DESCRIPTION

Title of Invention: AXLE BOX SUSPENSION OF BOGIE OF RAILCAR

Technical Field

[0001] The present invention relates to an axle box suspension of a bogie of a railcar.

Background Art

[0002] PTL 1 discloses a railcar axle box suspension which includes: an inner tube attached to a side sill so as to extend downward from the side sill; an axle box supporting an axle through a bearing; and a support arm extending in a car front-rear direction from the axle box toward the inner tube and surrounding an outer periphery of the inner tube, and in which a support rubber is located between the inner tube and the support arm.

Citation List

Patent Literature

[0003] PTL 1: Japanese Laid-Open Patent Application Publication No. 5-238389

Summary of Invention

Technical Problem

[0004] According to the configuration disclosed in PTL 1, since the support rubber is located outside the inner tube and inside the support arm, the support rubber needs to be attached to an inside of a tip end portion of the support arm when manufacturing the railcar axle box suspension. In PTL 1, the tip end portion of the support arm includes a mounting hole penetrating therethrough in an upper-lower direction, and the support rubber is press-fitted into the mounting hole.

[0005] In PTL 1, since the support rubber is press-fitted into the mounting hole of the support arm, a special device, such as a pressing machine, is required when attaching the support rubber to the support arm. Therefore, a worker needs to bring the support rubber and the support arm to the device, such as the pressing machine, for each attachment work, and this may make the work by the worker complicated.

[0006] Accordingly, an object of one aspect of the present disclosure is to facilitate, for example, attaching work of an axle box suspension in a bogie of a railcar which includes a coil spring located between an upper surface of an axle box and a bogie frame.

Solution to Problem

[0007] An axle box suspension of a bogie of a railcar according to the present disclosure includes: a coil spring located between an upper surface of an axle box and a bogie frame; a support arm that projects from the axle box toward a first side in a front-rear direction of the bogie and supports the axle box; a cylindrical laminated rubber located on the first side of the axle box and including an outer tube having an axis, a tubular rubber located inside the outer tube, and a core rod located inside the tubular rubber; a fixture that fixes the outer tube to the bogie frame in a state where an outer peripheral surface of the cylindrical laminated rubber is exposed, the outer tube including the outer peripheral surface of the cylindrical laminated rubber; and a positioner that positions the core rod with respect to the support arm.

Advantageous Effects of Invention

[0008] According to the present disclosure, in a state where the outer peripheral surface of the cylindrical laminated rubber is exposed, the outer tube is fixed to the bogie frame, so that the cylindrical laminated rubber is fixed to the bogie frame. Therefore, the cylindrical laminated rubber is fixed to the bogie frame without being press-fitted. Thus, the cylindrical laminated rubber is fixed to the bogie frame without using a special device, such as a pressing machine. When fixing the cylindrical laminated rubber to the bogie frame, it is unnecessary to carry the cylindrical laminated rubber to a special device, such as a pressing machine, so that a worker can more easily assemble the bogie.

Brief Description of Drawings

[0009] FIG. 1 is a side view of a bogie of a railcar.

FIG. 2 is a side view of an axle box suspension of the bogie of FIG. 1.

FIG. 3 is a plan view of the axle box suspension of FIG. 2.

FIG. 4 is a sectional view showing a cylindrical laminated rubber of the axle box suspension of FIG. 2 and taken along a plane extending in a front-rear direction and a vertical direction.

FIG. 5 is a sectional view showing a modified example of the axle box suspension of FIG. 1 and taken along a horizontal plane of a portion where a core rod is attached to a support arm.

FIG. 6 is a side view showing another modified example of the axle box suspension of FIG. 1 and showing a portion where a closing plate is in contact with a lower surface of the support arm from below.

FIG. 7 is a side view showing yet another modified example of the axle box

suspension of FIG. 1 and showing a portion where the closing plate is in contact with the lower surface of the support arm from below.

