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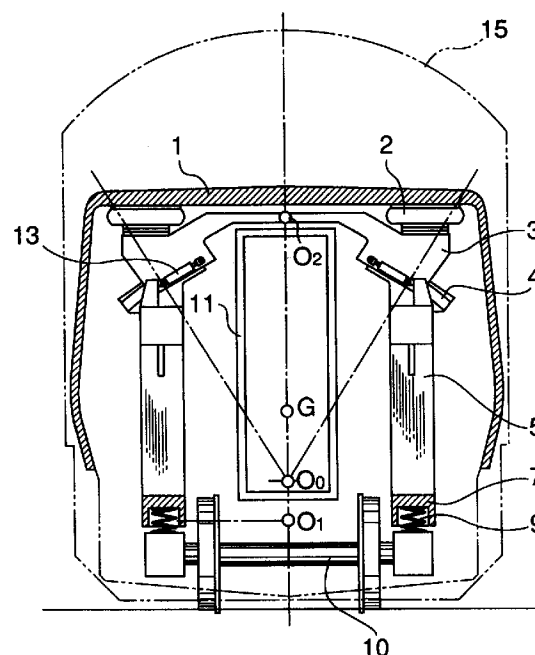
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(54) **A bogie equipped with a body-tilt system for a railway car.**

(57) An improved bogie equipped with a body-tilt system for a railway car is provided, wherein running velocity may further be increased in curves by preventing decrease in load applied to an inner wheel of the bogie during body tilt operation and riding comfort should not extremely be deteriorated even when the body-tilt system failed. The bogie of the present invention comprises a support pedestal 5 standing upwardly from a bogie frame 7 to a position adjacent to a roof of the car body 1, a tilting member 3 which is disposed on an upper position of the pedestal 5 and pendulates around a center of tilting O_0 in a lower portion of the car body 1, an actuator 13 for tilting the car body 1, a bolster spring 2 provided between the tilting member 3 and the car body 1. When the body tilts toward a center of the curve, the center of gravity of the body moves toward the center of the curve from the center of a track, thereby preventing the load applied to an inner rail wheel from reducing.

FIG.3



FIELD OF THE INVENTION

The present invention relates to a bogie equipped with a body-tilting system for a railway car in which running performance of a railway car going around curves in railway tracks is improved.

BACKGROUND OF THE INVENTION

Fig. 8 is a schematic front view illustrating a positional relation between the center of gravity, the center of tilting, the center of axle springs and the center of bolster springs (air springs) of a car body in a conventional railway car with an active body-tilt system (so called a pendulum train).

Fig. 9 is a schematic front view illustrating the car of Fig. 8 in a tilted state.

In Figs. 8 and 9, 1 denotes a car body, 2 bolster springs, 3 a pendulum beam, 7 a bogie frame, 9 axle springs, 10 an axle, 13 an actuator for tilting the body, 20 a body-tilt system (roller type), G the center of gravity of the body, O_0 the center of tilting of the body, O_1 the center of axle springs and O_2 the center of bolster springs.

A railway car equipped with a roller-type body-tilt system comprises a car body 1, bolster springs 2, a pendulum beam 3, a bogie frame 7, axle springs 9, an axle 10 and a body-tilt system (roller type) 20. In a natural tilt car without active tilt control, the body 1 is tilted around the center of tilting O_0 thereof in obedience to the centrifugal force which may act to the center of gravity G thereof in a curve. Also an active body-tilt control system has recently come into practical use, in which controlled body-tilting force is applied to the body 1 in addition to the centrifugal force acting to the center of gravity of the body 1, through a tilting actuator 13 such as an air cylinder between the pendulum beam 3 and the bogie frame 7 in order to improve riding comfort by swiftly (without delay) and gradually tilting the body 1 on transition curves provided entrances and exits of curves. Even in the active body-tilt system, however, in order to enable natural tilting caused by centrifugal forces when the active tilting system fails, the height of the center of tilting is maintained similar to those of conventional natural tilt systems.

As described above, since conventional pendulum trains in Japan fundamentally utilize centrifugal forces, which are applied to the car going around curves, as body tilting forces, the height of center of tilting O_0 is set as high as possible, for example, at 2,275mm to 2,300mm above rail running surface, and the height of center of gravity is set as low as possible at 1,300mm to 1,500mm above rail running surface, thereby enlarging a momentum force around the center of tilting produced by the centrifugal force acting to the center of gravity G, wherein the distance between the center of tilting O_0 and the center of gravity

G is the momentum arm length. And the height of center of bolster springs O_2 is generally set at 900mm to 1,000mm above rail running surface from the view point of body arrangement.

In the aforementioned conventional cars with body-tilt systems, however, it is impossible to further improve the performance of the cars under the concept of conventional positional relations between the center of gravity, the center of tilting, and the center of bolster springs of the car body of the cars due to many kinds of problems. This is because, when the car body is tilted around the center of tilting toward the inside of the curve (the center of the curve), wheel loads applied to inner rails become smaller due to the shift of the center of gravity from track center toward outside rails by "s" between G-G' in Fig. 9. Consequently, this phenomenon causes a danger of a derailment in an extreme case and forms a factor of restricting velocity of the car in curves.

Further, in case that the center of tilting is preserved as high as those in conventional cars equipped with body-tilt systems in order to promote a natural tilting by enlarging momentum forces around the center of tilting, which are caused by centrifugal forces acting to the center of gravity of the body, lateral movement of the body floor during body-tilting operation becomes greater, thereby, standing passengers and walking passengers would feel as if their legs were tackled and even sitting passengers would feel discomfort generated by bigger lateral movement, and furthermore, it becomes difficult for the cars to increase running velocities in curves.

In recent years, it has been a significant target for railway services, in connection with competition with automobiles and airplanes, to further increase running velocities in curves and improve passenger's comfort. To achieve this target, it has been required that the constructions of cars equipped with body-tilt systems should be modified to greatly improve running performances and riding comforts.

OBJECTS OF THE INVENTION

As described also in the BACKGROUND OF THE INVENTION, cars equipped with body-tilt systems in service in Japan have been generally so designed that the center of tilting is arranged as high as possible, the center of gravity is arranged as low as possible and bolster springs are disposed under the bogie frame as shown in Fig. 8 in order to enable natural pendulum and from the view point of body arrangement.

Accordingly, when a body of the car tilts toward the center of a curve during running on the curve, the center of gravity moves toward an outer rail of the curve, which causes bogie wheel loads applied to an inside rail to be reduced, resulting in restriction on car velocity. Also, when arranging the center of tilting

high, there is a problem that riding comfort deteriorates due to an increase in lateral movement of body floor. Furthermore, there is a problem that riding comfort also deteriorates due to a practical reduction of body tilting angle by the body-tilt system since the car body rolls and inclines toward the outside of the curve when bolster springs are installed at a low position.

Nowadays, such needs to further speed-up curve running velocity of the car equipped with a body-tilt system and to improve riding comfort during the car running transition curves have been very stronger. It is an object of the present invention to improve running performance by preventing the wheel load on an inside rail from decreasing even when the running velocity on a curve is further increased, and by changing relations between the heights of the center of tilting, the center of gravity and the center of bolster springs through changing greatly car structure of a conventional pendulum train.

It is another object of the present invention to enhance riding comfort by restraining lateral movement of a body floor and the rolling of the body during body tilting operation.

It is still another object of the present invention to enhance riding comfort by naturally tilting the body by a few degrees by centrifugal force during running on curves, and thereby reducing the influence of centrifugal acceleration by suspending bolster springs for body suspension system at high positions.

It is still another object of the present invention to provide a bogie equipped with a body-tilt system for a railway car in which riding comfort should not extremely be deteriorated even when a body-tilt system failed.

