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(54) Articulated coupling device for an articulated track-bound vehicle

(57) An articulated track-bound vehicle comprising two vehicle units (10, 12) supported on a common undercarriage (14) is provided with an articulated coupling (18) for connecting the two vehicle units (10, 12) and for allowing the two vehicle units (10, 12) to rotate with respect to each other and with an abutment means (44) for limiting transverse motion of the coupling (18) relative to the undercarriage (14) and for allowing predetermined transverse play of the coupling (18) with respect to the undercarriage (14). The abutment means (44) consists of a roller (46) connected to the coupling (18) and inserted into an opening of a plate fixed to the undercarriage. The walls of the opening have a cam-like shape such that the predetermined transverse play is variable as a function of the angular position of an element (42) of the articulated coupling (18) with respect to the undercarriage (14).

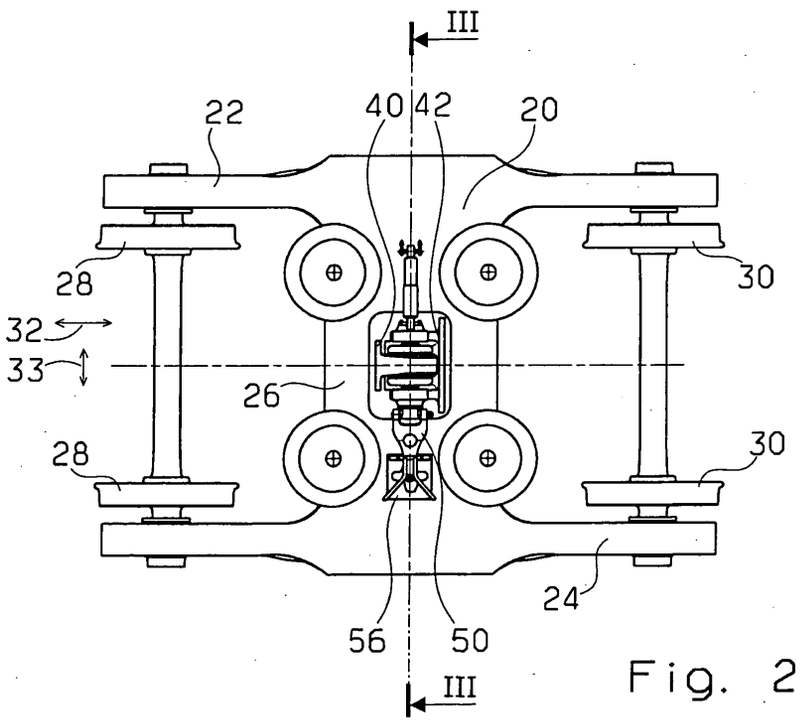

Fig. 2

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Description

[0001] The invention relates to a coupling device for coupling together the adjacent ends of two vehicle units of an articulated track-bound vehicle and to a track-bound vehicle including such a coupling device. More specifically, the invention relates to an articulated coupling device for an articulated track-bound vehicle comprising two vehicle units supported on a common undercarriage.

[0002] A coupling device for a Jacobs-type bogie is known from prior art document EP 0 520 301 A1. The facing ends of two vehicle units of an articulated rail-bound vehicle are supported on a common bogie and connected to one another in an articulated fashion via a universal joint. A fork of the universal joint is integral with the upper part of a vertical pivot bearing supported on the bogie. Such an arrangement does not provide any play in the transverse direction between the coupling and the bogie. The bogie has to be provided with a suspended cradle for supporting the vertical pivot bearing. The overall arrangement is bulky, heavy and subject to considerable wear.

[0003] An improved articulated connection between two subunits of a vehicle is known from DE 44 04 878 C1. The connection is provided with a fork attached to one vehicle subunit, a towing bar attached to the other vehicle subunit and a ball joint inserted between the fork and the towing bar. The two vehicle subunits are directly supported via a secondary suspension on a common Jacobs-type bogie located beneath the articulated connection. A vertical pin is secured to the towing bar and projects downwards into an open space in the bogie. Lateral and longitudinal springs are provided between the vertical pin and the walls of the open space. Thus, the articulation assembly is directly connected to the bogie frame. The width of the open space, i.e. the distance between the lateral walls of the open space, defines the maximum transverse displacement of the bogie with respect to the articulation assembly and/or to the vehicle subunits. A similar construction is known from prior art document EP 0 831 003. Two vehicle units are directly supported on a common undercarriage via a secondary suspension and attached to one another by means of a universal coupling. The undercarriage is provided with lateral buffers that limit the transverse movement of the universal joint with respect to the undercarriage. With such devices, the maximum relative motion between the vehicle subunits and the bogie is independent from the angular position of the vehicle subunits. It may become difficult to control the lateral movement of the vehicle units within the boundaries of the standard train profile, especially on curves, and to meet the conflicting requirements of vehicle stability and comfort.

