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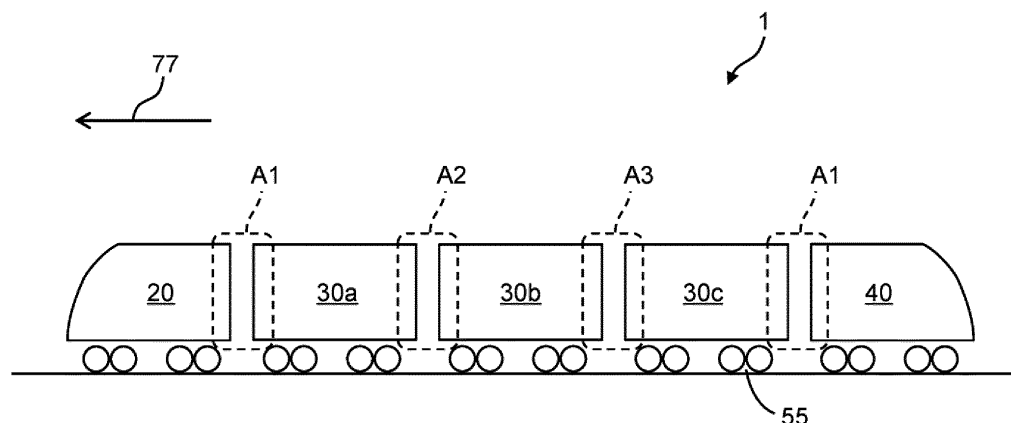
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(54) **ASSEMBLED VEHICLE PROVIDED WITH BETWEEN-BODY DAMPER DEVICE**

(57) An object of the invention is to provide a formation vehicle provided with inter-vehicle body damper devices that can reduce bending vibration and vibration in a roll direction of a vehicle body, and can effectively reduce left-right vibration and vibration in a yaw-direction of the vehicle body to further improve riding comfort of the vehicle. A formation vehicle 1 includes: first inter-vehicle body damper devices A1 provided between a leading vehicle 20 and a first intermediate vehicle 30a and

between a trailing vehicle 40 and a third intermediate vehicle 30c; and inter-vehicle body damper devices (A2, A3) provided at both ends in a longitudinal direction of the intermediate vehicles. The inter-vehicle body damper devices (A2, A3) include up-down dampers 4a (4b) provided on one side in the width direction of an end plate of a second intermediate vehicle along an up-down direction.

[FIG. 1]



Description

Technical Field

[0001] The present invention relates to a formation vehicle provided with inter-vehicle body damper devices that improve riding comfort of a railway vehicle.

Background Art

[0002] In recent years, along with speeding up of railway vehicles, roll vibration (vibration around an axis along a longitudinal direction of a vehicle) generated during a railway vehicle passes through a curved line, vehicle body bending vibration in an up-down direction, yaw vibration of the vehicle body (vibration in a horizontal plane) and the like become apparent and riding comfort tends to be reduced, so that it is required to suppress the vibration and improve the riding comfort. Therefore, in a coupling portion between a vehicle and a vehicle, an inter-vehicle body damper device constituted by a plurality of dampers bridged between the vehicles is provided to suppress the vibrations and improve the riding comfort.

[0003] As an example of such an inter-vehicle body damper device, there has been proposed an inter-vehicle damper device that suppresses up-down vibration of an end in the longitudinal direction of the vehicle body and prevents bending vibration by bridging a pair of up-down dampers in the up-down direction between the vehicles and on both sides of a penetration-path between the coupled vehicle bodies to generate a damping force with respect to an up-down relative speed generated between the coupled vehicle bodies (Refer to, for example, PTL 1).

Prior Art Literature

Patent Literature

[0004] PTL 1: JP-A-11-78881

Summary of Invention

Technical Problem

[0005] When a railway vehicle travels at a high speed, a rear truck that supports a vehicle body vibrates in the up-down direction due to an irregularity in the up-down direction of a track. As a result, the vehicle body supported by the truck, that vibrates in the up-down direction, is also vibrated in the up-down direction due to the truck, and bending vibration is generated at the vehicle body.

[0006] Since a natural frequency of the bending vibration of the vehicle body is close to a frequency band where human beings are likely to feel uncomfortable, the natural frequency of the bending vibration of the vehicle body tends to cause the reduction of the riding comfort in the up-down direction. Further, when the railway vehicle passes through a curved line at a high speed, the vehicle

body vibrates in a roll direction due to a canting of the track or track irregularity, which tends to cause the reduction of the riding comfort.

[0007] Since the inter-vehicle body damper device proposed in the aforementioned PTL 1 is bridged in the up-down direction between two coupled vehicle bodies, it is effective for reducing the bending vibration of the vehicle body and the vibration in the roll direction of the vehicle body.

[0008] However, since the inter-vehicle body damper device according to PTL 1 does not generate a damping force corresponding to left-right vibration of the vehicle body caused by the track irregularity in left-right direction and vibration in a yaw direction of the vehicle body, it is necessary to additionally dispose a damper capable of reducing the vibration in the yaw direction. However, in order to suppress the vibration caused by the track irregularities in the up-down direction and the left-right direction, it is effective by increasing the number of dampers bridged between the vehicle bodies, but as the number of dampers increases, the manufacturing costs and maintenance costs associated with the dampers also increase, so that it is desirable that the number of dampers is not large.

[0009] The invention is made in consideration of the above-mentioned points, and an object thereof is to provide a formation vehicle provided with inter-vehicle body damper devices that can effectively suppress the bending vibration of the vehicle body and the vibration in the yaw (left-right) direction and the roll direction of the vehicle body and improve the riding comfort while the number of the dampers is reduced and the manufacturing and maintenance costs associated with the dampers are decreased.

Solution to Problem

[0010] In order to solve the above-mentioned problem, a formation vehicle according to the invention includes a leading vehicle, a first intermediate vehicle coupled to the leading vehicle, a trailing vehicle, a third intermediate vehicle coupled to the trailing vehicle, a second intermediate vehicle coupled between the first intermediate vehicle and the third intermediate vehicle, first inter-vehicle body damper devices provided between the leading vehicle and the first intermediate vehicle and between the trailing vehicle and the third intermediate vehicle, and inter-vehicle body damper devices provided at both ends in the longitudinal direction of the second intermediate vehicle, wherein the first inter-vehicle body damper device includes two up-down dampers and a left-right damper which are bridged between the leading vehicle and the first intermediate vehicle, and the inter-vehicle body damper device includes one up-down damper and the left-right damper which are bridged between the second intermediate vehicle and vehicles coupled to both ends in the longitudinal direction of the second intermediate vehicle.

