turning curved railroad track, referring to FIG. 5B, the bolster 56 assumes a state where the bolster 56 yaws leftward with respect to the bogie frame. At this point of operation, the bolster 56 yaws with respect to the bogie frame (first cross beam 12) about the core receiver 30.

[0058] First, referring to FIG. 5A, the case of the left-turning curved railroad track is described. As described above, the bolster 56 is connected to the first frame body 10 (first cross beam 12) by way of the first connecting portion 52A disposed on the right side of the core receiver 30, and is connected to the second frame body 20 (second cross beam 22) by way of the second connecting portion 52B disposed on the left side of the core receiver 30. Accordingly, when the bolster 56 yaws rightward, a rearward force acts on the first frame body 10 through the first connecting portion 52A on the right side, and a forward force acts on the second frame body 20 through the second connecting portion 52B on the left side. That is, forces in directions opposite to each other in the longitudinal direction act on the first frame body 10 and the second frame body 20.

[0059] At this point of operation, as described above, the first frame body 10 and the second frame body 20 support each other in a slidable manner in the longitudinal direction. Accordingly, the above-mentioned forces individually act on the first frame body 10 and the second frame body 20 so that the first frame body 10 moves rearward, and the second frame body 20 moves forward. In short, relative longitudinal movement occurs between the first frame body 10 and the second frame body 20.

[0060] Accordingly, the axle boxes 33A and 33C, which are elastically supported on the fore and rear end portions 11a and 11b of the side beam 11 of the first frame body 10 respectively, display the following behavior. The axle box 33A on the forward right side is supported on the first frame body 10 and, at the same time, is joined to the second extending portion 23 of the second frame body 20, which is different from the first frame body 10, by way of the link 34A. With such a configuration, the axle box 33A on the forward right side receives a forward force in the direction opposite to the moving direction of the first frame body 10 through the link 34A, thus moving forward. On the other hand, the axle box 33C on the rearward right side is supported on the first frame body 10 and, at the same time, is joined to the first protruding portion 15 of the same first frame body 10 by way of the link 34C. With such a configuration, the axle box 33C on the rearward right side moves rearward together with the first frame body 10.

[0061] In contrast, the axle boxes 33B and 33D, which are elastically supported on the fore and rear end portions 21a and 21b of the side beam 21 of the second frame body 20 respectively, display the following behavior. The axle box 33B on the forward left side is supported on the second frame body 20 and, at the same time, is joined to the first extending portion 13 of the first frame body 10, which is different from the second frame body 20, by way of the link 34B. With such a configuration, the axle box 33B on the forward left side receives a rearward force in the direction opposite to the moving direction of the second frame body 20 through the link 34B, thus moving rearward. On the other hand, the axle box 33D on the rearward left side is supported on the second frame body 20 and, at the same time, is joined to the second protruding portion 25 of the same second frame body 20 by way of the link 34D. With such a configuration, the axle box 33D on the rearward left side moves forward together with the second frame body 20.

[0062] In this case, due to forward movement of the axle box 33A on the forward right side and rearward movement of the axle box 33B on the forward left side, the right side of the wheelset 31A on the forward side is displaced forward, and the left side of the wheelset 31A on the forward side is displaced rearward, thus allowing self-steering such that an axis of the wheelset 31A is directed to the center of curvature of the left-turning curved railroad track. On the other hand, due to rearward movement of the axle box 33C on the rearward right side and forward movement of the axle box 33D on the rearward left side, the right side of the wheelset 31B on the rearward side is displaced rearward, and the left side of the wheelset 31B on the rearward side is displaced forward, thus allowing self-steering such that an axis of the wheelset 31B is directed to the center of curvature of the left-turning curved railroad track. As described above, when relative yawing displacement occurs between the car body 50 and the bogie according to the left-turning curved railroad track, relative longitudinal movement occurs between the first frame body 10 and the second frame body 20, thus allowing self-steering of the wheelset 31A on the forward side and the wheelset 31B on the rearward side corresponding to the relative longitudinal movement.

[0063] At this point of operation, of the tread brake devices 40A and 40B on the forward side, the tread brake device 40A on the forward right side is held by the second cross beam 22 of the second frame body 20, thus moving forward together with the second frame body 20. The tread brake device 40B on the forward left side is held by the first cross beam 12 of the first frame body 10, thus moving rearward together with the first frame body 10. Further, with the displacement of the wheelset 31A on the forward side as described above, the wheel 32A on the forward right side moves forward, and the wheel 32B on the forward left side moves rearward. An amount of forward movement of the tread brake device 40A on the forward right side is substantially equal to an amount of forward movement of the wheel 32A. An amount of rearward movement of the tread brake device 40B on the forward left side is substantially equal to an amount of rearward movement of the wheel 32B. Accordingly, distances in the longitudinal direction between the respective wheels 32A and 32B on the forward side and the respective corresponding tread brake devices 40A and 40B are constant regardless of steering.

[0064] On the other hand, of the tread brake devices 40C and 40D on the rearward side, the tread brake device 40C on the rearward right side is held by the first cross beam 12 of the first frame body 10, thus moving rearward together with the first frame body 10. The tread brake device 40D on the rearward left side is held by the second cross beam 22 of the second frame body 20, thus moving forward together with the second frame body 20. Further, with the displacement of the wheelset 31B on the rearward side as described above, the wheel 32C on the rearward right side moves rearward, and the wheel 32D on the rearward left side moves forward. An amount of rearward movement of the tread brake device 40C on the rearward right side is substantially equal to an amount of rearward movement of the wheel 32C. An amount of forward movement of the tread brake device 40D on the rearward left side is substantially equal to an amount of forward movement of the wheel 32D. Accordingly, distances in the longitudinal direction between the respective wheels 32C and 32D on the rearward side and the respective corresponding tread brake devices 40C and 40D are constant regardless of steering.