Description of Embodiments

[0010] Hereinafter, an embodiment will be described with reference to the drawings. In the following description, a direction in which a railcar travels and a car body extends is referred to as a car longitudinal direction as a front-rear direction of the railcar, and a lateral direction orthogonal to the car longitudinal direction is referred to as a car width direction as a left-right direction of the railcar.

[0011] FIG. 1 is a side view of a bogie 2 of a railcar 1. FIG. 2 is an enlarged side view of an axle box suspension located on the front side in the front-rear direction in the bogie 2 of FIG. 1. As shown in FIGS. 1 and 2, the railcar 1 includes the bogie 2, a car body 3, and an air spring 4 located between the bogie 2 and the car body 3. In the present embodiment, the air spring 4 serves as a secondary suspension. The bogie 2 includes a bogie frame 5 supporting the car body 3 through the air spring 4.

[0012] A pair of wheelsets 6 are located on both sides of the bogie frame 5 in the car longitudinal direction. Each wheelset 6 includes: an axle 6a extending in the car width direction; and wheels 6b located on both sides of the axle 6a in the car width direction. Brakes 7 are located at positions opposed to treads of the wheels 6b. The brakes 7 decelerate or stop the rotation of the wheels 6b by pressing the treads of the wheels 6b from an inner side toward an outer side in the car longitudinal direction.

[0013] The bogie 2 includes axle box suspensions 8. Each axle box suspension 8 is attached to the bogie 2 and supports an axle box 9. The axle box 9 accommodates a bearing 10 supporting the axle 6a. The axle box suspension 8 includes a coil spring 12. The axle box 9 is coupled to the bogie frame 5 through the coil spring 12 of the axle box suspension 8. To be specific, the coil spring 12 is located between the bogie frame 5 and the axle box 9. In the present embodiment, the coil spring 12 serves as a primary suspension.

[0014] FIG. 2 is an enlarged side view showing the axle box suspension 8 located on the front side in the front-rear direction in the bogie 2 shown in FIG. 1 and partially showing an internal structure of the axle box 9. As shown in FIG. 2, the axle box suspension 8 includes the coil spring 12, a support arm 13, and a cylindrical laminated rubber 14. The coil spring 12 is located between an upper surface 9a of the axle box 9 and the bogie frame 5. The support arm 13 projects from the axle box 9 toward a center of the bogie 2 in the car longitudinal direction and supports the axle box 9.

[0015] The bogie frame 5 includes a side sill 15 and a receiving seat 16 projecting downward from a lower surface of the side sill 15. In the present embodiment, the receiving seat 16 is fixedly attached to the lower surface of the side sill 15 by welding. The receiving seat 16 may be attached to the side sill 15 by a method other than welding. For example, the receiving seat 16 may be attached to the side sill 15 by bolting. The cylindrical laminated rubber 14 is attached to a lower portion of the receiving seat 16. The cylindrical laminated rubber 14 includes an outer tube 17 on a radially outer side. In the present embodiment, the outer tube 17 of the cylindrical laminated rubber 14 includes tabs 18 projecting outward in a horizontal direction from an outside surface 17a. Moreover, the receiving seat 16 of the bogie frame 5 includes tabs 19 which project outward in the horizontal direction beyond the outside surface 17a of the outer tube 17 of the cylindrical laminated rubber 14 and overlap with the tabs 18 of the outer tube 17. Furthermore, the axle box suspension 8 includes bolts 20 that fasten the tabs 19 of the receiving seat 16 and the tabs 18 of the cylindrical laminated rubber 14. The cylindrical laminated rubber 14 is attached to the side sill 15 in such a manner that the tabs 19 of the receiving seat 16 and the tabs 18 of the outer tube 17 of the cylindrical laminated rubber 14 are fastened to each other by the bolts 20.

