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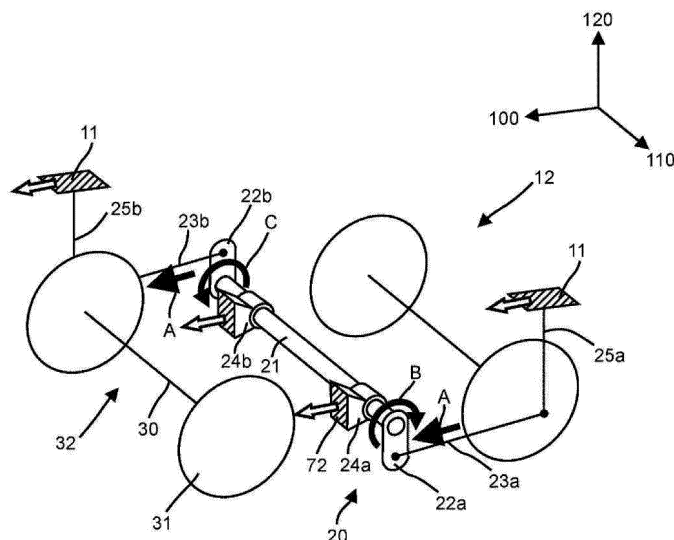
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(54) **RAILWAY VEHICLE**

(57) Provided is a railway vehicle equipped with a truck capable of being reduced in a size and a weight. A traction device (20) for connecting a railway vehicle to a truck includes a link shaft (21) disposed in a truck frame, a pair of link shaft arms (22) disposed at both ends of the link shaft (21), and two draw shafts (23) each connected to each of the link shaft arms (22). An upper end of one of the link shaft arms (22) is connected to the link shaft

(21), and a lower end of the other of the link shaft arms (22) is connected to the link shaft (21). Each of the draw arms (23) connects each of the link shaft arms (22) to a lower surface of a vehicle body. When the truck passes through a curve, the link shaft arms (22) turns in a vertical plane. Therefore, the truck turns in a horizontal plane around a virtual vertical axis at a central portion of the link shaft in a longitudinal direction thereof.

FIG. 4



## Description

### Technical Field

**[0001]** The present invention relates to a railway vehicle such as a railroad vehicle, a monorail vehicle, or a new transportation system vehicle, and particularly relates to a railway vehicle equipped with a virtual center plate method traction device and a truck capable of promoting reduction in a size and a weight.

### Background Art

**[0002]** Not only in a railroad vehicle but also in a railway vehicle such as a monorail vehicle or a new transportation system vehicle, a vehicle body is connected to a truck through a support device and a traction device. The support device mainly supports a weight of the vehicle body, and includes an air spring disposed on an upper surface of a truck frame and the like. The traction device transmits a force in a forward and backward direction such as a driving force or a braking force from the truck to the vehicle body, and turns the truck around a vertical axis at a central portion of the truck. The traction device includes a center pin extending vertically downward from a lower surface of the vehicle body at both ends thereof in a longitudinal direction thereof, a link connecting the center pin to a central portion of the truck frame, and the like.

**[0003]** Generally, in a vehicle requiring to dispose an actuator at a central portion of a truck, such as a diesel vehicle in which a propeller shaft extending from an internal combustion engine disposed on a lower surface of a vehicle penetrates through a central portion of a truck in a forward and backward direction, a pendulum vehicle in which a mechanism such as a pendulum beam, a roller, or a pendulum control actuator is integrated in a central portion of a truck, or a vehicle for supporting a vehicle body with one air spring per truck, it may be difficult to dispose a traction device at a central portion of a truck. PTL 1 discloses a traction device applied to a three-axis truck for a locomotive in which it is difficult to dispose a traction device at a central portion of the truck similarly to the above vehicle.

**[0004]** The traction device disclosed in PTL 1 includes a center plate seat, a center plate, and a center plate metal fitting (right angle crank) disposed sequentially downward from a lower surface of a portion near a center of a truck on left and right side beams of a truck frame, a vertical movement metal fitting connected to an outside of the center plate metal fitting in a sleeper direction through a link, a link shaft (link) for connecting a pair of center plate metal fittings disposed on the left and the right of the truck frame, and a V-shape link (draw shaft) for connecting both ends of the vertical movement metal fitting in a rail direction to link receivers disposed on a lower surface of an underframe of a vehicle body along the rail direction.

**[0005]** The center plate metal fitting (right angle crank)

can be rotated around a vertical axis of the center plate. The link shaft synchronizes rotational displacements of the center plate metal fittings on the left and the right of the truck frame due to planar motion. Rotational displacements generated in the center plate metal fittings (right angle cranks) on the left and the right of the truck frame are restrained by the link shaft. Therefore, a force in a forward and backward direction such as a driving force of the truck or a braking force thereof is transmitted to the vehicle body via a draw shaft connected to the vertical movement metal fitting through the center plates (pins) and the center plate metal fittings on the left and the right of the truck frame.

**[0006]** When the traction device passes through a curve, the center plate metal fittings (right angle cranks) on the left and the right of the truck frame are rotated using the center plates (pins) as vertical axes in accordance with a turning action of the truck along the curve, and the link (link shaft) rotates the center plate metal fittings on the left and the right in the same direction. Forces of compression and tension thereby act on each of the pair of draw shafts on the left and the right of the truck frame. Due to this action, the truck turns around a virtual center plate as if a virtual center plate (a member acting as a turning center of the truck) is present at the central portion of the truck frame (virtual center plate method). The traction device described in PTL 1 includes a part constituting the traction device, such as a center plate metal fitting or a draw shaft, below the truck (at a position close to a rail upper surface) in order to realize an axle weight compensation function.

### Citation List

#### Patent Literature

**[0007]** PTL 1: JP 59-100051 A

### Summary of Invention

### Technical Problem

**[0008]** Conventionally, a link shaft (link) constituting a virtual center plate method traction device has been disposed along a sleeper direction at a position offset from a central portion of a truck in a longitudinal (rail) direction thereof in the longitudinal direction. Therefore, it is necessary to make a design to avoid interference between the link shaft and a part such as a main motor receiver at the central portion of the truck. For example, a size of the truck in the longitudinal direction thereof is increased by the offset of the link shaft. This may be one of factors for inhibiting reduction in a size of the truck and a weight thereof.

**[0009]** In addition, there is a problem to be solved in terms of improving maintainability. For example, when the link shaft or the draw shaft is disposed near the rail upper surface below the truck frame, it may be necessary

to inspect these parts due to an impact of ballast that snow which has arrived at a lower surface of the truck is scattered by falling snow during travelling in winter.

**[0010]** The present invention has been achieved in view of this problem, and provides a traction device for a railway vehicle capable of reducing a size of a virtual center plate method truck and a weight thereof by reducing a size of the truck in a longitudinal direction thereof and improving maintainability in a railway vehicle equipped with the truck.

#### Solution to Problem

**[0011]** The above problem can be solved by the following characteristics of a railway vehicle of the present invention. That is, in the railway vehicle of the present invention, a vehicle is connected to a truck through a traction device. This traction device includes a link shaft disposed at a central portion of the truck in a longitudinal direction thereof along a width direction thereof, link shaft arms disposed at both ends of the link shaft, and draw shafts for connecting the link shaft arms to a vehicle body and disposed along a longitudinal direction of the vehicle body. One end of one of the link shaft arms is connected to one end of the link shaft. One of the draw shafts is connected to the other end of the one of the link shaft arms extending downward, and is disposed toward one end of the vehicle in a longitudinal direction thereof. One end of the other of the link shaft arms is connected to the other end of the link shaft. The other of the draw shafts is connected to the other end of the other of the link shaft arms extending upward, and is disposed toward the other end of the vehicle in a longitudinal direction thereof.