Advantageous Effect

[0011] According to the invention, it is possible to provide a formation vehicle provided with inter-vehicle body damper devices that can effectively suppress the bending vibration of the vehicle body and the vibration in the yaw (left-right) direction and the roll direction of the vehicle body and improve the riding comfort while the number of the dampers is reduced and the manufacturing and maintenance costs associated with the dampers are decreased.

Brief Description of Drawings

[0012]

FIG. 1 is a side view of a formation vehicle provided with inter-vehicle body damper devices according to Embodiment 1 of the invention.

FIG. 2 is a schematic view of a first inter-vehicle body damper device provided between a leading vehicle and a first intermediate vehicle and between a third intermediate vehicle and a trailing vehicle.

FIG. 3 is a schematic view of a second inter-vehicle body damper device provided at one end in a longitudinal direction of a second intermediate vehicle.

FIG. 4 is a schematic view of a third inter-vehicle body damper device provided at the other end in the longitudinal direction of the second intermediate vehicle.

FIG. 5 is a schematic view (perspective view) of the second intermediate vehicle provided with a second inter-vehicle body damper device on a front side and a third inter-vehicle body damper device on a rear side.

FIG. 6 is a schematic view showing a state in which the first intermediate vehicle to the third intermediate vehicle of the formation vehicle traveling at a high speed vibrate in an up-down direction in a side view. FIG. 7 is a schematic view showing a state in which the first intermediate vehicle to the third intermediate vehicle of the formation vehicle traveling at a high speed vibrate in a left-right direction and a yaw direction in a top view.

FIG. 8 is a schematic view showing a state in which the second inter-vehicle body damper device and the third inter-vehicle body damper device of the formation vehicle traveling at a high speed overlap each other in the longitudinal direction of the formation vehicle and adjacent vehicles vibrate in a roll direction.

FIG. 9 is a table showing an arrangement of the dampers constituting the inter-vehicle damper devices according to Embodiment 1 of the invention.

FIG. 10 is a table showing an arrangement of the dampers constituting inter-vehicle damper devices according to Embodiment 2 of the invention.

Description of Embodiments

[0013] Next, a formation vehicle provided with inter-vehicle body damper devices according to embodiments of the invention will be described with reference to the drawings. First, each direction for explanation will be defined. A traveling direction (front-rear, longitudinal, rail direction) of a formation vehicle is referred to as "front" or "front side", a direction opposite to the traveling direction is referred to as "rear" or "rear side", one side in a width (left-right, sleeper) direction of the vehicle body as seen from the traveling direction is referred to as "right" or "right side", and similarly the other side in the width direction is referred to as "left" or "left side".

[0014] The embodiments described below are examples for describing the invention, and the invention is not limited to these embodiments. Therefore, the invention can be embodied in various forms without departing from the spirit thereof. The various dampers described herein are devices that damp vibration by converting the vibration (kinetic energy) into heat in a process of expanding and contracting along the longitudinal direction thereof.

(Embodiment 1)

[0015] FIG. 1 is a side view of a formation vehicle provided with inter-vehicle body damper devices according to Embodiment 1 of the invention. A formation vehicle 1 includes 5 vehicles which are a leading vehicle 20 coupled at one end of the formation vehicle 1, a trailing vehicle 40 coupled at the other end of the formation vehicle 1, and a first intermediate vehicle 30a, a second intermediate vehicle 30b, and a third intermediate vehicle 30c which are provided between the leading vehicle 20 and the trailing vehicle 40.

[0016] A first inter-vehicle body damper device A1 constituted by dampers bridged in an up-down direction, a front-rear direction, a left-right direction between the vehicles is provided between the leading vehicle 20 and the first intermediate vehicle 30a and between the third intermediate vehicle 30c and the trailing vehicle 40 (coupling portions). A portion (position) where the inter-vehicle body damper device is provided is between a vehicle and a vehicle or is referred to as a coupling portion between a vehicle and a vehicle.

[0017] The second intermediate vehicle 30b is provided with a second inter-vehicle body damper device A2 on a front side thereof and a third inter-vehicle body damper device A3 on a rear side thereof. The second intermediate vehicle 30b is coupled to the first intermediate vehicle 30a via the second inter-vehicle body damper device A2 and is coupled to the third intermediate vehicle 30c via the third inter-vehicle body damper device A3.

[0018] Details of installation locations and the installation number and the like of up-down dampers, left-right dampers, and front-rear dampers constituting the first inter-vehicle body damper device A1, the second inter-ve-

hicle body damper device A2, and the third inter-vehicle body damper device A3 are as shown in an arrangement table of the dampers constituting the inter-vehicle body damper device shown in FIG. 9, and the details will be described later. Although FIG. 1 shows a 5-vehicle formation in which the second intermediate vehicle 30b is coupled to the first intermediate vehicle 30a and the third intermediate vehicle 30c, the formation vehicle may be made up of 6 vehicles or more in which another vehicle is coupled between the second intermediate vehicle 30b and the first intermediate vehicle 30a or between the second intermediate vehicle 30b and the third intermediate vehicle 30c.

[0019] FIG. 2 is a schematic view of the first inter-vehicle body damper device provided between the leading vehicle and the first intermediate vehicle and between the third intermediate vehicle and the trailing vehicle. As shown in FIG. 2, the first inter-vehicle body damper device A1 includes a pair of up-down dampers 4a (4b) that suppresses relative displacement in the up-down direction between two vehicles, one left-right damper 8 that suppresses relative displacement in the left-right direction between the two vehicles, and a pair of front-rear dampers 7a (7b) that suppresses relative displacement in the front-rear direction between the two vehicles.

[0020] One end in the longitudinal direction of the up-down damper 4a (4b) is connected to a bracket 42a (42b) fixed to an end plate of one vehicle, and the other end of the up-down damper 4a (4b) is connected to a bracket 44a (44b) fixed to an end plate of the other vehicle. For this reason, the up-down damper 4a (4b) is bridged across the two facing vehicles at the coupling portion. Brackets 46 (48) provided at both ends of the left-right damper 8 and brackets (not shown) of the front-rear dampers 7a (7b) are similarly bridged across the two vehicles at the coupling portions.