[0016] FIG. 3 is an enlarged plan view showing the axle box suspension 8 located on the front side in the front-rear direction in the bogie frame 5. As shown in FIG. 3, in the present embodiment, the receiving seat 16 includes the two tabs 19 on the front side of the bogie frame 5. To be specific, the tabs 19 of the receiving seat 16 are located on both the outer side and the inner side of the side sill 15 in the left-right direction. The two tabs 19 are located symmetrically with respect to a central axis L1 of the cylindrical laminated rubber 14. As shown in FIG. 2, the cylindrical laminated rubber 14 includes the two tabs 18 corresponding to the two tabs 19 of the receiving seat 16. Therefore, in the cylindrical laminated rubber 14 as well, the two tabs 18 are located symmetrically with respect to the central axis L1. The tabs 19 of the receiving seat 16 include respective through holes, and the tabs 18 of the outer tube 17 of the cylindrical laminated rubber 14 include respective screw holes. The cylindrical laminated rubber 14 is fixed to the bogie frame 5 in such a manner that the bolts 20 fasten the outer tube 17, which includes an outer peripheral surface of the cylindrical laminated rubber 14, to the bogie frame 5. To be specific, in the present embodiment, the bolts 20 serve as fixtures that fasten the tabs 19 of the receiving seat 16 and the tabs 18 of the cylindrical laminated rubber 14.

[0017] FIG. 4 is a sectional view showing the cylindrical laminated rubber 14 of the axle box suspension 8 of FIG. 2 and taken along a plane passing through the central axis L1 and extending in the front-rear direction and the vertical direction. The cylindrical laminated rubber

14 includes tubular rubbers 21 and a core rod 22 in addition to the outer tube 17. In the present embodiment, the outer tube 17 and the core rod 22 are made of metal. The cylindrical laminated rubber 14 is located on the bogie center side of the axle box 9 in the car longitudinal direction. The outer tube 17 has an axis L1 that is the same as the central axis L1 of the cylindrical laminated rubber 14 and extends in the vertical direction, and the outer tube 17 extends in the vertical direction.

[0018] The tubular rubbers 21 are located on a radially inner side of the outer tube 17. In the present embodiment, tubular bodies 23 are located on a radially inner side of the outer tube 17 and a radially outer side of the core rod 22. In the present embodiment, the tubular bodies 23 are made of metal. The two tubular bodies 23 are located between the outer tube 17 and the core rod 22 in a radial direction. Moreover, in the present embodiment, the tubular rubbers 21 are located on a radially inner side of the outer tube 17 and a radially outer side of the core rod 22. The three tubular rubbers 21 are located between the outer tube 17 and the core rod 22 in the radial direction. The three tubular rubbers 21 are located between the outer tube 17 and the tubular body 23, between the tubular bodies 23, and between the tubular body 23 and the core rod 22. Between the outer tube 17 on a radially outer side and the core rod 22 on a radially inner side, the tubular bodies 23 made of metal and the tubular rubbers 21 are alternately laminated in the radial direction. Each tubular rubber 21 is attached to the outer tube 17, the tubular body 23, or the core rod 22 by vulcanization bonding.

[0019] The core rod 22 is located on a radially inner side of the tubular rubber 21. The core rod 22 has the axis L1 that is the same as the central axis L1 of the cylindrical laminated rubber 14 and extends in the vertical direction, and the core rod 22 extends in the vertical direction. The core rod 22 includes two screw holes 24. The screw holes 24 extend upward in the vertical direction from a lower end portion 22a that is an end portion of the core rod 22. The core rod 22 has a hollow shape in which an internal space is defined along the central axis L1, except for a lower portion of the core rod 22 which includes the screw holes 24. The internal space of the core rod 22 is open upward and closed at a lower side. An inside surface 22b of an upper portion of the core rod 22 is inclined outward as it extends upward, and a radial thickness of the upper portion decreases toward an upper end 22c of the core rod 22.