[0065] For this reason, even when general-purpose components are used as the tread brake devices 40A, 40B, 40C and 40D, the distances in the longitudinal direction between the respective wheels 32A, 32B, 32C and 32D and the respective corresponding tread brake devices 40A, 40B, 40C and 40D are constant regardless of steering. Accordingly, sufficient braking performance can be always maintained.

[0066] The traction motor 41A on the forward side and the traction motor 41B on the rearward side are held by the first cross beam 12 of the first frame body 10, thus moving rearward together with the first frame body 10. Further, the gear unit 42A on the forward side is mounted on the wheelset 31A on the forward side at a position adjacent to the wheel 32B on the forward left side. The gear unit 42B on the rearward side is mounted on the wheelset 31B on the rearward side at a position adjacent to the wheel 32C on the rearward right side. Accordingly, with the displacement of the wheelset 31A on the forward side and the wheelset 31B on the rearward side as described above, the gear unit 42A on the forward side and the gear unit 42B on the rearward side move rearward. An amount of rearward movement of the traction motor 41A on the forward side and an amount of rearward movement of the traction motor 41B on the rearward side slightly differ from an amount of rearward movement of the gear unit 42A on the forward side and an amount of rearward movement of the gear unit 42B on the rearward side. However, respective joints (gear couplings or flexible couplings) 43A and 43B on the forward and rearward sides, each of which connects the traction motor and the gear unit with each other, allow a difference in amount of movement. Accordingly, even when general-purpose components are used as the traction motors 41A and 41B, the gear units 42A and 42B, and the joints 43A and 43B, distances in the longitudinal direction between the respective gear units 42A and 42B and the respective corresponding joints 43A and 43B are constant regardless of steering. Therefore, smooth driving of the respective wheelsets 31A and 31B can be always maintained.

[0067] Next, referring to FIG. 5B, the case of the right-turning curved railroad track is described. When the car runs through the right-turning curved railroad track, the bolster 56 assumes a state opposite to that in the above-mentioned left-turning curved railroad track, that is, a state where the bolster 56 yaws leftward with respect to the bogie. When the bolster 56 yaws leftward, contrary to the case of the above-mentioned left-turning curved railroad track, a forward force acts on the first frame body 10 through the first connecting portion 52A on the right side, and a rearward force acts on the second frame body 20 through the second connecting portion 52B on the left side. Accordingly, relative longitudinal movement which occurs between the first frame body 10 and the second frame body 20 is in the direction opposite to the relative longitudinal movement which occurs in the case of the above-mentioned left-turning curved railroad track. Therefore, behavior of respective constitutional elements in the case of the right-turning curved railroad track is simply opposite in the lateral direction to that in the case of the above-mentioned left-turning curved railroad track.

[0068] As has been described above, according to this embodiment, when the railroad car runs through a curved railroad track, relative yawing displacement occurs between the bolster 56 (car body 50) and the bogie frame (the first frame body 10 and the second frame body 20) according to the curved railroad track. Due to such relative yawing displacement, relative longitudinal movement occurs between the first frame body 10 and the second frame body 20, thus allowing self-steering of the wheelsets 31A and 31B on the forward and rearward sides corresponding to the relative longitudinal movement. Further, the bolster 56 is supported at one point by the core receiver 30 and hence, the bolster 56 can smoothly rotate with respect to the bogie frame (first cross beam 12) in the yawing direction. Accordingly, a lateral force at a curved railroad track can be sufficiently reduced.

[0069] The respective axle boxes 33A, 33B, 33C and 33D are elastically supported on the first frame body 10 and the second frame body 20 by the respective corresponding axle box suspensions. Further, the first frame body 10 and the second frame body 20 are allowed to relatively rotate in the pitching direction about an axis which connects two supporting points with each other. Accordingly, in a transition curve section, relative rolling displacement between the wheelset 31A on the forward side and the wheelset 31B on the rearward side which occurs with the bending of the track can be allowed. Therefore, it is possible to suppress fluctuation in wheel load in the transition curve section. Particularly, the bolster 56 (car body 50) and the bogie frame (the first frame body 10 and the second frame body 20) are connected with each other in a flexible manner by the first connecting portion 52A and the second connecting portion 52B and hence, when the railroad car runs through a section from an exit transition curve section to a straight section, the bolster 56 does not restrain relative longitudinal movement between the first frame body 10 and the second frame body 20. For this reason, the wheelset 31A on the forward side and the wheelset 31B on the rearward side can smoothly return to normal orientation. Accordingly, generation of a lateral force and fluctuation in wheel load in a transition curve section can be sufficiently suppressed.

[0070] Furthermore, the present invention is not limited to the above-mentioned embodiment, and various modifications are conceivable without departing from the gist of the present invention. For example, in the above-mentioned embodiment, the mono-link type axle box suspension is adopted as the axle box suspension. However, a so-called axle beam type axle box suspension, or a support plate (leaf spring) type axle box suspension may be adopted. The axle beam type axle box suspension is an axle box suspension of a type where an arm extends in the longitudinal direction while forming an integral body with an axle box, a rubber bush is inserted into a distal end portion of the arm, and the arm is joined to a bogie frame. In the case of adopting the axle beam type axle box suspension, the arm extending from the axle box corresponds to the link of the axle box suspension in the above-mentioned embodiment. The leaf spring type axle box suspension is an axle box suspension of a type which joins an axle box and a bogie frame with each other by two leaf springs which extend in the longitudinal direction parallel to each other. In the case of adopting the leaf spring type axle box suspension, the leaf springs extending from the axle box correspond to the link of the axle box suspension in the above-mentioned embodiment.

[Example]

[0071] To confirm advantageous effects of the present invention, numerical simulation analysis was performed. To be more specific, various car models, each of which includes one car body and two steering bogies, were prepared, and situations where cars run through curved railroad tracks were simulated by numerical analysis using these models. A curved railroad track consisting of five sections (A: entry straight section, B: entry transition curve section, C: steady curve section, D: exit transition curve section, and E: exit straight section) was adopted as the curved railroad track for the numerical analysis. A radius of curvature of the steady curve section C was set to 200 m (curvature: 0.005). Main conditions for the models are as shown in following Table 1.

