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(54) **RAILROAD VEHICLE CARRIAGE**

SCHIENENFAHRZEUGWAGEN

CHARIOT DE VÉHICULE DE CHEMIN DE FER

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## Description

### TECHNICAL FIELD

**[0001]** The present invention relates to a bogie for a railway vehicle. The object of the invention is to reduce a decrease in a wheel load that occurs when traveling at low speed, particularly in an exit easement curve section.

### BACKGROUND ART

**[0002]** As shown in FIG. 4, two bogies 2 are typically disposed at the front and the back of a railway vehicle 1 in the direction of travel. Four air springs 4 are installed in a bogie frame 3 which constitutes each of the bogies 2, with two springs disposed in a width direction on each of the two sides of the railway vehicle to support a vehicle body 5.

**[0003]** In a railway vehicle having the above construction, a height of the vehicle body 5 is varied according to the number of passengers, by relaxing the spring rigidity of the air springs 4, in order to enhance the riding comfort of the passengers. Therefore, an automatic height adjusting device 6 (referred to below as an LV) is installed in the vehicle body 5. The LV 6 detects the height of the air springs, supplies air, and vents air, so as to maintain a constant height of the vehicle body 5 and to eliminate a difference in level with a platform, to ensure safety when passengers alight from the railway vehicle. In FIG. 4, Reference Numeral 7 is a wheel set on which are mounted wheels 7b attached to both sides of a shaft 7a, and Reference Numeral 8 is a rail.

**[0004]** As shown in FIG. 5, the LV 6 is installed on both sides in a width direction of the railway vehicle 5, and one end of a lever 11 is attached to an operating shaft 6a. The other end of the lever 11 is rotatably coupled to one end of a coupling rod 12 so that the other end thereof rotates freely in the bogie frame 3 (see paragraph 0002 and FIG. 10 of Patent Reference 1). Reference Numeral 9 in FIG. 5 is an axle box which supports the wheel set 7 so that it rotates freely. Reference Numeral 10 is an axle spring mounted on the axle box 9.

**[0005]** Straight sections and curved sections of the rail are connected via an easement curve section in which a rail surface twists with a gradually changing curvature and cant.

**[0006]** When traveling through a curved section, a high lateral force operates on the wheels on an outer rail side of a wheel set on the front side in the traveling direction of the bogie (referred to below as the front axle).

**[0007]** While the bogie travels through the easement curve section in which the rail surface twists, the height of the axle springs and the air springs changes in order for the wheels to follow the rail, and this change in the height of the springs causes the resulting spring force to vary the wheel load. In particular, the wheel load decreases when the air springs on the outer rail side of the front axle expand, resulting in an easing of the wheel load.

Accordingly, the derailment coefficient, obtained by dividing the lateral force Q by the wheel load P, increases at the exit easement curve section (see FIG. 6).

**[0008]** Moreover, when traveling at a low speed in the exit easement curve section, the twisting of the rail surface causes the air springs on the outer rail side of the front axle to expand, and the air springs on the inner rail side of the front axle to compress, the LV operates, while the air springs on the outer rail side are vented, so the inner pressure drops, and the air springs on the inner rail side are supplied with air, so the inner pressure rises. The decrease in wheel load becomes significant on the outer rail side of the front axle, because the spring force of the air springs decreases due to the reduced inner pressure of the air springs on the outer rail side.

**[0009]** European patent application EP 0 683 081 A1 describes a bogie equipped with a body-tilt system for a railway car.

### PRIOR ART REFERENCES

#### PATENT REFERENCES

**[0010]** Patent Reference 1: Japanese Patent Application Kokai Publication No. 2007-269076

### SUMMARY OF THE INVENTION

#### PROBLEMS TO BE SOLVED BY THE INVENTION

**[0011]** The problem that the present invention aims to solve is that in the case of a prior art bogie for a railway vehicle, when traveling at low speed through an exit easement curve section, a decrease in wheel load occurs in a front wheel on an outer rail side, and the LV promotes this decrease in wheel load.