#### Advantageous Effects of Invention

**[0012]** The present invention can provide a traction device for a railway vehicle capable of reducing a size of a virtual center plate method truck and a weight thereof by reducing a size of the truck in a longitudinal direction thereof and improving maintainability in a railway vehicle equipped with the truck.

#### Brief Description of Drawings

##### **[0013]**

[FIG. 1] FIG. 1 is a side view of a railroad vehicle.

[FIG. 2] FIG. 2 is a side view of a truck indicated by A part in FIG. 1.

[FIG. 3] FIG. 3 is a plan view of a truck illustrated in FIG. 2.

[FIG. 4] FIG. 4 is a perspective view for explaining an action of a traction device when the vehicle illustrated in FIGS. 1 to 3 accelerates.

[FIG. 5] FIG. 5 is a perspective view for explaining an action of the traction device when the vehicle illustrated in FIGS. 1 to 3 passes through a curve.

[FIG. 6] FIG. 6 is a side view of a truck of a vehicle in Example 2.

[FIG. 7] FIG. 7 is a side view of a truck of a monorail vehicle in Example 3, to which the traction device illustrated in FIGS. 2 to 6 is applied.

[FIG. 8] FIG. 8 is a plan view of the truck of a monorail vehicle illustrated in FIG. 7.

#### Description of Embodiments

**[0014]** Hereinafter, embodiments of the present invention will be described with reference to FIGS. 1 to 8. Before the present invention is described, directions will be defined. The directions are a longitudinal direction (forward and backward direction) of a railway vehicle or a truck or a rail direction 100, a width (lateral) direction of the railway vehicle or the truck or a sleeper direction 110, and a height direction 120. These directions are simply referred to as a longitudinal direction (forward and backward direction) 100, a width (lateral) direction 110, and a height (vertical) direction 120.

**[0015]** The railway vehicle is a vehicle travelling along a laid track, and includes a railroad vehicle, a monorail vehicle, a new transportation vehicle, a tram, and the like. In Examples of the present invention, as a representative of the railway vehicle, the railroad vehicle and the monorail vehicle will be exemplified, but the railway vehicle can be also applied to a truck of the new transportation vehicle, the tram, or the like.

##### [Example 1]

**[0016]** FIG. 1 is a side view of a railroad vehicle. FIG. 2 is a side view of a truck of a vehicle indicated by A part in FIG. 1. FIG. 3 is a plan view of a truck illustrated in FIG. 2. A truck 12 includes a truck frame 70 and a wheel shaft 32 obtained by connecting two wheels 31 through an axle 30. The truck frame 70 includes two side beams 71 disposed apart from each other along the longitudinal direction 110 and a transverse beam 72 for connecting center portions of the side beams 71 in the longitudinal direction to each other, and is a substantially H-shaped part when being overlooked. In FIG. 3, the two transverse beams 72 connect the side beams 71 to each other, but one transverse beam 72 may connect the side beams 71 to each other. The wheel shaft 32 rolling on a rail 1 is obtained by connecting the two wheels 31 through the axle 30, and is rollably held by axle boxes 34 disposed at both ends of the wheel shaft 32. The axle boxes 34 support both ends of each of the side beams 71 in the longitudinal direction via a shaft spring 33 disposed on each of the axle boxes 34.

**[0017]** A vehicle body 11 is connected to the truck 12 via a vehicle body support device 40. The vehicle body support device 40 includes an air spring 46 for supporting a load of the vehicle body in a vertical direction and a traction device 20 for transmitting a driving force or a braking force (force acting in the forward and backward

direction 100) of the truck 12 to the vehicle body 11.

**[0018]** The traction device 20 includes a link shaft 21 disposed at a central portion of the truck 12 in the longitudinal direction 100 along the width direction 110, a link shaft arm 22 one end of which is connected to one end of the link shaft 21, a draw shaft 23 one end of which is connected to the other end of the link shaft arm 22, and a draw shaft bracket 25 for connecting the other end of the draw shaft 23 to the vehicle body 11.

**[0019]** Both ends of the link shaft 21 are disposed rotatably to a pair of link shaft brackets 24 disposed on an upper surface of the truck frame 70 (side beams 71 on the left and the right). Between the link shaft 21 and each of the link shaft brackets 24, a bearing structure reducing friction and wear by a self-lubricating function such as OILES (registered trademark) and capable of withstanding a force in the forward and backward direction (radial load) from the truck 12 is desirable. The link shaft brackets 24 may be omitted, and the link shaft 21 may be disposed by opening a hole on a side surface of the side beam 71 between the two transverse beams 72 and disposing the above-described bearing structure in this hole. Furthermore, when only one hollow transverse beam 72 is disposed, the link shaft 21 may be disposed at a center line (at an axis in a case of a cylinder) of the transverse beam 72 in a longitudinal direction thereof (width direction 110).

**[0020]** A pair of the link shaft arms 22 disposed along the height direction 120 is connected to both ends of the link shaft 21. One link shaft arm 22a (refer to FIG. 4) is disposed such that an upper end thereof is connected to one end of the link shaft 21, and a lower end thereof extends downward. The other link shaft arm 22b (refer to FIG. 4) is disposed such that a lower end thereof is connected to the other end of the link shaft 21, and an upper end thereof extends upward. The link shaft arm 22 is disposed along the height direction 120, but may be disposed not only in the vertical direction but also in such a manner that the link shaft arm 22 is inclined in the longitudinal direction 100. The link shaft arms 22 on the left and the right have the same size in the height direction. The link shaft arms 22 and the link shaft 21 have an integral structure in which the link shaft arms 22 and the link shaft 21 are connected to each other by welding, press fitting, or the like.

**[0021]** A lower end of the one link shaft arm 22a is connected to a draw shaft bracket 25a (refer to FIG. 4) disposed at one end of a lower surface of the vehicle body 11 in the width direction 110 through a draw shaft 23a. An upper end of the other link shaft arm 22b is connected to a draw shaft bracket 25b (refer to FIG. 4) disposed at the other end of the lower surface of the vehicle body 11 in the width direction 110 through a draw shaft 23b. The one draw shaft 23a is disposed from the lower end of the link shaft arm 22a toward one end of the vehicle in the longitudinal direction 100. The other draw shaft 23b is disposed from the upper end of the link shaft arm 22b toward the other end of the vehicle in the longitudinal

direction 100.

**[0022]** A bearing having a rotational degree of freedom around the lateral direction 110 as an axis may be disposed at one end of the draw shaft 23, and a bearing having a rotational degree of freedom around the vertical direction 120 as an axis may be disposed at the other end of the draw shaft 23 such that relative lateral and vertical displacements are allowable between the vehicle body and the truck. In order to reduce transmission of vibration from the truck 12 to the vehicle body 11 caused by track irregularity or the like, a spherical bearing capable of allowing displacements in the lateral direction 110 and the vertical direction 120 or an elastic body such as a rubber bush may be disposed at both ends of the draw shaft 23.

**[0023]** FIG. 4 is a perspective view for explaining an action of the traction device when the vehicle accelerates. The arrows indicated in the vehicle body 11, the draw shafts 23a and 23b, the link shaft arms 22a and 22b, and the link shaft brackets 24a and 24b illustrated in FIG. 4 indicate forces acting on parts constituting the traction device when a vehicle 10 accelerates.

**[0024]** The vehicle 10 accelerates in such a manner that a driving force generated by rolling of the wheel shaft 32 driven by a main motor (not illustrated) mounted on the truck 12 on the rail 1 pulls or propels the vehicle body 11 via the traction device (draw shaft). At this time, forces A having the same magnitude and the same direction are transmitted to the draw shaft 23a as a pulling force (tensile force) and the draw shaft 23b as a propulsion force (compression force).

**[0025]** A moment force acts on the link shaft 21 by the force A transmitted to each of the draw shafts 23a and 23b and the link shaft arms 22a and 22b. A moment force in a direction of an arrow B acts on one end of the link shaft 21. A moment force in a direction of an arrow C acts on the other end of the link shaft 21. A direction in which a moment force acts on one end of the link shaft 21 is opposite (reverse) to a direction in which a moment force acts on the other end of the link shaft 21.