[0020] The support arm 13 includes a through hole 13a that is open in the vertical direction. The lower end portion 22a of the core rod 22 is inserted into the through hole 13a of the support arm 13 from above. Moreover, a closing plate 25 is located under the through hole 13a of the support arm 13. The closing plate 25 is separate from the core rod 22. The closing plate 25 is larger than the through hole 13a and interferes from below with a portion of the support arm 13

which is located around the through hole 13a. The closing plate 25 includes through holes 25a that are open in the vertical direction. Moreover, the support arm 13 includes a recess 13b that is located above the through hole 13a, is larger in diameter than the through hole 13a, and is open upward. In other words, the through hole 13a extends downward from a bottom portion of the recess 13b. In a state where the closing plate 25 is in contact with a lower surface of the support arm 13, bolts 26 are inserted into the through holes 25a of the closing plate 25 from below the closing plate 25. The bolts 26 are fastened to the screw holes 24 of the core rod 22. By fitting the core rod 22 into the through hole 13a, horizontal displacement of the core rod 22 relative to the support arm 13 is restricted. Moreover, by contact of the closing plate 25 with the support arm 13, vertical displacement of the core rod 22 relative to the support arm 13 is restricted.

[0021] As described above, the closing plate 25 contacts, from below, a lower surface that is an end surface of the through hole 13a of the support arm 13. In a state where the lower surface of the support arm 13 and the closing plate 25 are in contact with each other, the bolts 26 are fastened to the lower end portion 22a of the core rod 22 through the through holes 25a of the closing plate 25 from the lower side of the support arm 13. Therefore, the closing plate 25 contacting the support arm 13 from below and the bolts 26 fastened to the core rod 22 serve as positioners that position the lower end portion 22a of the core rod 22 with respect to the support arm 13.

[0022] The axle box suspension 8 includes a base 27 located between the support arm 13 and the core rod 22. The base 27 is accommodated in the recess 13b of the support arm 13. The core rod 22 includes: a lower end shaft portion 22e as a first shaft portion inserted into the through hole 13a of the support arm 13; and an intermediate shaft portion 22d as a second shaft portion that is located on an upper side of the lower end shaft portion 22e and larger in diameter than the lower end shaft portion 22e. In a state where the core rod 22 is in the through hole 13a of the support arm 13, the lower end shaft portion 22e of the core rod 22 is in the through hole 13a, and the intermediate shaft portion 22d of the core rod 22 projects upward from the through hole 13a and is not in the through hole 13a.

[0023] A diameter of the core rod 22 changes at a boundary between the intermediate shaft portion 22d and the lower end shaft portion 22e, and an outside surface of the core rod 22 includes a step 22f. The base 27 is in contact with the step 22f located at the boundary between the intermediate shaft portion 22d and the lower end shaft portion 22e on the outside surface of the core rod 22. Since the base 27 is in contact with the outside surface of the core rod 22, a load on the core rod 22 is supported by the support arm 13 through the base 27. Since the core

rod 22 is supported by the support arm 13 from below through the base 27, the cylindrical laminated rubber 14 is supported by the support arm 13 from below. The portion of the support arm 13 which is located around the through hole 13a is sandwiched between the step 22f of the core rod 22 and the closing plate 25 in the vertical direction.

[0024] As shown in FIG. 4, an upper portion 16a and a lower portion 16b of the receiving seat 16 are different in diameter from each other. The upper portion 16a is larger in diameter than the lower portion 16b. An outer diameter of the outer tube 17 of the cylindrical laminated rubber 14 is substantially the same as an outer diameter of the upper portion 16a of the receiving seat 16, and an inner diameter of the outer tube 17 of the cylindrical laminated rubber 14 is substantially the same as an outer diameter of the lower portion 16b of the receiving seat 16. Therefore, when an upper end surface 17b of the outer tube 17 is brought into contact with a lower end surface of the upper portion 16a of the receiving seat 16, an inside surface of the outer tube 17 contacts an outside surface of the lower portion 16b of the receiving seat 16, and an upper end portion 17c as an end portion of the outer tube 17 of the cylindrical laminated rubber 14 is fitted to the receiving seat 16 from below.

[0025] In a state where the outer tube 17 of the cylindrical laminated rubber 14 is fixed to the bogie frame 5 by the bolts 20, and the core rod 22 is positioned and fixed to the support arm 13 by the bolts 26, an outer peripheral surface 28 of the cylindrical laminated rubber 14 is in an exposed state.