SUMMARY OF THE INVENTION

The bogie equipped with a body-tilt system for a railway car according to the present invention comprises:

a wheelset including a wheel, an axle and an axle box;

a bogie frame supported on said wheelset;

a support pedestal standing upwardly from said bogie frame to a position adjacent to a roof of the car body;

a tilting member which is disposed on an upper position of said pedestal and pendulates around a center of tilting in a lower portion of the car body;

an actuator with a controller therefor for tilting the car body disposed between said support pedestal and said tilting member; and

an elastic suspension means such as a bolster spring provided between said tilting member and the car body.

A bogie equipped with a body-tilt system according to an embodiment of the present invention comprises:

a wheel set of a railway car;

a bogie frame supported on said wheel set through an axle spring;

a body suspension system composed of an air-spring and the like for suspending a car body, the body suspension system suspended at a high position close to a body roof;

a body-tilt system of bearing guide type, roller type or link type and the like for tilting the car body toward centers of curves when the car going around curves;

a body-tilt control system composed of a hydraulic or air cylinder and the like for controlling body tilting; and

a support pedestal fixed on said bogie frame for suspending said body suspension system and body-tilt system at a high position close to the body roof,

wherein, the curvature of the bearing guide or roller type guide or a construction of a link in the link type is arranged to position the center of tilting below the center of gravity of the car body and at around floor level of the body, when the body tilts toward the center of the curve, the center of gravity of the body moves to inside from the center of a track, thereby preventing wheel load reduction of an inner rail wheel and consequently improving running performance, and also improving riding comfort by reducing lateral movement of the body floor during the tilting operation, and the body suspension system such as an air spring and the like is suspended at a high position close to the body roof to cause the body naturally to tilt by a few degrees toward the center of the curve by centrifugal force during the car going around the curve in addition to body tilting angle produced by the body-tilt system, consequently reducing lateral normal acceleration on the body floor and thereby enhancing riding comfort, and, even when the body-tilt system fails, the riding comfort is not extremely deteriorated by the natural tilting action.

A bogie equipped with a body-tilt system according to another embodiment of the present invention comprises:

a wheel set of a railway car;

a bogie frame supported on said wheel set through an axle spring;

a body suspension system composed of an air-spring and the like for suspending a car body, the body suspension system suspended at a high position close to a body roof;

a body-tilt system of bearing guide type, roller type or link type and the like for tilting the car body toward centers of curves when the car going around curves;

a body-tilt control system composed of a hydraulic or air cylinder and the like for controlling body tilting; and

a support pedestal fixed on said bogie frame

for suspending said body suspension system and body-tilt system at a high position close to the body roof,

wherein, the curvature of the bearing guide or roller type guide or a construction of a link in the link type is arranged to position the center of tilting below the center of gravity of the car body and at around floor level of the body, when the body tilts toward the center of the curves, the center of gravity of the body moves toward the center of the curve from the center of a track, thereby preventing wheel load reduction of an inner rail wheel and consequently improving running performance, and also improving riding comfort by reducing lateral movement of the body floor during the tilting operation, and even when the body-tilt system fails, the body suspension system such as an air spring and the like is suspended at a high position close to the body roof, so that the body naturally tilts by a few degrees to the center of the curve by centrifugal force during the car going around the curve, consequently reducing lateral normal acceleration on the body floor, thereby preventing riding comfort from being extremely deteriorated.

As for conventional cars each equipped with a body-tilt system in which the center of gravity is positioned at a high position, when bodies are tilted toward inside of curves, the center of gravity inevitably moves toward the outer rail, accordingly wheel load of each bogie on the inner rail becomes small. If one should try to prevent wheel load of each bogie on inner rails from decreasing without changing arrangement of conventional car equipped with a body-tilt system, he should have to move the whole bogie horizontally toward curve inner simultaneously with body tilting timing. Although, this system is not practical as the equipment arrangement becomes very large. At the same time, when the center of tilting is as high as a conventional car equipped with a body-tilt system, lateral motion of body floor naturally get bigger and it is difficult to overcome this problem. Then, several types of railway car arrangements have been studied, in which load of inner rail wheel of the bogie would not be decreased and lateral movement of body floor would be minimized when the car body is tilted at curves by changing height relations between the center of tilting, the center of gravity and the center of bolster springs in a conventional car equipped with a body-tilt system. Fig. 1 is a schematic diagram illustrating height relations between the center of gravity, the center of tilting and the center of bolster springs in a car equipped with a body-tilt system. Herein, G denotes the center of gravity, O_0 denotes the center of tilting, O_1 denotes center of axle springs and O_2 denotes center of bolster springs.

CASE [1] to [5] are examples of car arrangement combining, in several types, the center of gravity G, the center of tilting O_0 , the center of axle springs O_1 and the center of bolster springs O_2 in

order to improve running performance.

CASE[1] is a prior-art car with a body-tilt system, in which the center of tilting O_0 is set as high as possible and the center of gravity is set as low as possible thereby permitting enhanced natural tilt. CASE[2] is a car arrangement, in which the center of tilting O_0 is set lower than that of CASE [1] within an extent such that natural tilt is available, thereby suppressing shift of center of gravity and lateral movement of the body floor.

CASE[3] is a car arrangement, in which both the center of tilting O_0 and the center of gravity G are lowered as low as possible in comparison to CASE [2] thereby, further improving running performance as a car with a body-tilt system.

CASE [4] is a car arrangement, in which the center of tilting O_0 and the center of gravity G are maintained similar to those of CASE [3], but bolster springs are suspended in higher position, thereby tilting car body in response to centrifugal force during the car running the curve, and by means of spring effect of bolster springs, a few degrees toward inside of curves in addition to a tilting angle produced by the body-tilt system in order to improve riding comfort of a car equipped with a body-tilt system.

CASE [5] is a car arrangement, to which an embodiment of the present is applied, and the center of bolster springs O_2 and the center of gravity are maintained at similar heights as in CASE[4], but the center of tilting O_0 is set lower than the center of gravity G in order to suppress wheel load decrease of bogie inner wheels by moving center of gravity toward the center of the curve from the center of the track when the car body tilts toward the center of the curve.

By arranging the center of tilting O_0 as low as possible and the center of bolster springs as high as possible, it has been enabled to greatly improve running performance and riding comfort at the same time which had been a target for cars equipped with a body-tilt system.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be more apparent from the ensuring description with reference to the accompanying drawings wherein:

Fig. 1 is a schematic diagram illustrating height relations between the center of gravity, the center of tilting and the center of bolster springs in a car equipped with a body-tilt system;

Fig. 2 is a side view of a bogie equipped with a body-tilt system for a railway car according to an embodiment of the present invention applied to an articulated car and disposed between car bodies;

Fig. 3 is a view of the bogie and the car body in

Fig. 2 taken along the line A-A;

Fig. 4 is a view of the bogie and the car body in Fig. 2 taken along the line B-B;

Fig. 5 is a detailed perspective view of a bearing guide which partly constitutes a bearing guide type body-tilt system installed in the bogie in Figs. 2 to 4;

Fig. 6 is a view of the bogie and the car body in Fig. 2 taken along the line C-C;

Fig. 7 is a front view of a bogie according to another embodiment of the present invention which includes a body-tilt hold-back cylinder for sustaining the car body at a neutral position;

Fig. 8 is a schematic front view illustrating positional relations between the center of gravity, the center of tilting, the center of axle springs and the center of bolster springs of a car body in a conventional railway car equipped with a body-tilt system (so called a pendulum train);

Fig. 9 is a schematic front view illustrating the car in Fig. 8 in a tilted state;

Fig. 10 is a front view schematically showing a tilting suspension mechanism for a car body in a railway car bogie equipped with a body-tilt system according to an embodiment of the present invention;

Fig. 11 is a front view schematically showing an actuated state of pendulum mechanism in the bogie in Fig. 10; and

Fig. 12 is a front view schematically showing an actuated state of a body tilting mechanism with bolster springs in the bogie shown in Fig. 10.

EMBODIMENTS

Now, embodiments of the present invention will be explained.

First, referring to Figs. 10, 11 and 12, a tilting suspension mechanism of a bogie equipped with a body-tilt system for a railway car according to the present invention will be described.

