(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 234 357 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
30.08.2023 Bulletin 2023/35

(21) Application number: **21881670.0**

(22) Date of filing: **13.08.2021**

(51) International Patent Classification (IPC):
B61B 3/00 *(2006.01)* ***B61B 3/02*** *(2006.01)*
B61B 12/02 *(2006.01)* ***B61B 12/04*** *(2006.01)*
B61F 5/52 *(2006.01)* ***B61F 5/04*** *(2006.01)*
B61C 13/04 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
B61B 3/00; B61B 3/02; B61B 12/02; B61B 12/04; B61C 13/04; B61F 5/04; B61F 5/52

(86) International application number:
PCT/CN2021/112564

(87) International publication number:
WO 2022/083251 (28.04.2022 Gazette 2022/17)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority:
20.10.2020 CN 202011126908
20.10.2020 CN 202011126901
20.10.2020 CN 202022351980 U
20.10.2020 CN 202011126928
20.10.2020 CN 202022349865 U

(71) Applicant: **CRRC Yangtze Co., Ltd.**
Wuhan, Hubei 430212 (CN)

(72) Inventors:
- **SU, Lijie**
  Wuhan, Hubei 430212 (CN)
- **LIU, Aiwen**
  Wuhan, Hubei 430212 (CN)
- **WANG, Quanhu**
  Wuhan, Hubei 430212 (CN)
- **YAO, Xiong**
  Wuhan, Hubei 430212 (CN)
- **LUO, Hui**
  Wuhan, Hubei 430212 (CN)
- **HUANG, Meilin**
  Wuhan, Hubei 430212 (CN)
- **HUANG, Heng**
  Wuhan, Hubei 430212 (CN)
- **CHEN, Zhiguo**
  Wuhan, Hubei 430212 (CN)
- **SUN, Bo**
  Wuhan, Hubei 430212 (CN)
- **KE, Xiaole**
  Wuhan, Hubei 430212 (CN)
- **CUI, Can**
  Wuhan, Hubei 430212 (CN)
- **FENG, Ye**
  Wuhan, Hubei 430212 (CN)
- **HOU, Jianyun**
  Wuhan, Hubei 430212 (CN)
- **MEI, Kun**
  Wuhan, Hubei 430212 (CN)
- **SONG, Shaobo**
  Wuhan, Hubei 430212 (CN)
- **LIU, Wei**
  Wuhan, Hubei 430212 (CN)
- **PENG, Quanhai**
  Wuhan, Hubei 430212 (CN)
- **YIN, Gang**
  Wuhan, Hubei 430212 (CN)

(74) Representative: **Zaboliene, Reda**
Metida
Business center Vertas
Gyneju str. 16
01109 Vilnius (LT)

(54) CENTRAL SUSPENSION DEVICE, BOGIE, AND SUSPENDED RAIL TRANSIT SYSTEM

(57) A central suspension device (6), a bogie (200) and a suspended rail transit system. The suspended rail transit system comprises a rail beam (a), vehicle frame (100) and bogies (200), the vehicle frame (100) being connected to the rail beam (a) by means of the plurality of bogies (200), and each bogie (200) comprising a framework (4), a swing bolster (5) and a central suspension device (6), wherein the framework (4) comprises an

Processed by Luminess, 75001 PARIS (FR)

(Cont. next page)

upper chord beam (41), a lower chord beam (43) and connecting beams (42), the upper chord beam (41) and the lower chord beam (43) are arranged opposite each other, and the upper chord beam (41) and the lower chord beam (43) are connected by means of the plurality of connecting beams (42) arranged at intervals; and the swing bolster (5) is suspended in the middle of the lower chord beam (43) by means of the central suspension device (6), and the swing bolster (5) is arranged below the vehicle frame (100), and can be driven by the bogies (200) to drive the vehicle frame (100) to travel below the rail beam (a). In the system, the structural sizes of the rail beam (a) can be reduced, so as to reduce the steel consumption and achieve the aim of reducing the line construction cost.

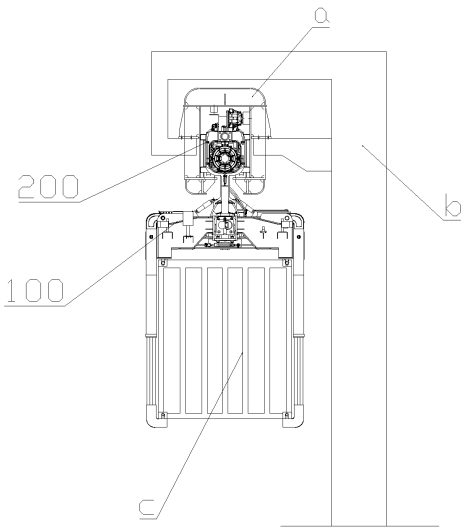

FIG. 1

Description

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims the priorities to Chinese patent application No. CN202011126901.7 filed on October 20, 2020 and entitled "CENTRAL SUSPENSION DEVICE", Chinese patent application No. 202011126908.9 filed on October 20, 2020 and entitled "SUSPENDED RAIL TRANSIT SYSTEM", and Chinese patent application No. 202011126928.6 filed on October 20, 2020 and entitled "BOGIE", the entire contents of which are hereby incorporated by reference.

TECHNICAL FIELD

[0002] The embodiments of the disclosure relate to the field of rail transit, in particular to a central suspension device, a bogie and a suspended rail transit system.

BACKGROUND

[0003] The suspended rail transit system uses a box-shaped section rail beam with an open bottom, the vehicle frame travels under the rail beam, and the vehicle frame and the rail beam are connected by bogies.

[0004] In the prior art, the bogie framework is mostly H-shaped, for example, in the patent documents with patent numbers of "201610938552.6", "201610932024.X", etc., the bogie frameworks are all H-shaped. The H-shaped bogie framework has a larger transverse dimension, which leads to a corresponding increase in the structural dimensions of the rail beam and pier column, resulting in a larger amount of steel used and an increase in the cost of line construction.

[0005] In addition, the swing bolster of the bogie is mostly located above the bogie framework, and the swing bolster is connected to the vehicle frame below the bogie through a central suspension device, resulting in a long length of the central suspension device and a large swing amplitude of the vehicle, which is not conducive to passing through curved paths.

SUMMARY

[0006] In view of the above-mentioned deficiencies in the prior art, the present disclosure provides a central suspension device, a bogie, and a suspended rail transit system, so as to solve the problem of increase in the cost of line construction caused by the increase of the load on the vehicle frame in the prior art.

[0007] In one aspect of the present disclosure, a central suspension device is provided, which includes a center pin and a swing bolster, an upper end of the center pin being suspended on a framework of a bogie, the swing bolster being located below the framework, and a lower end of the center pin and the swing bolster are rotatably connected.

[0008] In some embodiments, the upper end of the center pin is provided with a limiting cap.

[0009] In some embodiments, the central suspension device further includes two pendulum dampers, wherein upper ends of the two pendulum dampers are respectively connected to both transverse ends of the limiting cap, lower ends of the two pendulum dampers are connected to a vehicle frame, and the swing bolster is arranged below the vehicle frame.

[0010] In some embodiments, the two pendulum dampers are in a splayed shape, and an included angle between a central axis of the pendulum damper and a top surface of the vehicle frame is 60 °.

[0011] In some embodiments, both transverse ends of the swing bolster are respectively provided with damper mounting bases; the central suspension device further includes two vertical dampers, the vertical dampers and the damper mounting bases are arranged in one-to-one correspondence, a lower end of each vertical damper is connected to the corresponding damper mounting base, and upper ends of the two vertical dampers are respectively connected to both transverse ends of the vehicle frame.

[0012] In some embodiments, a connecting hole is provided vertically in the middle of the swing bolster, the lower end of the center pin passes through the vehicle frame and is arranged in the connecting hole; the central suspension device further includes a connecting pin, the middle of the connecting pin moves longitudinally through the lower end of the center pin, and two ends of the connecting pin move through the swing bolster and are provided with corresponding locking screws.

[0013] In some embodiments, the central suspension device further includes a plurality of elastomers, wherein the plurality of elastomers are arranged at intervals around a central axis of the center pin, and two ends of each elastomer are connected between the swing bolster and the vehicle frame respectively.

[0014] In some embodiments, the central suspension device further includes a stopper assembly mounted on the vehicle frame, the stopper assembly includes lateral stoppers and longitudinal stoppers, two lateral stoppers are arranged facing each other and said two lateral stoppers are arranged on both transverse sides of the center pin, two longitudinal stoppers are arranged facing each other and said two longitudinal stoppers are arranged on both longitudinal sides of the center pin.

[0015] In some embodiments, two of the stopper assembly are arranged vertically.

[0016] In some embodiments, both longitudinal sides of the lower end of the center pin are respectively provided with spigots, a backing plate is provided inside each spigot, and the connecting pin passes through two backing plates.

[0017] The central suspension device disclosed in the present disclosure includes the center pin and swing bolster, the upper end of the center pin is suspended on the framework of the bogie and the swing bolster is located

below the framework, the swing bolster includes the swing bolster and the lower end of the center pin and the swing bolster are rotatably connected, which can not only reduce the length of the center pin of the central suspension device, but also limit the lower end of the center pin so as to decrease the swing amplitude of the center pin, thereby reducing the swing amplitude of the vehicle frame to narrow the opening size of the rail beam, as a result, the structural dimensions of the rail beam and pier column can be reduced, which will accordingly reduce the weights of the pier column and the rail beam and decrease the construction cost.

[0018] In another aspect of the present disclosure, a bogie is provided, which includes a framework including an upper chord beam, a lower chord beam and a plurality of connecting beams, the upper chord beam and the lower chord beam being arranged facing each other and connected by the connecting beams arranged at intervals; a swing bolster; and the central suspension device mentioned above, the swing bolster being suspended in the middle of the lower chord beam through the central suspension device.