[0021] In the first inter-vehicle body damper device A1, the up-down damper 4a and the front-rear damper 7a are provided on a right side 78 of a penetration-path 50, and the up-down damper 4b and the front-rear damper 7b are provided on a left side 79 of the penetration-path 50. The left-right damper 8 is provided above the penetration-path 50.

[0022] FIG. 3 is a schematic view of the second inter-vehicle body damper device provided at one end in the longitudinal direction of the second intermediate vehicle, and FIG. 4 is a schematic view of the third inter-vehicle body damper device provided at the other end in the longitudinal direction of the second intermediate vehicle. FIG. 5 is a schematic view (perspective view) of the second intermediate vehicle provided with the second damper device on the front side and the third inter-vehicle body damper device on the rear side.

[0023] As shown in FIGS. 3 and 5, the second inter-vehicle body damper device A2 includes the up-down damper 4b that suppresses the relative displacement in the up-down direction between two vehicles and that is provided only on the left side 79 (one side in the width

direction of the end plate) of the penetration-path 50 provided in one end plate 2 in the longitudinal direction of the second intermediate vehicle 30b, the left-right damper 8 that suppresses the relative displacement in the left-right direction between the two vehicles, and a pair of (two) front-rear dampers 7a (7b) that suppresses the relative displacement in the front-rear direction between the two vehicles.

[0024] As shown in FIGS. 4 and 5, the third inter-vehicle body damper device A3 includes the up-down damper 4a that suppresses the relative displacement in the up-down direction between two vehicles and that is provided only on the right side 78 (the other side in the width direction of the end plate) of the penetration-path 50 provided in the other end plate 3 in the longitudinal direction of the second intermediate vehicle 30b, the left-right damper 8 that suppresses the relative displacement in the left-right direction between the two vehicles, and a pair of (two) front-rear dampers 7a (7b) that suppresses the relative displacement in the front-rear direction between the two vehicles.

[0025] In the second intermediate vehicle 30b provided with a second inter-vehicle body damper device A2 on the front side and a third inter-vehicle body damper device A3 on the rear side, the up-down damper 4b provided on the left side 79 of the penetration-path 50 in the end plate 2 provided at one end in a traveling direction 77 and the up-down damper 4a provided on the right side 78 of the penetration-path 50 in the end plate 3 provided at the other end in the traveling direction 77 are provided diagonally with respect to a plane including a center line C intersecting the width direction of the vehicle body.

[0026] FIG. 6 is a schematic view showing a state in which the first intermediate vehicle to the third intermediate vehicle of the formation vehicle traveling at a high speed vibrate in the up-down direction in a side view. When the formation vehicle 1 travels at a high speed, a truck 55 vibrates in the up-down direction due to the track irregularity in the up-down direction and the like. The first intermediate vehicle 30a, the second intermediate vehicle 30b, and the third intermediate vehicle 30c, which are supported by the truck 55 that vibrates in the up-down direction, are vibrated in the up-down direction due to the truck 55 and bending vibration is generated.

[0027] There are two bending vibration modes of the bending vibration generated at a plurality of coupled intermediate vehicles. In one bending vibration mode, the bending vibration having a phase difference is generated between the front and rear vehicles such that a central portion in the longitudinal direction of the second intermediate vehicle 30b is displaced upward and a central portions in the longitudinal direction of the first intermediate vehicle 30a and the third intermediate vehicle 30c are displaced downward (see FIG. 6). In the other bending vibration mode, the bending vibration having no phase difference (same phase) is generated between the front and rear vehicles such that the central portions in the longitudinal direction of the second intermediate

vehicle 30b, the first intermediate vehicle 30a and the third intermediate vehicle 30c are displaced in the same direction (not shown).

[0028] The actions and effects of vibration reduction, in a case where the central portions of the adjacent vehicles shown in FIG. 6 are displaced in different directions and a phase difference is generated, will be described. Dotted lines 300a, 300b, and 300c schematically show a state in which the first intermediate vehicle 30a, the second intermediate vehicle 30b, and the third intermediate vehicle 30c are deformed along with the bending vibration, respectively. In the bending vibration with a phase difference between adjacent intermediate vehicles, a downward speed is generated at both ends in the front-rear direction of the second intermediate vehicle 30b, and an upward speed is generated at a rear end of the first intermediate vehicle 30a and a front end of the third intermediate vehicle 30c.

[0029] As a result, the up-down damper 4b of the second inter-vehicle body damper device A2 and the up-down damper 4a of the third inter-vehicle body damper device A3 generate a relative speed that expands and contracts in the up-down direction, and a damping force 66 in a direction canceling the relative speed is generated. Since the vibration in the up-down direction of the first intermediate vehicle 30a, the second intermediate vehicle 30b, and the third intermediate vehicle 30c is suppressed by the damping force 66 of the up-down dampers 4a (4b), the riding comfort can be improved while the number of the dampers is reduced, the manufacturing and maintenance costs associated with the dampers can be decreased.

[0030] FIG. 7 is a schematic view showing a state in which the first intermediate vehicle to the third intermediate vehicle (corresponding to a part D of FIG. 1) of the formation vehicle traveling at a high speed vibrate in the left-right direction and a yaw direction in a top view. When the formation vehicle 1 travels at a high speed, the truck 55 vibrates in the left-right direction due to the track irregularity in the left-right direction and the like. As a result, the vehicle bodies of the first intermediate vehicle 30a, the second intermediate vehicle 30b, and the third intermediate vehicle 30c, which are supported by the truck 55 that vibrates in the left-right direction, are vibrated in the left-right direction due to the truck 55 and vibrate in the left-right direction and the yaw direction.

[0031] Dotted lines 310a, 310b, and 310c shown in FIG. 7 schematically show vibration 90 in the yaw direction of the first intermediate vehicle 30a, the second intermediate vehicle 30b, and the third intermediate vehicle 30c, respectively. A state is shown in which the rear end of the first intermediate vehicle 30a vibrates to the right side 78 and the front end of the second intermediate vehicle 30b vibrates to the left side 79. Similarly, a state is shown in which the rear end of the second intermediate vehicle 30b vibrates to the right side 78 and the front end of the third intermediate vehicle 30c vibrates to the left side 79.