[0004] The invention provides an improved articulated connection between two vehicle units supported on a common undercarriage. More specifically, the invention provides, by simple means, improved control of the relative reciprocal transverse motion between the vehicle units and the undercarriage.

[0005] According to a first aspect of the present invention, there is provided an articulated coupling device for an articulated track-bound vehicle comprising two vehicle units supported on a common undercarriage, said articulated coupling device comprising:

- an articulated coupling for connecting the two vehicle units and for allowing the two vehicle units to rotate with respect to each other; and
- an abutment means for limiting transverse motion of the coupling relative to the undercarriage and for allowing predetermined transverse play of the coupling with respect to the undercarriage, wherein the abutment means is such that the predetermined transverse play is variable as a function of the angular position of an element of the articulated coupling with respect to the undercarriage.

[0006] The coupling comprises at least two elements, one of which is affixed to one of the vehicle units, while the other is attached to the other vehicle unit. In most cases, the articulated coupling will include one or more additional intermediate elements. Any one of these elements can be used for varying the clearance between the coupling and the undercarriage.

[0007] With this arrangement, the limitation of the free transverse motion takes place between the coupling and the undercarriage, two components that are close to one another and easily accessible. This makes the assembly and adjustment of the device very simple. Moreover, it is not necessary to add transverse abutments between the vehicle units and the undercarriage so that the device can be kept compact.

[0008] Preferably, the transverse clearance, i.e. the amount of play in the transverse direction, decreases when the element of the articulated coupling moves away from an angular mid position relative to the undercarriage, said angular mid position corresponding to an alignment of the first and second vehicle units on a straight track. Particularly smooth running is achieved when the vehicle is travelling on a rectilinear track, while cornering stability is improved. Alternatively, it is also possible to keep the clearance constant, allowing less free transverse motion in one direction, e.g. towards the angular point in the centripetal direction, and more free transverse motion in the opposite transverse direction, e.g. away from the angular point in the centrifugal direction.

[0009] Advantageously, the abutment means comprises a stop element cooperating with a counter-stop element, the stop element being supported by the coupling and the counter-stop element being supported by the undercarriage. Preferably, the stop element is movable in a vertical plane with respect to its support so as to compensate for the vertical suspension motion of the vehicle units and of the coupling with respect to the un-

dercarriage. Advantageously, the stop element is articulated on the coupling about a horizontal pivot axis. The orientation of the horizontal pivot axis is not essential, but a longitudinal pivot axis is preferred because it allows the device to accommodate both the vertical suspension movement and the tilting movement of the coupling with respect to the undercarriage, which makes the device well adapted to tilting trains. According to one embodiment, the stop element is carried by an arm pivotally connected to the base. The abutment means may further comprise a guiding means for guiding the stop element towards the counter-stop element in the vertical direction.

[0010] Advantageously, the abutment means comprises opposed curved walls bordering an open space and a follower inserted into the open space and limited in motion by the curved walls. Only one stop element is necessary for controlling the movement of the coupling in both directions along the transverse axis of the undercarriage, which makes the device particularly compact.

[0011] Advantageously, the coupling further comprises a shock absorber between the coupling and the undercarriage for absorbing kinetic energy in the transverse direction.

[0012] According to a second aspect of the invention, there is provided an articulated track-bound vehicle comprising:

- a first vehicle unit ;
- a second vehicle unit ;
- an undercarriage having a frame supported on at least one pair of right and left wheels;
- a secondary suspension for supporting the first and second vehicle units on the frame of the undercarriage ;
- an articulated coupling for connecting the first and second vehicle units and for allowing the first and second vehicle units to rotate with respect to each other;
- an abutment means for limiting motion of the coupling relative to the undercarriage in a transverse direction relative to the undercarriage and allowing predetermined transverse play between the coupling and the undercarriage, wherein the abutment means is such that said predetermined transverse play is variable as a function' of the angular position of an element of the articulated coupling with respect to the frame of the undercarriage.

[0013] Advantageously, the abutment means is such that the amount of transverse play decreases when the element of the articulated coupling moves away from an angular mid position relative to the undercarriage, said angular mid position corresponding to an alignment of the first and second vehicle units on a straight track.