[0019] In some embodiments, two connecting beams are provided and the two connecting beams are oppositely disposed at both ends of the upper chord beam and the lower chord beam, the middle of the upper chord beam and the middle of the lower chord beam are connected by two central beams arranged side by side.

[0020] According to the present disclosure, the framework of the bogie includes the upper chord beam, the lower chord beam and the connecting beam, the upper chord beam and the lower chord beam are arranged facing each other and are connected by the plurality of connecting beams arranged at intervals, so the framework in the present disclosure is a structure extending vertically, and has a smaller lateral dimension compared with the framework structure of the laterally extending bogie in the prior art, thus the structural dimensions of the rail beam and the pier column supporting the rail beam can be reduced, thereby reducing the amount of steel used and reducing the cost of line construction.

[0021] In addition, the swing bolster of the present disclosure is suspended in the middle of the lower chord beam through the central suspension device, which can reduce the length of the central suspension device to decrease the swing amplitude of the center pin, thereby reducing the swing amplitude of the vehicle frame to narrow the opening size of the rail beam, as a result, the purpose of reducing the structural dimensions of the rail beam and the pier column can be achieved, which will accordingly reduce the weights of the pier column and the rail beam and decrease the construction cost.

[0022] In still another aspect of the present disclosure, a suspended rail transit system is provided, which includes a rail beam and a vehicle, the vehicle includes a vehicle frame and the bogie as mentioned above, the vehicle frame and the rail beam are connected through a plurality of said bogies, each of the bogies includes a framework, a swing bolster and a central suspension device, the framework includes an upper chord beam, a lower chord beam and a plurality of connecting beams, the upper chord beam and the lower chord beam are arranged facing each other and connected by the connecting beams arranged at intervals, the swing bolster is suspended in the middle of the lower chord beam through the central suspension device, and the swing bolster is arranged below the vehicle frame, and be driven by the bogies to drive the vehicle frame to travel under the rail beam.

[0023] The present disclosure discloses a suspended rail transit system, which includes a rail beam and a vehicle. The vehicle includes a vehicle frame and bogies. Since the upper chord beam and the lower chord beam of the bogie framework are connected by a plurality of connecting beams arranged at intervals, the bogie framework in the present disclosure is a vertically extending structure, and has a smaller lateral dimension compared with the laterally extending bogie structure in the prior art, thus the structural dimension of the bogie can be reduced to reduce the weight of the bogie, as a result, the structural dimensions of the rail beam and the pier column supporting the rail beam can be reduced, thereby reducing the amount of steel used and reducing the cost of line construction.

[0024] In addition, the swing bolster is suspended in the middle of the lower chord beam through the central suspension device and is arranged below the vehicle frame, which can reduce the length of the center pin of the central suspension device to reduce the swing amplitude of the center pin, thereby decreasing the swing amplitude of the vehicle frame to narrow the opening size of the rail beam, therefore, the structural dimensions of the rail beam and the pier column can be reduced, which will accordingly reduce the weights of the pier column and the rail beam and decrease the construction cost.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025]

FIG.1 shows a structural diagram of a suspended rail transit system according to some embodiments of the present disclosure.

FIG.2 shows a structural diagram of the vehicle in FIG. 1.

FIG. 3 shows a top view of FIG. 2.

FIG. 4 shows a structural diagram of the bogie in FIG. 2.

FIG. 5 shows a structural diagram of the framework in FIG. 4.

FIG. 6 shows a structural diagram of the driving mechanism in FIG. 4.

FIG. 7 shows a structural diagram of the swing bolster in FIG. 4.

FIG. 8 shows a schematic diagram of the internal structure of the swing bolster in FIG. 7.

FIG. 9 shows a structural diagram of the first web plate in FIG. 8.

FIG. 10 shows a schematic diagram of the installation of the elastomer base.

FIG. 11 shows a structural diagram of the central suspension device in FIG. 4.

FIG. 12 shows a side view of FIG. 10.

FIG. 13 shows a structural diagram of the vehicle frame of FIG. 1.

FIG. 14 shows a structural diagram of the supporting box beam in FIG. 13 with the top plate removed.

FIG. 15 shows a structural diagram of the supporting box beam in FIG. 13 with the support plate removed.

[0026] In the drawings: rail beam-a, pier column-b, integrated unit-c, vehicle frame-100, bogie-200, electric traction component-300, driving mechanism-1, guide wheel-2, steady wheel-3 , framework-4, upper chord beam-41, brake hanger 410, longitudinal block-411, safety rope holder-412, connecting beam-42, first motor mounting block-421, second motor mounting block 422, first threading hole-423, lower chord beam-43, second threading hole-431, central beam-44, pinch plate-441, wheel set mounting base-45, transponder mounting base-46, current collector mounting base-47, pin bush-48, wear plate-49, swing bolster-5, upper cover plate-51, lower cover plate-52, second web plate-53, first web plate-54, arc plate-541, seam-542 , pin sleeve-56, longitudinal stopper-57, first elastic supporting base 58, bottom plate-581, elastic supporting navel-582, second rib plate-59, third rib plate-510, first rib plate-511, central suspension device-6, center pin-61, pendulum damper-62, vertical damper-63 elastomer-64, lateral stopper-65, connecting pin-66, backing plate-67, limiting cap-68, longitudinal stopper-69, safety rope-7, current collector-8, brake disc-9, basic frame 10, traveling wheel-11, gear box-12, brake disc mounting base-13, coupling-14, traction motor 15, gearbox bolt-16, main longitudinal beam-17, center pin hole-18, support box beam 19, top plate-191, support plate-192, connecting plate-193, first reinforcing plate-194, second reinforcing plate-195, third reinforcing plate-196, second elastomer base-20, bending part-21, rotation stopper-22, first transverse beam-23, side longitudinal rod-24, connecting rod-25, second transverse beam-26, lockset-27, connecting base-28.

DETAILED DESCRIPTION

[0027] FIG.1 shows a structural diagram of a suspended rail transit system according to some embodiments of the present disclosure. Combining with FIG. 1, the suspended rail transit system includes a vehicle and a rail beam a. The rail beam a is supported by a pier column and the vehicle includes a vehicle frame 100 and a plurality of bogies 200 that can travel on the rail beam a. The vehicle frame 100 and the rail beam a are connected by the plurality of bogies 200 and be driven by the bogies 200 to drive the vehicle frame 100 to travel below the rail beam a.

[0028] Combining with FIG. 1, the bottom of the vehicle frame 100 can be provided with an integrated unit c, which can be a train compartment or a container with goods, and by driving the train compartment or container to move, transportation of passengers or goods can be realized.

[0029] FIG.2 shows a structural diagram of the vehicle in FIG. 1, and FIG. 3 shows a top view of FIG. 2. Combining with FIG. 2 and FIG. 3, the vehicle includes a vehicle frame 2 and bogies 200, and an electric traction component 300 is arranged on the vehicle frame 100.

[0030] FIG. 4 shows a structural diagram of the bogie in FIG. 2. Combining with FIG. 4, the bogie includes a driving mechanism 1, a guide wheel 2, a steady wheel 3, a framework 4, a swing bolster 5, a central suspension device 6, a safety rope 7, a current collector 8 and a brake disc 9.

[0031] FIG. 5 shows a structural diagram of the framework in FIG. 4. Combining with FIG. 5, the framework 4 includes an upper chord beam 41, a lower chord beam 43 and connecting beams 42, the upper chord beam 41 and the lower chord beam 43 are arranged facing each other along a vertical direction and are connected by a plurality of connecting beams 42 arranged at intervals, so the framework 4 of the bogie is a vertically extending structure, and has a smaller lateral dimension compared with the laterally extending bogie structure in the prior art, thus the structural dimension and the weight of the bogie are reduced, as a result, the structural dimensions of the rail beam and the pier column supporting the rail beam can be reduced, thereby decreasing the amount of steel used and the cost of line construction.

[0032] Combining with FIG. 5, a transponder mounting base 46 and a current collector mounting base 47 are arranged on the top of the upper chord beam 41 and are apart from each other, a current collector 8 is mounted on the current collector mounting base 47, and a transponder is mounted on the transponder mounting base 46.

[0033] Combining with FIG. 5, both longitudinal ends of the upper chord beam 41 are provided with longitudinal blocks 411. When the longitudinal blocks 411 contact the stoppers set on the rail beam, the bogie can be stopped.

[0034] Combining with FIG. 5, two connecting beams 42 are arranged, and the two connecting beams 42 are arranged facing each other at both ends of the upper chord beam 41 and the lower chord beam 43. The middle of the upper chord beam 41 and the middle of the lower chord beam 43 are connected by two central beams 44 arranged side by side to strengthen the structure, so that the whole structure is in a "lattice" shape.

[0035] The two ends of the upper chord beam 41 can be fixedly connected to the middle of the top of the connecting beam 42 by welding or integral forming, the two ends of the lower chord beam 43 are bent upward to form bending parts, and the bending parts at the two ends of the lower chord beam 43 can also be fixedly connected to the middle of the bottom of the connecting beam 42

by welding or integral forming, thereby expanding the vertical size of the component and providing space for the installation of other components.

[0036] Combining with FIG. 5, a pinch plate 441 is also provided between each central beam 44 and lower chord beam 43 to further strengthen the structure between the central beam 44 and the lower chord beam 43.

[0037] Combining with FIG. 5, the pinch plate 441 is located at the connection between the central beam 44 and the lower chord beam 43, and the two pinch plates 441 corresponding to the central beam 44 can be set symmetrically facing away from each other.