[0032] When each vehicle forming the formation vehicle 1 vibrates in the yaw direction in the manner shown in FIG. 7, since the relative speed that expands and contracts in the left-right direction is generated at the left-right damper 8 of the second inter-vehicle body damper device A2 and the left-right damper 8 of the third inter-vehicle body damper device A3, a damping force 66 in a direction canceling the relative speed (the vibration in the left-right direction and the vibration 90 in the yaw direction) is generated at the left-right damper 8. The vibration in the yaw direction caused by the vibration in the left-right direction of the first intermediate vehicle 30a, the second intermediate vehicle 30b, and the third intermediate vehicle 30c is reduced, the riding comfort can be improved while the number of the dampers can be reduced and the manufacturing and maintenance costs associated with the dampers can be decreased.

[0033] FIG. 8 is a schematic view showing a state in which the second inter-vehicle body damper device and the third inter-vehicle body damper device of the formation vehicle traveling at a high speed overlap each other in the longitudinal direction of the formation vehicle and the adjacent vehicles vibrate in the roll direction.

[0034] When the formation vehicle 1 passes through a curved line at a high speed, the first intermediate vehicle 30a, the second intermediate vehicle 30b, and the third intermediate vehicle 30c vibrate around an axis (roll direction) along the longitudinal direction thereof, due to canting of the track or track irregularity.

[0035] Dotted lines shown in FIG. 8 schematically show a state in which the second intermediate vehicle 30b vibrates in the roll direction, and a dashed line shows the first intermediate vehicle 30a and the third intermediate vehicle 30c. When vibration (displacement) 91 in the roll direction is generated at the second intermediate vehicle 30b and the leading vehicle 20, a relative displacement in the roll direction occurs between the adjacent first intermediate vehicle 30a and the adjacent third intermediate vehicle 30c. The up-down damper 4b and the left-right damper 8 of the second inter-vehicle body damper device A2, and up-down damper 4a and the left-right damper 8 of the third inter-vehicle body damper device A3 expand and contract according to the roll displacement.

[0036] At this time, since the up-down dampers 4a (4b) and the left-right dampers 8 generate the damping force 66 in the direction against the vibration 91 in the roll direction corresponding to the relative speed, the vibration 91 in the roll direction of the second intermediate vehicle 30b can be suppressed to improve the riding comfort.

[0037] The up-down damper 4b of the second inter-vehicle body damper device A2 provided on the front side of the second intermediate vehicle 30b and the up-down damper 4a of the third inter-vehicle body damper device A3 provided on the rear side of the second intermediate vehicle 30b are provided diagonally with respect to a plane including a center line C intersecting the width direction of the vehicle body.

[0038] Therefore, even when the vibration 91 in the roll

direction is generated at the first intermediate vehicle 30a, the second intermediate vehicle 30b, and the third intermediate vehicle 30c, since the upward damping force 66 generated at the up-down damper 4b and the downward damping force 66 generated at the up-down damper 4a cancel each other, and the damping force 66 accompanying with the vibration 91 in the roll direction does not cause vibration of the first intermediate vehicle 30a to third intermediate vehicle 30c in the up-down direction, the bending vibration accompanied by the damping force 66 is hardly generated.

[0039] Therefore, since the occurrence of vibration in the up-down direction caused by the vibration in the roll direction can be suppressed, the riding comfort can be improved while the number of the dampers is reduced and the manufacturing and maintenance costs associated with the dampers can be decreased.

[0040] Since the first inter-vehicle body damper device A1 provided between the leading vehicle 20 and the first intermediate vehicle 30a and between the third intermediate vehicle 30c and the trailing vehicle 40, includes a pair of up-down dampers 4a (4b), the vibration in the roll direction is converted into the vibration in the up-down direction so as to be reduced. Therefore, since the occurrence of vibration in the up-down direction caused by the vibration in the roll direction can be suppressed, the riding comfort can be improved.

[0041] In Embodiment 1, an example is shown in which the first inter-vehicle body damper device A1 including the pair of up-down dampers 4a (4b) is provided at a coupling portion between the leading vehicle 20 and the first intermediate vehicle 30a or a coupling portion between the third intermediate vehicle 30c and the trailing vehicle 40. The first inter-vehicle body damper device A1 is not limited to be provided at the coupling portions between the vehicles at both ends of the formation vehicle and the intermediate vehicles coupled to the vehicles at both ends, and may be provided at, for example, a coupling portion between a first class (intermediate) vehicle that requires a higher riding comfort or an intermediate vehicle in which riding comfort is easily reduced due to fluid force acting on a current collector mounted on a roof and another intermediate vehicle coupled to this intermediate vehicle.

[0042] Although an example, in which the left-right dampers 8 of the first inter-vehicle body damper device A1, the second inter-vehicle body damper device A2, and the third inter-vehicle body damper device A3 are provided above the penetration-path 50, is shown Embodiment 1, it is not limited thereto, and the left-right damper 8 may be provided below the penetration-path 50.

[0043] When the vehicle travels at a high speed, turbulence of airflow accompanied with a large vortex is likely to be generated at a downstream of the trailing vehicle 40, and the trailing vehicle 40 may vibrate in the left-right direction due to a pressure fluctuation caused by the turbulence of the airflow. Therefore, the first inter-vehicle body damper device A1 are provided with a pair

(two) of the front-rear dampers 7a (7b), thereby suppressing the vibration in the left-right direction and improving the riding comfort. Since the second inter-vehicle body damper device A2 and the third inter-vehicle body damper device A3 are provided between the intermediate vehicles having a low risk of receiving large pressure fluctuation, the front-rear dampers 7a (7b) may be omitted.

10 (Embodiment 2)

[0044] Next, a formation vehicle provided with inter-vehicle body damper devices according to Embodiment 2 of the invention will be described with reference to the drawings. In Embodiment 2, description of the various dampers described in Embodiment 1 and description of parts common to those in Embodiment 1 will be omitted, and specific configurations of Embodiment 2 will be described.

20 **[0045]** As can be seen from the arrangement table of the dampers constituting the inter-vehicle damper devices shown in Fig. 10, the formation vehicle provided with the inter-vehicle body damper devices according to Embodiment 2 is characterized in that the second inter-vehicle body damper device A2 is provided instead of the third inter-vehicle body damper device A3 described in Embodiment 1. That is, the inter-vehicle body damper devices according to Embodiment 2 include the second vehicle body damper devices A2 on the front side and the rear side of the second intermediate vehicle 30b, and the up-down damper 4b is provided on the left side 79 of the penetration-path 50 provided in the end plate 2 and the end plate 3 of the second intermediate vehicle 30b.