The bogie of the present invention utilizes the following two tilting suspension mechanisms:

1. Tilting member (pendulum beam etc.) which tilts around the center of tilting located at a lower portion of the body, and driving actuator thereof (hereinafter called as pendulum mechanism); and
2. Elastic suspension means provided between the tilting member disposed at a higher portion of a car body (upper portion of support pedestal) and the car body (hereinafter called as tilting mechanism with bolster springs).

In Fig. 10, a car body 1 illustrated as a hatched portion is suspended by a pendulum beam 3 through bolster springs 2 composed of a relatively soft spring such as an air spring. The pendulum beam 3 is disposed at an upper portion of a car which is close to a

body roof 1 and swings in an arc with radius R around the center of tilting O_2 which is positioned at a lower position of the car. Specifically, the lower ridge of pendulum beam 3 is formed into an arc and is put tiltablely on a roller-type body-tilt system 20, which may be a bearing guide type, attached to an upper portion of a support pedestal 5.

A pedestal 5 is a structure including a pair of left and right columns standing on the bogie frame 7. An upper end of the columns of the pedestal 5 extends nearly to roof of the body 1 and upper ends of the columns are connected to each other with a tie beam 6.

The pendulum beam 3 is actuated relative to the pedestal 5 by a body-tilt control cylinder 13, which may be an oil or an air cylinder. A base portion of the body-tilt control cylinder 13 is fixed to the pedestal 5 and an end of the cylinder rod is fixed to the pendulum beam 3. Accordingly, when the cylinder 13 rod extends, the pendulum beam 3 moves right, and when the rod of the cylinder 13 collapses the pendulum beam 3 moves left.

The bogie frame 7 is suspended on an axle box 22 through axle springs 9. The axle springs 9 are composed of relatively hard coil springs or rubber. Axle boxes 22 are supported on the axle 26 and wheels 24. Wheels 24, axle 26, axle box 22 and so on form a wheelset.

In Fig. 11, the rod of the body-tilt control cylinder 13 is contracted and the pendulum beam 3 is moved (tilted) to the left. In accordance with the tilting of the pendulum beam 3, the body 1 supported by the pendulum beam 3 is also tilted around the center of tilting O_0 to the left by angle α . At this moment, the center of gravity G of the body 1 has moved to G' by a distance S left from the center of gravity G.

In the state of Fig. 11, where the body 1 is tilted to the left, the car is running around a curved track with a center thereof at a distant point in the left. In such a state, centrifugal force towards the right side in the Fig. 11 is generated and the body 1 is tilted to cancel the centrifugal force in the car body 1. When the body 1 is actively tilted as described above, the center of gravity of the body 1 moves from G to G', that is, toward inside of the curve. This movement of the center of gravity is one of significant features of the present invention. Due to this movement of the center of gravity, the load applied to the inner (left) rail wheel 24' is increased and the reduction in the wheel load on an inner rail caused by centrifugal force is supplemented.

Next, referring now to Fig. 12, another body tilting mechanism utilizing expansion and contraction of bolster springs for the bogie equipped with a body-tilt system for a railway car in Fig. 20 will be described. In the bogie shown in Fig. 12, no active pendulum works to tilt the body. When the car is running around a curved track with a center at a distant point in the left like the state illustrated in Fig. 11, centrifugal

force toward right is applied to the car. But, this centrifugal force is canceled by a moment produced by differential reaction forces of bolster springs 2 which support the body 1 and by oblique component of gravity produced by tilting of the body 1 due to an unequal contraction or expansion in left and right bolster springs 2. As a result of such action, the body 1 is swung to the right around a point O_3 , which is at approximately the center of the both bolster springs 2, and the body 1 tilts left.

The bogie equipped with a body-tilt system for a railway car according to the present invention utilizes both two body tilting mechanisms or selectively activates one of them.

(1) MODE activating both pendulum mechanism and bolster spring tilting mechanism:

Even this MODE, body-tilting by pendulum mechanism is mainly used and bolster spring tilting is somewhat additional. For example, at an entrance and an exit of a transition curve, when body-tilting should be started and stopped prior to the generation/miss of centrifugal force in order not to delay in body-tilting, the pendulum mechanism is activated.

In this mode, an actual tilting angle is measured and feedbacked time to time, then the tilting angle of bolster springs are subtracted from a target body tilting angle, and then control should be continued setting the residual angle to be a necessary tilting angle for the pendulum mechanism.

(2) MODE activating only pendulum mechanism

This MODE is the most normal and, in this MODE, only the pendulum mechanism is activated with bolster spring tilting mechanism locked.

In one of specific means to lock tilting by bolster springs, a height controlling device for bolster springs is provided and the height of bolster springs is maintained constant at a predetermined value. For example, in a general device in service which utilizes an air spring as a bolster spring, the height of air springs is constantly measured and when the height deviates from the standard height, air is supplied to or discharged from the air spring to maintain the predetermined height of the air spring. Although even in this type device, control delay and control dead band causes the bolster spring to tilt the car body. As a result, this tilting generally gives slight additional body tilt angle whereby reducing lateral stationary acceleration and improving passengers' riding comfort.

Even in this mode, when control of pendulum mechanism fails, the mode may be changed into bolster spring tilting mode to prevent extremely poor riding comfort. This is an advantage of this mode.

(3) MODE activating only tilting mechanism with bolster springs:

When pendulum mechanism control system fails, tilting mechanism by bolster springs shall be activated to prevent riding comfort from getting extremely worse. Also, when the car runs a track section where no curve data necessary for pendulum mechanism control are accumulated, by activating this tilting mechanism with bolster springs, the car can run faster than NON-PENDULUM cars without extremely spoiling riding comfort. This is an advantage of this mode.

As for a specific means for holding back the pendulum mechanism, there is a method of shutting off the pendulum mechanism control and fixing the pendulum beam through body-tilt hold-back cylinder. On the other hand, the activation of tilting mechanism with bolster springs may be realized by not activating the spring height adjusting system for the air springs or interconnecting air chambers of right and left air springs through an interconnecting tube.

Now, the next embodiment of a bogie equipped with a body-tilt system for a railway car according to the present invention applied to an articulated car will be described referring to attached drawings.

In the Figs. 2 to 7, 1 denotes a car body, 2 bolster springs (air springs), 3 a pendulum beam, 4 a bearing-type body-tilt system, 5 a support pedestal, 6 a tie beam of the support pedestal, 7 a bogie frame, 8 an axle box suspension, 9 axle springs, 10 an axle, 11 a pass way between car bodies, 12 a yaw damper, 13 an actuator for body tilting, 14 an actuator for holding back body tilt, 15 a vehicle gauge, 16 a bearing guide block, 17 a bearing guide rail, 18 bearing guide balls, 19 a bearing guide seal, G the center of gravity of the car body, O_1 the center of axle springs, O_2 the center of bolster springs and R radius of curvature.

Fundamental concept of the bogie equipped with a body-tilt system for a railway car of this embodiment is to arrange the body-tilt system for suspending the bolster springs (air springs) 2 at a position as high as possible, at the same time to dispose the center of tilting O_0 still below the center of gravity of the car body and approximately as low as the car body floor.

Then, an embodiment of the present invention is described. The bolster springs (air spring) 2 are suspended at a high position close to the roof of the car body 1 as illustrated in Figs. 2 to 4. The pendulum beam 3 and the body-tilt system 4 (bearing guide type) are also suspended at a high position similar to bolster spring 2 as shown in Figs. 2 to 4, since it is difficult to set the center of tilting O_0 at a position with the same height as the body floor when the design is ruled by the prior art bogie equipped with a body-tilt system for a railway car in which body-tilt system is suspended between a bogie and a car body.