[0014] According to a preferred embodiment, a first pair of left and right wheels is provided under the first vehicle unit, and a second pair of left and right wheels is provided under the second vehicle unit. The secondary suspension comprises a first secondary suspension unit for supporting the first vehicle unit on the frame of the undercarriage and a second secondary suspension unit for supporting the second vehicle unit on the frame of the undercarriage. Preferably, the secondary suspension units are located between the front and rear pairs of wheels.

[0015] Advantageously, the first and second secondary suspension units provide springing at least in the vertical direction and in the horizontal transverse direction.

[0016] Other advantages and features of the invention will become more apparent from the following description of specific embodiments of the invention given as non-restrictive examples only and illustrated in the accompanying drawings in which:

- figure 1 is a side view of a track-bound vehicle according to one embodiment of the invention;
- figure 2 is a top view of a coupling device and of an undercarriage according to the embodiment of figure 1;
- figure 3 is a cross-section through line III-III of figure 2;
- figure 4 is an isometric view of an abutment means of the coupling device according to the embodiment of figure 1;
- figure 5 is an isometric view of an abutment means of an alternative embodiment of the invention.

[0017] With reference to figures 1 to 4, a track-bound vehicle, in this embodiment a railway or tramway vehicle, comprises two vehicle units 10, 12 supported on a common undercarriage 14 via a secondary suspension 16, and attached to one another by means of an articulated coupling 18 about a vertical axis 19.

[0018] The undercarriage 14 is provided with a H-shaped frame 20 with two longitudinal beams 22, 24 linked by a cross-member 26. The frame 20 is supported on a first pair of left and right wheels 28 and a second pair of left and right wheels 30, via a primary suspension 31.

[0019] The undercarriage 14 can be used for defining a spatial reference for the purpose of the description. More specifically, the general horizontal direction of movement of the undercarriage on the track will be defined as longitudinal direction 32, and the direction perpendicular to the longitudinal direction will be defined as transverse direction 33. If the wheels are steerable, the longitudinal direction will be defined by the mid position of the wheels.

[0020] The secondary suspension 16 comprises a first pair of springs 34 for directly supporting the car body of the first vehicle unit 10 on the cross member 26, a second pair of springs 36 for directly supporting the car body of the second vehicle unit 12 on the cross member

26 and several shock absorbers arranged between the car bodies and the undercarriage. The secondary suspension may also comprise other elements such as torsion bars to control the tilting motion of the car bodies. The wheel axles 28, 30 are located on each side of the two pairs of springs 34, 36 of the secondary suspension, below the car bodies.

[0021] The articulated coupling 18 comprises a first bracket 40 bolted or otherwise rigidly affixed to the car body of the first vehicle unit 10, a second bracket 42 bolted or otherwise rigidly affixed to the car body of the second vehicle unit 12, each of these brackets supporting an element of a spherical bearing 43 (figure 3) for articulating the first and second brackets with respect to one another. This kind of coupling is well known and described in more detail e.g. in document EP 0 831 003 A2, the description of which is incorporated herein by reference. One of the vehicle units is also connected to the undercarriage via a longitudinal connecting rod for integrally transmitting braking and/or acceleration forces in the longitudinal direction between the undercarriage and the vehicle units.

[0022] Abutment means 44 consisting of a roller 46 cooperating with two opposed cam-like side walls 48, 49 so that the relative motion between the coupling and the undercarriage is limited in the transverse direction. The roller 46 is supported at the free end of a support arm 50 articulated on the bracket 42 via a cylindrical bearing 52. The roller 46 is inserted in an opening 54 of a plate 56 rigidly affixed to the frame 20. This opening 54 is delimited by the curved cam-like side walls 48, 49. The distance measured in the transverse direction between the opposed side walls 48, 49 varies along a longitudinal axis. More specifically in this example, the opening 54 has a substantially cross-like shape, with two narrow longitudinal ends and a median part of greater dimension in the transverse direction. A slide bar 62 supported at the end of a double arm 64 bears against the upper side of the articulated arm 50 so as to tilt the free end of the arm 50 towards the opening 54. The lower side of the arm 50 bears against a wear plate 66. The roller 46 is thus guided in the vertical direction and maintained between the side walls 48, 49 irrespective of the vertical relative movement between the coupling 18 and the frame of the undercarriage 20, while it is free to move horizontally within the limits defined by the side walls 48, 49 of the opening.

[0023] Preferably, a shock absorber 70 is also articulated on the bracket 42 and on the frame of the undercarriage 20. The lower part of bracket 42 extends through an aperture 71 of the frame cross member 26, which is provided with lateral bumpers 72. The clearance between the bracket 42 and the bumpers 72 is relatively small, smaller than the shortest distance measured in the transverse direction between the opposed side walls 48, 49 of the plate 56, so that the bracket 42 will always contact one of the bumper before the roller 46 contacts one of the side walls 48, 49. However, the bumpers are soft and do not operate as stops.