35 **[0046]** Similarly with Embodiment 1, in the formation vehicle provided with the vehicle body damper devices according to Embodiment 2, the number of the dampers is reduced, the manufacturing and maintenance costs associated with the dampers can be decreased, the bending vibration and the vibration in the roll direction of the vehicle body can be reduced, the vibration in the left-right direction and the vibration in the yaw direction of the vehicle body can be reduced, and the riding comfort of the vehicle can be improved.

45 **[0047]** In addition, in Embodiment 2, since the up-down damper 4b is provided only on one side of the end plate, an operator can handle the up-down dampers 4b from only one side of the formation vehicle 1 when installing the up-down damper 4b during manufacturing and inspecting or exchanging during the maintenance work, so that the manufacturing and operation efficiency can be improved.

Reference Sign List

55 **[0048]** 1...formation vehicle 2, 3...end plate 4a, 4b...up-down damper 7a, 7b...front-rear damper 8...left-right damper 20...leading vehicle 30a...first intermediate vehicle 30b...second intermediate vehicle 30c...third inter-

mediate vehicle 40...trailing vehicle 42a, 44a...bracket 42b, 44b...bracket 46, 48...bracket 50...penetration-path 55...truck 66...damping force 77...traveling direction 78...right side 79...left side 90...vibration in a yaw direction 91...vibration in a roll direction A1...inter-vehicle body damper device A2...inter-vehicle body damper device A3...inter-vehicle body damper device

Claims

1. A formation vehicle comprising:

a leading vehicle;
 a first intermediate vehicle coupled to the leading vehicle;
 a trailing vehicle;
 a third intermediate vehicle coupled to the trailing vehicle;
 a second intermediate vehicle coupled between the first intermediate vehicle and the third intermediate vehicle;
 first inter-vehicle body damper devices provided between the leading vehicle and the first intermediate vehicle and between the trailing vehicle and the third intermediate vehicle; and
 inter-vehicle body damper devices provided at both ends in a longitudinal direction of the second intermediate vehicle, wherein
 the first inter-vehicle body damper device includes two up-down dampers and a left-right damper which are bridged between the leading vehicle and the first intermediate vehicle, and
 the inter-vehicle body damper device includes one up-down damper and the left-right damper which are bridged between the second intermediate vehicle and vehicles coupled to both ends in the longitudinal direction of the second intermediate vehicle.

2. The formation vehicle according to claim 1, wherein the inter-vehicle body damper device includes:

a second inter-vehicle body damper device including the up-down damper provided at one end in the longitudinal direction of the second intermediate vehicle and provided on one side in the width direction of an end plate of the second intermediate vehicle, and
 a third inter-vehicle body damper device including the up-down damper provided at the other end in the longitudinal direction of the second intermediate vehicle and provided on the other side in the width direction of the end plate of the second intermediate vehicle.

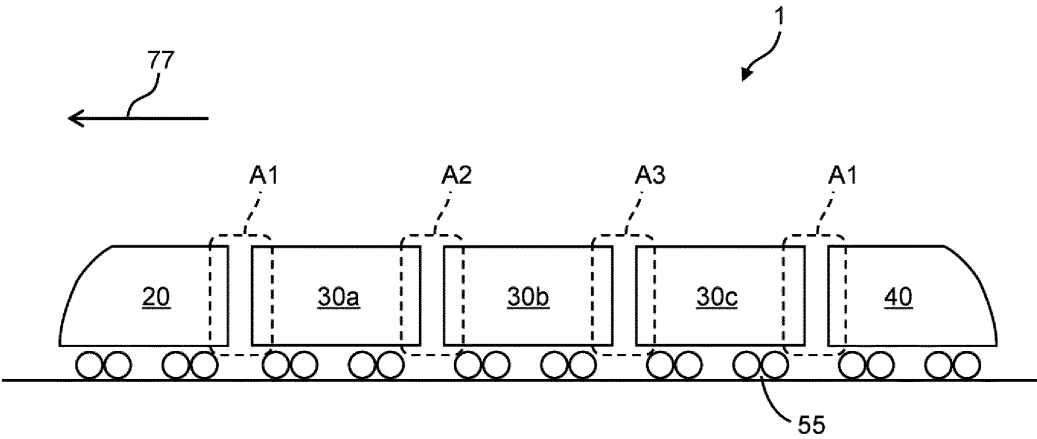
3. The formation vehicle according to claim 1, wherein the inter-vehicle body damper device includes the

up-down damper provided on one side in the width direction of the end plate of the second intermediate vehicle.

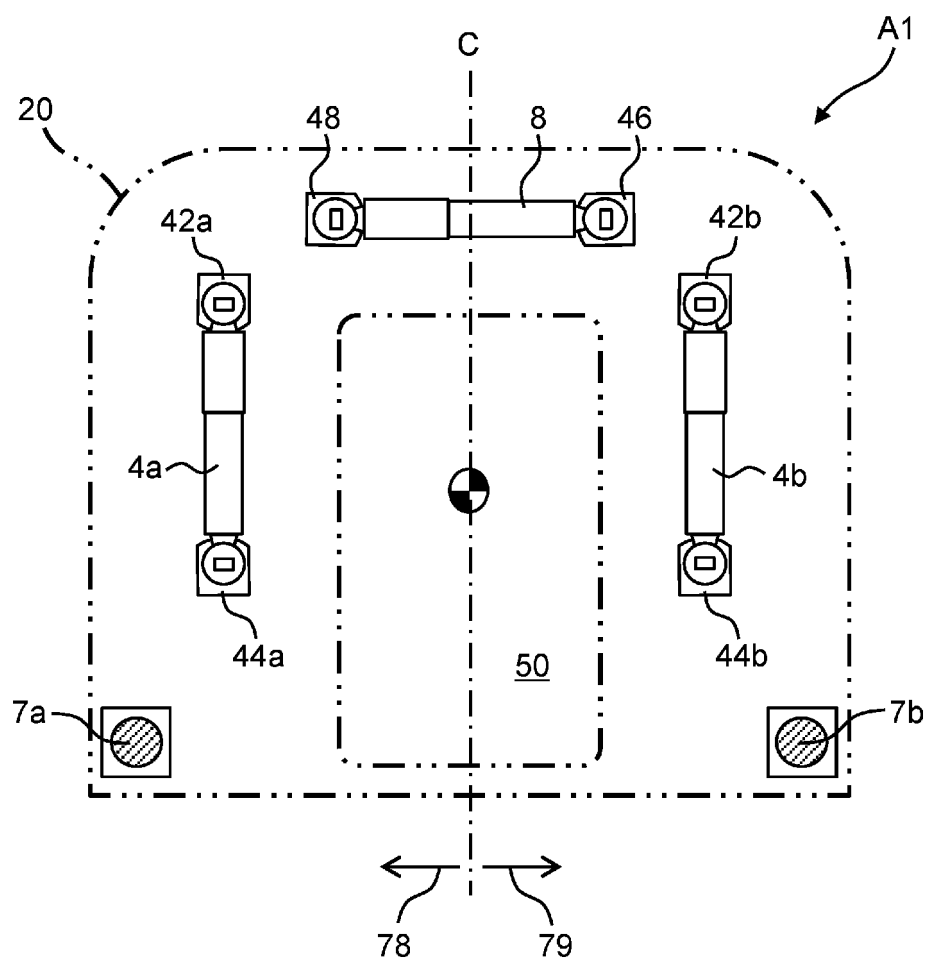
4. The formation vehicle according to claim 2 or 3, wherein
 the first inter-vehicle body damper device includes two front-rear dampers bridged between the leading vehicle and the first intermediate vehicle, and
 the third inter-vehicle body damper device includes two front-rear dampers bridged between the trailing vehicle and the third intermediate vehicle.