As this embodiment is applied to an articulated

car, the body suspension system such as the air springs 2, the pendulum beam 3 and the bearing-type body-tilt system 4 are provided in two sets on one bogie as shown in Fig. 2 such that they may support and tilt the car bodies of front and rear cars independently. The air spring 2 and others are supported by the support pedestal 5 standing on the bogie frame 7 as shown in Figs. 2 to 4. Right and left columns of the pedestal 5 are tied to each other with a tie beam 6 as shown in Fig. 6 to increase strength of the pedestal 5.

The body-tilt system 4 adopts a bearing guide type system which is compact and light and easily arranged for suspension at a high position. Details of the bearing guide which is used in the bearing guide type body-tilt system is shown in Fig. 5. Several number of grooves 17a are formed on a bearing guide rail 17 which partly constitute a body-tilt system guide and has a radius of curvature R. These grooves 17a engage a row of balls 18 which circulate within bearing guide block 16 and bearing guide block 16 and rail 17 relatively moves in an arc having an identical center with the rail 17 and loads may be transferred between the block 16 and rail 17.

In the bogie of Figs. 2 to 4, two or four sets of bearing guides of Fig. 5 are attached between the pedestals 5 and the pendulum beam 3 supporting two bolster springs 2, with the center of their guide rails being coincident with the center of tilting the body which is situated about the same level with the body floor. As shown in Figs. 2 and 3, air or oil pressure actuator for body tilting 13 are attached between the pendulum beam 3 and support pedestal 5. These actuator 13 contribute in improving riding comfort through body tilt control of the car running around a transition curve or a circular curve.

Now, another embodiment of the present invention will be described. In the bogie in Fig. 7, a stopper bracket 3a provided in the center of the pendulum beam 3 is sandwiched from right and left by body-tilt hold-back actuators 14 which is suspended on the tie beam 6 of the support pedestal 5, and the actuator 14 hold back the car body 1 to a neutral position, thereby preventing body 1 from falling into an inverted pendulum state and inclining to one side (left or right) in case that body tilt control is ceased or fails.

ADVANTAGEOUS EFFECT OF THE INVENTION

As described above, the present invention may improve running performance by preventing decrease in inside rail wheel load and may enhance riding comfort by depressing lateral movement of body floor during body tilting operation by greatly changing the structure of the body tilt system and the body suspension system compared with the conventional pendulum train by disposing the center of tilting O_0 below the center of gravity of the car body and approximate-

ly as low as the car body floor, or by suspending the bolster springs of the body suspension system at a high position close to the body roof.

Claims

1. A bogie equipped with a body-tilt system for a railway car comprising:
 - a wheelset including a wheel, an axle and an axle box;
 - a bogie frame supported on said wheelset;
 - a support pedestal standing upwardly from said bogie frame to a position adjacent to a roof of the car body;
 - a tilting member which is disposed on an upper position of said pedestal and pendulates around a center of tilting in a lower portion of the car body;
 - an actuator with a controller therefor for tilting the car body disposed between said support pedestal and said tilting member; and
 - an elastic suspension means provided between said tilting member and the car body.
2. A bogie equipped with a body-tilt system for a railway car comprising:
 - a wheel set of a railway car;
 - a bogie frame supported on said wheel set through an axle spring;
 - a body suspension system composed of an air-spring and the like for suspending a car body, said body suspension system suspended at a high position close to a body roof;
 - a body-tilt system of bearing guide type, roller type or link type and the like for tilting the car body toward centers of curves when the car going around curves;
 - a body-tilt control system composed of a hydraulic or air cylinder and the like for controlling body tilting; and
 - a support pedestal fixed on said bogie frame for suspending said body suspension system and body-tilt system at a high position close to the body roof,
 - wherein, the curvature of the bearing guide or roller type guide or a construction of a link in the link type is arranged to position the center of tilting below the center of gravity of the car body and at around floor level of the body, when the body tilts toward the center of the curve, the center of gravity of the body moves to inside from the center of a track, thereby preventing wheel load reduction of an inner rail wheel and consequently improving running performance, and also improving riding comfort by reducing lateral movement of the body floor during the tilting operation, and the body suspension system such as

an air spring and the like is suspended at a high position close to the body roof to cause the body naturally to tilt by a few degrees toward the center of the curve by centrifugal force during the car going around the curve in addition to body tilting angle produced by the body-tilt system, consequently reducing lateral normal acceleration on the body floor and thereby enhancing riding comfort, and, even when the body-tilt system fails, the riding comfort is not extremely deteriorated by the natural tilting action.

3. A bogie equipped with a body-tilt system for a railway car comprising:

- a wheel set of a railway car;
- a bogie frame supported on said wheel set through an axle spring;
- a body suspension system composed of an air-spring and the like for suspending a car body, the body suspension system suspended at a high position close to a body roof;
- a body-tilt system of bearing guide type, roller type or link type and the like for tilting the car body toward centers of curves when the car going around curves;
- a body-tilt control system composed of a hydraulic or air cylinder and the like for controlling body tilting; and
- a support pedestal fixed on said bogie frame for suspending said body suspension system and body-tilt system at a high position close to the body roof,

wherein, the curvature of the bearing guide or roller type guide or a construction of a link in the link type is arranged to position the center of tilting below the center of gravity of the car body and at around floor level of the body, when the body tilts toward the center of the curves, the center of gravity of the body moves toward the center of the curve from the center of a track, thereby preventing wheel load reduction of an inner rail wheel and consequently improving running performance, and also improving riding comfort by reducing lateral movement of the body floor during the tilting operation, and even when the body-tilt system fails, the body suspension system such as an air spring and the like is suspended at a high position close to the body roof, so that the body naturally tilts by a few degrees to the center of the curve by centrifugal force during the car going around the curve, consequently reducing lateral normal acceleration on the body floor, thereby preventing riding comfort from being extremely deteriorated.

4. A bogie equipped with a body-tilt system for a railway car according to one of claims 1 to 3, wherein a body-tilt hold-back actuator for holding back

said car body to a neutral position is added to said body tilt system to prevent said body from falling into an inverted pendulum state and inclining to one side (right and left) when said body tilt control is ceased or fails.

