extending portion 30b of the plate spring 30 is formed such that a thickness T thereof gradually increases in a direction from a front-rear direction end portion toward a middle portion. Specifically, in the extending portion 30b of the plate spring 30, the thickness of the lower layer portion 35 gradually increases in a direction from the front-rear direction end portion toward the middle portion, and the thickness of the upper layer portion 36 is constant. For example, the thickness of a thinnest portion of the lower layer portion 35 is 3 to 10 times the thickness of a thinnest portion of the upper layer portion 36, and the thickness of a thickest portion of the lower layer portion 35 is 5 to 15 times the thickness of a thickest portion of the upper layer portion 36. A concave-convex fitting structure including fitting portions that are fitted to each other in the upper-lower direction with a play is provided at a portion where the contact surface 33a of the contact member 33 and the upper surface of the plate spring 30 contact each other. Specifically, a concave portion 33b that is concave upward is formed at a middle portion of the contact surface 33a of the contact member 33, and a convex portion 36a that is fitted to the concave portion 33b with a play is formed on an upper surface of the upper layer portion 36 of the plate spring 30.

[0022] Fig. 6 is a main portion side view showing the plate spring 30 and the supporting member 31 of the axle box 8 in ~~the bogie~~the bogie 1 shown in Fig. 3 and including plate springs. As shown in Fig. 6, the supporting member 31 is disposed on the upper end portion of the axle box 8. A hole portion 31a is formed at a center of the supporting member 31, and a convex portion 8a provided on the axle box 8 is fitted in the hole portion 31a. The supporting member 31 is formed by stacking a rubber plate 41, a metal plate 42, and a rubber plate 43 in this order from below such that these plates 41 to 43 are adhered to one another. That is, a contact surface ~~33a~~43a, contacting the lower layer portion 35 made of fiber-reinforced resin, of the supporting member 31 is made of rubber.

[0023] The front-rear direction end portion 30c of the plate spring 30 is disposed on the supporting member 31 from above so as to freely contact the supporting member 31. In other words, the front-rear direction end portion 30c of the plate spring 30 contacts an upper surface of the supporting member 31 so as not to be fixed to the

vehicle occupancy. Therefore, a railcar that is high in ride quality both when the vehicle occupancy is low and when the vehicle occupancy is high is realized. Since the other components herein are the same as those in Embodiment 1, explanations thereof are omitted.

[0033] **Embodiment 4**

Fig. 9 is a diagram showing the bogie including plate springs according to Embodiment 4 of the present invention and corresponds to Fig. 6. As shown in Fig. 9, in the bogie of Embodiment ~~3~~4, rubber plates 61 are firmly fixed to a lower surface of the lower layer portion 35 made of fiber-reinforced resin so as to be respectively located at front-rear direction end portions 130c of a plate spring 130 (side member). A supporting member 131 provided at the upper end portion of the axle box 8 is formed by stacking the rubber plate 41 and the metal plate 42 in this order from below. To be specific, an upper surface of the supporting member 131 is made of metal, but a lower surface of the front-rear direction end portion 130c of the plate spring 130 is made of rubber. Therefore, the lower layer portion 35 made of the fiber-reinforced resin in the plate spring 130 can be appropriately protected. Since the other components herein are the same as those in Embodiment 1, explanations thereof are omitted.

[0034] **Embodiment 5**

Fig. 10 is a diagram showing the bogie including plate springs according to Embodiment 5 of the present invention and corresponds to Fig. 6. As shown in Fig. 10, in the bogie of Embodiment 5, an upper surface of a supporting member 231 provided at the upper end portion of the axle box 8 is formed in a substantially circular-arc shape that is convex upward in a side view. Specifically, the supporting member 231 is formed by stacking the rubber plate 41, the metal plate 42, and a rubber plate 143 in this order from below. An upper surface 143a of the rubber plate 143 that is an uppermost layer is formed in a substantially circular-arc shape in a side view. That is, in a side view, the curvature of the upper surface 143a of the supporting member 231 is larger than that of a lower surface of a portion (front-rear direction end portion 30c), contacting the supporting member 231, of the plate spring 30. With this, as the downward load applied to the cross beam 4 (Fig. 4) increases, and this causes the elastic deformation of

the plate spring 30, the shortest distance from the portion, contacting the contact member 33 (Fig. 4), of the plate spring 30 to a portion, contacting the supporting member 231, of the plate spring 30 becomes short. Therefore, as the vehicle occupancy of the carbody 11 increases, the spring constant of the plate spring 30 increases. Thus, the spring constant changes in accordance with the change in the vehicle occupancy. Therefore, a railcar that is high in ride quality both when the vehicle occupancy is low and when the vehicle occupancy is high can be realized. Since the other components herein are the same as those in Embodiment 1, explanations thereof are omitted.