[0038] FIG. 6 shows a structural diagram of the driving mechanism in FIG. 4. Combining with FIG. 4-FIG. 6, a plurality of driving mechanisms 1 are arranged longitudinally, and the driving mechanisms 1 and the connecting beams 42 are arranged in one-to-one correspondence. Each driving mechanism 1 includes a traction motor 15, a gear box 12 and a traveling wheel 11. The traction motor 15 is fixedly arranged on the connecting beam 42 corresponding to the driving mechanism 1. An output end of the traction motor 15 is connected to an input end of the gear box 12. The gear box 12 is fixedly connected to the upper chord beam 41. The gear box 12 has two output ends, which are arranged horizontally, and each output end of the gear box 12 is correspondingly provided with a traveling wheel 11.

[0039] There are two driving mechanisms 1 and two connecting beams 42, which are set correspondingly.

[0040] Combining with FIG. 4 to FIG. 6, the connecting beam 42 may have the shape of a rectangle. A first motor mounting block 421 is provided at the inner side of the side of the connecting beam 42, a second motor mounting block 422 is provided at the inner side of the top of the connecting beam 42, the traction motor 15 of the driving mechanism 1 of the bogie is fixedly arranged inside the connecting beam 42 through the first motor mounting block 421 and the second motor mounting block 422, and two wheel set mounting bases 45 are arranged at the bottom of the upper chord beam 41. The guide wheel and steady wheel of each driving mechanism 1 of the bogie are correspondingly installed on one wheel set mounting base 45.

[0041] Combining with FIG. 6, the output end of the traction motor 15 is connected with the input end of the gear box 12 through a coupling 14, and the coupling 14 is provided with a brake disc mounting base 13 on which a brake disc 9 is mounted.

[0042] Combining with FIG. 4 to FIG. 6, brake hangers 410 are provided at intervals at the bottom of the upper chord beam 41, the brake hangers 410 have brake means installed thereon, output ends of the brake means act on brake disc 9 so as to brake the output of the traction motor 15.

[0043] Combining with FIG. 4 to FIG. 6, the top surface of the gear box 12 of each driving mechanism 1 can be fixedly connected to the bottom of the upper chord beam 41 through a plurality of gear box bolts 16 to assemble the driving mechanism 1 on the framework 4.

[0044] Combining with FIG. 4 and FIG. 5, the bottom of the upper chord beam 41 is provided with a wheel set mounting base 45 corresponding to the driving mechanism, and a set of auxiliary wheels are provided at both transverse sides of each wheel set mounting base 45, and each auxiliary wheel includes a steady wheel 3 located at the upper end and a guide wheel 2 at the lower end. The guide wheel 2 and the steady wheel 3 are matched with the corresponding rail of the rail beam a to improve vehicle running stability.

[0045] The span between the steady wheels 3 on both sides of each wheel set mounting base 45 is smaller than that between the guide wheels 2 on both sides to facilitate smooth passage of the vehicle through curved paths.

[0046] Combining with FIG. 4 and FIG. 5, the connecting beam 42 and the lower chord beam 43 are both hollow structures. A first threading hole 423 is provided on the connecting beam 42 and a second threading hole 431 is provided on the lower chord beam 43. The connecting beam 42 and the lower chord beam 43 serve as grooves to guide pipelines on the bogie 200 to the vehicle frame 100 to avoid contact between the pipelines and the rail beam.

[0047] Combining with FIG. 4 and FIG. 5, there are two safety rope holders 412 spaced on lower chord beam 43. The safety rope holder 412 and the safety rope 7 correspond to each other. The middle part of the safety rope 7 is installed on the corresponding safety rope holder 412, both ends of the safety rope 7 can pass through above the lower chord beam of the framework and below the vehicle frame, which plays a protective role in safety accidents caused by the breakage of the center pin and connecting pin as mentioned below so as to improve the safety of running of the vehicle.

[0048] Combining with FIG. 5, the two safety rope holders 412 can be set on the opposite sides of the two pinch plates 441.

[0049] Combining with FIG. 5, a through-hole is provided in the middle of the lower chord beam 43, and a pin bush 48 is fixed inside the through-hole, while a wear plate 49 is provided on the lower chord beam 43 and is located outside the through-hole and between the two central beams 44.

[0050] Combining with FIG. 4, the swing bolster 5 is suspended in the middle of the lower chord beam 43 by means of the central suspension device 6, wherein the central suspension device 6 includes a center pin 61, whose upper end is provided with a limit cap 610 that is placed on the wear plate 49, and the upper end of the center pin 61 passes through the pin bush 48. By means of the limit cap, the upper end of the center pin 61 is suspended on the lower chord beam 43, and the swing bolster 5 is connected to the lower end of the center pin 61, and the swing bolster 5 is arranged below the vehicle frame 100, thereby connecting the vehicle to the bogie.

[0051] FIG. 7 shows a structural diagram of the swing bolster in FIG. 4. Combining with FIG. 7, the swing bolster

5 is located below the framework 4 of the bogie, the middle of the swing bolster 5 is provided with a connection hole vertically, and the lower end of the center pin 61 is rotatably connected to the connection hole to achieve connection between the center pin 61 and the swing bolster 5.

[0052] The upper end of the center pin 61 can be fitted with the pin bush 48 for small clearance activities and is suspended on the lower chord beam 43 of framework 4. Due to the limit of the swing bolster 5 to the lower end of the center pin 61, the length of the center pin 61 can be shorted to reduce the swing amplitude of the center pin 61, thereby reducing the swing amplitude of the vehicle frame so as to narrow the opening size of the rail beam and decrease the structural dimension of the pier column, as a result, the weights of the pier column and the rail beam can be reduced.

[0053] FIG. 8 shows a schematic diagram of the internal structure of the swing bolster in FIG. 7. Combining with FIG. 7 and FIG. 8, the swing bolster 5 includes an upper cover plate 51, a lower cover plate 52 and a web plate. The upper cover plate 51 and lower cover plate 52 are set vertically facing each other. A circumference of the upper cover plate 51 and a circumference of the lower cover plate 52 are connected via the web plate to form a box-shaped structure, and a through hole for the center pin 61 to pass through is provided at the middle of the upper cover plate 51.

[0054] Combining with FIG. 7, the upper cover plate 51 and the lower cover plate 52 are narrowed in the middle of the longitudinal side to reduce the weight of the swing bolster 5.

[0055] Combining with FIG. 7 and FIG. 8, the web plate consists of a first web plate 54 and a second web plate 53. The first web plate 54 is of a waist shape. The length direction of the waist shape is the longitudinal direction. Two first web plates 54 are provided facing each other between the upper cover plate 51 and the lower cover plate 52 along the transverse direction. The two first web plates 54 are connected by a plurality of second web plates 53 arranged at intervals. Such an arrangement can realize lightweight of the swing bolster while ensuring sufficient connection strength.

[0056] Combining with FIG. 7 and FIG. 8, the second web plates 53 are divided longitudinally into two groups facing each other, with coaxial mounting holes in the middle of each second web plate 53, and connecting pins 66 are installed in the mounting holes. The lower end of the center pin 61 is arranged between the two groups of second web plates 53. The middle of the connecting pin 66 rotatably passes through the lower end of the center pin 61 to achieve a rotatable connection between the lower end of the center pin 61 and the swing bolster 5.

[0057] Combining with FIG. 4, FIG. 7 and FIG. 8, a pin sleeve 56 can be set in the mounting hole and both ends of the connecting pin 66 fixedly pass through the pin sleeve 56 in the corresponding mounting hole, thus reducing the wear of the mounting hole by the center pin 61, and the service life of the swing bolster can be prolonged by replacing the pin sleeve 56.

[0058] Locking screws are provided at both ends of the connecting pin 66 and set at the outside of the pin sleeve 56 at the same end to facilitate assembling of the connecting pin 66 on the swing bolster.

[0059] FIG. 9 shows a structural diagram of the first web plate in FIG. 8. Combining with this figure, each first web plate 54 is formed by welding two arc plates 541. Two seams 542 are formed after welding the two arc plates 541, which are diagonally symmetrically arranged to avoid interference with the second rib plate 59 as mentioned below.

[0060] Combining with FIG. 7, two first elastomer bases 58 are provided at each longitudinal end of the swing bolster 5. FIG. 10 shows a schematic diagram of the installation of the elastomer base. Combining with FIG. 10, each first elastomer base 58 includes a base plate 581 and an elastic supporting navel 582, which is fixed at the middle of the top surface of the base plate 581.

[0061] Combining with FIG. 8 and FIG. 10, each first web plate 54 is provided with a first rib plate 511, which divides the first web plate 54 transversely into two cavities, each with a second rib plate 59 and a third rib plate 510. The second rib plate 59 and the third rib plate 510 are cross-shaped. The tops of the second rib plate 59 and the third rib plate 510 have notches. The upper cover plate 51 is provided with corresponding avoidance holes for the notches. The elastic supporting navel 582 and notches are arranged correspondingly. The base plate 581 of the first elastomer base 58 is fixed on the corresponding notch, and the elastic supporting navel 582 passes through the avoidance hole arranged on the upper cover plate 51 and corresponding to the base plate 581 to realize installation of the first elastomer base 58 on the swing bolster 5.

[0062] Two sides of the second rib plate 59 and the third rib plate 510 at the notch are beveled, while the elastomer navel is in the shape of a cone platform to avoid the rubber bulge caused by the elastomer 64 installed on the first elastic support base 58 under heavy vehicle working conditions, thereby preventing the rubber from being damaged due to friction with the metal parts.

[0063] Combining with FIG. 8, the opposite sides of the two first web plates 54 are provided with damper mounting bases 55 for installing the dampers, while both ends of the longitudinal side of the swing bolster 5 are provided with longitudinal stoppers 57 to prevent damage to the swing bolster caused by the impact of the swing bolster with the outside during swing.

[0064] FIG. 11 shows a structural diagram of the central suspension device in FIG. 4 and FIG. 12 shows a side view of FIG. 11. Combining with FIG. 4, FIG. 11 and FIG. 12, the central suspension device 6 includes, in addition to the center pin 61, a pendulum damper 62, a vertical damper 63, an elastomer 64, a lateral stopper 65, a connecting pin 66, a backing plate 67, a longitudinal

stopper 69 and the swing bolster 5.