[Table 1]

[0072]

TABLE 1

classification	support of bolster	connection between bolster and bogie frame
Example	core receiver (one portion)	shaft portion and hole portion (including rubber bush)
Conventional Example	side bearings (two portions)	center plate
Comparative Example 1	side bearings (two portions)	shaft portion and hole portion (including rubber bush)
Comparative Example 2	core receiver (one portion)	center plate

[0073] The model of the Example satisfies all conditions in this embodiment. In the model of the Conventional Example, in the same manner as the bogie of Patent Literature 1, a bolster is supported by side bearings, and the bolster and a bogie frame are connected with each other by a center plate. In the model of the Comparative Example 1, a bolster and a bogie frame are connected with each other by a shaft portion and a hole portion (including rubber bush) in the same manner as the Example, however the bolster is supported by side bearings in the same manner as the Conventional Example. In the model of the Comparative Example 2, a bolster is supported by a core receiver in the same manner as the Example, however the bolster and a bogie frame are connected with each other by a center plate in the same manner as the Conventional Example.

[0074] To evaluate fluctuation in lateral force of the respective models, the lateral force which acts on a wheel on the outer track side of a wheelset on the forward side of each model was investigated. To evaluate the fluctuation in wheel load, displacement in the lateral direction of the wheelset on the forward side of each model was further investigated.

[0075] FIG. 6 is a view showing fluctuation in lateral force at a curved railroad track. FIG. 7 is a view showing displacement in a lateral direction of a wheelset at the curved railroad track. Referring to FIG. 6, in the Comparative Example 1, compared with the Conventional Example, a lateral force was reduced in the exit transition curve section (section D in FIG. 6). However, referring to FIG. 7, in the Comparative Example 1, displacement in the lateral direction of the wheelset was not restored to the center of the track in the exit straight section (section E in FIG. 6).

[0076] Referring to FIG. 6, in the Comparative Example 2, compared with the Conventional Example, a lateral force was not significantly reduced in the exit transition curve section (section D in FIG. 6). However, referring to FIG. 7, in the Comparative Example 2, displacement in the lateral direction of the wheelset was restored to the center of the track in the exit straight section (section E in FIG. 6).

[0077] Referring to FIG. 6, in the Example, a lateral force was remarkably reduced in the exit transition curve section (section D in FIG. 6). Further, referring to FIG. 7, in the Example, displacement in the lateral direction of the wheelset was restored to the center of the track in the exit straight section (section E in FIG. 6). Accordingly, it became apparent that the bogie and the car of this embodiment can favorably reduce a lateral force particularly in the exit transition curve section, and can suppress deviation of the wheelset from the center of the track after the bogie and the car traverse the curved railroad track.

INDUSTRIAL APPLICABILITY

[0078] The present invention is applicable to a variety of railroad cars having a bolster, and is effectively applicable particularly to a railroad car for subways which have many curved railroad tracks.

REFERENCE SIGNS LIST

[0079]

10	first frame body
11	right side beam
11a	fore end portion
11b	rear end portion
11c	opening
12	first cross beam
13	first extending portion
15	first protruding portion
16a, 16b	traction motor seat
17a, 17b	suspension tool seat
20	second frame body
21	left side beam
21a	fore end portion
21b	rear end portion
21c	opening
22	second cross beam
23	second extending portion
24	second projecting piece portion
25	second protruding portion
30	core receiver
30a	pedestal
30b	projecting portion

31A, 31B	wheelset
32A, 32B, 32C, 32D	wheel
33A, 33B, 33C, 33D	axle box
34A, 34B, 34C, 34D	link to axle box
35	coil spring
36a, 36b	rubber bush of axle box suspension
37	wearing plate
40A, 40B, 40C, 40D	tread brake device
41A, 41B	traction motor
42A, 42B	gear unit
43A, 43B	joint
44A, 44B	suspension tool
50	car body
51	air spring
52A	first connecting portion
52B	second connecting portion
53A	first shaft portion
53B	second shaft portion
54A	first hole portion
54B	second hole portion
55A	first rubber bush
55B	second rubber bush
56	bolster
57	side bearing
57a	pedestal
57b	projecting portion

Claims

1. A railroad car bogie which includes wheelsets on forward and rearward sides of the bogie, and which allows self-steering of the wheelsets, the bogie comprising:

a first frame body including a side beam on a right side, and a first cross beam integrally formed with the side beam on the right side;
a second frame body including a side beam on a left side, and a second cross beam integrally formed with the side beam on the left side;
axle boxes respectively attached to right and left end portions of the respective wheelsets;
axle box suspensions configured to elastically support the respective axle boxes; and
a bolster disposed above the first cross beam or the second cross beam, wherein
the first frame body and the second frame body support each other, and are slidable in a longitudinal direction,
the axle box suspension on a forward right side supports the axle box on the forward right side with a fore end portion of the side beam of the first frame body, and the axle box on the forward right side is joined to the second frame body,
the axle box suspension on a forward left side supports the axle box on the forward left side with a fore end portion of the side beam of the second frame body, and the axle box on the forward left side is joined to the first frame body,
the axle box suspension on a rearward right side supports the axle box on the rearward right side with a rear end portion of the side beam of the first frame body, and the axle box on the rearward right side is joined to the first frame body,
the axle box suspension on a rearward left side supports the axle box on the rearward left side with a rear end portion of the side beam of the second frame body, and the axle box on the rearward left side is joined to the second frame body,
the bogie further comprises:

a core receiver configured to support a center portion of the bolster, the core receiver being provided on an upper surface of the first cross beam or the second cross beam;
a first connecting portion configured to connect the first cross beam and the bolster with each other, the

first connecting portion being disposed on a right side of the core receiver; and
a second connecting portion configured to connect the second cross beam and the bolster with each other, the second connecting portion being disposed on a left side of the core receiver,
the first connecting portion includes a first shaft portion and a first hole portion, the first shaft portion protruding in a vertical direction from either one of the first cross beam or the bolster, and the first hole portion being formed on the other of the first cross beam or the bolster, and accommodating a distal end portion of the first shaft portion, and
the second connecting portion includes a second shaft portion and a second hole portion, the second shaft portion protruding in the vertical direction from either one of the second cross beam or the bolster, and the second hole portion being formed on the other of the second cross beam or the bolster, and accommodating a distal end portion of the second shaft portion.