FIG.1

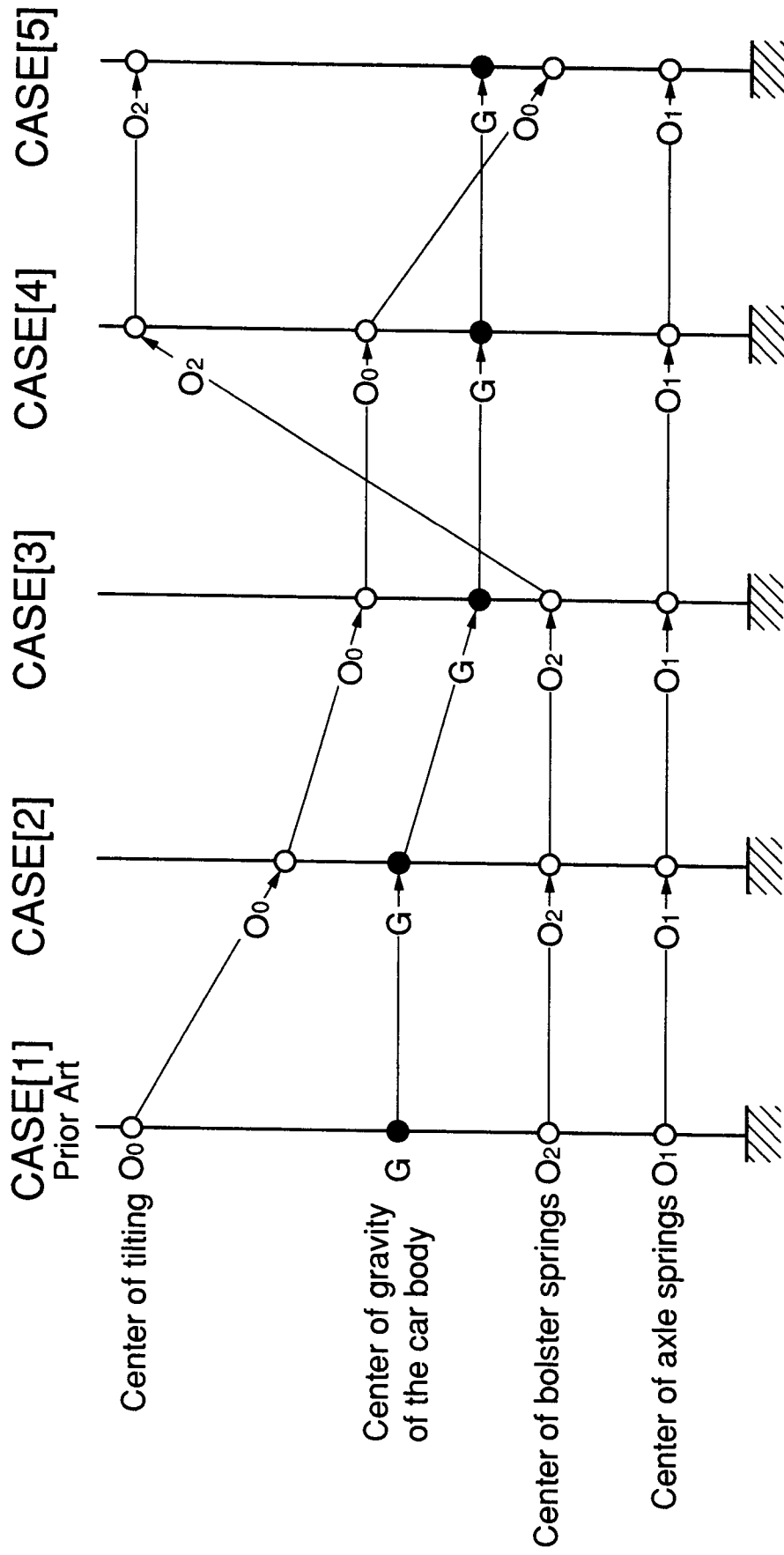


FIG. 2

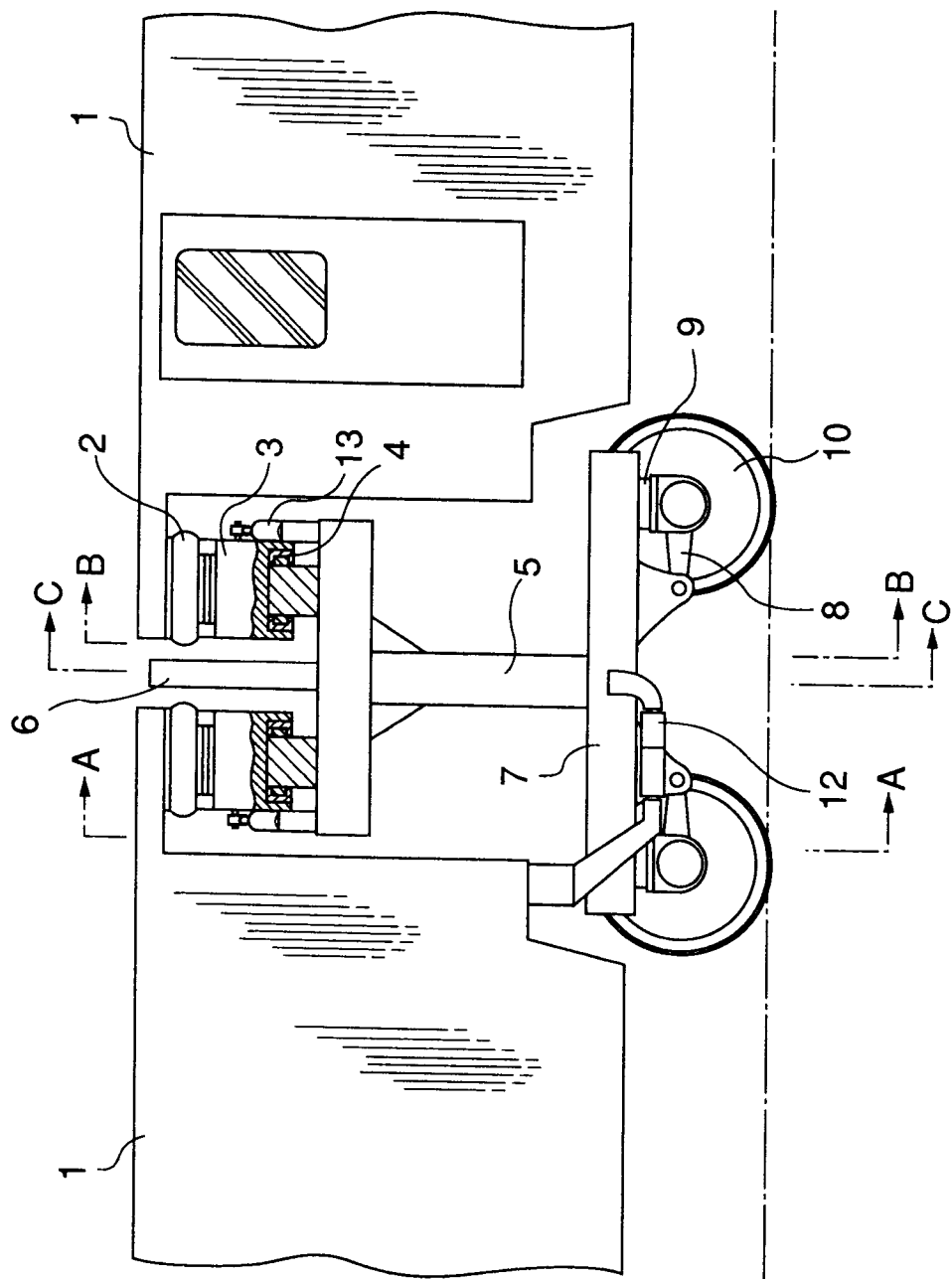


FIG.3

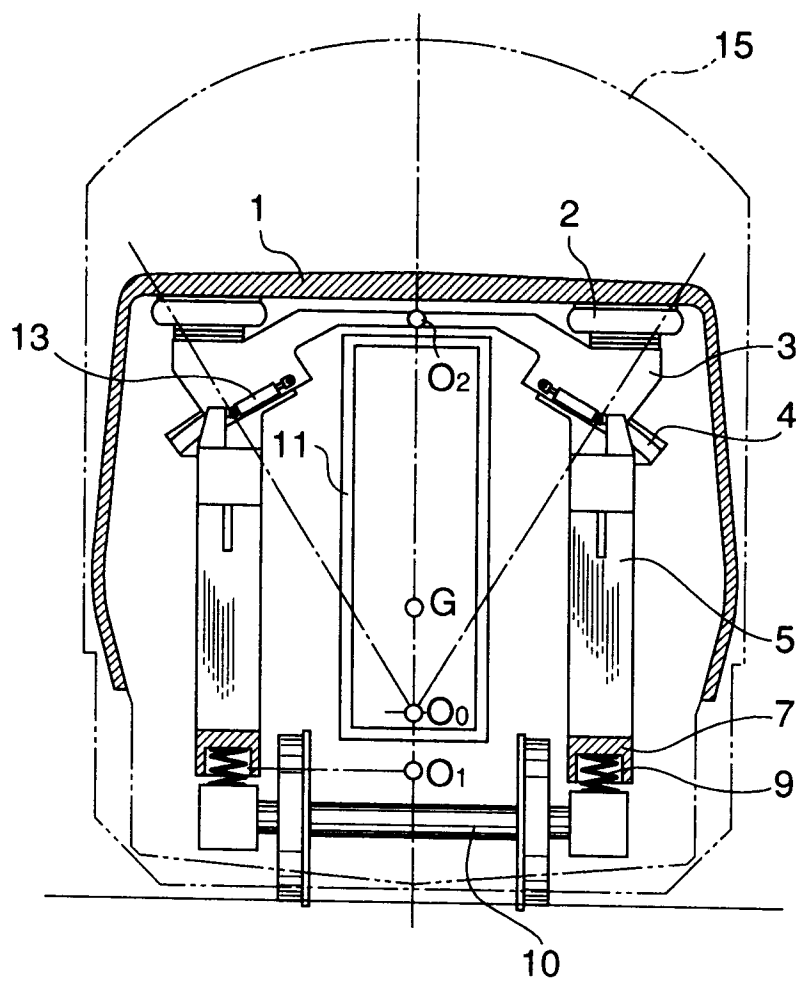


FIG.4

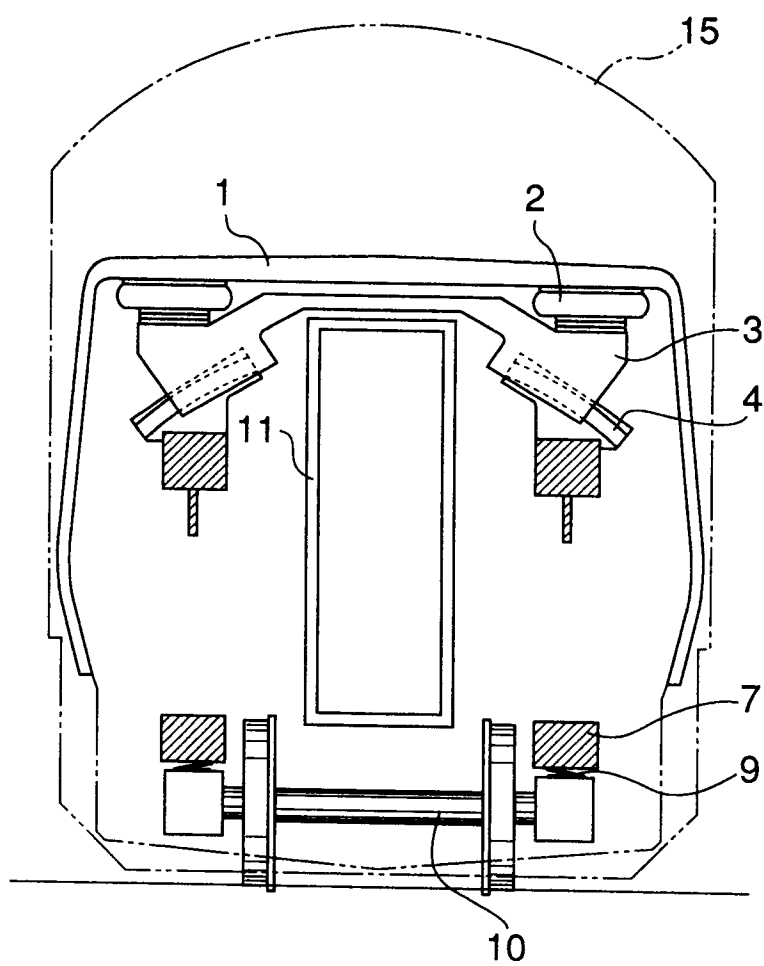


FIG.5

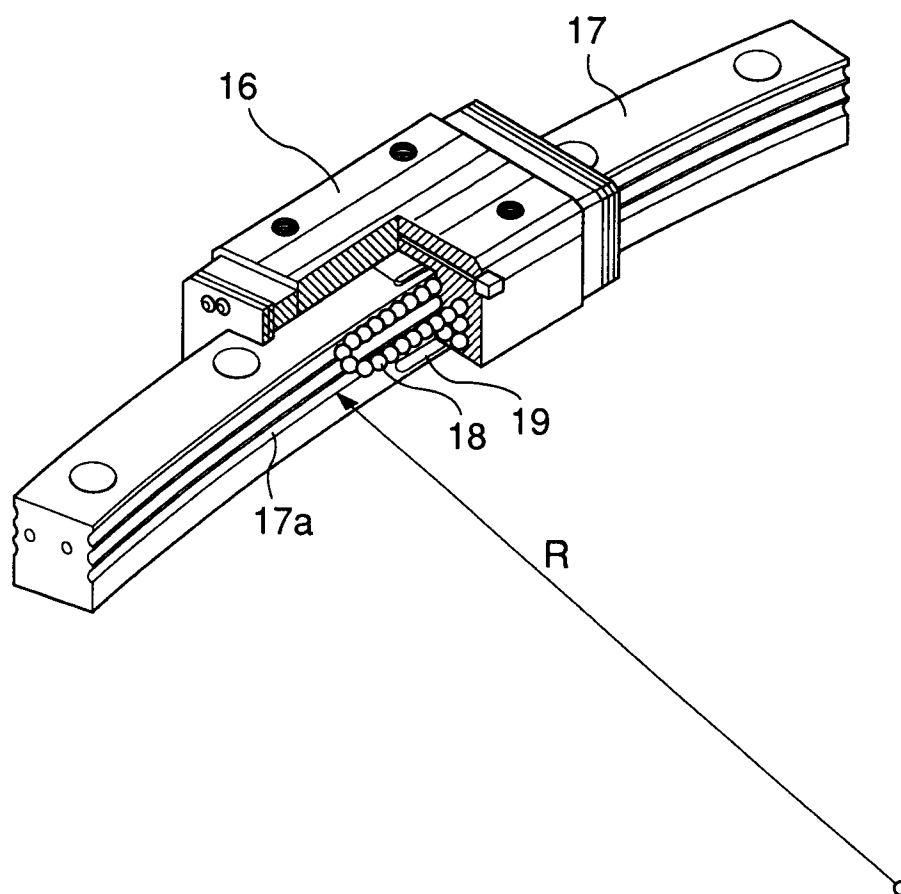


FIG.6

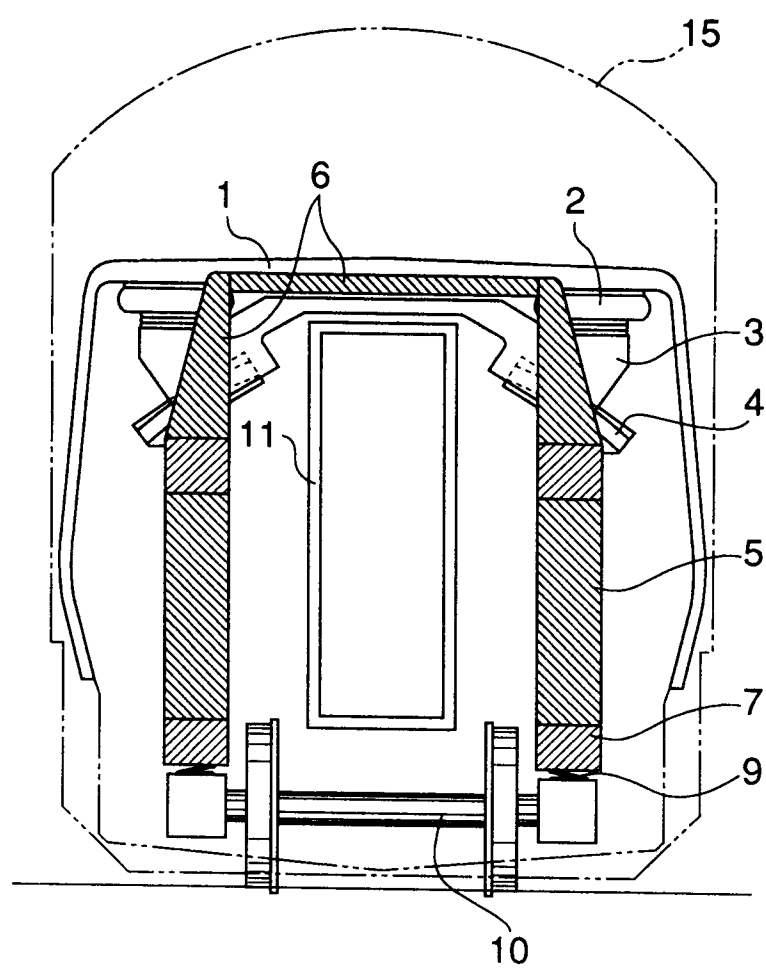


FIG.7