[0065] Combining with FIG. 11, the limit component 68 provided at the upper end of the center pin 61 can be integrally formed or welded with the center pin 61.

[0066] The limiting cap 68 can be a waist circle shape, and the length direction of the limiting cap 68 is the transverse direction.

[0067] Combining with FIG. 11 and FIG. 12, two pendulum dampers 62 are provided, whose upper ends are respectively connected to the lateral ends of the limiting cap, and whose lower ends are connected to the vehicle frame, and the swing bolster 5 is arranged below the vehicle frame.

[0068] The two pendulum dampers 62 are in a splayed shape. An included angle between a central axis of the pendulum damper 62 and a top surface of the vehicle frame is preferably 60 °.

[0069] Combining with FIG. 11 and FIG. 12, two vertical dampers 63 are provided. The vertical damper 63 and the damper mounting base 55 are arranged in one-to-one correspondence. Lower ends of the vertical dampers 63 are connected to the corresponding damper mounting base 55, and upper ends of two vertical dampers 63 are connected to both transverse ends of the vehicle frame.

[0070] The damping performance of the vehicle during operation can be improved through the setting of the pendulum dampers 62 and the vertical dampers 63. The central axis of the pendulum damper 62 is oblique, providing both swing damping and vertical damping. If the vehicle runs at a low speed, the vertical dampers 63 can be canceled.

[0071] The lower end of the center pin 61 passes through the vehicle frame and is matched with the connecting pin 66 so that the lower end of the center pin 61 is rotatably connected to the connecting hole of the swing bolster 5.

[0072] Combining with FIG. 11 and FIG. 12, a plurality of elastomers may be provided, which are spaced around the central axis of the center pin 61, and both ends of the elastomer 64 are respectively connected to the swing bolster and the vehicle frame.

[0073] The lower end of the elastomer 64 is assembled in the first elastic supporting navel 582 on the first elastic support base 58, while the upper end of the elastomer 64 is connected to the bottom of the vehicle frame, which can not only cushion the target when the vehicle is running, but also avoid direct contact between the center pin and the vehicle frame. In addition, through the setting of the elastomer, a flexible connection is formed between the center pin and the vehicle frame, avoiding the impact of rigid shock caused by the direct connection between the center pin and the vehicle frame in the prior art, thus improving the stress level of the vehicle frame and increasing the fatigue life of the vehicle frame.

[0074] In addition, the elastomer and swing bolster are both arranged below the vehicle frame, so as not to increase the overall height of the vehicle, thus the lateral swing stiffness of the vehicle is low, and the vehicle frame can have very low stiffness of head-shaking, lateral moving and side rolling, and excellent dynamic performance, moreover, both the vehicle frame and the swing bolster are under pressure, so the fatigue properties of the welds and the suspension safety are good.

[0075] Combining with FIG. 11 and FIG. 12, lateral stoppers 65 and longitudinal stoppers 69 constitute a stopper assembly, which is mounted on the vehicle frame. Two lateral stoppers 65 are provided facing each other on two lateral sides of the center pin 61, and two longitudinal stoppers 69 are provided facing each other on both longitudinal sides of the center pin 61 to limit the rotation angle of the center pin.

[0076] There are two lateral stoppers 65 of the stopper assembly provided along the vertical direction to improve the ability to limit the lateral displacement and swing of the vehicle frame.

[0077] Combining with FIG. 12, there are spigots on both longitudinal sides of the lower end of the center pin 61. In each spigot, there is a backing plate 67. The connecting pin 66 passes through two backing plates 67. The backing plate 67 can prevent friction between the second web plate and the center pin 61 to reduce the strength of the center pin 61 and increase the service life.

[0078] As the center pin 61 is suspended in the middle of the lower chord beam 43, i.e. the center pin 61 is installed at the bottom of the framework 4, the length of the center pin 61 can be reduced from 2 m to less than 600 mm compared to the prior art technical solution in which the center pin 61 is installed at the top of the framework 4. This not only significantly reduces the manufacturing cost, but also significantly reduces the additional bending moment suffered by the center pin while the vehicle is running to improve safety.

[0079] In addition, the framework travels on the rail beam through the driving mechanism, the swing bolster is located below the vehicle frame, and by limiting both ends of the center pin, the swing amplitude of the swing bolster and further the vehicle frame can be limited so as to reduce the opening size of the rail beam, as a result, the structural dimension of the pier column can be reduced, which will accordingly reduce the weights of the pier column and the rail beam, thereby saving steel and reducing cost.

[0080] FIG. 13 shows a structural diagram of the vehicle frame of FIG. 1. Combining with FIG. 13, the vehicle frame 100 includes a basic frame 10, which includes a main longitudinal beam 17. The main longitudinal beam 17 may adopt a fish-belly structure which is high in the middle and low at the two ends. There are several center pin holes 18 arranged at intervals on the main longitudinal beam, and center pin holes 18 and center pins 61 are arranged in one-to-one correspondence. The lower end of the center pin 61 moves through the corresponding center pin hole 18 and is connected to the swing bolster 5 which is located below the basic frame. Multiple elastomers 55 are provided between the swing bolster 5 and the main longitudinal beam 17.

[0081] Two center pin holes 18 and two center pins 61 are correspondingly provided, while four elastomers 55 are provided, which can be springs, the four elastomers 5 are arranged at intervals around the central axis of the center pin hole 18.

[0082] Combining with FIG. 12, the main longitudinal beam 17 is provided with a support box beam 19 corresponding to the center pin hole 18, the middle of each support box beam 19 is provided with one center pin hole 18, and a plurality of elastomers 55 are arranged between the swing bolster 5 and the support box beam 19.

[0083] The center pin is for connecting the bogie framework and the swing bolster, while the elastomer is for providing the vertical supporting force between the swing bolster and the vehicle frame and for connecting the swing bolster and the vehicle frame. The elastomer can be a rubber spring to provide a vertical damping function, and the upper and lower end faces thereof can be twisted relative to each other within a certain angle range, and when the bogie drives the swing bolster to steer, the elastomer can be twisted and the vehicle frame steers accordingly to adapt to the steering of the bogie. It can also provide dispersed support to the vehicle frame to improve the stress level and fatigue life of the vehicle frame.

[0084] As stated above, four elastomers 64 can be provided, which are spaced around the central axis of central pin hole 18.

[0085] FIG. 14 shows a structural diagram of the support box beam in FIG. 13 with the top plate removed, and FIG. 15 shows a structural diagram of the support box beam in FIG. 13 with the support plate removed. Combining with FIGS. 12-14, the support box beam 19 includes a top plate 191, a support plate 192 and a connecting plate 193. The top plate 191 and the support plate 192 are arranged facing each other. A circumference of the top plate 191 and a circumference of the support plate 192 are connected via the connecting plate 193 to form a box-shaped structure. Both the top plate 191 and the support plate 192 are provided with a central pin hole 18 for the center pin to pass through, while the main longitudinal beam 17 fixedly passes through the connecting plate 193 to achieve the assembly of the support box beam 19 on the main longitudinal beam 17, wherein the main longitudinal beam 17 divides the box-shaped structure into two cavities.

[0086] Combining with FIG. 14 and FIG. 15, the support box beam 19 further includes a first reinforcing plate 194, a second reinforcing plate 195 and a third reinforcing plate 196. The first reinforcing plate 194 is provided transversely in each cavity, which divides the cavity into two chambers. Each chamber is provided with the second reinforcing plate 195 and the third reinforcing plate 196, which are cross-shaped. The structure of the support box beam can be strengthened by the first reinforcing plate 194, the second reinforcing plate 195 and the third reinforcing plate 196.

[0087] The bottoms of the second reinforcing plate 195 and the third reinforcing plate 196 have notches, and the support plate 192 is provided with avoidance holes corresponding to the notches. The upper end of each elastomer 64 is connected to a corresponding notch via the second elastomer base 20 to achieve the installation of elastomer 64 on the support box beam.

[0088] The second elastomer base 20 has the same structure as the first elastomer base 18, both including the base plate and the elastic support navel. The elastic support navel is fixed in the middle of the bottom surface of the base plate. The base plate of the second elastomer base 20 is fixed in the corresponding notch, and the elastic support navel of the second elastomer base passes through the avoidance hole provided in the support plate 192. The upper end of the elastomer 64 is connected to the elastic support navel.

[0089] Likewise, two side of both the second reinforcing plate 195 and the third reinforcing plate 196 at the notch are beveled, and the elastomer navel is in the shape of a cone platform to avoid the rubber bulge caused by the elastomer 64 installed on the second elastic support base 58 under heavy vehicle working conditions, thereby preventing the rubber from being damaged due to friction with the metal parts.

[0090] Further, combining with FIGS. 13-15, the above-mentioned stopper assembly is arranged within the support box beam 19 of the vehicle frame to limit the vertical and lateral rotation angles of the vehicle frame.

[0091] Combining with FIGS. 13-15, both longitudinal sides of the bottom of the support box beam 19 are bent downward to form bending parts 21, each of which is provided with a rotary stopper 22 to enhance the function of rotation limit of the basic frame, thereby limiting the rotation angle of the vehicle frame so as to prevent the adverse impact caused by the direct collision between the vehicle frame and the swing bolster when the vehicle frame swings, and to improve the reliability of running of the vehicle.

[0092] Combining with FIG. 14 and FIG. 15, a connecting base 28 is provided at both transverse ends of the support box beam 19, and the lower ends of the two pendulum dampers 62 are connected to the connecting bases 28 provided on the transverse ends of the support box beam 19 respectively.