[0026] Moreover, by locating one or more shim plates in a gap between the recess 13b of the support arm 13 and a lower surface of the base 27 in the upper-lower direction, a load transmitted to the bogie frame 5 can be adjusted in response to individual variations among the coil springs 12. Thus, the imbalance of the load due to the individual variations among the coil springs 12 located on the bogie frame 5 can be minimized.

[0027] According to the railcar 1 configured as above, when the car body 3 is displaced in the vertical direction, the coil spring 12 and the tubular rubbers 21 of the cylindrical laminated rubber 14 are displaced while elastically deforming. Thus, the coil spring 12 and the tubular rubbers 21 can absorb vertical kinetic energy. Moreover, regarding horizontal displacement, the tubular rubbers 21 of the cylindrical laminated rubber 14 are displaced while elastically deforming, so that the tubular rubbers 21 can absorb horizontal kinetic energy.

[0028] According to the above configuration, in a state where the outer peripheral surface 28 of the cylindrical laminated rubber 14 is exposed, the outer tube 17 is fixed to the bogie frame 5, so that the cylindrical laminated rubber 14 is fixed to the bogie frame 5. Therefore, the cylindrical laminated rubber 14 is fixed to the bogie frame 5 without being press-fitted. Thus,

the cylindrical laminated rubber 14 is fixed to the bogie frame 5 without using a special device, such as a pressing machine. When fixing the cylindrical laminated rubber 14 to the bogie frame 5, it is unnecessary to carry the cylindrical laminated rubber 14 to a special device, such as a pressing machine, so that a worker can more easily assemble the bogie 2. Moreover, since it is unnecessary to use a special device, such as a pressing machine, when assembling the bogie 2, the manufacturing cost of the bogie 2 can be minimized. Furthermore, at the time of the maintenance of the bogie 2, the cylindrical laminated rubber 14 can be easily replaced in such a manner that the cylindrical laminated rubber 14 is detached from the bogie frame 5 and the support arm 13, and a new cylindrical laminated rubber 14 is attached to the bogie frame 5 and the support arm 13.

[0029] Moreover, the core rod 22 is inserted into the through hole 13a of the support arm 13, and the closing plate 25 is brought into contact with the support arm 13 from below the through hole 13a and fastened to the lower end portion 22a of the core rod 22 by the bolts 26 from below while sandwiching the closing plate 25. Therefore, the core rod 22 is fastened to the closing plate 25 by the bolts 26, so that the dislodgement of the core rod 22 can be appropriately suppressed. Thus, the core rod 22 can be surely and easily positioned and fixed to the support arm 13 without press-fitting the core rod 22 to the support arm 13. Moreover, when attaching and detaching the core rod 22 to and from the support arm 13, a special device, such as a pressing machine, is unnecessary. Therefore, the manufacturing cost of the bogie 2 can be minimized.

[0030] Moreover, since the cylindrical laminated rubber 14 is supported by the support arm 13 through the base 27, the cylindrical laminated rubber 14 can be stably supported. Furthermore, the upper end portion 17c of the outer tube 17 is fitted to the receiving seat 16 of the bogie frame 5 from below. Therefore, in a state where the outer tube 17 is temporarily held to the receiving seat 16 by fitting, fixing between the outer tube 17 and the receiving seat 16 by bolting can be performed. Thus, a worker who performs assembly or maintenance of the bogie 2 can easily fix the outer tube 17 to the receiving seat 16. Furthermore, since the bolts 20 fasten the tabs 19 of the receiving seat 16 of the bogie frame 5 and the tabs 18 of the outer tube 17 of the cylindrical laminated rubber 14 to fix the outer tube 17 to the bogie frame 5, the outer tube 17 can be easily fixed to the bogie frame 5.