2. The railroad car bogie according to claim 1, wherein
the axle box suspensions include links respectively extending from the axle boxes along a longitudinal direction, the first cross beam includes a first extending portion extending toward the fore end portion of the side beam of the second frame body, and the second cross beam includes a second extending portion extending toward the fore end portion of the side beam of the first frame body,
the axle box on the forward right side and the second frame body are joined with each other by joining the link, which extends from the axle box on the forward right side, and the second extending portion of the second cross beam with each other,
the axle box on the forward left side and the first frame body are joined with each other by joining the link, which extends from the axle box on the forward left side, and the first extending portion of the first cross beam with each other,
the axle box on the rearward right side and the first frame body are joined with each other by joining the link, which extends from the axle box on the rearward right side, and the side beam of the first frame body with each other, and
the axle box on the rearward left side and the second frame body are joined with each other by joining the link, which extends from the axle box on the rearward left side, and the side beam of the second frame body with each other.

3. The railroad car bogie according to claim 1 or claim 2, the bogie further comprising:

a first elastic member disposed in a gap formed between the distal end portion of the first shaft portion and the first hole portion; and
a second elastic member disposed in a gap formed between the distal end portion of the second shaft portion and the second hole portion.

4. The railroad car bogie according to claim 3, wherein
the first elastic member is a first rubber bush, and the second elastic member is a second rubber bush.

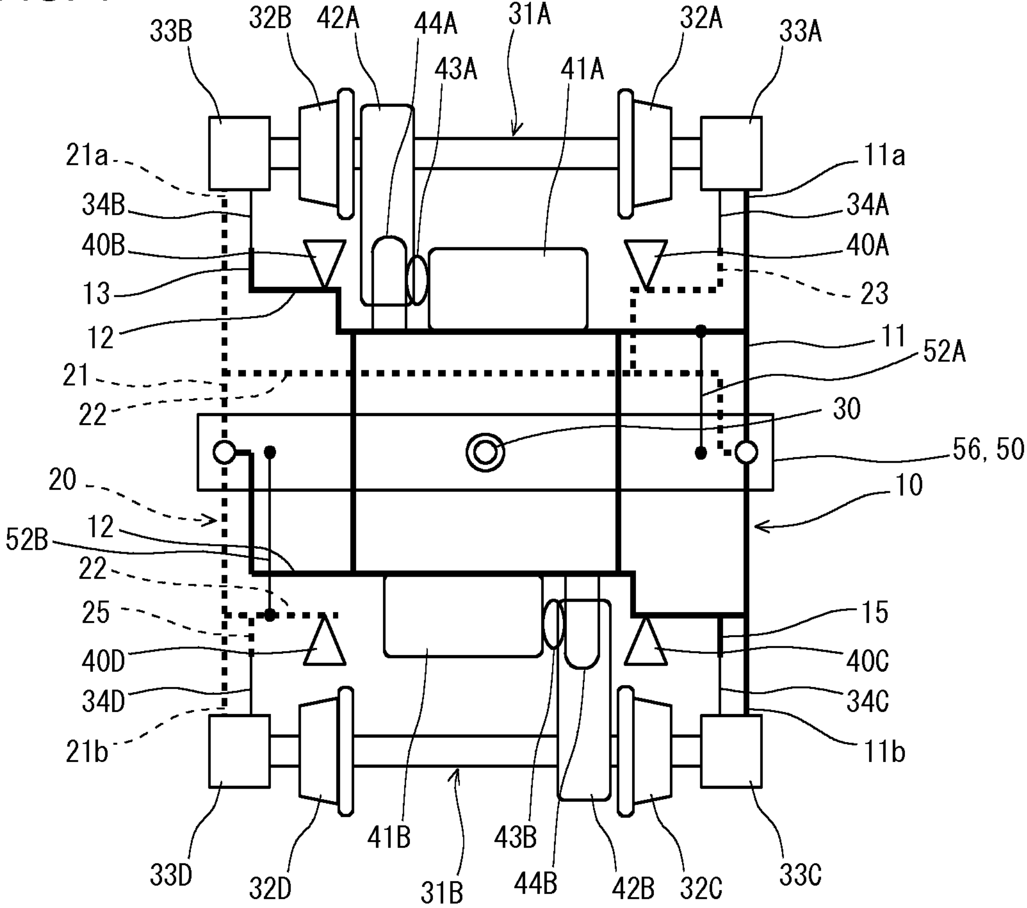
5. The railroad car bogie according to any one of claim 1 to claim 4, the bogie further comprising,
side bearings respectively provided on an upper surface of the side beam of the first frame body and an upper surface of the side beam of the second frame body, the side bearings opposedly facing right and left end portions of the bolster with gaps formed between the side bearings and the bolster.

6. The railroad car bogie according to any one of claim 1 to claim 5, the bogie further comprising:

tread brake devices configured to correspond to respective right and left wheels of the respective wheelsets; and traction motors and gear units configured to drive the respective wheelsets, wherein
the respective tread brake devices on the forward left side and on the rearward right side are held by the first cross beam,
the respective tread brake devices on the forward right side and on the rearward left side are held by the second cross beam, and
the respective traction motors on the forward and rearward sides are held by one of the first cross beam or the second cross beam, and the respective gear units on the forward and rearward sides are held by one of the first cross beam or the second cross beam.