[0093] Combining with FIG. 12, the basic frame further includes a first transverse beam 23, two first transverse beams 23 are provided on the both longitudinal sides of each support box beam 19, and the middle parts of the two first transverse beams 23 are connected through the main longitudinal beam 17, thereby increasing the bearing capacity of the vehicle frame.

[0094] A groove is provided in the middle of each first transverse beam 23, and the main longitudinal beam 17 can be fixed and embedded in the grooves in the middle of a plurality of first transverse beams 23 by welding.

[0095] Combining with FIG. 12, the basic frame further includes a side longitudinal rod 24 and a connecting rod 25. The ends of the first beams at the same sides are connected by the side longitudinal rod 24, and the side

longitudinal rod 24 and the main longitudinal beam 17 are connected by a plurality of connecting rods which are arranged at intervals so as to further increase the bearing capacity of the vehicle frame.

[0096] Combining with FIG. 12, the basic frame further includes multiple second transverse beams 26, inner ends of the second transverse beams are vertically connected to the side of main longitudinal beam 17, and outer ends of the second transverse beams are connected to side longitudinal rod 24 to further increase the vehicle frame bearing capacity.

[0097] The electrical traction component 300 can be arranged on the second transverse beam 26, while the two ends of the first transverse beam 23 can be provided with lockset 27 for connecting train compartments or containers containing goods. The lockset 27 can use the container transfer anti-drop device in the Chinese patent "CN 2018222496756", which is not to be repeated herein.

[0098] In summary, the suspended rail transit system as shown in the present disclosure is full of practical value, because the framework of the bogie is designed as a vertically extending structure, and the upper end of the center pin is suspended in the middle of the lower chord beam of the bogie framework, the lower end of the center pin passes through the vehicle frame and is rotatably connected to the swing bolster, thereby reducing the length of the center pin and the swing of the vehicle in motion, accordingly, it can improve the dimensions of the rail beam and the pier column structuring supporting the rail beam so as to reduce the amount of steel used and the cost of line construction.

[0099] The embodiments described above are preferred embodiments of the present disclosure and are intended only to facilitate the illustration of the disclosure, not to limit the present disclosure in any form. Any equivalent embodiments obtained by those with general knowledge in the art by making local modifications on the basis of the disclosed technical contents of the present disclosure without departing from the technical features of the present disclosure shall fall within the scope of the technical features of the present disclosure.

Claims

1. A central suspension device, **characterized by** comprising:

   a center pin and a swing bolster, and
   an upper end of the center pin being suspended on a framework of a bogie, the swing bolster being located below the framework, and a lower end of the center pin and the swing bolster being rotatably connected.

2. The central suspension device according to claim 1, wherein a limiting cap is provided on the upper end of the center pin.

3. The central suspension device according to claim 2, further comprising two pendulum dampers, wherein upper ends of the two pendulum dampers are respectively connected to both transverse ends of the limiting cap, lower ends of the two pendulum dampers are connected to a vehicle frame, and the swing bolster is arranged below the vehicle frame.

4. The central suspension device according to claim 3, wherein said two pendulum dampers are in a splayed shape, and an included angle between a central axis of the pendulum damper and a top surface of the vehicle frame is 60°.

5. The central suspension device according to claim 3, wherein both transverse ends of the swing bolster are respectively provided with damper mounting bases; and
   the central suspension device further comprises two vertical dampers, the vertical dampers and the damper mounting bases are arranged in one-to-one correspondence, a lower end of each vertical damper is connected to the corresponding damper mounting base, and upper ends of the two vertical dampers are respectively connected to both transverse ends of the vehicle frame.

6. The central suspension device according to claim 5, wherein a connecting hole is provided vertically in the middle of the swing bolster, the lower end of the center pin passes through the vehicle frame and is arranged in the connecting hole; and
   the central suspension device further comprises a connecting pin, the middle of the connecting pin moves longitudinally through the lower end of the center pin, and two ends of the connecting pin move through the swing bolster and are provided with corresponding locking screws.

7. The central suspension device according to claim 6, further comprising a plurality of elastomers, wherein the plurality of elastomers are arranged at intervals around a central axis of the center pin, and two ends of each elastomer are connected to the swing bolster and the vehicle frame respectively.

8. The central suspension device according to claim 7, further comprising a stopper assembly mounted on the vehicle frame, wherein the stopper assembly comprises lateral stoppers and longitudinal stoppers, two lateral stoppers are arranged facing each other and said two lateral stoppers are arranged on both transverse sides of the center pin, and two longitudinal stoppers are arranged facing each other and said two longitudinal stoppers are arranged on both longitudinal sides of the center pin.

9. The central suspension device according to claim 8,

wherein two of the stopper assembly are arranged vertically.

10. The central suspension device according to claim 6, wherein both longitudinal sides of the lower end of the center pin are respectively provided with spigots, a backing plate is provided inside each spigot, and the connecting pin passes through two backing plates.

11. A bogie, **characterized by** comprising:

a framework comprising an upper chord beam, a lower chord beam and a plurality of connecting beams, the upper chord beam and the lower chord beam being arranged facing each other and connected by the connecting beams arranged at intervals;
a swing bolster; and
the central suspension device according to any one of claims 1-10, the swing bolster being suspended in the middle of the lower chord beam through the central suspension device.

12. The bogie according to claim 11, wherein two connecting beams are provided, and the two connecting beams are oppositely disposed at both ends of the upper chord beam and the lower chord beam, the middle of the upper chord beam and the middle of the lower chord beam are connected by two central beams arranged side by side.

13. A suspended rail transit system, **characterized by** comprising: a rail beam and a vehicle,
wherein the vehicle comprises a vehicle frame and the bogie according to claim 11, the vehicle frame and the rail beam are connected through a plurality of said bogies, each of the bogies comprises a framework, a swing bolster and a central suspension device, the framework comprises an upper chord beam, a lower chord beam and a plurality of connecting beam, the upper chord beam and the lower chord beam are arranged facing each other and connected by the connecting beams arranged at intervals, the swing bolster is suspended in the middle of the lower chord beam through the central suspension device, and the swing bolster is arranged below the vehicle frame and be driven by the bogies to drive the vehicle frame to travel under the rail beam.