[0031] Moreover, in the axle box suspension 8 according to the present embodiment, the cylindrical laminated rubber 14 can be displaced more significantly in the upper-lower direction than an axle-beam axle box suspension. Therefore, as the coil spring 12 is displaced in the upper-lower direction, the tubular rubbers 21 are displaced relative to the outer tube 17, and the

core rod 22 can be displaced in the same manner as the displacement of the coil spring 12. At this time, since the tubular rubbers 21 of the cylindrical laminated rubber 14 are significantly displaced, the cylindrical laminated rubber 14 can greatly absorb displacement in the upper-lower direction. Therefore, when a rear end portion of the support arm 13 in the front-rear direction is displaced by the displacement of the core rod 22, it is not necessary to rotate the support arm 13 to absorb the displacement in the upper-lower direction. Thus, the length of the support arm 13 in the front-rear direction can be reduced. Since the support arm 13 can be made short, the brake 7 is exposed to the outside in the left-right direction. Therefore, workability for a worker who performs maintenance of the bogie 2 can be improved.

[0032] Moreover, compared to the axle-beam axle box suspension, the cylindrical laminated rubber 14 is attached to the bogie frame 5 and the support arm 13 by the fastening between the tabs 19 of the receiving seat 16 and the tabs 18 of the outer tube 17 by the bolts 20 and the fastening between the support arm 13 and the core rod 22 by the bolts 26. Therefore, it is unnecessary to attach the cylindrical laminated rubber 14 to the bogie frame 5 and the support arm 13 by using a special configuration, such as a wedge. Generally, in an axle box suspension, when an axle box is attached to a bogie frame by using a wedge, a special tool is required when detaching the axle box from the bogie frame for maintenance. Moreover, each time the axle box is detached from the bogie frame, wear or deformation occurs at a portion where the wedge is located. Therefore, the durability of the axle box suspension may be affected by it.

[0033] The above embodiment has described a case where the tabs of the outer tube of the cylindrical laminated rubber and the tabs of the receiving seat of the bogie frame are fastened to each other by the bolts. That is, the above embodiment has described a case where the fixtures are the bolts. Moreover, the above embodiment has described a case where the core rod is fixed to the support arm in such a manner that the closing plate is brought into contact with the lower surface of the support arm from below, and the bolts fasten the closing plate to the lower end portion of the core rod from below. That is, the above embodiment has described a case where the positioners are the closing plate and the bolts. However, the present invention is not limited to the above embodiment. The fixtures and the positioners may be configurations different from the above. As long as the cylindrical laminated rubber is attached to the bogie frame, and the cylindrical laminated rubber is attached to the support arm, the fixtures and the positioners may be the other configurations.

[0034] Moreover, the above embodiment has described a case where the cylindrical core rod 22 is inserted into the through hole 13a of the support arm 13, and the cross section of the through hole 13a taken along a horizontal plane is circular. However, the present invention is

not limited to the above embodiment. The core rod 22 and the support arm 13 may include a rotation prevention structure 30 that inhibits the rotation of the core rod 22 about the axis of the through hole 13a. For example, an outer periphery of the core rod 22 may include a side surface that inhibits the rotation of the core rod 22 about the axis of the through hole 13a, and an outer periphery of the through hole 13a may include a side surface that inhibits the rotation of the core rod 22 about the axis of the through hole 13a. FIG. 5 is a sectional view showing the core rod 22 and the support arm 13 in a modified example and taken along a horizontal plane. In the example of FIG. 5, the outer periphery of the core rod 22 includes a side surface 22g which extends in the width direction and the upper-lower direction and is located on a side close to the axle box 9 in the front-rear direction. Moreover, the through hole 13a of the support arm 13 includes a side surface 13d which extends in the width direction and the upper-lower direction and corresponds to the side surface 22g of the core rod 22. In the example of FIG. 5, the through hole 13a of the support arm 13 includes the side surface 13d which extends in the width direction and the upper-lower direction and is located on a side close to the axle box 9 in the front-rear direction.