7. A railroad car comprising: the bogie described in any one of claim 1 to claim 6; a car body; and a pair of right and left air springs disposed on the bolster, and configured to support the car body.

FIG. 1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13
23
12
11
21
52A
22
30
56, 50
20
10
12
52B
22
15
25
40D
40C
34D
34C
21b
11b
41B
43B
33D
32D
31B
44B
42B
32C
33C

FIG. 2

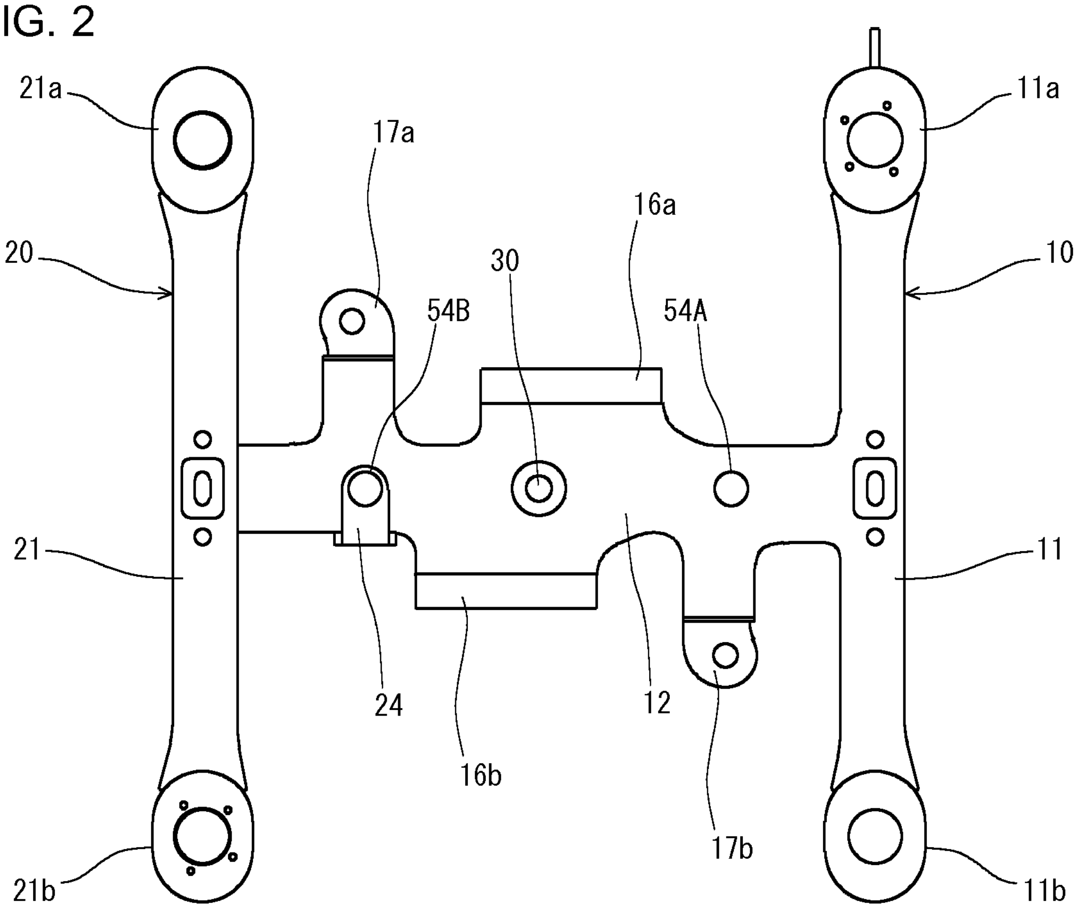
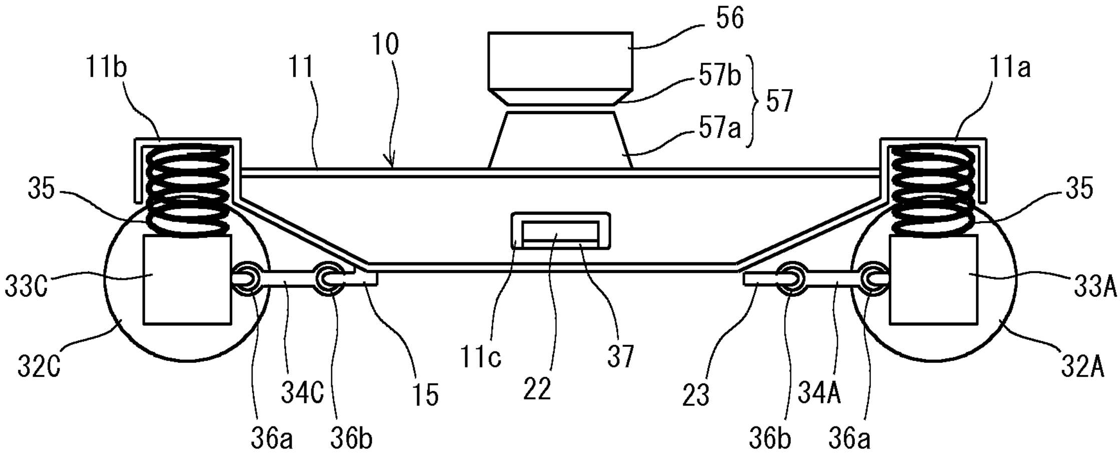