**[0026]** The link shaft arms 22a and 22b are connected to both ends of the link shaft 21 integrally. Therefore, the moment forces acting on both ends of the link shaft 21 in opposite directions are cancelled. Due to the cancellation of the moment forces, the link shaft arms 22a and 22b do not make a rotational displacement, and the force A acting on the draw shafts 23a and 23b is directly transmitted to the vehicle body 11 via the draw shaft brackets 25a and 25b. By such a balance of the driving forces and such an action, the vehicle 10 continues to accelerate in a forward direction. When the truck 12 generates a braking force, a translational force or a moment force is generated in a direction opposite to the case where the above driving force is generated, and the vehicle 10 decelerates.

**[0027]** FIG. 5 is a perspective view for explaining an action of the traction device when the vehicle illustrated in FIGS. 1 to 3 passes through a curve. FIG. 5 illustrates

a state when the truck 12 yaws (turns) in a direction of an arrow D with respect to the vehicle body 11 and the vehicle 10 passes through a left curve. In FIG. 5, a two-dot chain line indicates states of the vehicle body and the truck when the vehicle 10 travels straight, and a solid line indicates states thereof when the vehicle 10 passes through a curve. The arrows illustrated in the vehicle body 11, the draw shafts 23a and 23b, and the link shaft arms 22a and 22b indicate forces acting on parts constituting the traction device when the truck 12 yaws in the direction of the arrow D with respect to the vehicle body 11. An arrow E illustrated on a front side of the truck 12 indicates a traveling direction of the vehicle 10 passing through a left curve, and the arrow D illustrated at the central portion of the truck 12 indicates a direction in which the truck 12 yaws with respect to the vehicle body 11.

**[0028]** First, when the truck 12 yaws in the direction of the arrow D with respect to the vehicle body 11, a force F acts on the link shaft arm 22a from the draw shaft 23a, and a force G acts on the link shaft arm 22b from the draw shaft 23b. The link shaft arm 22a and 22b are rotated in a vertical plane by these forces F and G to generate moment forces H in the same direction at both ends of the link shaft 21. At this time, the link shaft arm 22a is connected to the draw shaft 23a, and the link shaft arm 22b is connected to the draw shaft 23b. Therefore, one end of the link shaft 21 (a side of the link shaft arm 22a) integrated with the link shaft arm 22 is displaced in a direction of an arrow J, and the other end of the link shaft 21 (a side of the link shaft arm 22b) is displaced in a direction of an arrow I.

**[0029]** As a result, the link shaft 21 makes a yawing displacement (turns) in the direction of the arrow D in a horizontal plane around the central portion in the longitudinal direction (width direction 110) thereof. The link shaft 21 is fixed to the truck frame 70 via the link shaft brackets 24a and 24b. Therefore, the truck 12 is displaced in accordance with the yawing motion of the link shaft 21, and makes a yawing displacement in the direction of the arrow D around a vertical axis at a central portion of the truck 12 with respect to the vehicle body 11 as if a center plate is present.

**[0030]** In a traction device realizing a conventional virtual center plate method, including a link shaft, a right angle crank, and the like, the right angle crank or the like moves in a horizontal plane, and therefore a compression load and a tensile load act on the link shaft. Meanwhile, in the link shaft 21 included in the traction device according to the present invention, when a vehicle accelerates or decelerates and passes through a curve (when a truck turns), a compression load or a tensile load is not generated in an axis direction of the link shaft 21, and only a torsional (moment) load acts on the link shaft 21. Therefore, by forming the link shaft 21 with a cylindrical member robust with respect to a torsional load, reduction in weights of the traction device and the truck can be promoted.

**[0031]** Due to the above structure, a railway vehicle

equipped with the above traction device, such as a diesel vehicle in which a propeller shaft penetrates through a central portion of a truck in a forward and backward direction, a pendulum vehicle in which a mechanism such as a pendulum beam, a roller, or a pendulum control actuator is integrated in a central portion of a truck, or a vehicle for supporting a vehicle body with one air spring per truck, can be provided in place of a conventional traction device with a central pin.

**[0032]** In addition, in the conventional virtual center plate method traction device, a link shaft is connected to a right angle crank making a rotational displacement around a vertical axis, and performs a planar motion on an upper surface of a truck frame (a transverse beam or a side beam). Therefore, the link shaft is disposed at a position offset from a central portion of a truck in a longitudinal direction thereof. Therefore, in order to avoid interference between the link shaft and a part such as a wheel, the central portion of the truck requires a length of at least the offset in a longitudinal direction of a vehicle.

**[0033]** Meanwhile, in the traction device of the present invention, the link shaft is rotated around a lateral direction of the vehicle as an axis, and the link shaft can be thereby disposed at the central portion of the truck without providing an offset in the longitudinal direction of the vehicle. That is, the length of the truck in the longitudinal direction of the vehicle, required for avoiding interference between the link shaft and a part such as a wheel, can be reduced, and a railway vehicle equipped with the truck promoting reduction in a size and a weight can be provided.

**[0034]** In Examples of the present invention, the link shaft is disposed so as to be connected to the side beams on the left and the right between the transverse beams disposed apart from each other along the longitudinal direction 100, but may be disposed on an upper surface of the truck frame. In addition, the link shaft bracket may be connected to the vehicle body, and the draw shaft bracket may be connected to the truck. Furthermore, by forming a suspension device above the upper surface of the truck frame, an impact of ballast due to falling snow or the like on the traction device can be avoided. Therefore, an increase in maintenance cost of the traction device can be suppressed.

**[0035]** In a conventional steering truck, a vehicle body is connected to a truck, and the truck is connected to a wheel shaft through a plurality of links, and the links are driven in accordance with relative yawing of the vehicle and the truck caused when the truck passes through a curve. The steering truck steers the wheel shaft such that the wheel shaft is directed to a radial direction of the curve, and does not have a function of turning the truck around a vertical axis of the central portion thereof. Meanwhile, in the traction device of the present invention, the vehicle body is connected to the truck through the link shaft, the draw shaft, or the like, the link shaft makes a rotational displacement in accordance with relative yawing of the vehicle and the truck caused when the traction

device passes through a curve, and the truck yaws around a vertical axis of the central portion thereof with respect to the vehicle body. The conventional steering truck is largely different from the present invention in a structure thereof and an effect in accordance with an action thereof.

[Example 2]

**[0036]** FIG. 6 is a side view of a truck of a vehicle in Example 2. The same reference sign is given to a part having a common or similar effect to a part constituting the traction device illustrated in FIGS. 1 to 5 and a railroad vehicle including the traction device. Only a part and a structure different from those in FIGS. 1 to 5 will be described.

**[0037]** Two link shaft arms 22 of a traction device 20 illustrated in FIG. 6 are disposed at both ends of a link shaft 21 along a height direction. One link shaft arm 22a is integrally connected to an end of the link shaft 21 at a central portion in a longitudinal direction thereof by welding or the like. A draw shaft 23a is connected to one end of the link shaft arm 22a extending downward, and one end of a yaw damper 26a is connected to the other end thereof extending upward. The other end of the yaw damper 26a is connected to a yaw damper bracket 27a disposed on a side surface of a side beam 71 forming a truck frame 70.

**[0038]** The other link shaft arm 22b is integrally connected to an end of the link shaft 21 at a central portion in a longitudinal direction thereof by welding or the like. A draw shaft 23b (not illustrated) is connected to one end of the link shaft arm 22b extending upward, and one end of a yaw damper 26b (not illustrated) is connected to the other end thereof extending downward. The other end of the yaw damper 26b is connected to a yaw damper bracket 27b (not illustrated) disposed on a side surface of the side beam 71 forming the truck frame 70.