#### MEANS FOR SOLVING THESE PROBLEMS

**[0012]** Because a wheel follows a twisting of a rail surface when traveling through an exit easement curve section, a wheel load varies according to changes in a height of an axle spring. An amount of change in wheel load  $\Delta P_{\text{bogie}}$  from when the railroad vehicle is at rest (stationary wheel load) can be obtained from the following formula, having a spring constant k of an axle spring mounted on both sides in a width direction in a bogie frame, a distance  $b_l$  between the axial centers of the axle springs on both sides, and a distance  $b_c$  between the contact points of a wheel and a rail (see FIG. 1).

$$\Delta P_{\text{bogie}} = C \times \theta \times k \times b_l^2 \div b_c$$

(Where  $\theta$  is the angle of twisting of the rail surface, and C is a coefficient determined by the stationary wheel load.)

**[0013]** In order to inhibit a decreased wheel load when traveling at low speed in an exit easement curve section, the inventors conceived of mounting axle springs disposed on both sides in a width direction of the railway vehicle so as to position it as much as possible on the center side in the width direction of the railway vehicle.

**[0014]** Moreover, in order to study a height detection position (the position of the distance indicated by  $b_2$  in FIG. 1) of an LV that promotes a decrease in a wheel load, the inventors simulated a ratio of the decrease in the wheel load when a standard commuter train passes through an easement curve section at a speed of 5 km/h, where the easement curve section has a radius of curvature of 200 m, a cant of 105 mm, and a cant diminution rate of 300-fold.

**[0015]** As a result, it was found that the ratio of the decrease in wheel load, when the height detection position of the LV was changed from an outer side of a width direction of a railway vehicle to a center of the railway vehicle in the width direction, decreased more when it was located on the center side of the railway in the width direction from the axial center of the air springs, as shown in FIG. 3. It was also found that the ratio of decrease in wheel load increases when the height detection position of the LV is located on the center side in the width direction of the railway vehicle than when disposed in the axial center of the axle springs. The ratio of decrease in wheel load shown in FIG. 3 shows a case where the value is 1 at a current height detection position of the LV when disposed in the width direction of the railway vehicle on a side which is more on the outside than the air springs which are disposed on both sides in the width direction of the railway vehicle in the bogie frame.

**[0016]** The present invention was designed on the basis of the above concepts and the research carried out by the inventors. In particular, the present invention employs the following construction in order to reduce the decrease in wheel load on the outer rail side of the front axle when traveling at low speed in an exit easement curve section.

**[0017]** The present invention is a bogie for a railway vehicle comprising a bogie frame supported by axle springs disposed on axle boxes which rotatably support a wheel set, air springs disposed on both sides of the railway vehicle in a width direction of the bogie frame, an LV provided for each of the air springs for maintaining a constant height of a vehicle body which is supported by the air springs, wherein the axle boxes are disposed at positions closer to the center side of the railway vehicle in the width direction than the wheels attached to both sides of a shaft which constitutes a wheel set, and a height of the LV is detected at a position of the LV which is located between an axial center of the air springs and an axial center of the axle springs.

**[0018]** According to the present invention, the axle boxes provided with axle springs are disposed at positions closer to the center side of the railway vehicle in the width direction than the wheels attached to both sides of the

shaft which constitutes the wheel set. Therefore, the distance between the two axle springs disposed on both sides in the width direction of the railway vehicle becomes narrower, and the amount of change in the height of the air springs decreases, so there is less fluctuation in wheel load when traveling through an exit easement curve section.

**[0019]** In addition, according to the present invention, the height of the LV is detected at a location between the axial center of the air springs and the axial center of the axle springs. Therefore, there is a greater reduction in the decrease in wheel load than when the height detection position of the LV is located on the outer side of the air springs in the width direction of the railway vehicle.

## ADVANTAGEOUS EFFECTS OF THE INVENTION

**[0020]** According to the present invention, the bogie is constructed so that the distance between the two axle springs disposed on both sides in the width direction of the railway vehicle becomes smaller, and the height detection position of the LV is located more on the center side in the width direction of the railway vehicle than in the prior art. Therefore, when traveling at low speed in an exit easement curve section, it is possible to greatly reduce the decrease in wheel load on the outer rail side of the front axle, thus improving the ability to pass through exit easement curve sections.

## BRIEF DESCRIPTION OF THE DRAWINGS

### [0021]

FIG. 1 is a drawing illustrating the schematic structure of a bogie for a railway vehicle according to the present invention. FIG. 1 (a) is a frontal view in the direction of travel of the railway vehicle. FIG. 1 (b) is a view from above the railway vehicle.

FIG. 2 is a drawing illustrating wheel load when traveling through an exit easement curve section. FIG. 2 (a) shows a bogie for a railway vehicle according to the present invention. FIG. 2 (b) shows a prior art bogie for a railway vehicle.