5. The formation vehicle according to claim 4, wherein the left-right damper is provided above a penetration-path connecting the leading vehicle and the first intermediate vehicle and connecting the trailing vehicle and the third intermediate vehicle.

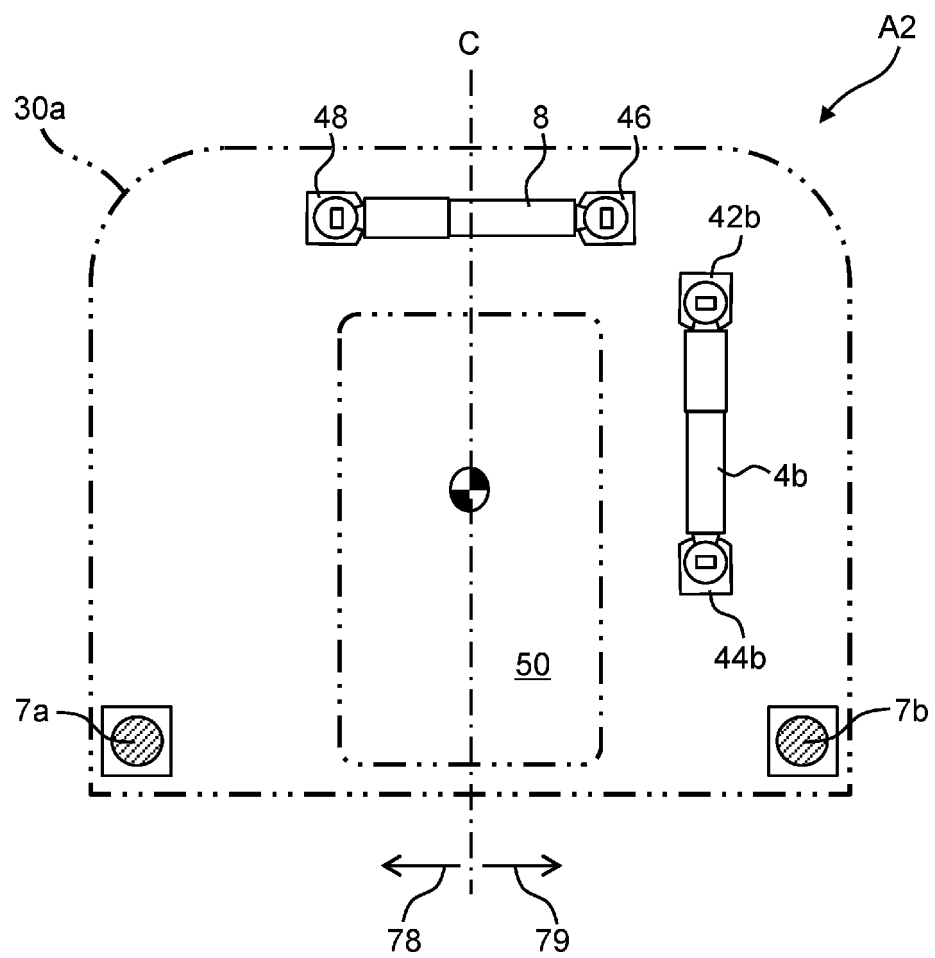
[FIG. 1]



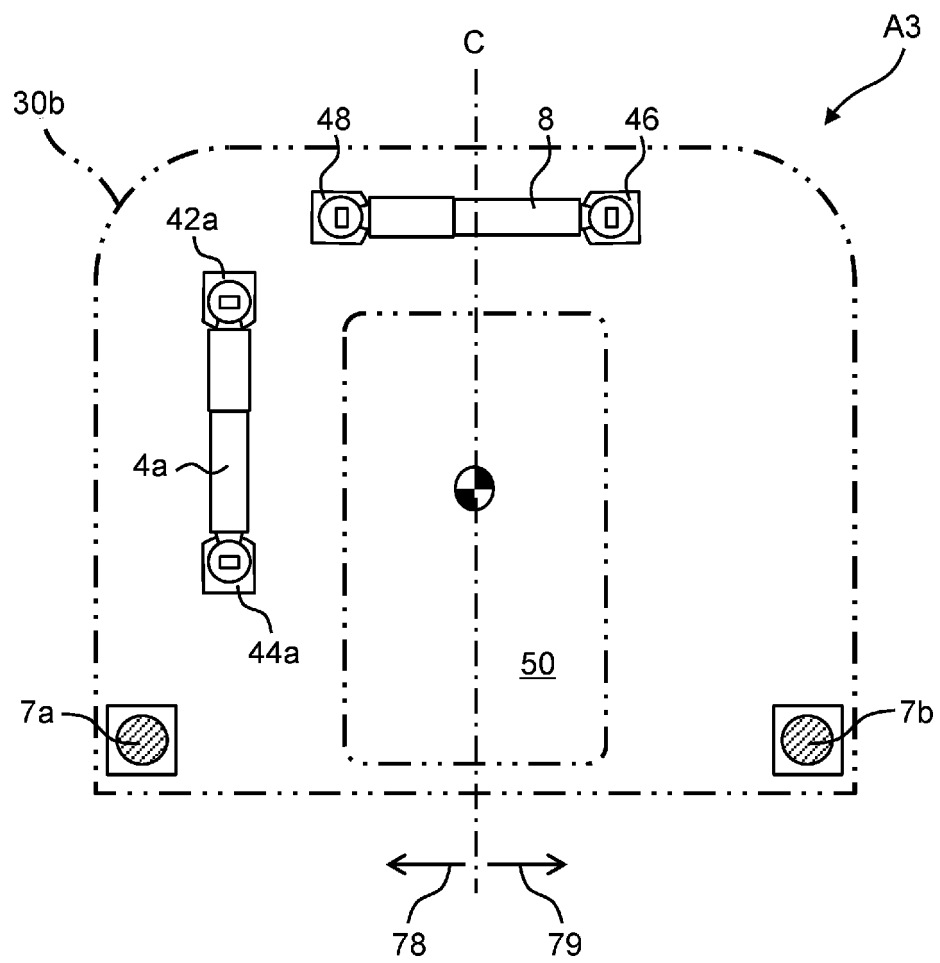
[FIG. 2]