FIG. 3A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11a
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11c
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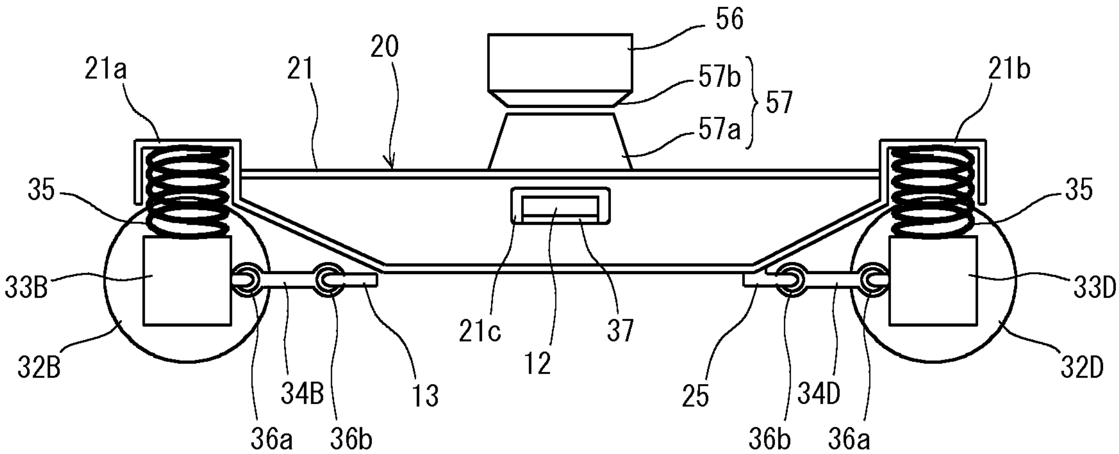
34A
36a
36b
36b
36a

FIG. 3B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35
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21c
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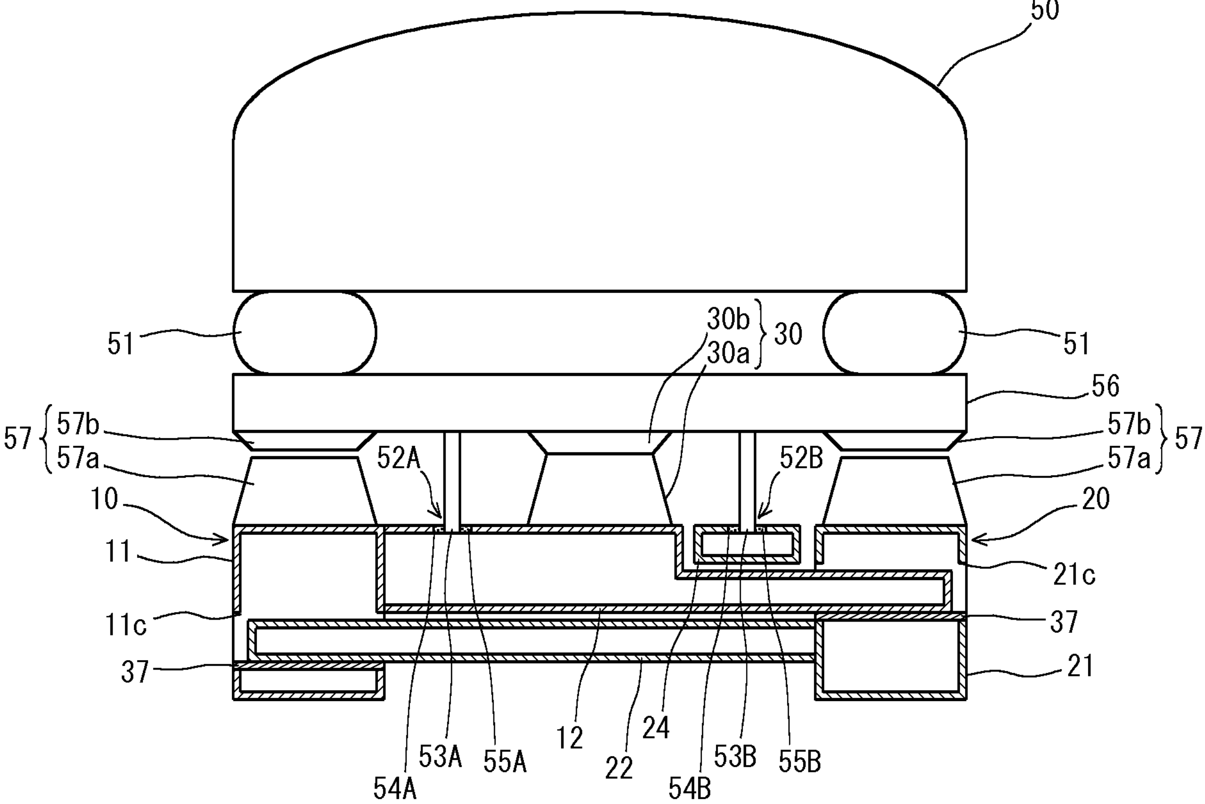
34B
13
25
34D
36a
36b
36b
36a