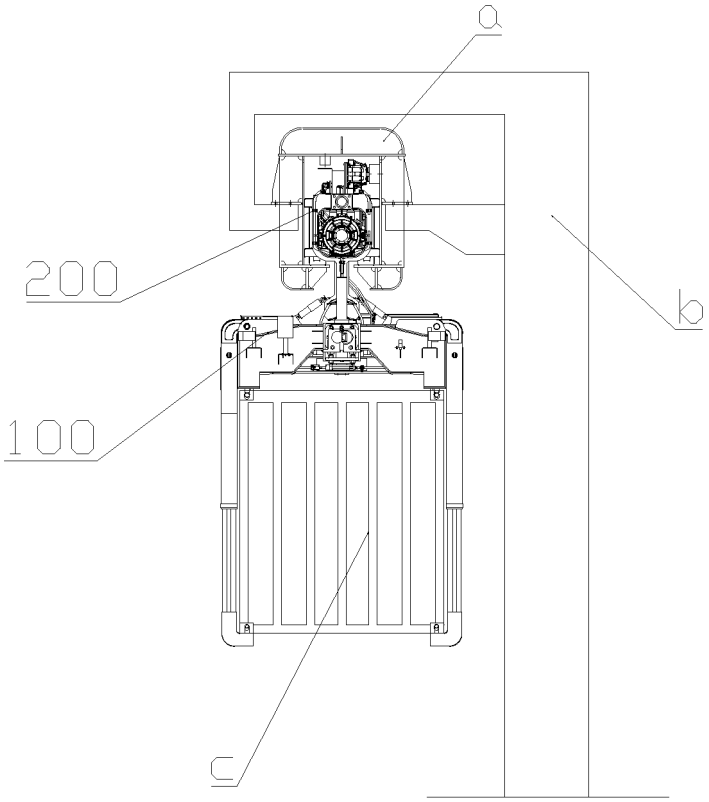

FIG. 1

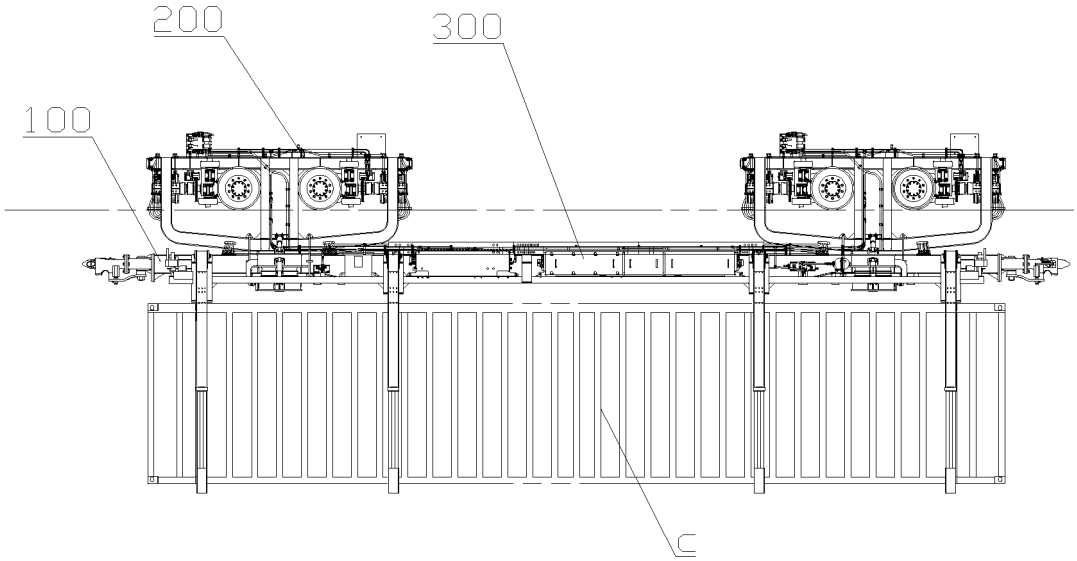

FIG. 2

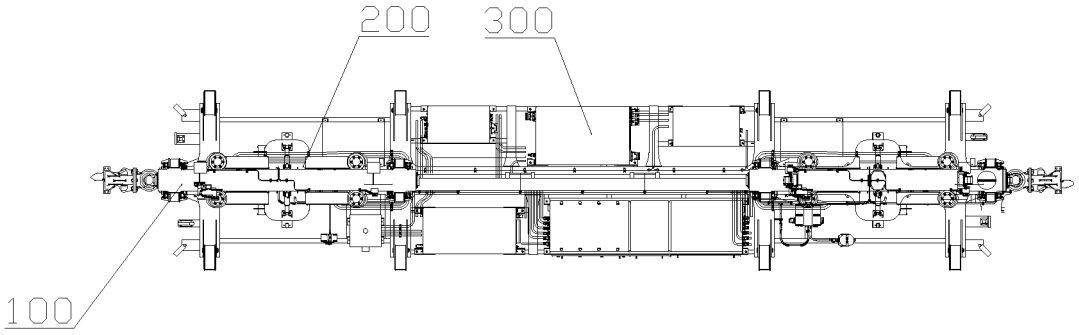

FIG. 3

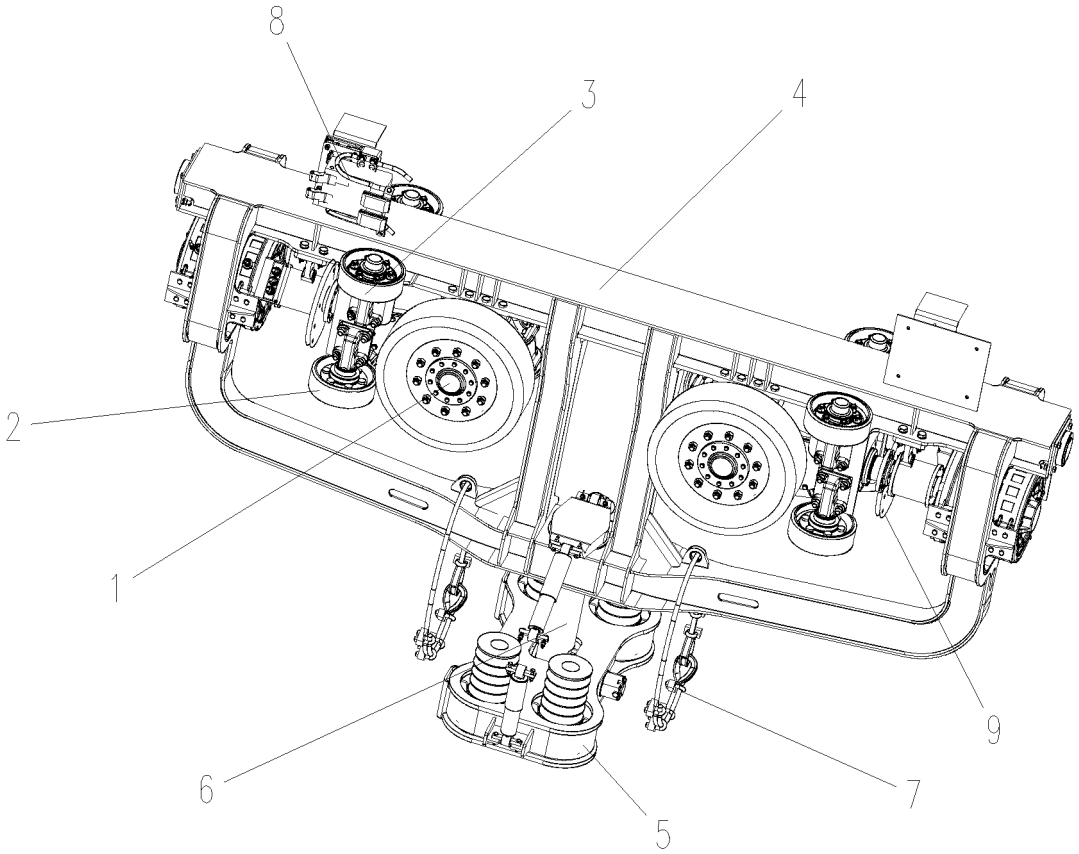

FIG. 4

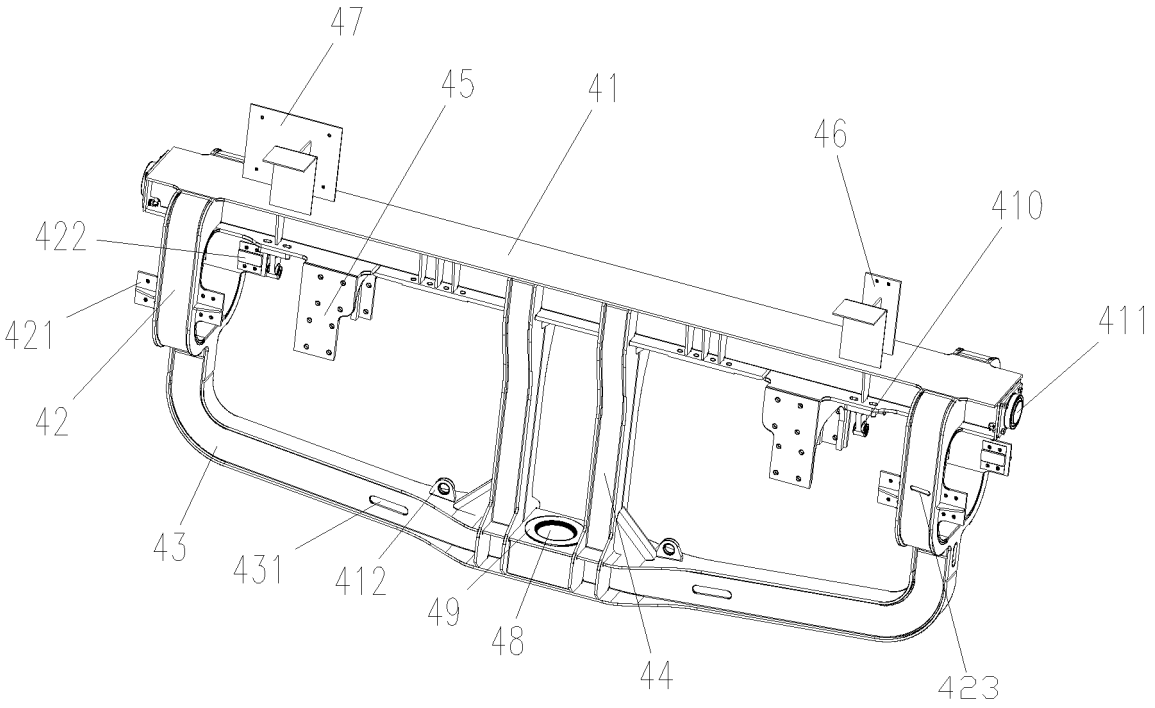
47
45
41
46
410
422
411
421
42
43
431
412
49
48
44
423