**[0039]** This yaw damper 26 includes a piston, a cylinder, an adjusting valve, a relief valve, and the like. The cylinder is filled with oil. As described in Example 1, when a relative yawing motion occurs in a vehicle body 11 and a truck 12, for example, when a vehicle 10 passes through a curve, the link shaft arm 22 makes a rotational displacement around a lateral direction 110 as an axis together with the link shaft 21. When the link shaft arm 22 makes a rotational displacement counter-clockwise around the lateral direction 110 as an axis, a piston of the yaw damper 26 is displaced in a stretching direction with respect to a cylinder. On the contrary, when the link shaft arm 22 makes a rotational displacement clockwise around the lateral direction 110 as an axis, the piston is displaced in a contracting direction with respect to the cylinder.

**[0040]** The oil in the cylinder passes through the adjusting valve or the relief valve in the cylinder in accordance with the stretching and contracting motion of the piston, a damping force is thereby generated in the yaw

damper 26. This damping force attenuates a rotational displacement of the link shaft arm 22 and a back and forth displacement of the draw shaft 23 in accordance with the rotational displacement of the link shaft arm 22, attenuates a displacement of a mechanism connected to the draw shaft 23, the link shaft arm 22, and the link shaft 21, and thereby attenuates yawing of the truck 12 with respect to the vehicle body 11.

**[0041]** The higher the stretching and contracting speed of the piston is, the larger the damping force of the yaw damper 26 is. Therefore, a large damping force is not generated with respect to a slow yawing motion when the vehicle 10 passes through a curve, and a large damping force is generated with respect to a fast yawing motion such as a snake behavior generated when the vehicle 10 travels at a high speed. As another method to form the yaw damper 26, a rotary damper to attenuate a rotational motion of the link shaft 21 or the like may be formed between the link shaft 21 and the truck frame 70 to attenuate the relative yawing motion of the vehicle body 11 and the truck 12.

**[0042]** In Example 2, a yaw damper for attenuating a relative yawing motion of a vehicle body and a truck is added to the structure of Example 1. Example 2 thereby can suppress self-excited vibration called a snake behavior by which the vehicle body or the truck swings violently to the left and the right when the vehicle travels at a high speed, and improves travelling stability of the vehicle in addition to the effect of Example 1.

[Example 3]

**[0043]** FIG. 7 illustrates another Example, and is a side view of a truck 14 of a monorail vehicle to which the traction device illustrated in FIGS. 2 to 6 is applied. FIG. 8 is a plan view of the truck 14 illustrated in FIG. 7. The same reference sign is given to a part having a common or similar effect to a part constituting the traction device illustrated in FIGS. 1 to 6 and a railroad vehicle including the traction device. Only a part and a structure different from those in FIGS. 1 to 6 will be described.

**[0044]** A truck frame 70 of the truck 14 of a monorail vehicle includes three types of wheels, a running wheel 35, a guiding wheel 36, and a stabilizing wheel 37. The running wheel 35 is a wheel for supporting a load of a vehicle body 13 of the monorail vehicle and the truck 14 thereof in a vertical direction, and rolls on an upper surface of a track beam 2 having a rectangular cross section. The guiding wheel 36 rolls at an upper end of a side surface of the track beam 2 in a horizontal plane, and guides the monorail vehicle in a rolling direction along the track beam 2 when the monorail vehicle travels on a curved track. The stabilizing wheel 37 rolls at a lower end of a side surface of the track beam 2 in a horizontal plane, and maintains a stable posture such that the monorail vehicle does not fall down on the track beam 2.

**[0045]** A traction device 20 illustrated in FIGS. 7 and 8 is basically obtained by disposing a link shaft 21 (refer

to FIGS. 2 to 6) disposed so as to pass through side beams 71 on the left and the right between transverse beams 72 on upper surfaces of the transverse beams 72.

[0046] Such a structure of Example 3 can exhibit an effect similar to Examples 1 and 2 described with reference to FIGS. 1 to 6. As a main effect thereof, offset disposition of a link shaft at a central portion of a truck in the longitudinal direction 100 is not necessary with respect to the conventional virtual center plate method traction device. A length of the truck in the longitudinal direction can be thereby reduced. Such a reduction has been required for avoiding interference between the link shaft and a part such as a running wheel. Therefore, a monorail truck having a short wheel base can be formed. In addition, due to the reduction in the wheel base, it is possible to provide a traction device capable of forming a small and light monorail truck capable of reducing a burden load of a guiding wheel when the monorail truck passes through a curve.

#### Reference Signs List

#### [0047]

|              |                                               |
|--------------|-----------------------------------------------|
| 1            | rail                                          |
| 2            | track beam                                    |
| 10           | vehicle                                       |
| 11, 13       | vehicle body                                  |
| 12, 14       | truck                                         |
| 20           | traction device                               |
| 21           | link shaft                                    |
| 22, 22a, 22b | link shaft arm                                |
| 23, 23a, 23b | draw shaft                                    |
| 24, 24a, 24b | link shaft bracket                            |
| 25, 25a, 25b | draw shaft bracket                            |
| 26           | yaw damper                                    |
| 27           | yaw damper bracket                            |
| 30           | axle                                          |
| 31           | wheel                                         |
| 32           | wheel shaft                                   |
| 33           | shaft spring                                  |
| 34           | axle box                                      |
| 35           | running wheel                                 |
| 36           | guiding wheel                                 |
| 37           | stabilizing wheel                             |
| 40           | vehicle body support device                   |
| 46           | air spring                                    |
| 70           | truck frame                                   |
| 71           | side beam                                     |
| 72           | transverse beam                               |
| 73           | guiding wheel support frame                   |
| 74           | stabilizing wheel support frame               |
| 100          | forward and backward (longitudinal) direction |
| 110          | lateral (width) direction                     |
| 120          | vertical (height) direction                   |

#### Claims

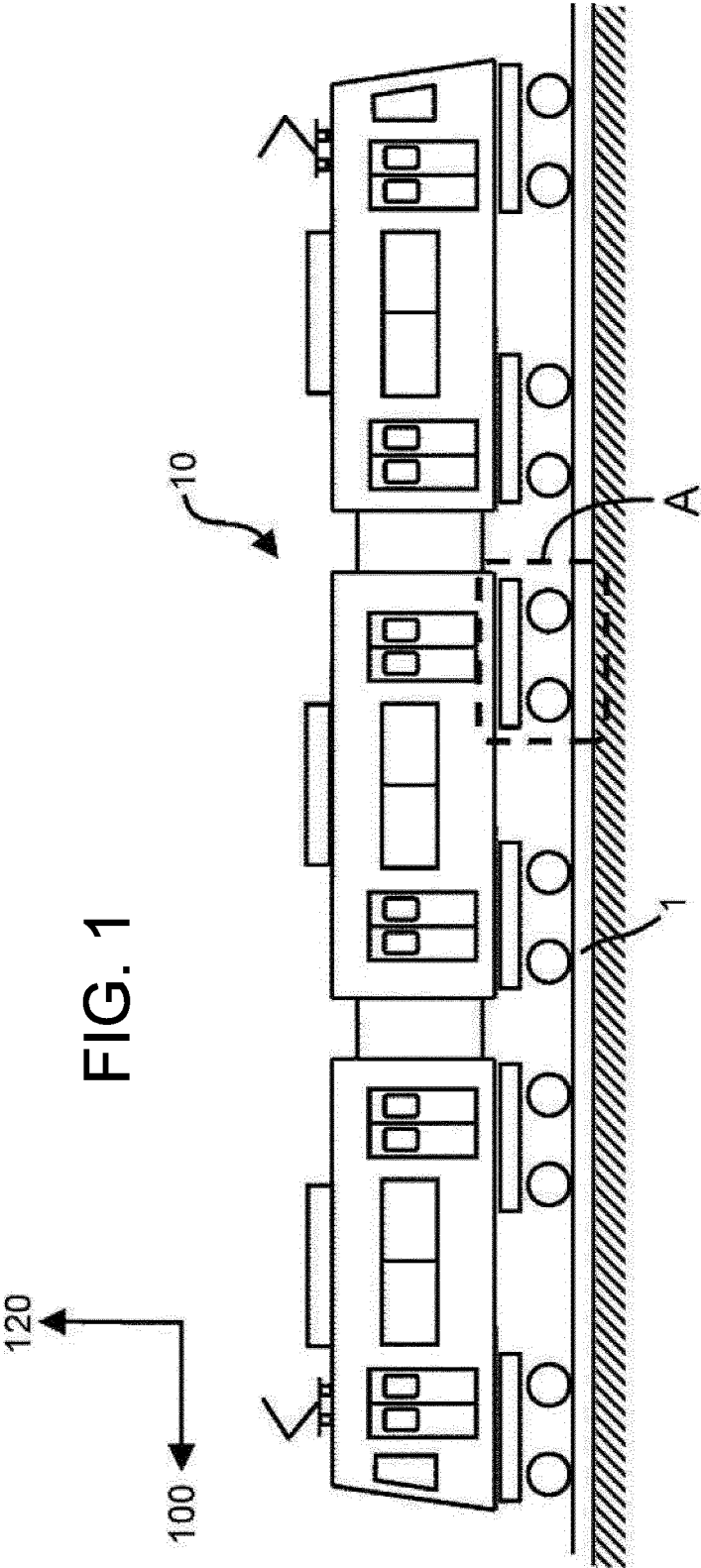
1. A railway vehicle having a vehicle and a truck connected to each other through a traction device, wherein the traction device includes:

a link shaft disposed at a central portion of the truck in a longitudinal direction thereof along a width direction thereof;  
link shaft arms disposed at both ends of the link shaft; and  
draw shafts for connecting the link shaft arms to a vehicle body and disposed along a longitudinal direction of the vehicle body,  
one end of one of the link shaft arms is connected to one end of the link shaft, and one of the draw shafts is connected to the other end of the one of the link shaft arms extending downward and is disposed toward one end of the vehicle in a longitudinal direction thereof, and  
one end of the other of the link shaft arms is connected to the other end of the link shaft, and the other of the draw shafts is connected to the other end of the other of the link shaft arms extending upward and is disposed toward the other end of the vehicle in the longitudinal direction thereof.

2. The railway vehicle according to claim 1, wherein the link shaft is connected to a side of a central portion of a side beam of a truck frame of the truck in the longitudinal direction thereof.

3. The railway vehicle according to claim 2, wherein the link shaft is a cylinder.

4. The railway vehicle according to claim 3, wherein one end of one of yaw dampers for suppressing excessive turning of the truck is connected to an upper end of an extending part extending upward from the one end of one of the link shaft arms, and the other end of the one of the yaw dampers is connected to the side beam of the truck, and  
one end of the other of the yaw dampers is connected to a lower end of an extending part extending downward from the other end of the other of the link shaft arms, and the other end of the other of the yaw dampers is connected to the side beam of the truck.



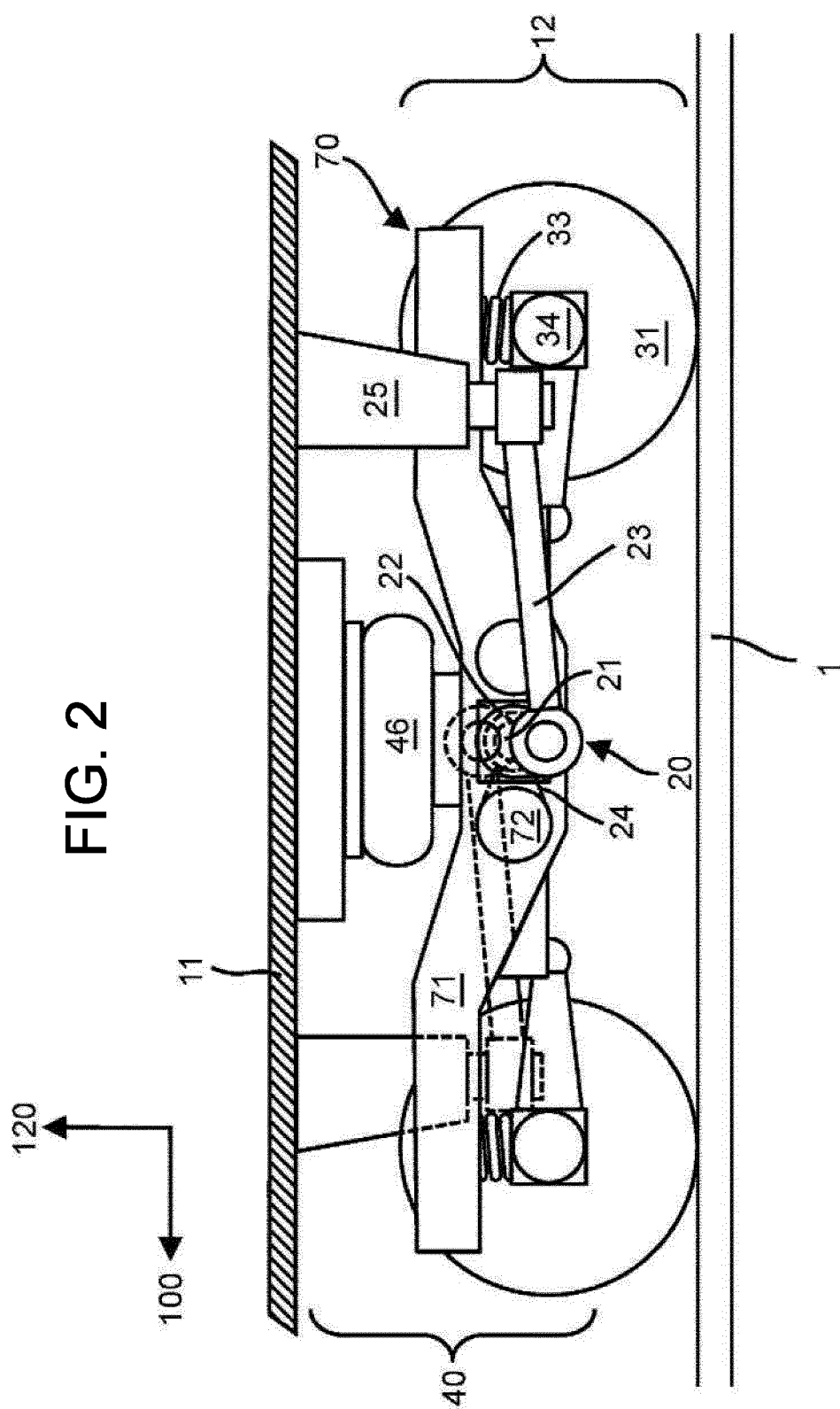
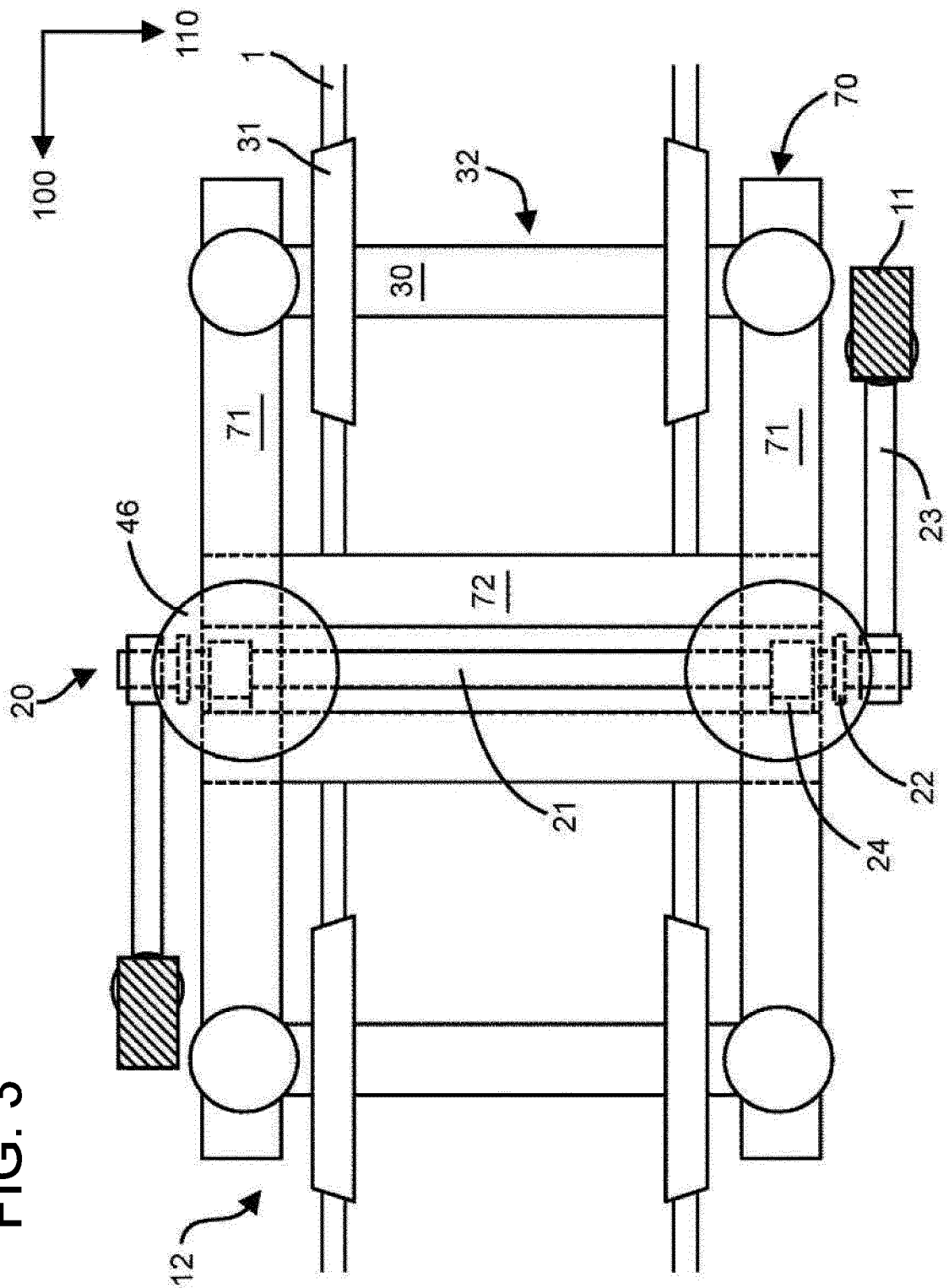