FIG. 4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11c
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12
24
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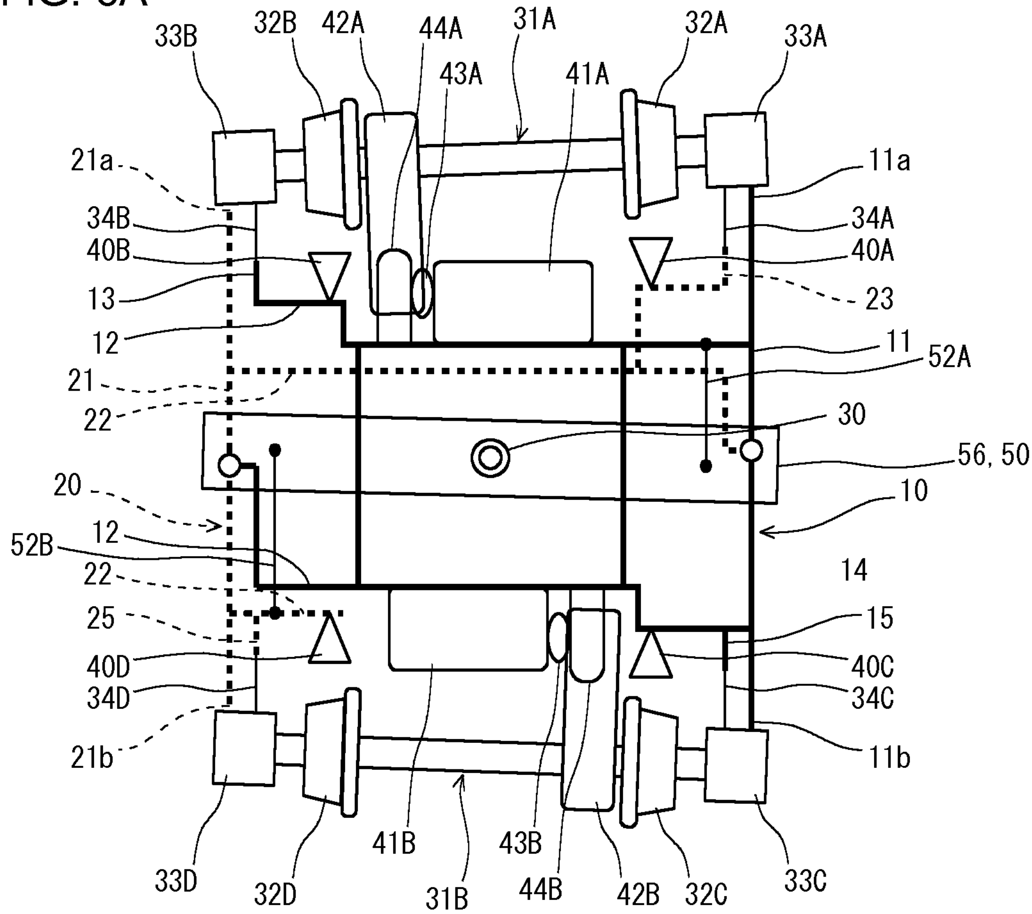
53A
55A
54A
53B
55B
54B

FIG. 5A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22
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12
52B
14
22
25
15
40D
40C
34D
34C
21b
11b
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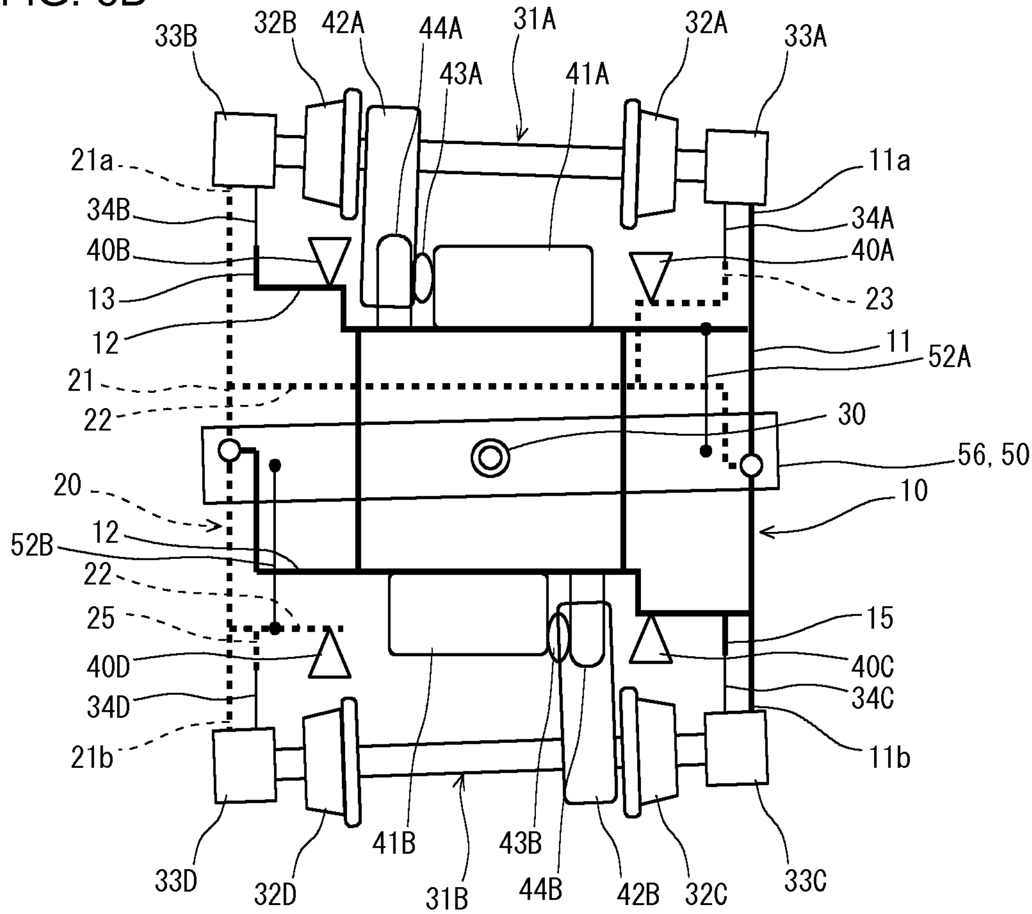
33D
32D
31B
44B
42B
32C
33C

FIG. 5B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25
40D
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31B
44B
42B
32C
33C