FIG. 3 is a graph showing the relationship between the height detection position of the LV and the decrease in wheel load.

FIG. 4 is a drawing illustrating a prior art bogie for a railway vehicle in a manner similar to FIG. 1 (b).

FIG. 5 is a drawing illustrating a prior art bogie for a railway vehicle in a manner similar to FIG. 1 (a).

FIG. 6 is a graph showing the lateral force  $Q$  and the wheel load  $P$  which operate on a front axle wheel while traveling through an exit easement curve sec-

tion.

## EMBODIMENT OF THE INVENTION

**[0022]** The object of the present invention is to reduce a decrease in wheel load on the outer rail side of the front axle that occurs when traveling at low speed, particularly in an exit easement curve section. This object is achieved by constructing the bogie in such a manner that the distance between the two axle springs disposed on both sides of the railway vehicle in the width direction becomes smaller, and by locating the height detection position of the LV more on the center side in the width direction of the railway vehicle than in the prior art.

## EXAMPLE

**[0023]** An example of an embodiment is described below, making reference to FIG. 1.

**[0024]** FIG. 1 is a drawing illustrating the schematic structure of a bogie for a railway vehicle according to the present invention.

**[0025]** Reference Numeral 21 is a bogie, and in the present invention, it is an inboard type bogie wherein the axle boxes 9, provided with axle springs 10 that support a bogie frame 22, are disposed at positions closer to the center side of the railway vehicle in the width direction than the wheels 7b attached to both sides of the shaft 7a which constitutes the wheel set 7.

**[0026]** Therefore, since the axle boxes 9 are disposed on the outer side from the wheels 7b in the width direction of railway vehicle, the construction differs from that of the outboard type bogie 2 depicted in FIG. 4 and FIG. 5. Side beams 22a which constitutes the bogie frame 22 are positioned on an inner side of the wheels 7b.

**[0027]** In other words, in the case of the inboard type bogie 21, the height detection position of the LV 6 can be located closer to an inward side of the air springs 4 which are disposed on both sides of the railway vehicle in the width direction in the bogie frame 22.

**[0028]** Additionally, according to the present invention, the height detection position of the LV 6 provided to the air springs 4 to maintain a constant height of the vehicle body 5, is located between the axial center of the air springs 4 and the axial center of the axle springs 10.

**[0029]** According to the present invention having the above construction, the distance  $b_1$  between the two axle springs 10 disposed on both sides of the railway vehicle in the width direction becomes narrower and the amount of change in the height of the air springs decreases, so that, as shown in FIG. 2 (a), the wheel load P, which operates on the four wheels 7b while traveling at low speed through an exit easement curve section, becomes smaller than that for the outboard type bogie 2 depicted in FIG. 2 (b).

**[0030]** The stationary wheel load of the four wheels 7b does not become unbalanced, because the height detection position of the LV 6 is located between the axial

center of the air springs 4 and the axial center of the axle springs 10. Therefore, the ratio of decrease in the wheel load is reduced in comparison with the case where the height detection position of the LV 6 is located on the outer side of the air springs 4.

**[0031]** According to the present invention described above, the decrease in wheel load on the outer rail side of the front axle can be greatly reduced when traveling at low speed in an exit easement curve section, thus making it possible to improve the ability to pass through exit easement curve sections.

**[0032]** The present invention is not limited to the above-described example, and the preferred embodiment may, of course, be advantageously modified within the scope of the technical ideas recited in the claims.

**[0033]** For example, FIG. 1 shows a bolsterless bogie, but the present invention is also suitable for a bogie with a bolster. Moreover, the present invention can also be used in a steering bogie.

## EXPLANATION OF THE REFERENCE NUMERALS

### [0034]

|    |                 |
|----|-----------------|
| 1  | Railway vehicle |
| 4  | Air spring      |
| 5  | Vehicle body    |
| 6  | LV              |
| 7  | Wheel set       |
| 9  | Axle box        |
| 10 | Axle spring     |
| 21 | Bogie           |
| 22 | Bogie frame     |

## Claims

1. A railway vehicle (1) having a bogie (2, 21), wherein the bogie (2, 21) comprises:

a bogie frame (3, 22) supported by axle springs (10) disposed on axle boxes (9) which rotatably support a wheel set (7);

air springs (4) disposed on both sides of the railway vehicle (1) in a width direction of the bogie frame (3, 22); and

an automatic height adjusting device (6) provided for each of the air springs (4) for maintaining a constant height of a vehicle body (5) of the railway vehicle (1), wherein the vehicle body (5) is supported by the air springs (4), **characterised in that**

the axle boxes (9) are disposed at positions closer to the center side of the railway vehicle (1) in the width direction than the wheels (7b) attached to both sides of a shaft (7a) which constitutes a wheel set (7),

and **in that** the location of a height detection

position of the automatic height adjusting device (6) is between an axial center of the air springs (4) and an axial center of the axle springs (10).