[0035] **Embodiment 6**

Fig. 11 is a diagram showing a bogie 301 according to Embodiment 6 of the present invention and corresponds to Fig. 3. As shown in Fig. 11, instead of the plate springs 30, the bogie 301 ~~including plate springs~~ of Embodiment 6 includes elongated members 330 (side members) each constituted by a stiff member (such as a non-elastic member made of metal, fiber-reinforced resin, or the like) and extending in the front-rear direction. The elongated member 330 has, for example, a tubular shape. Each of the elongated members 330 includes: a front-rear direction middle portion 330a supporting a crosswise direction end portion 304a of a cross beam 304; front-rear direction end portions 330c respectively supported by the axle boxes 8 and located at positions higher than the middle portion 330a; and inclined portions 330b each connecting the middle portion 330a and each of the end portions 330c. To be specific, in the elongated member 330, the middle portion 330a and a pair of inclined portions 330b respectively located in front of and behind the middle portion 330a form a concave portion. Each of coil springs 331 as primary suspensions is interposed between the end portion 330c of the elongated member 330 and the axle box 8. A part of the inclined portion 330b of the elongated member 330 is arranged so as to overlap the coupling mechanism 16 in a side view. Specifically, a part of the inclined portion 330b of the elongated member 330 is inserted through the space 27 (see Fig. 1) sandwiched between the pair of receiving seats 21 and 22.

[0036] Contact members 333 as bottom walls are respectively provided at the crosswise direction end portions 304a of the cross beam 304. Each of the contact

constant, and the upper layer 561 is ~~thinner~~thicker than the lower layer 563.

[0044] When the carbody 11 supported by the bogie 1 is empty, an inclination angle θ of the longitudinal direction end portion 530c of the plate spring 530 relative to the horizontal surface is set to not smaller than 10° and not larger than 25° (for example, 15°). While the railcar is running, upper-lower, front-rear, and left-right vibrations are transmitted from the wheels 6 to the bogie frame, and upper-lower vibrational components that have dominant accelerations out of the entire vibrational components are transmitted and absorbed by the plate springs 530. At this time, since the lower surface of the longitudinal direction end portion 530c of the plate spring 530 is inclined, an upward force F transmitted from the supporting member 531 to the plate spring 530 by the vibrations is divided into a vertical component force Fa that is vertical relative to the longitudinal direction end portion 530c of the plate spring 530 and a horizontal component force Fb that is horizontal relative to the longitudinal direction end portion 530c of the plate spring 530. Therefore, the load transmitted from the supporting member 531 to the plate spring 530 decreases from the force F to the component force Fa ($Fa = F \cdot \cos\theta$). The plate spring 530 is not fixed to the contact member 533 and can swing like a seesaw along the circular-arc lower surface 533a of the contact member 533. Therefore, when the upper-lower vibrations are applied to one of the longitudinal direction end portions 530c of the plate spring 530, the acceleration of the upper-lower vibrations can be absorbed also by the swinging of the plate spring 530 based on the longitudinal direction middle portion 530a as a fulcrum. In a case where the inclination angle θ of one of the longitudinal direction end portions 530c of the plate spring 530 has become larger than the inclination angle θ of the other of the longitudinal direction end portions 530c by the vibrations, the component force Fa of the end portion 530c having the larger inclination angle θ becomes lower than the component force Fa of the end portion 530c having the smaller inclination angle θ. Therefore, forces act such that the inclination angles θ of both longitudinal direction sides of the plate spring 530 become the same as each other (that is, the plate spring 530 returns to the original posture). Thus, the plate spring 530 has a self correction function to keep the balance.

[0045] Further, when the plate spring 530 bends by the upward loads respectively

CLAIMS

~~[Claim 1]~~1. A railcar bogie comprising:

a cross beam configured to support a carbody of a railcar;

a pair of front and rear axles sandwiching the cross beam and respectively arranged in front of and behind the cross beam in a railcar longitudinal direction so as to extend in a railcar width direction;

bearings respectively provided at both railcar width direction sides of each of the axles and configured to rotatably support the axles;

axle boxes configured to respectively accommodate the bearings;

~~side members~~plate springs extending in the railcar longitudinal direction ~~so as to respectively support both railcar width direction end portions of the cross beam and each including both railcar longitudinal direction end portions respectively supported by the axle boxes~~;

contact members respectively provided at both railcar width direction end portions of the cross beam, ~~and~~ respectively disposed separably on railcar longitudinal direction middle portions of the ~~side members~~plate springs so as not to be fixed to the ~~side members~~plate springs in an upper-lower direction; and

supporting members respectively provided at the axle boxes and respectively supporting the railcar longitudinal direction end portions of the ~~side members~~plate springs, wherein

an upper surface of the railcar longitudinal direction middle portion of each of the plate springs has a substantially circular-arc shape that is convex downward in a side view.