FIG. 6

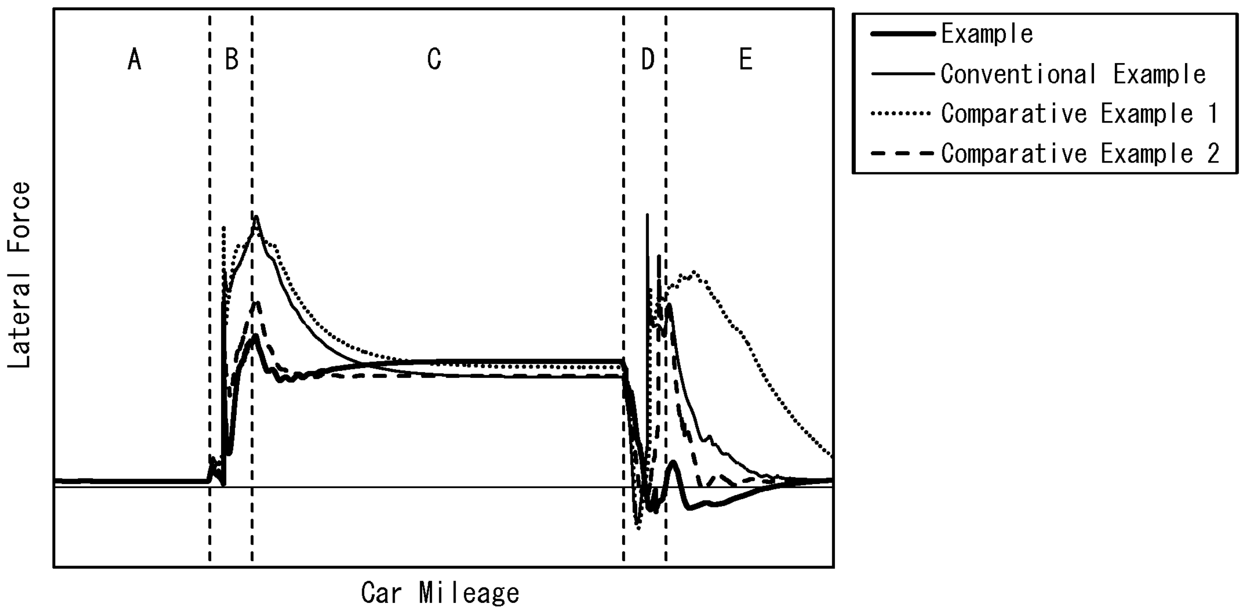
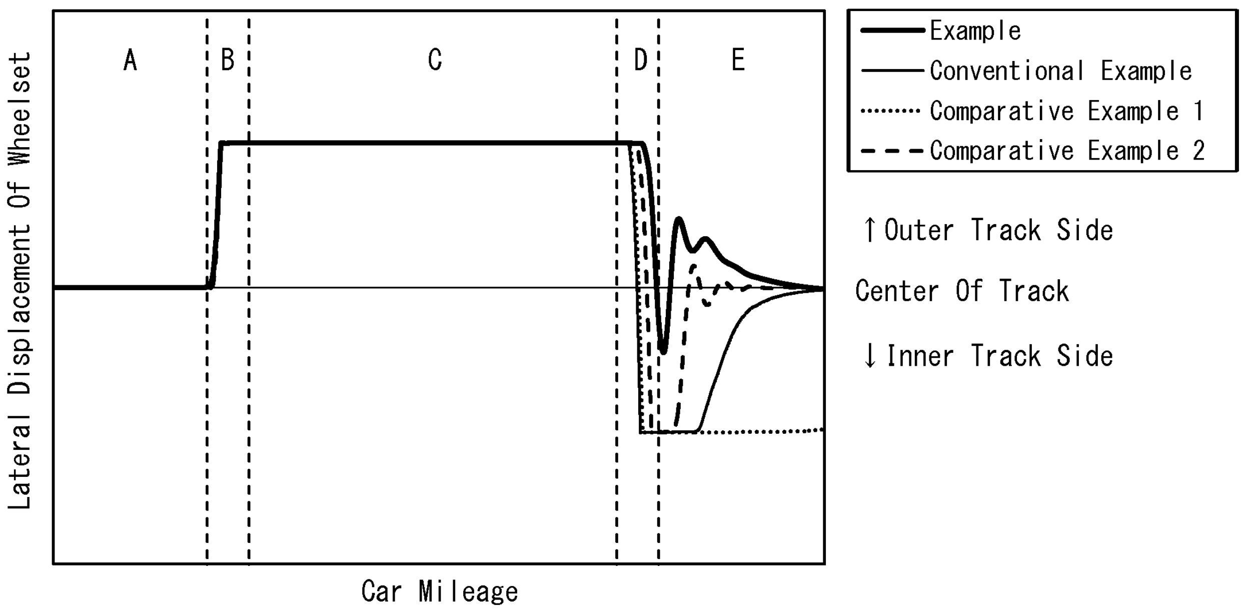

A
B
C
D
E
Lateral Force
Car Mileage
Example
Conventional Example
Comparative Example 1
Comparative Example 2

FIG. 7


A
B
C
D
E
Example
Conventional Example
Comparative Example 1
Comparative Example 2
↑Outer Track Side
Center Of Track
↓Inner Track Side
Lateral Displacement Of Wheelset
Car Mileage

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2017/024862

A. CLASSIFICATION OF SUBJECT MATTER

B64F5/40(2017.01)i, *B61C9/38*(2006.01)i, *B61F5/10*(2006.01)i, *B61F5/14*(2006.01)i, *B61F5/30*(2006.01)i, *B61F5/40*(2006.01)i, *B61F5/52*(2006.01)i, *B61H7/00*(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)

B64F5/40, B61C9/38, B61F5/10, B61F5/14, B61F5/30, B61F5/40, B61F5/52, B61H7/00

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	1996-2017
Kokai Jitsuyo Shinan Koho	1971-2017	Toroku Jitsuyo Shinan Koho	1994-2017

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.
A	WO 2016/017103 A1 (Nippon Steel & Sumitomo Metal Corp.), 04 February 2016 (04.02.2016), paragraphs [0075] to [0079]; fig. 17 & EP 3176048 A1 paragraphs [0083] to [0087]; fig. 17 & CN 106573629 A & TW 201620756 A	1-7
A	JP 2015-127200 A (Nippon Steel & Sumitomo Metal Corp.), 09 July 2015 (09.07.2015), fig. 1 (Family: none)	1-7

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

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
08 September 2017 (08.09.17)	19 September 2017 (19.09.17)

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2017/024862

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2009/017114 A1 (The University of Tokyo), 05 February 2009 (05.02.2009), fig. 2 & EP 2184214 A1 fig. 2	1-7

Form PCT/ISA/210 (continuation of second sheet) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 2016017103 A **[0003] [0006]**