[0035] In the configuration of FIG. 5, the outer periphery of the core rod 22 includes the side surface 22g extending in the width direction and the upper-lower direction, and the through hole 13a of the support arm 13 includes the side surface 13d extending in the width direction and the upper-lower direction. As a result, the cross section of the core rod 22 taken along a horizontal plane is not circular, and the cross section of the through hole 13a of the support arm 13 taken along a horizontal plane is not circular. Therefore, when attaching the axle box 9 to the cylindrical laminated rubber 14, the core rod 22 can be prevented from rotating about the axis of the through hole 13a within the through hole 13a and from shifting. Thus, the axle box 9 can be easily attached to the cylindrical laminated rubber 14. FIG. 5 shows that the core rod 22 includes the side surface 22g which extends in the width direction and the upper-lower direction and is located on a side close to the axle box 9 in the front-rear direction, and the through hole 13a includes the side surface 13d which extends in the width direction and the upper-lower direction and is located on a side close to the axle box 9 in the front-rear direction. However, the present invention is not limited to the above embodiment. The position of the side surface 22g in the core rod 22 and the position of the side surface 13d in the through hole 13a do not have to be the position on a side close to the axle box 9 in the front-rear direction and may be a position on a side close to the brake 7 in the front-rear direction. As long as the cross sections of the core rod 22 and the through hole 13a taken along a horizontal plane are not circular, and therefore, the rotation of the core rod 22 about the axis of the through hole 13a can be inhibited,

the side surface 22g may be located at any position of the outer periphery of the core rod 22, and the side surface 13d may be located at any position of the through hole 13a.

[0036] Moreover, the above embodiment has described a case where a lower tip end of a portion, supporting the cylindrical laminated rubber 14, of the support arm 13 is cylindrical, and the through hole 13a of the support arm 13 is closed by the closing plate 25 having a disc shape. However, the present invention is not limited to the above embodiment. The support arm 13 and the closing plate 25 may include a rotation prevention structure 31 that inhibits the rotation of the closing plate 25 about the axis of the through hole 13a relative to the support arm 13. FIG. 6 is a side view showing the support arm 13 and the closing plate 25 regarding a portion where the closing plate 25 contacts the lower surface of the support arm 13 from below in another modified example. In the example of FIG. 6, the closing plate 25 includes a protrusion 25b projecting upward, and the support arm 13 includes a recess 13h. The protrusion 25b of the closing plate 25 and the recess 13h of the support arm 13 are fitted to each other. Since the protrusion 25b and the recess 13h are fitted to each other between the support arm 13 and the closing plate 25, the rotation of the closing plate 25 about the axis of the through hole 13a relative to the support arm 13 can be suppressed. To be specific, the closing plate 25 and the support arm 13 include the protrusion 25b and the recess 13h as the rotation prevention structure 31 that inhibits the rotation of the core rod 22, fastened to the closing plate 25, about the axis of the through hole 13a. Therefore, the core rod 22 fixed to the closing plate 25 can be prevented from rotating about the axis of the through hole 13a. Moreover, when attaching the closing plate 25 to the support arm 13, the occurrence of a positioning error between the closing plate 25 and the support arm 13 can be suppressed. Thus, the closing plate 25 can be more easily attached to the support arm 13.

[0037] Moreover, FIG. 7 is a side view showing the support arm 13 and the closing plate 25 regarding a rotation prevention structure 32 at a portion where the closing plate 25 contacts the lower surface of the support arm 13 from below in yet another modified example. In the example of FIG. 7, the support arm 13 includes a protrusion 13k projecting downward, and the closing plate 25 includes a recess 25c. The protrusion 13k of the support arm 13 and the recess 25c of the closing plate 25 are fitted to each other. With this configuration as well, effects similar to those of FIG. 6 can be obtained. As above, the rotation prevention structure 32 of the closing plate 25 and the support arm 13 may be the combination of the protrusion 13k of the support arm 13 projecting downward and the recess 25c of the closing plate 25.