FIG. 5

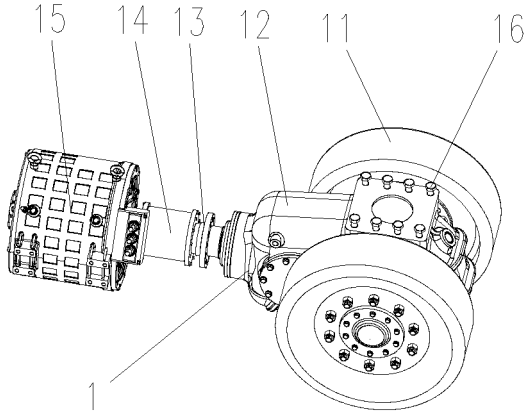
15
14
13
12
11
16
1

FIG. 6

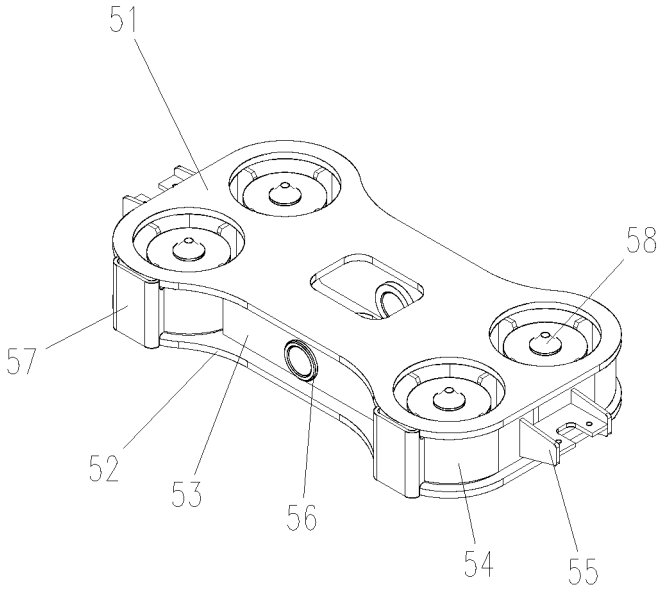

FIG. 7

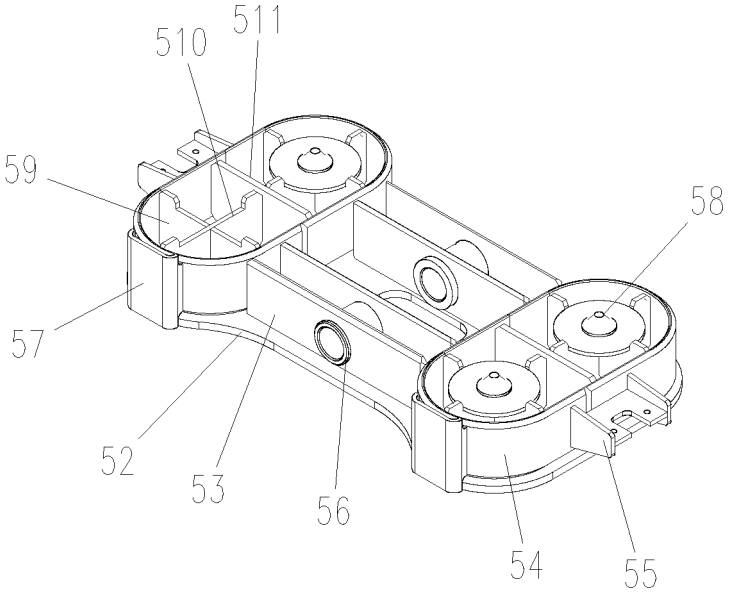

FIG. 8

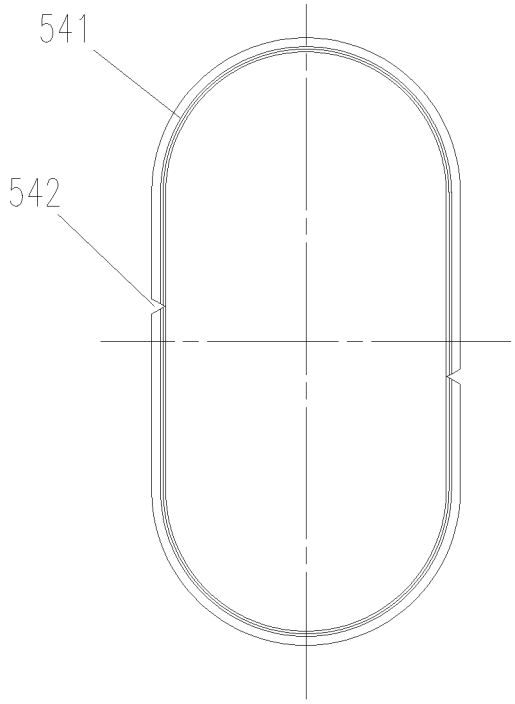

FIG. 9

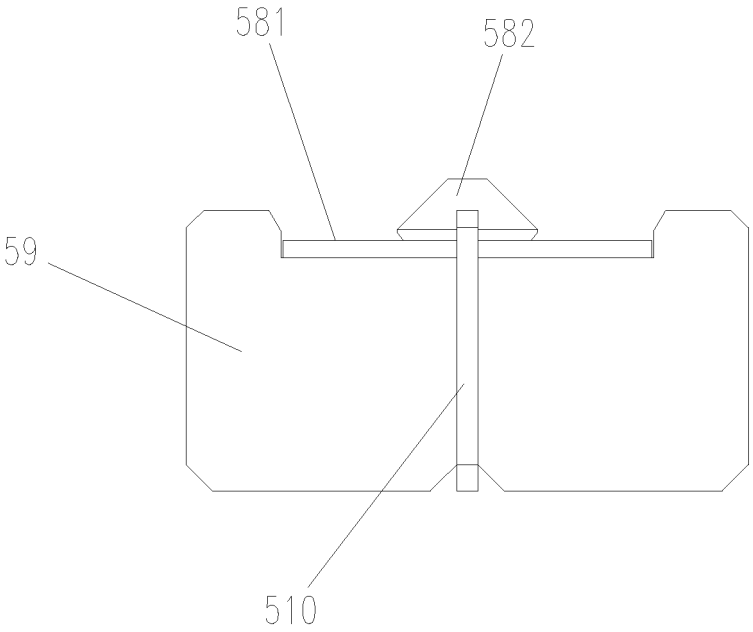

FIG. 10

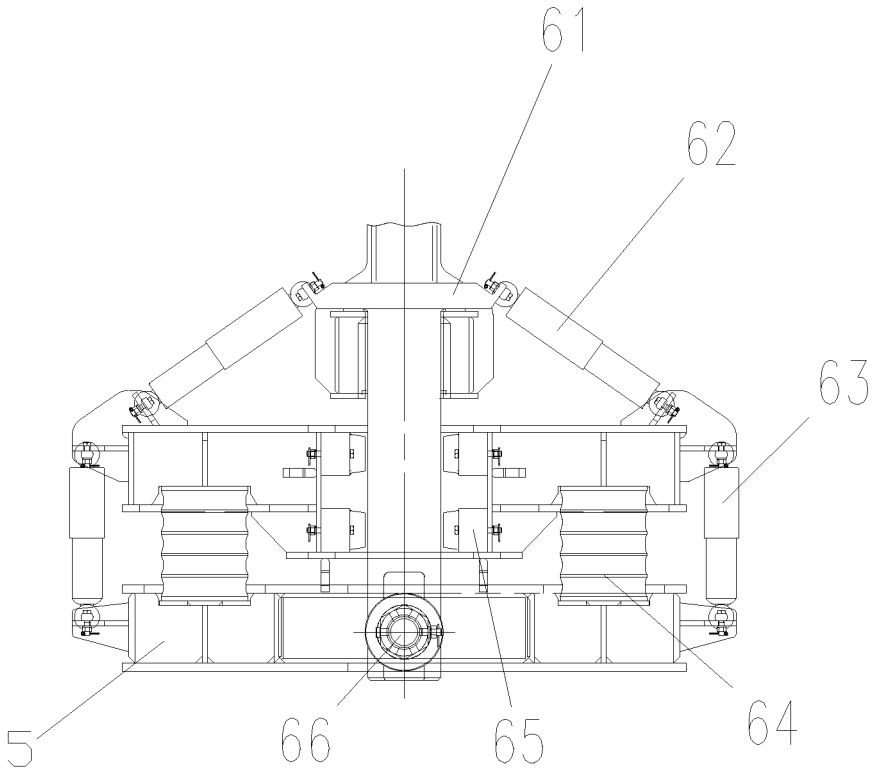

FIG. 11

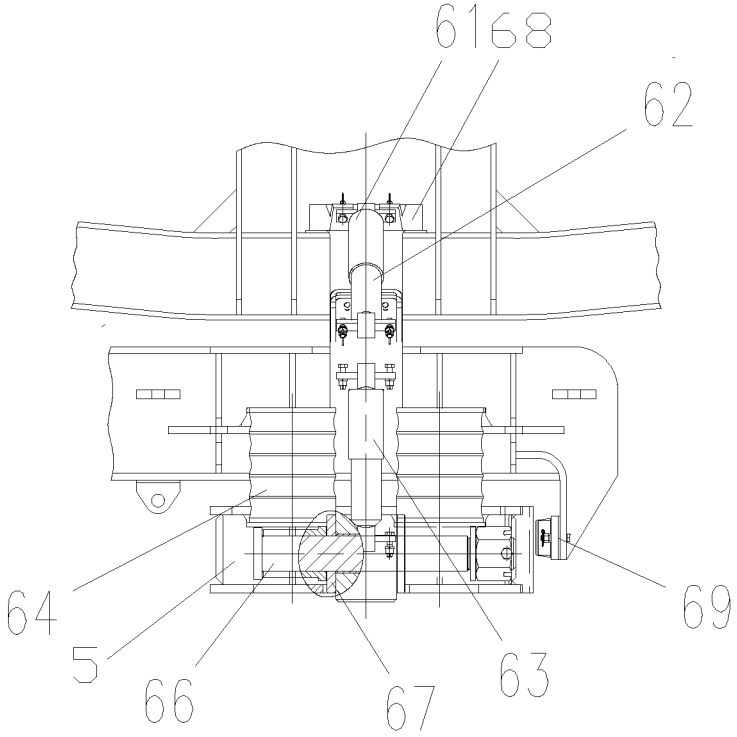

FIG. 12

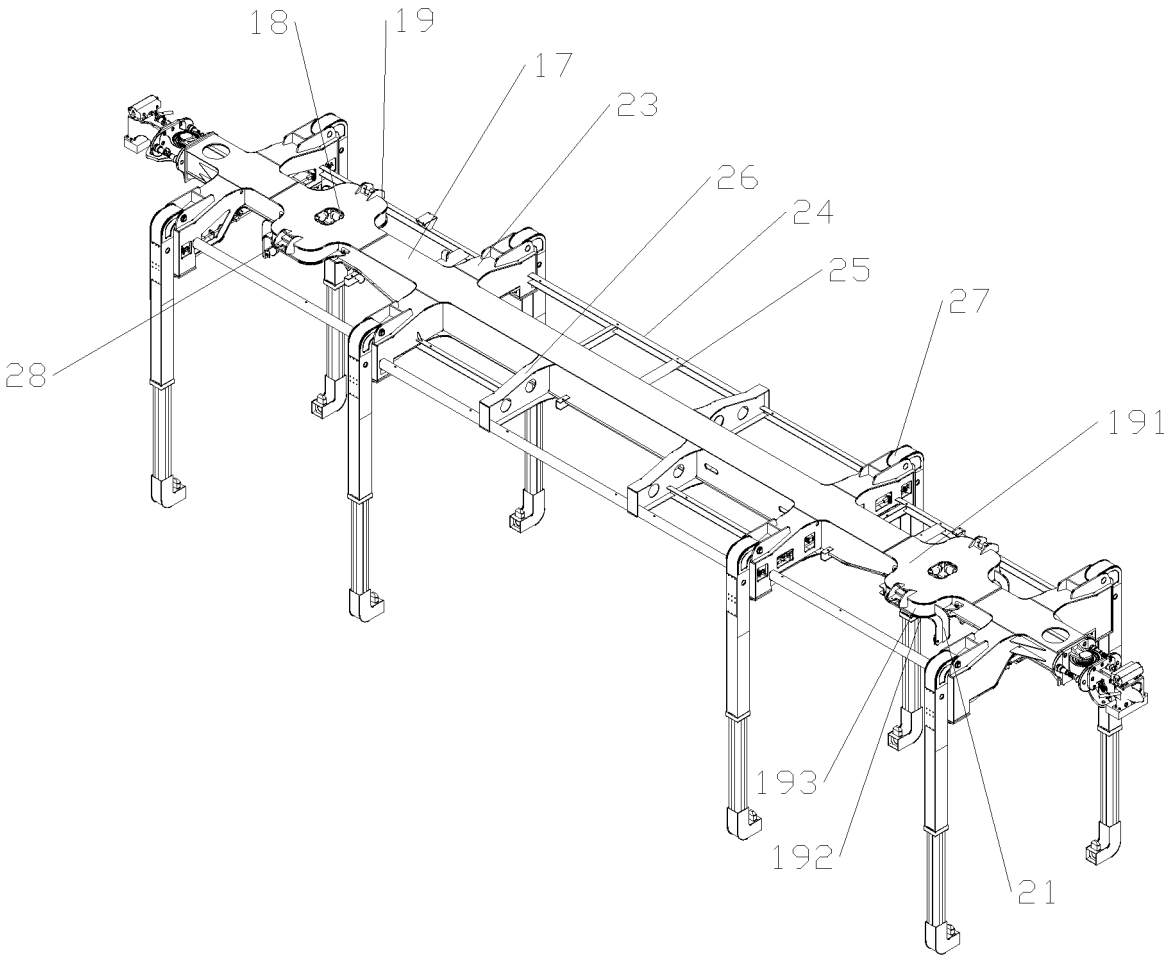

FIG. 13

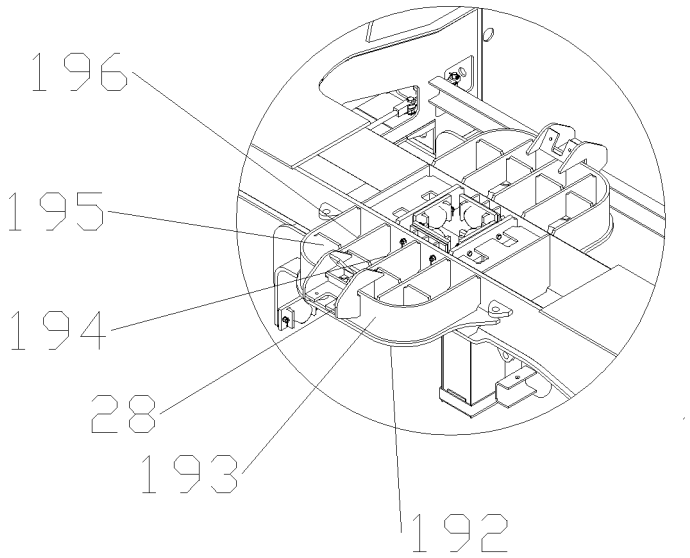

FIG. 14

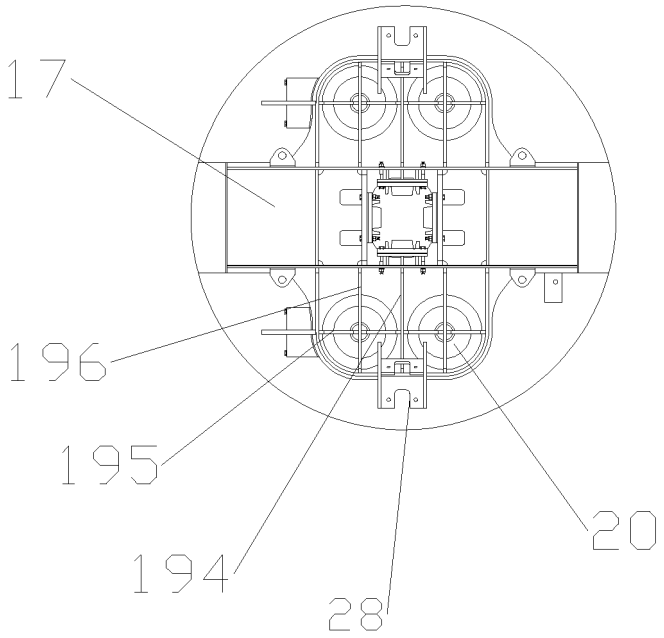

FIG. 15

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2021/112564

A. CLASSIFICATION OF SUBJECT MATTER

B61B 3/00(2006.01)i; B61B 3/02(2006.01)i; B61B 12/02(2006.01)i; B61B 12/04(2006.01)i; B61F 5/52(2006.01)i; B61F 5/04(2006.01)i; B61C 13/04(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B61B3/-, B61B12/-, B61F5/-

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNABS, CNTXT, CNKI: 中车长江, 悬挂, 轨道车辆, 悬吊, 转向架, 构架, 中心销, 摇枕, 减震, 减振, 车架, 下方; VEN, USTXT, IEEE: suspend+, rail+ w vehicle, hang+, bogie, frame, core w pin, center w pin, bolster, damp+, absorb+, nonrat+, below.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 213799625 U (CRRC YANGTZE CO., LTD.) 27 July 2021 (2021-07-27) description paragraphs 38-109	1-13
PX	CN 213862215 U (CRRC YANGTZE CO., LTD.) 03 August 2021 (2021-08-03) description paragraphs 45-116	1-13
PX	CN 213799623 U (CRRC YANGTZE CO., LTD.) 27 July 2021 (2021-07-27) description paragraphs 38-109	1-13
PX	CN 112406910 A (CRRC YANGTZE CO., LTD.) 26 February 2021 (2021-02-26) description, paragraphs [0039]-[0109]	1-13
PX	CN 112277969 A (CRRC YANGTZE CO., LTD.) 29 January 2021 (2021-01-29) description paragraphs 38-109	1-13
PX	CN 213799622 U (CRRC YANGTZE CO., LTD.) 27 July 2021 (2021-07-27) description paragraphs 38-109	1-13
PX	CN 213799624 U (CRRC YANGTZE CO., LTD.) 27 July 2021 (2021-07-27) description paragraphs 38-109	1-13
PX	CN 112277967 A (CRRC YANGTZE CO., LTD.) 29 January 2021 (2021-01-29) description paragraphs 38-109	1-13

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 October 2021	**12 November 2021**
Name and mailing address of the ISA/CN **China National Intellectual Property Administration (ISA/CN)** **No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088** **China**	Authorized officer
Facsimile No. **(86-10)62019451**	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2021/112564

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 112277970 A (CRRC YANGTZE CO., LTD.) 29 January 2021 (2021-01-29) description paragraphs 38-109	1-13