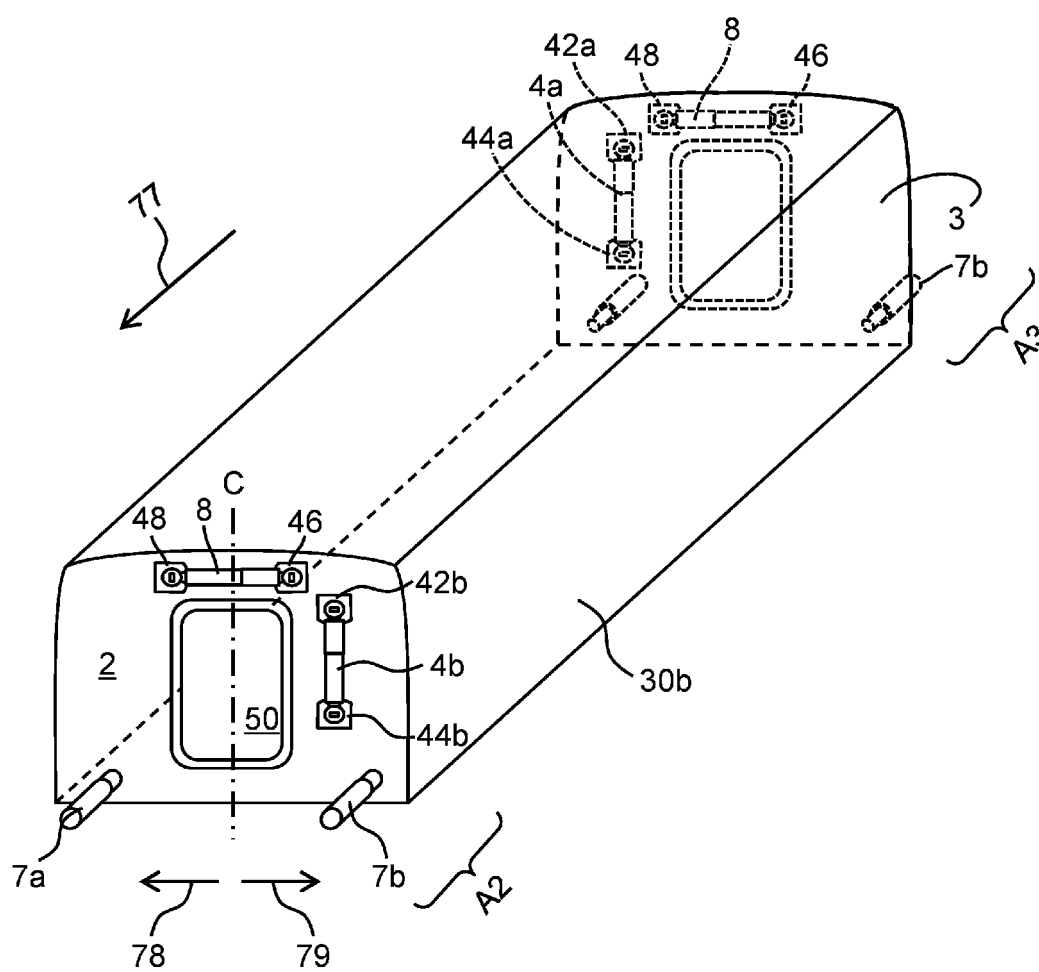
[FIG. 3]



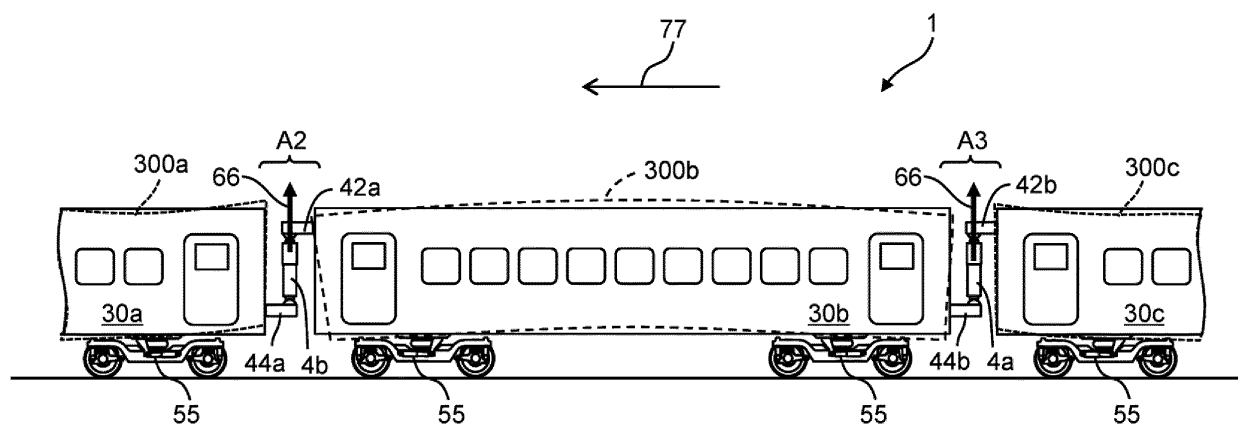
[FIG. 4]