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## Patentansprüche

1. Schienenfahrzeug (1) mit einem Fahrwerk (2, 21), wobei das Fahrwerk (2, 21) umfasst:

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einen Fahrwerkrahmen (3, 22), der durch Achsfedern (10) gelagert ist, die an Achslagern (9) angeordnet sind, die einen Radsatz (7) drehbeweglich lagern;

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Luftfedern (4), die auf beiden Seiten des Schienenfahrzeugs (1) in einer Breitenrichtung des Fahrwerkrahmens (3, 22) angeordnet sind; und eine automatische Höhenanpassungsvorrichtung (6), die für jede der Luftfedern (4) vorgesehen ist, um eine konstante Höhe eines Fahrzeugaufbaus (5) des Schienenfahrzeugs (1) aufrechtzuerhalten, wobei der Fahrzeugaufbau (5) durch die Luftfedern (4) gelagert ist,

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**dadurch gekennzeichnet, dass**

die Achslager (9) an Positionen angeordnet sind, die in der Breitenrichtung näher an der Mittenseite des Schienenfahrzeugs (1) sind als die Räder (7b), die an beiden Seiten einer Welle (7a) angebracht sind, die einen Radsatz (7) bildet,

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und dass die Stelle einer Höhenerfassungsposition der automatischen Höhenanpassungsvorrichtung (6) zwischen einer axialen Mitte der Luftfedern (4) und einer axialen Mitte der Achsfedern (10) liegt.

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## Revendications

1. Véhicule ferroviaire (1) présentant un boggie (2, 21), sachant que le boggie (2, 21) comprend :

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un châssis de boggie (3, 22) supporté par des ressorts d'essieu (10) disposés sur des boîtes d'essieu (9) qui supportent en rotation un ensemble de roues (7) ;

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des ressorts pneumatiques (4) disposés des deux côtés du véhicule ferroviaire (1) dans une direction de largeur du châssis de boggie (3, 22) ; et

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un dispositif de réglage automatique de hauteur (6) prévu pour chacun des ressorts pneumatiques (4) pour maintenir une hauteur constante d'un corps de véhicule (5) du véhicule ferroviaire (1), sachant que le corps de véhicule (5) est supporté par les ressorts pneumatiques (4), **carac-**