FIG. 3



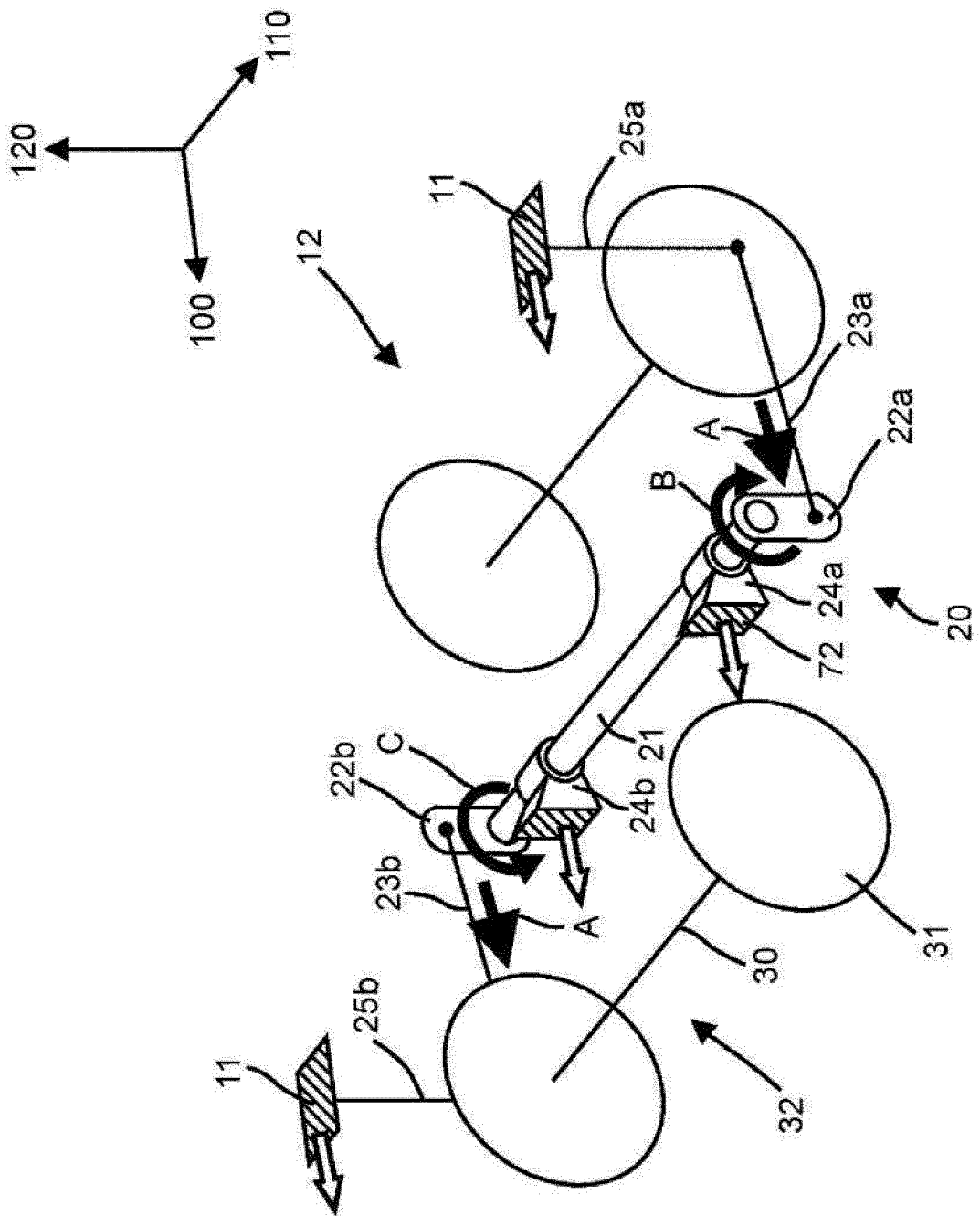


FIG. 4

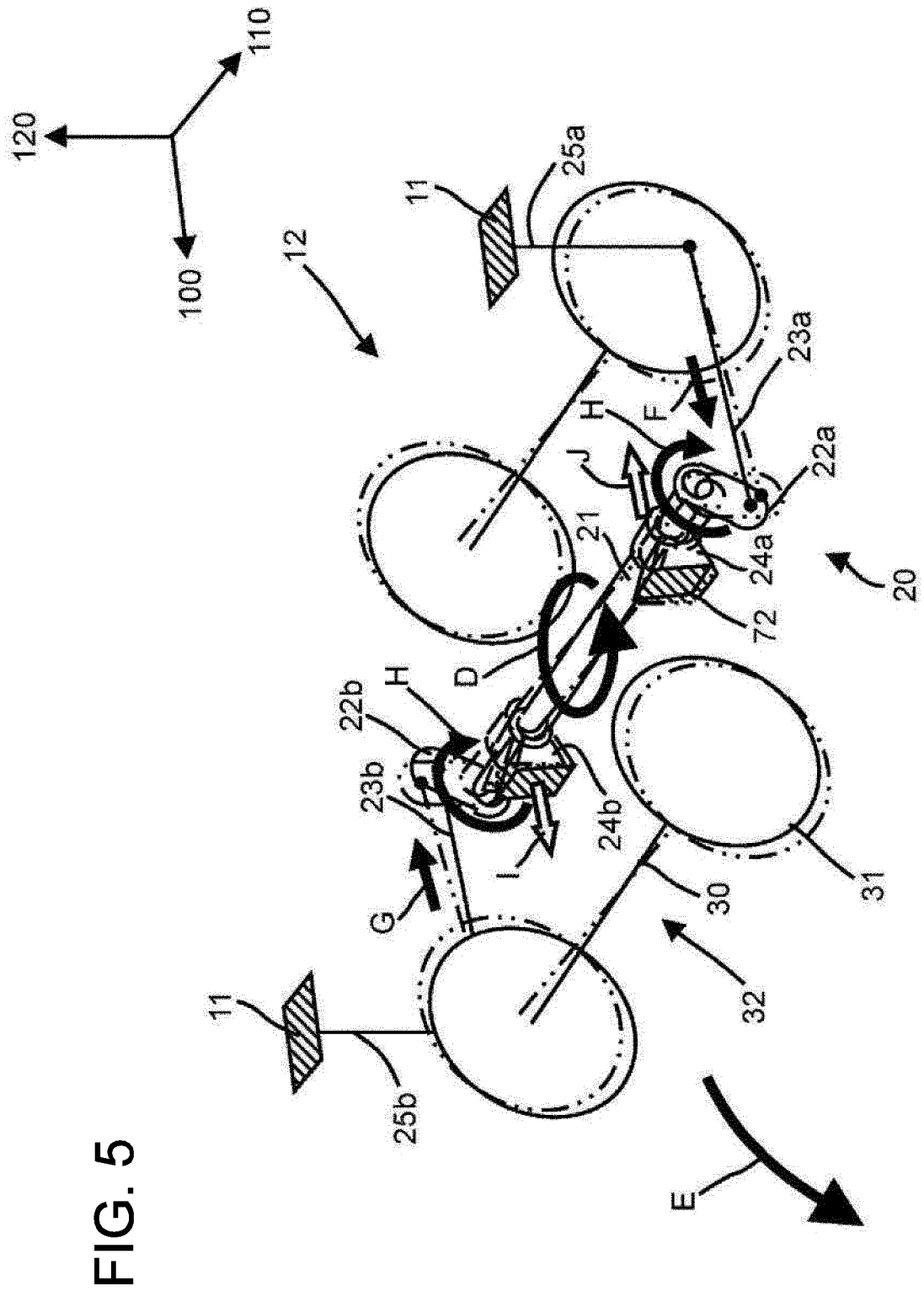