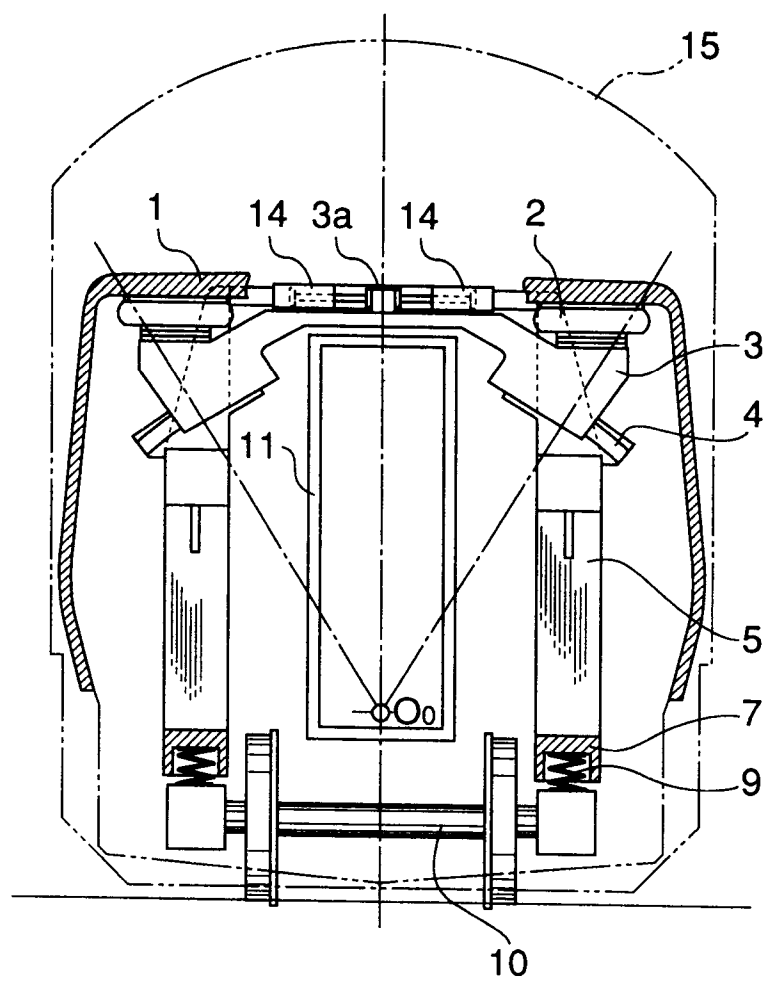


FIG.8

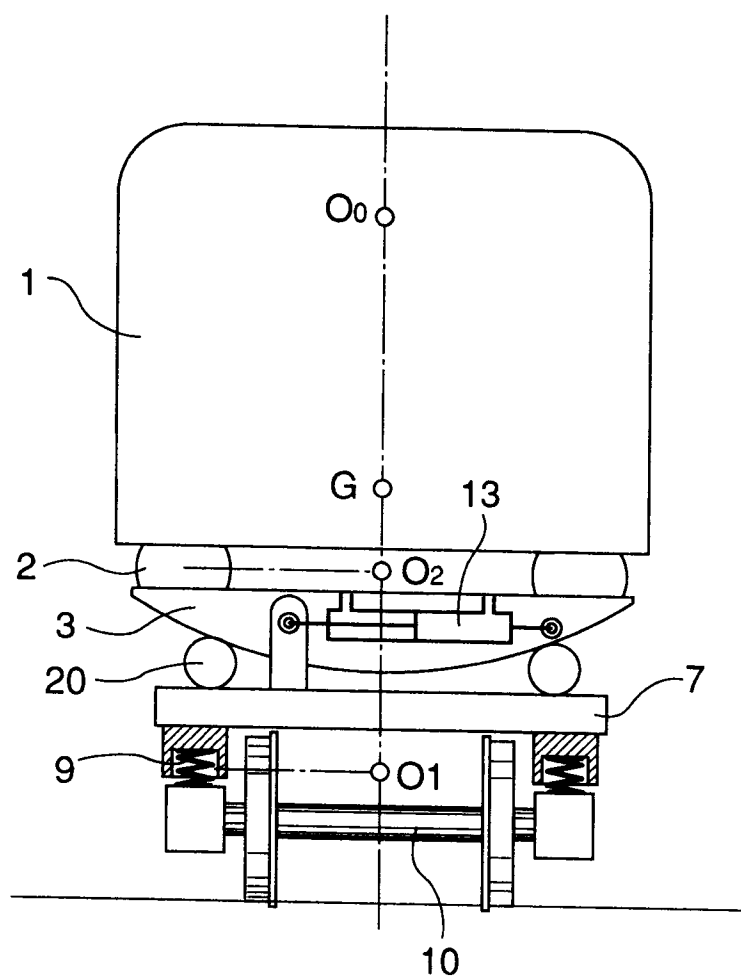


FIG.9

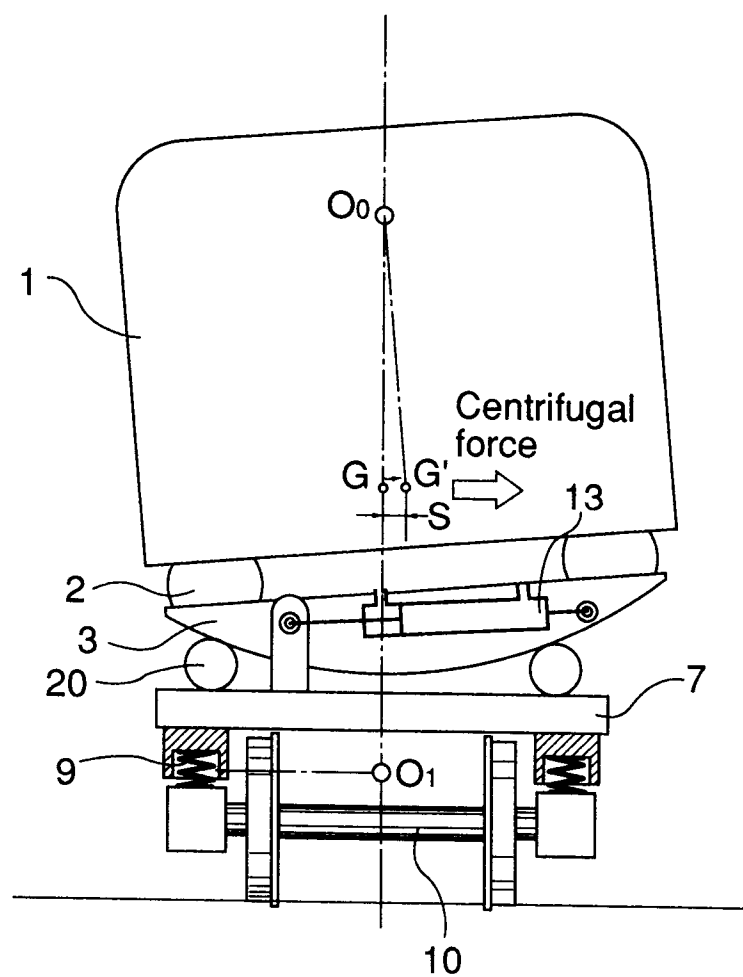


FIG.10

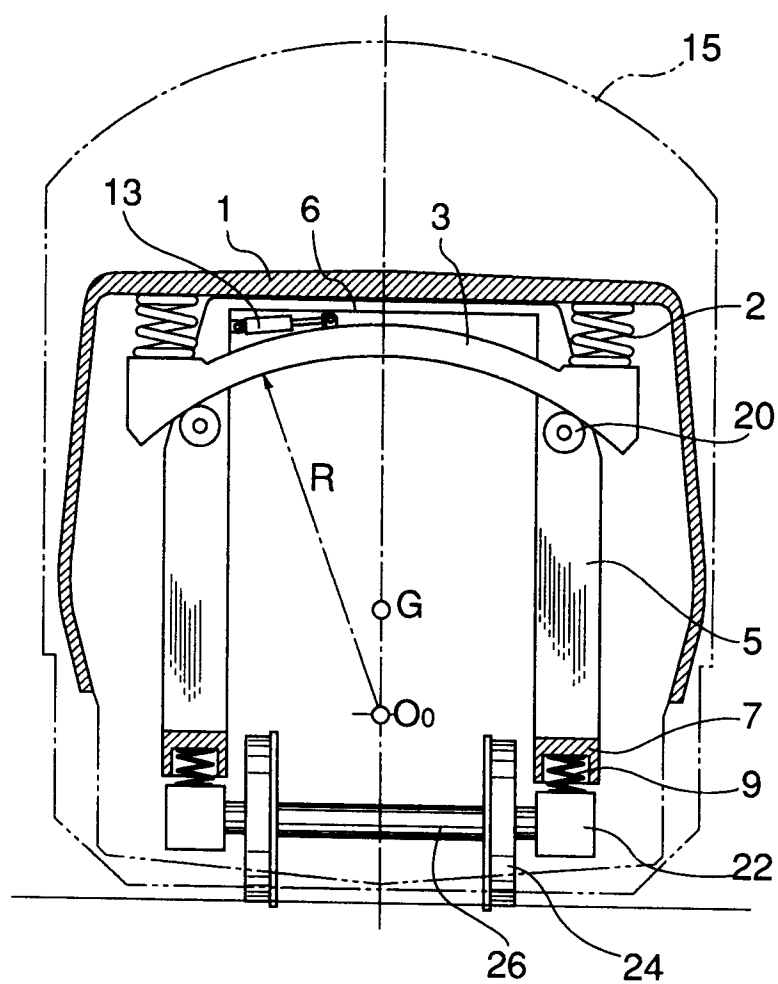


FIG.11

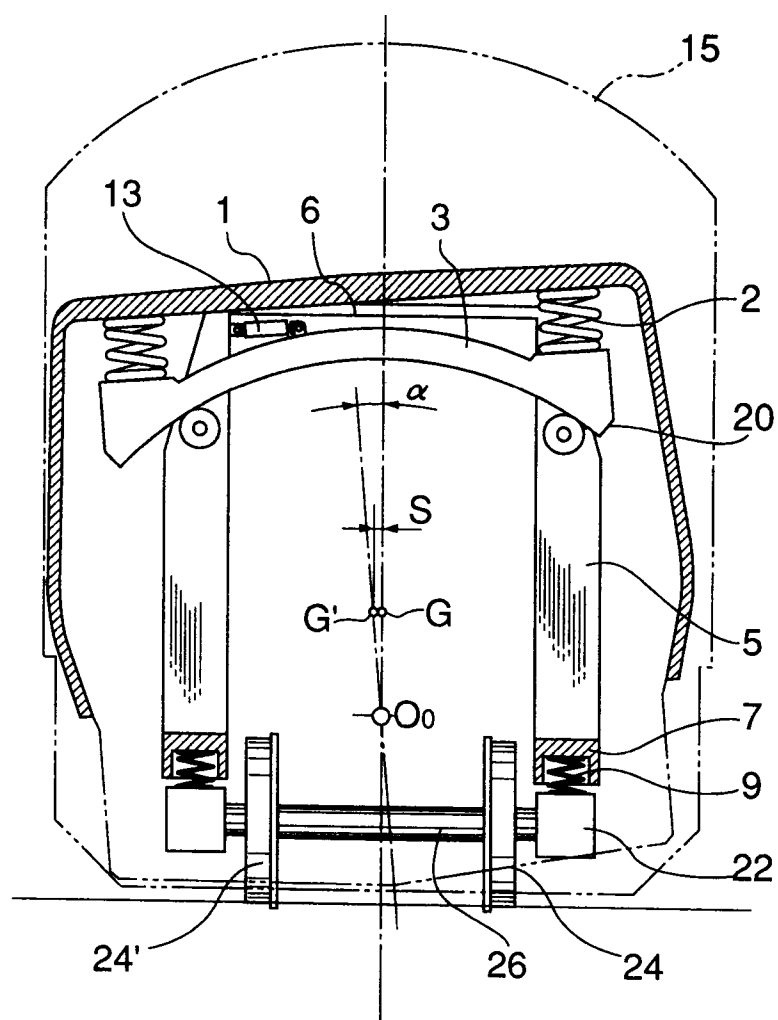
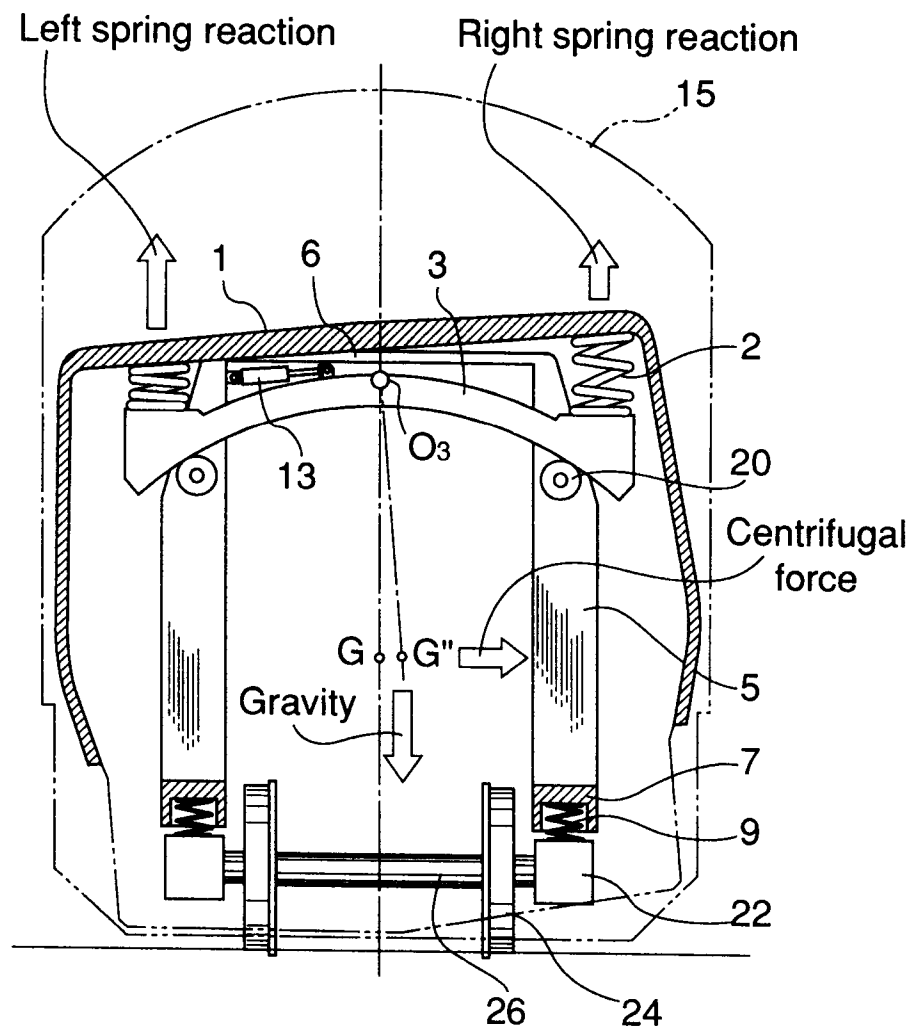


FIG.12





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 10 7628

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	GB-A-525 858 (C. T. HILL) 5 September 1940 * page 5, line 8 - line 118 * * page 8, line 5 - line 40; figures 1,2 * ----	1-3	B61F5/22
A	US-A-2 954 746 (A. R. CRIPE) 4 October 1960 * column 3, line 53 - column 4, line 4; figure 6 * -----	1-3	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			B61F
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 24 August 1995	Examiner Chlosta, P
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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