55

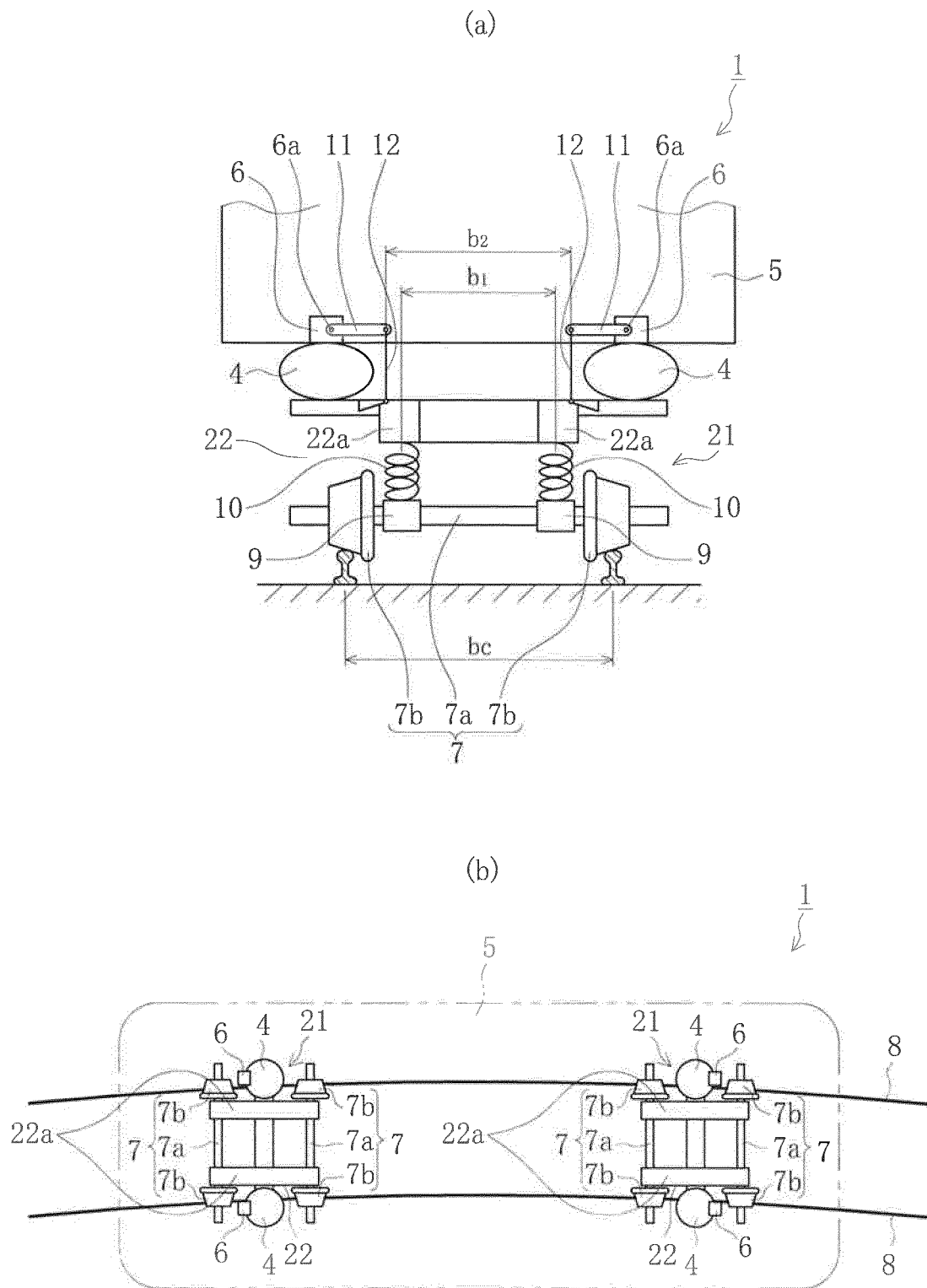
**térisé en ce que**

les boîtes d'essieu (9) sont disposées dans des

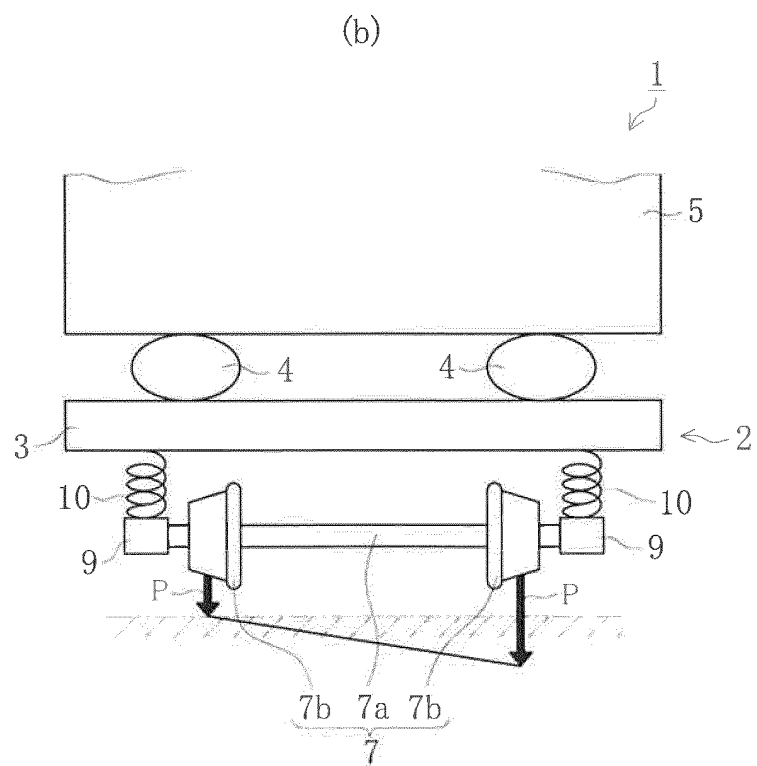
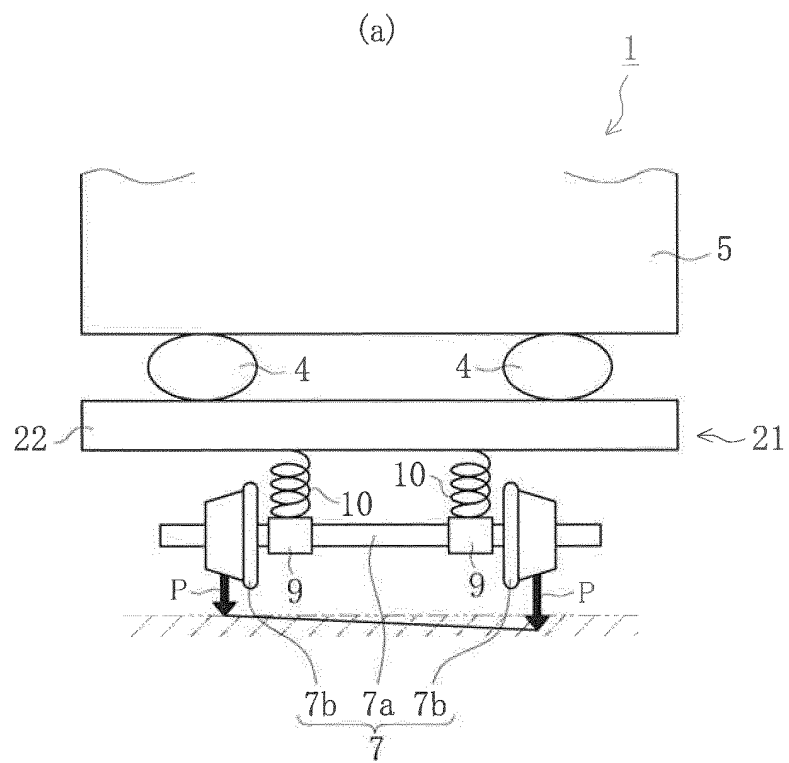
positions plus proches du côté central du véhicule ferroviaire (1) dans la direction de largeur que les roues (7b) fixées aux deux côtés d'un arbre (7a) qui constitue un ensemble de roues (7),

et **en ce que** l'emplacement d'une position de détection de hauteur du dispositif de réglage automatique de hauteur (6) se situe entre un centre axial des ressorts pneumatiques (4) et un centre axial des ressorts d'essieu (10).