FIG. 5

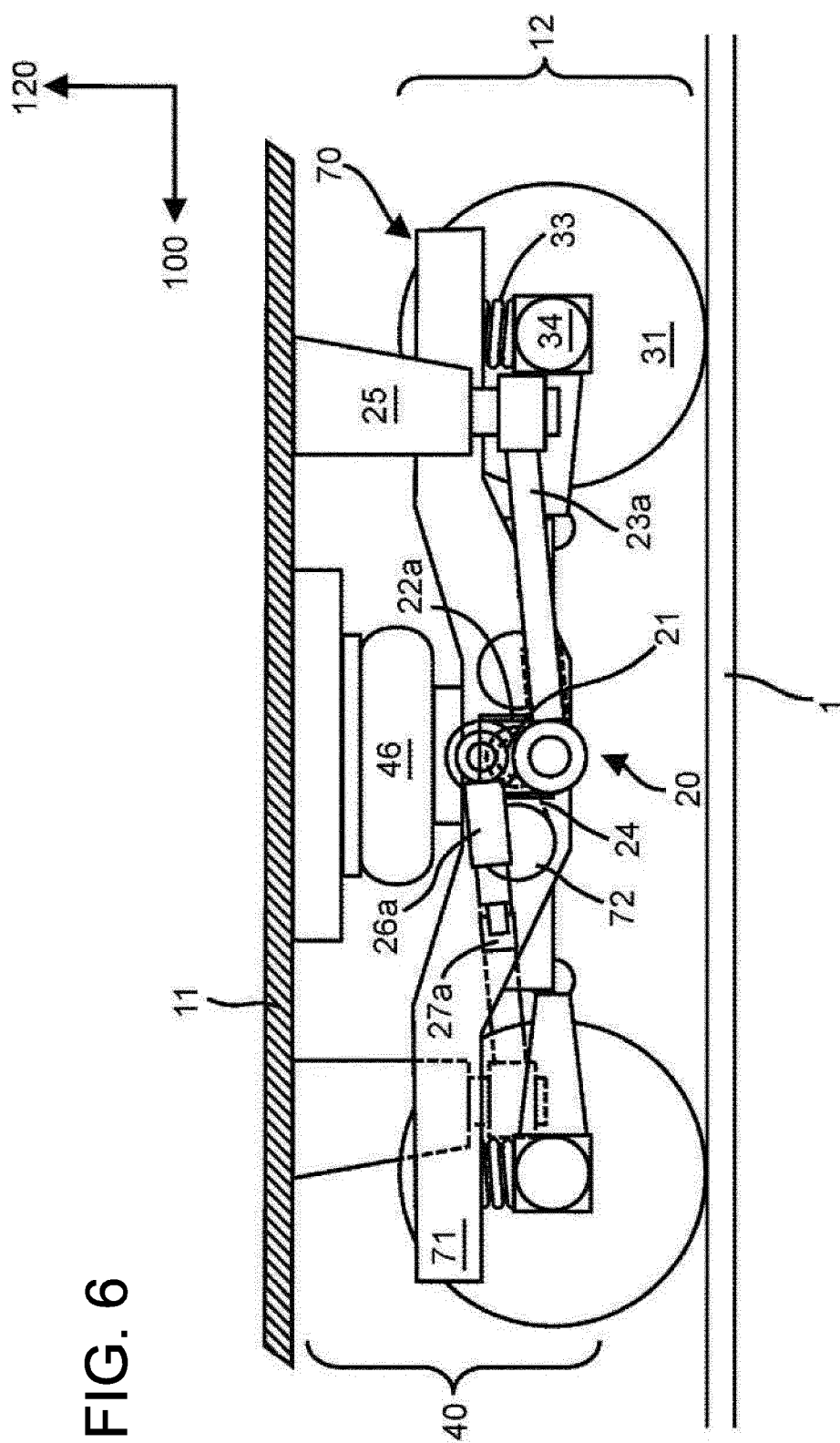
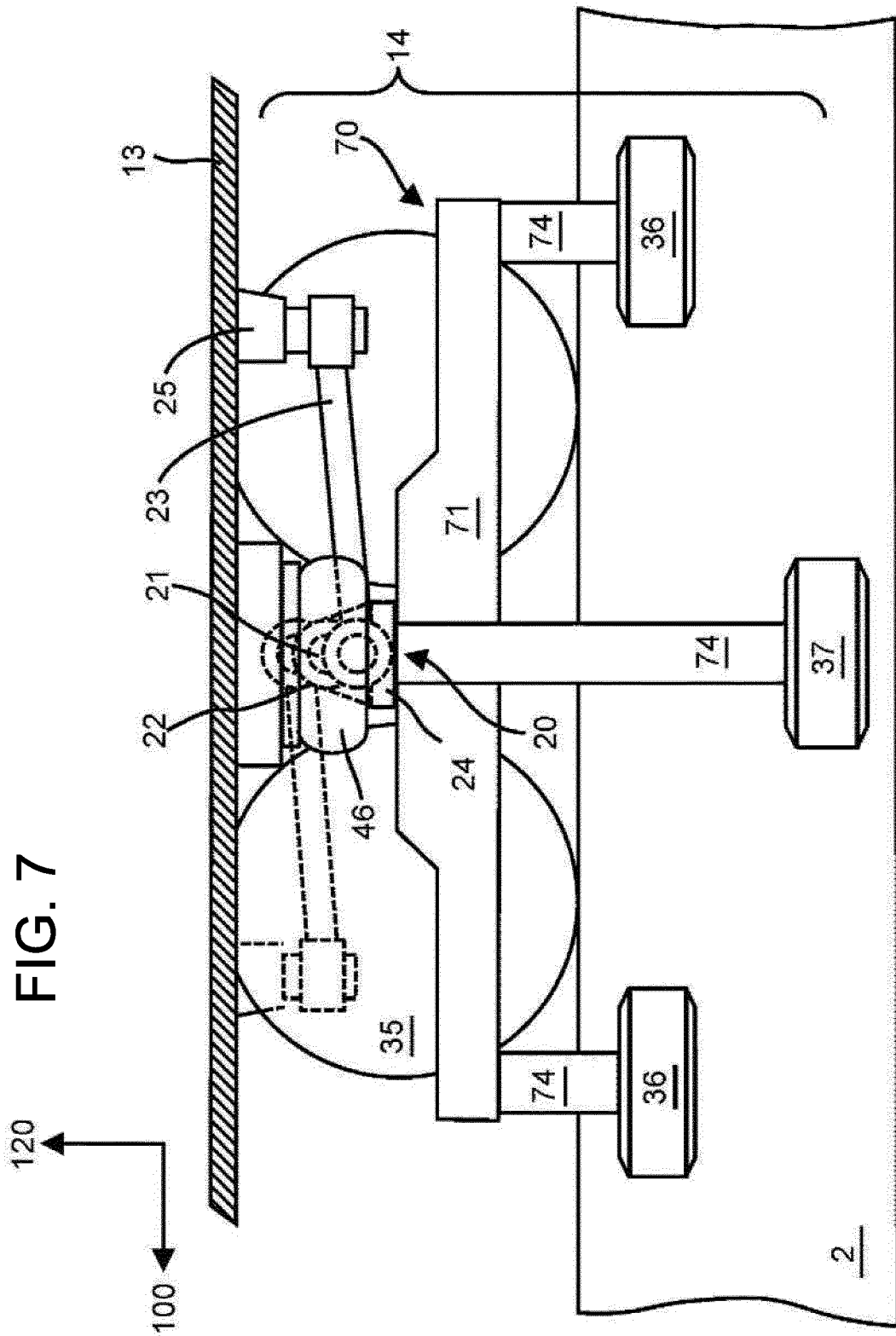