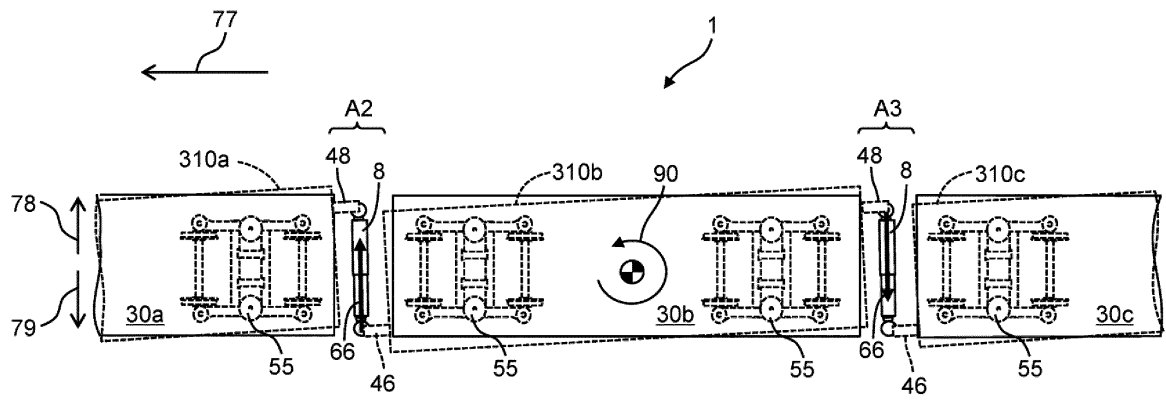
[FIG. 5]



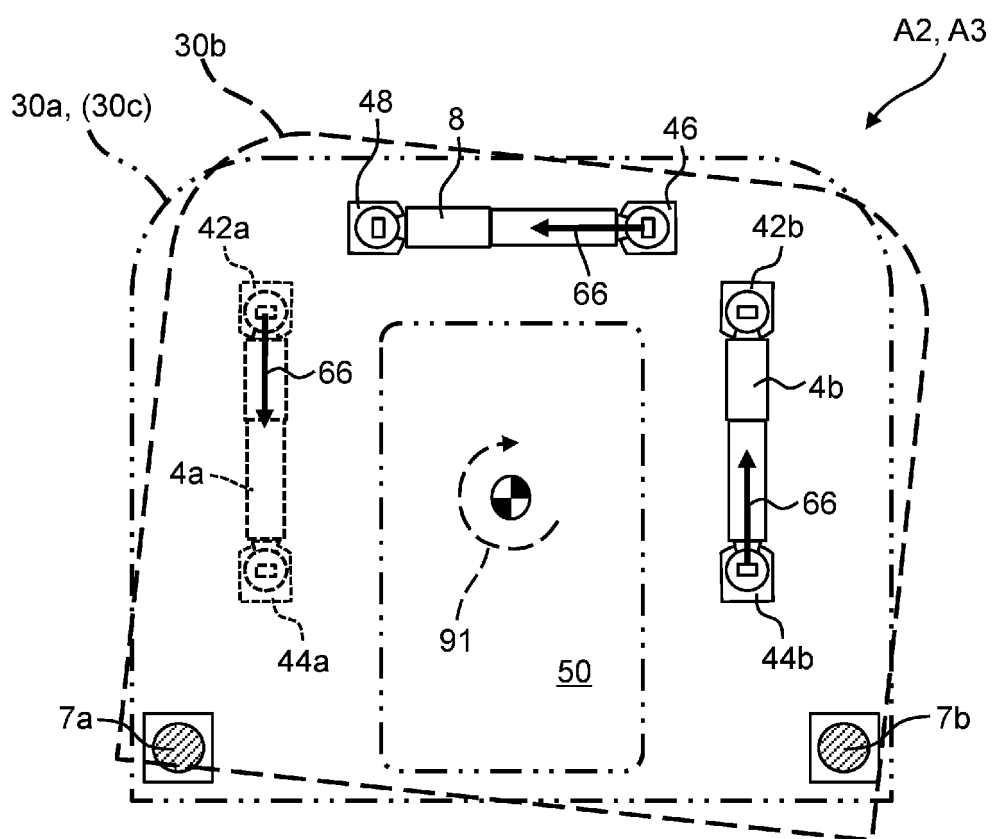
[FIG. 6]



[FIG. 7]



[FIG. 8]



[FIG. 9]

ARRANGEMENT OF VARIOUS DAMPERS OF INTER-VEHICLE BODY DAMPER DEVICE
OF EMBODIMENT 1

		INTER-VEHICLE BODY DAMPER DEVICE			
		A1	A2	A3	A1
UP-DOWN DAMPER	RIGHT SIDE	○	×	○	○
	LEFT SIDE	○	○	×	○
LEFT-RIGHT DAMPER	—	○	○	○	○
FRONT-REAR DAMPER	RIGHT SIDE	○	(○)	(○)	○
	LEFT SIDE	○	(○)	(○)	○

[FIG. 10]

ARRANGEMENT OF VARIOUS DAMPERS OF INTER-VEHICLE BODY DAMPER DEVICE
OF EMBODIMENT 2

		INTER-VEHICLE BODY DAMPER DEVICE			
		A1	A2	A2	A1
UP-DOWN DAMPER	RIGHT SIDE	○	×	×	○
	LEFT SIDE	○	○	○	○
LEFT-RIGHT DAMPER	—	○	○	○	○
FRONT-REAR DAMPER	RIGHT SIDE	○	(○)	(○)	○
	LEFT SIDE	○	(○)	(○)	○

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2016/071300

A. CLASSIFICATION OF SUBJECT MATTER

B61G5/02 (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)

B61G5/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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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	JP 2007-253679 A (Kawasaki Heavy Industries, Ltd.), 04 October 2007 (04.10.2007), (Family: none)	1-5
A	JP 2012-148723 A (Railway Technical Research Institute), 09 August 2012 (09.08.2012), (Family: none)	1-5

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

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Date of the actual completion of the international search
08 August 2016 (08.08.16)Date of mailing of the international search report
16 August 2016 (16.08.16)Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 11078881 A [0004]