[0038] The above embodiment has described a case where the central axis L1 of the cylindrical laminated rubber 14, the axis L1 of the outer tube 17, and the axis L1 of the core rod

22 extend in the vertical direction. However, the above embodiment is not limited to this case. The central axis L1 and the axes L1 may extend in the horizontal direction or a different direction. Accordingly, for example, the arrangement of the closing plate 25 and the bolts 26 of the positioner, the through hole 13a and the recess 25c of the support arm 13, the tabs 18 of the outer tube, the receiving seat 16 and the tabs 19 of the bogie frame 5, and the like may be suitably changed. For example, the core rod 22 may include a first shaft portion inserted into the through hole 13a and a second shaft portion larger in diameter than the first shaft portion, and the support arm 13 may include the recess 25c that is located on a side close to the second shaft portion in the through hole 13a, is larger in diameter than the through hole 13a, and is open toward the second shaft portion. To be specific, for example, the through hole 13a and the recess 25c of the support arm 13 may be open in the horizontal direction or a different direction, the first shaft portion of the core rod 22 may be inserted into the through hole 13a, and the base 27 may be accommodated in the recess 25c.

[0039] The foregoing has described the embodiment as an example of the technology disclosed in the present application. However, the technology in the present disclosure is not limited to this and is also applicable to embodiments in which modifications, replacements, additions, omissions, and the like have been suitably made. Moreover, a new embodiment may be prepared by combining the components described in the embodiment. For example, a part of the configuration or method in one embodiment may be applied to another embodiment. A part of the configuration in an embodiment may be arbitrarily extracted separately from the other part of the configuration in the embodiment. Furthermore, the components shown in the accompanying drawings and the detailed description include not only components essential for solving the problems but also components not essential for solving the problems in order to exemplify the technology.

[0040] The following aspects disclose preferred embodiments.

[0041] **First Aspect**

An axle box suspension of a bogie of a railcar,

the axle box suspension including:

a coil spring located between an upper surface of an axle box and a bogie frame;

a support arm that projects from the axle box toward a first side in a front-rear direction of the bogie and supports the axle box;

a cylindrical laminated rubber located on the first side of the axle box and including

an outer tube having an axis,

a tubular rubber located inside the outer tube, and

a core rod located inside the tubular rubber;

a fixture that fixes the outer tube to the bogie frame in a state where an outer peripheral surface of the cylindrical laminated rubber is exposed, the outer tube including the outer peripheral surface of the cylindrical laminated rubber; and

a positioner that positions the core rod with respect to the support arm.

[0042] **Second Aspect**

The axle box suspension according to the first aspect, wherein

the support arm includes a through hole,

an end portion of the core rod is in the through hole of the support arm, and

the positioner includes:

a closing plate that is in contact with an end surface of the support arm; and

a bolt that fastens the closing plate to the end portion of the core rod.

[0043] **Third Aspect**

The axle box suspension according to the second aspect, further including a base located between the support arm and the core rod, wherein

the core rod includes:

a first shaft portion in the through hole; and

a second shaft portion larger in diameter than the first shaft portion,

the support arm further includes a recess that is located on a side close to the second shaft portion in the through hole, is larger in diameter than the through hole, and is open toward the second shaft portion,

the base is accommodated in the recess of the support arm, and

the cylindrical laminated rubber is supported by the support arm in such a manner that the second shaft portion of the core rod is supported by the support arm through the base.

[0044] **Fourth Aspect**

The axle box suspension according to any one of the first to third aspects, wherein

the bogie frame includes:

a side sill; and

a receiving seat projecting from the side sill, and

an end portion of the outer tube of the cylindrical laminated rubber is fitted to the receiving seat.

[0045] **Fifth Aspect**

The axle box suspension according to any one of the first to fourth aspects, wherein

the outer tube of the cylindrical laminated rubber includes a tab projecting outward,

the bogie frame includes a tab projecting outward and overlapping with the tab of the outer tube, and

the fixture fastens the tab of the outer tube to the tab of the bogie frame.

[0046] **Sixth Aspect**

The axle box suspension according to the second or third aspect, further including a rotation prevention structure that inhibits rotation of the core rod about an axis of the through hole.