FIG. 6



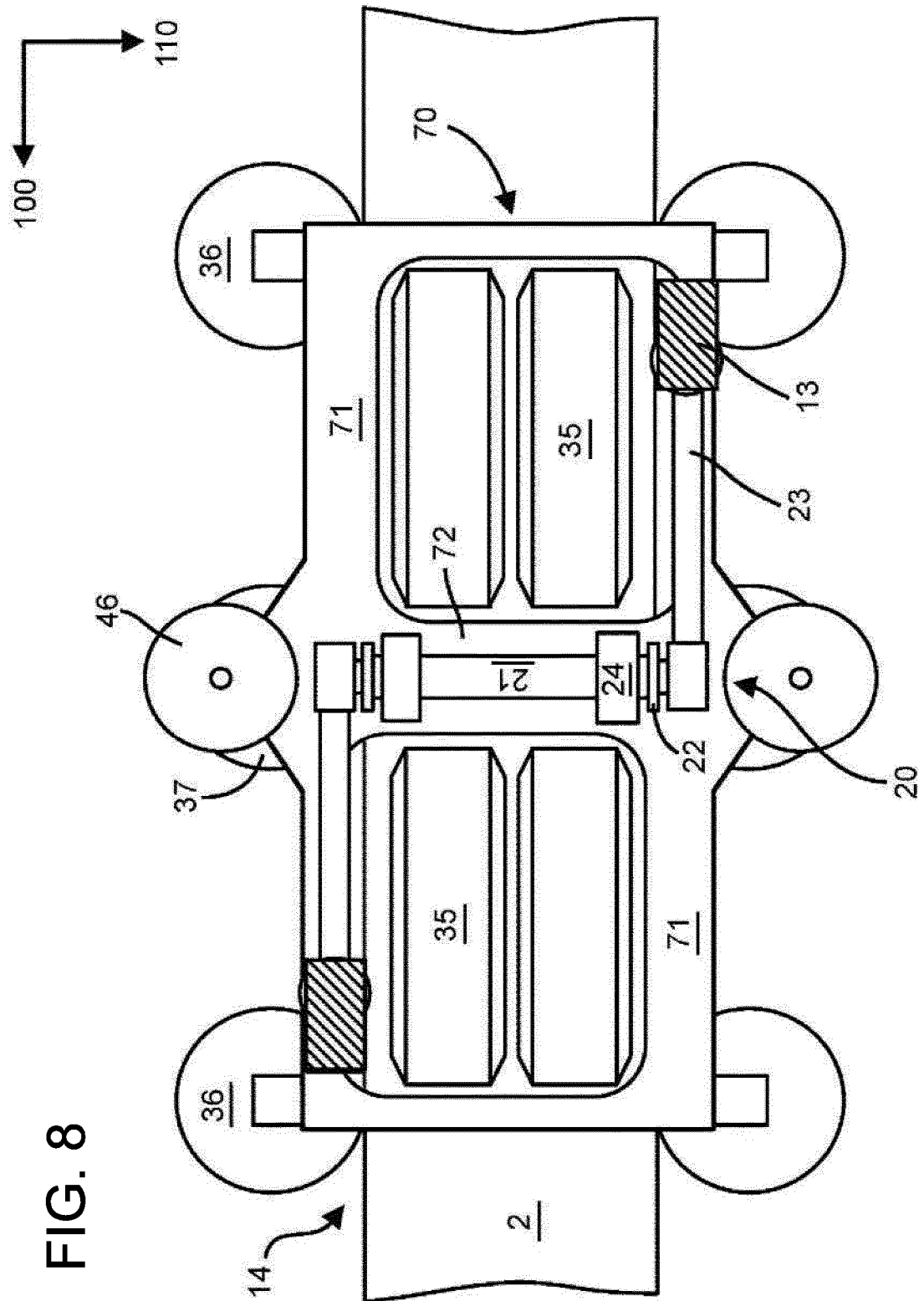


FIG. 8

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/069129

## A. CLASSIFICATION OF SUBJECT MATTER

B61F5/02(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)

B61F5/00-B61F5/02, B61F5/22

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

|                           |           |                            |           |
|---------------------------|-----------|----------------------------|-----------|
| Jitsuyo Shinan Koho       | 1922-1996 | Jitsuyo Shinan Toroku Koho | 1996-2014 |
| Kokai Jitsuyo Shinan Koho | 1971-2014 | Toroku Jitsuyo Shinan Koho | 1994-2014 |

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

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                                   | Relevant to claim No. |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| A         | JP 1-56941 B2 (Toshiba Corp.),<br>01 December 1989 (01.12.1989),<br>column 4, line 21 to column 6, line 4; fig. 2<br>to 4<br>& JP 59-164263 A        | 1-4                   |
| A         | JP 2862702 B2 (Toshiba Corp.),<br>03 March 1999 (03.03.1999),<br>paragraphs [0012] to [0016], [0029] to [0031];<br>fig. 1 to 4, 9<br>& JP 4-356270 A | 1-4                   |

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

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Date of the actual completion of the international search  
06 October, 2014 (06.10.14)Date of mailing of the international search report  
21 October, 2014 (21.10.14)Name and mailing address of the ISA/  
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**Patent documents cited in the description**

- JP 59100051 A [0007]