PX	CN 112277968 A (CRRC YANGTZE CO., LTD.) 29 January 2021 (2021-01-29) description paragraphs 45-116	1-13
PX	CN 112277971 A (CRRC YANGTZE CO., LTD.) 29 January 2021 (2021-01-29) description paragraphs 38-109	1-13
X	CN 110001665 A (CHENGDU XINZHU ROAD & BRIDGE MACHINERY CO., LTD.) 12 July 2019 (2019-07-12) description, paragraphs 22-27, figures 1-4	1-4
Y	CN 110001665 A (CHENGDU XINZHU ROAD & BRIDGE MACHINERY CO., LTD.) 12 July 2019 (2019-07-12) description, paragraphs 22-27, figures 1-4	5-13
Y	CN 107878494 A (JIANGSU TIANLE INTELLIGENT TECHNOLOGY CO., LTD.) 06 April 2018 (2018-04-06) description, paragraphs 22-26, figures 1-5	5-10
Y	CN 104442880 A (CSR ZHUZHOU ELECTRIC LOCOMOTIVE CO., LTD.) 25 March 2015 (2015-03-25) description, paragraphs 24-38, figures 1-3	7-10
Y	CN 109677441 A (CHINA RAILWAY ENGINEERING MACHINERY RESEARCH & DESIGN INSTITUTE CO., LTD. et al.) 26 April 2019 (2019-04-26) description, paragraphs 29-33, figures 1-2	11-13
A	CN 107010082 A (CRRC NANJING PUZHEN CO., LTD.) 04 August 2017 (2017-08-04) entire document	1-13
A	CN 109466564 A (CRRC YANGTZE CO., LTD.) 15 March 2019 (2019-03-15) entire document	1-13
A	US 2016023670 A1 (KAWASAKI HEAVY IND. LTD.) 28 January 2016 (2016-01-28) entire document	1-13

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2021/112564

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 213799625 U	27 July 2021	None	
CN 213862215 U	03 August 2021	None	
CN 213799623 U	27 July 2021	None	
CN 112406910 A	26 February 2021	None	
CN 112277969 A	29 January 2021	None	
CN 213799622 U	27 July 2021	None	
CN 213799624 U	27 July 2021	None	
CN 112277967 A	29 January 2021	None	
CN 112277970 A	29 January 2021	None	
CN 110001665 A	12 July 2019	None	
CN 107878494 A	06 April 2018	None	
CN 104442880 A	25 March 2015	None	
CN 109677441 A	26 April 2019	None	
CN 107010082 A	04 August 2017	None	
CN 109466564 A	15 March 2019	None	
US 2016023670 A1	28 January 2016	US 9902407 B2	27 February 2018
		CN 105008205 A	28 October 2015
		KR 20150125695 A	09 November 2015
		KR 101733602 B1	10 May 2017
		JP 2014172437 A	22 September 2014
		JP 6185727 B2	23 August 2017
		EP 2965966 A1	13 January 2016
		EP 2965966 A4	14 December 2016
		EP 2965966 B1	21 October 2020
		WO 2014136449 A1	12 September 2014

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- CN 202011126901 **[0001]**
- CN 202011126908 **[0001]**
- CN 202011126928 **[0001]**
- CN 201610938552 **[0004]**
- CN 201610932024X **[0004]**
- CN 2018222496756 **[0097]**