~~[Claim 2] The railcar bogie according to claim 1, wherein the side members are plate springs.~~

~~[Claim 3]~~2. The railcar bogie according to claim ~~2~~1, wherein:

the supporting members are respectively provided at upper end portions of the axle boxes; and

the railcar longitudinal direction end portions of the plate springs are respectively disposed on the supporting members from above so as not to be fixed to the supporting members in the upper-lower direction.

~~[Claim 4]~~3. The railcar bogie according to claim ~~2~~1 or ~~3~~2, wherein when a downward load applied to the cross beam increases, the plate springs elastically deform, and a contact area between each of the plate springs and each of the contact members increases.

~~[Claim 5]~~4. The railcar bogie according to any one of claims ~~2~~1 to 4~~3~~, wherein the plate springs include fiber-reinforced resin.

~~[Claim 6]~~5. The railcar bogie according to claim ~~5~~4, wherein at least one of a contact surface, contacting the contact member, of the plate spring and a contact surface, contacting the supporting member, of the plate spring is constituted by a covering member covered with the fiber-reinforced resin.

~~[Claim 7]~~6. The railcar bogie according to claim ~~5~~4, wherein:

at least one of a contact surface, contacting the plate spring, of the contact member and a contact surface, contacting the plate spring, of the supporting member is made of rubber; and

a contact surface, contacting the rubber, of the plate spring is made of the fiber-reinforced resin.

~~[Claim 8]~~7. The railcar bogie according to any one of claims ~~2 to 7~~1 to 6, wherein:

each of the plate springs includes a plurality of layers; and

a compressive strength of an upper layer portion out of the plurality of layers is higher than that of a lower layer portion out of the plurality of layers.

~~[Claim 9]~~8. The railcar bogie according to claim ~~8~~7, wherein the lower layer portion is

thicker than the upper layer portion and made of fiber-reinforced resin.

~~[Claim 10]~~9. The railcar bogie according to any one of claims ~~2 to 9~~1 to 8, wherein a front-rear direction middle portion of each of the plate springs is located at a position lower than the railcar longitudinal direction end portions of the plate spring.

~~[Claim 11]~~10. The railcar bogie according to any one of claims ~~2 to 10~~1 to 9, wherein as a downward load applied to the cross beam increases, and this causes elastic deformation of the plate spring, a shortest distance from a portion, contacting the contact member, of the plate spring to a portion, contacting the supporting member, of the plate spring becomes short.

~~[Claim 12]~~11. The railcar bogie according to any one of claims ~~2 to 11~~1 to 10, wherein~~:~~

a contact surface, contacting the plate spring, of each of the contact members has a substantially circular-arc shape that is convex downward in a side view; and

in a side view, a curvature of the contact surface of the contact member is larger than that of a portion, contacting the contact member, of the plate spring.

~~[Claim 13]~~12. The railcar bogie according to any one of claims ~~2 to 12~~1 to 11, wherein~~:~~

each of the contact members include

a main body portion constituted by a stiff member including a lower surface having a substantially circular-arc shape that is convex downward in a side view, and

an elastic member covering the lower surface of the main body portion and including a lower surface contacting the plate spring; and

when the plate spring elastically deforms, the lower surface of the elastic member follows an upper surface of the plate spring, that is, a state where the lower

surface of the elastic member surface-contacts the upper surface of the plate spring is maintained.

~~[Claim 14]~~13. The railcar bogie according to any one of claims 1 to ~~13~~12, further comprising

coupling mechanisms each configured to couple the cross beam and each of the axle boxes, wherein

each of the ~~side members~~plate springs is arranged such that a part thereof overlaps the coupling mechanism in a side view.

~~[Claim 15]~~14. The railcar bogie according to any one of claims 1 to ~~14~~13, wherein the contact member and the ~~side member~~plate springs respectively include fitting portions that are fitted to each other in the upper-lower direction.

~~[Claim 16]~~15. The railcar bogie according to any one of claims 1 to ~~15~~14, wherein the cross beam is made by a cutting work of metal.

~~[Claim 17]~~16. The railcar bogie according to any one of claims 1 to ~~16~~15, wherein lower surfaces of the railcar longitudinal direction end portions of the ~~side members~~plate springs are inclined relative to a horizontal surface.

~~[Claim 18]~~17. The railcar bogie according to any one of claims 1 to ~~17~~16, wherein each of the ~~side members~~plate springs is formed in an arch shape that is convex downward as a whole in a side view.