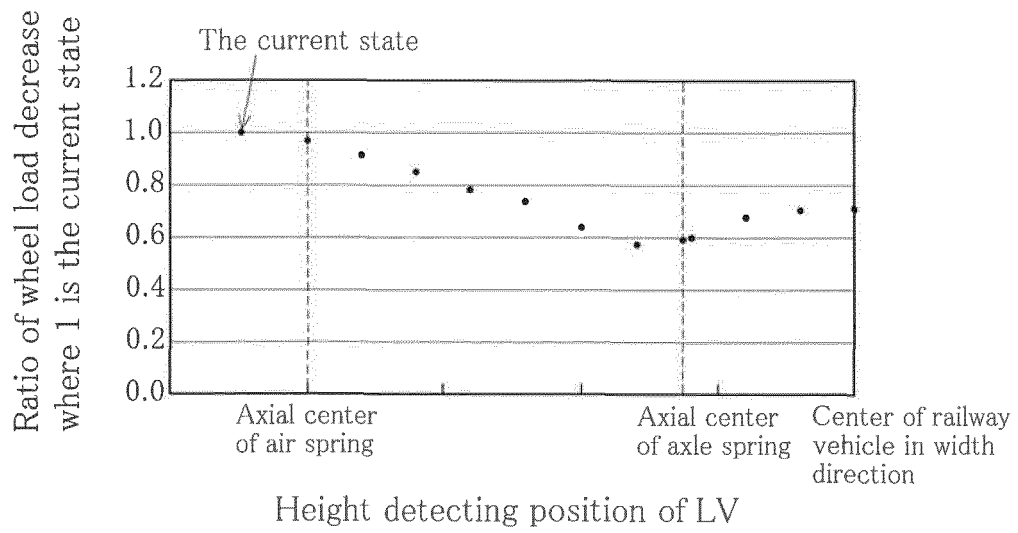
【Fig.1】



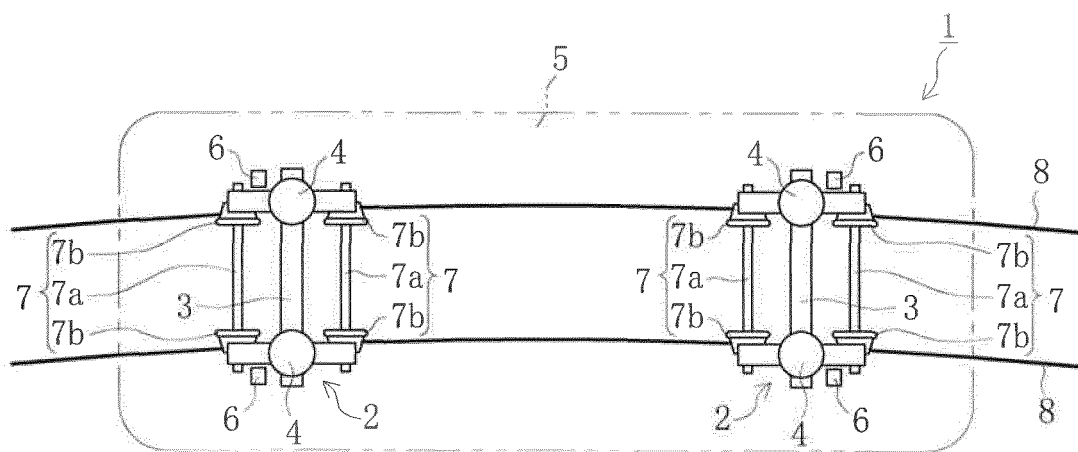
【Fig.2】



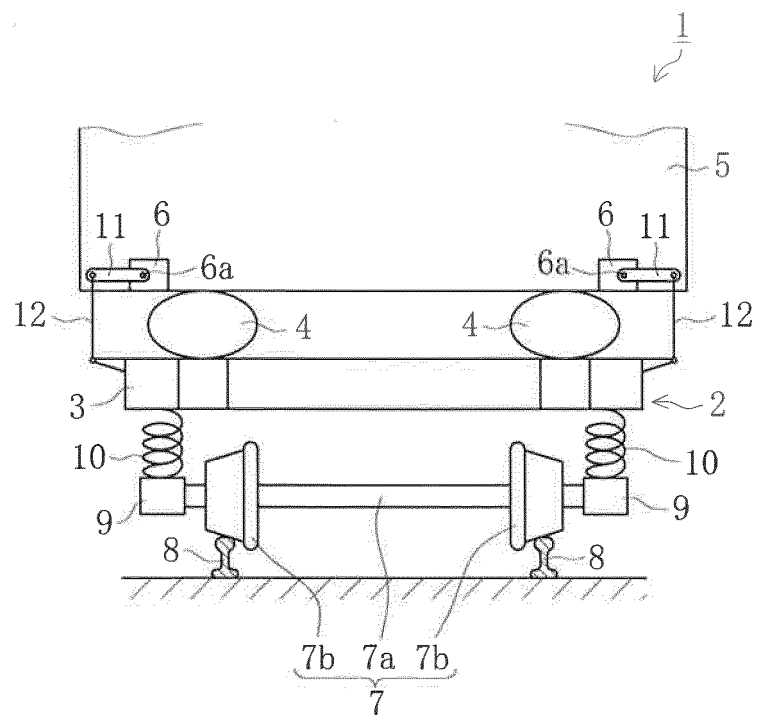
【Fig.3】



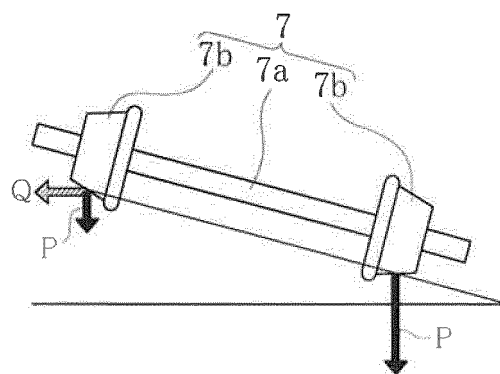
【Fig.4】



【Fig.5】



【Fig.6】



**REFERENCES CITED IN THE DESCRIPTION**

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