[0024] The device operates as follows: when the vehicle is moving on a straight track, the car bodies of the two vehicle units 10, 12 are aligned and the arm 50 is perpendicular to the longitudinal axis 32 of the undercarriage 14. In such a case, the roller 46 is located in the central part of the opening 54. The distance between the side walls 48, 49 of the opening defines the maximum relative free movement or clearance between the bracket 42 and the undercarriage 14 in the transverse direction 33. The coupling 18 is thus able to move laterally together with the vehicle units 10, 12 relative to the undercarriage 14. The springs 34 and 36, which provide both vertical and transverse suspension, regulate the transverse reciprocal motion together with the bumpers 72 and the shock absorber 70. This transverse play is critical for increasing the smooth running of the train.

[0025] When the vehicle enters a curve, the two vehicle units 10, 12 gradually pivot about the pivot axis of the coupling, while the undercarriage 14 rotates to stay on track. As a result, the motion of the bracket 42 with respect to the undercarriage 14 includes a rotation about a vertical geometrical axis, even if the motion as a whole is not pure rotation. The rotation component of the motion makes the roller enter one of the narrow parts of the opening 54. The transverse play between the roller 46 and the side walls 48, 49, and thus between the coupling 18 and the undercarriage 14, is reduced. The deflection of the car bodies with respect to the undercarriage 14 in the transverse direction is therefore more tightly controlled so that a greater cornering stability is achieved, while the vehicle conforms to the standard train profile or envelope on curves. It should however be stressed that the bumpers 72 and the shock absorber 70 remain active on curves, which means that the bracket will abut against the bumper before the roller contacts one of the side walls 48, 49.

[0026] The shape of the side walls 48, 49 can be adjusted depending on the desired relation between the angular position of the coupling 18 and the undercarriage 14: The shape of the side walls is not necessarily symmetrical.

[0027] A detail of a second embodiment of the invention is shown in figure 5. The arm 50 is articulated via pivots 52 to one part of the coupling 18 and carries at its free end a roller 46, which is free to move between two to cam-like plates 56A, 56B bolted to a base plate. The shape of the two cam-like plates 56A, 56B is such that the lateral clearance is made dependent on the direction of rotation, so that more play is given in the centrifugal direction than in the centripetal direction. The cam-like plates can be taken apart and replaced by other plates of different shapes as desired.

[0028] While preferred embodiments of the invention have been described, it is to be understood that the invention is not limited to these embodiments. Many variations are possible:

[0029] The frame of the undercarriage can be articu-

lated or made deformable, e.g. for allowing a deformation to compensate for unevenness of the track. The frame can have a square shape with right and left longitudinal beams connected by a front and a rear cross-member. In such a case, the arm can be oriented longitudinally between the coupling and one of the cross-member, or transversely between the coupling and one of the longitudinal beams.

[0030] The undercarriage can have one or more pairs of left and right wheels. The wheels of each pair can be mounted on a common axle or be independent from one another. In most cases, the frame of the undercarriage will be suspended on the wheels by means of a primary suspension, so that the wheels will be allowed at least vertical movement with respect to the frame. The wheels can be articulated on the frame with a vertical axis of rotation for limited active or passive steering purposes. The undercarriage may have drive wheels, which can be driven individually or in pairs.

[0031] The secondary suspension can have any type of springs, e.g. coil springs or fluid springs. Preferably, each of the two car bodies is supported on a secondary suspension unit, as described above. However, the invention is also suitable for a vehicle assembly in which only one of the vehicle units is directly supported on the undercarriage via the secondary suspension, provided the second vehicle unit is properly supported on the first vehicle unit, e.g. via springs and or via the articulated connection itself. The invention is also well suited to tilting trains.

[0032] The articulation can be a spherical or cylindrical bearing. It can also be a connecting arm articulated on both car bodies.

Claims

1. An articulated coupling device for an articulated track-bound vehicle comprising . two vehicle units (10, 12) supported on a common undercarriage (14), said articulated coupling device comprising:

   - an articulated coupling (18) for connecting the two vehicle units (10, 12) and for allowing the two vehicle units (10, 12) to rotate with respect to each other;
   - an abutment means (44) for limiting transverse motion of the coupling (18) relative to the undercarriage (14) and for allowing predetermined transverse play of the coupling (18) with respect to the undercarriage (14), wherein the abutment means (44) is such that the predetermined transverse play is variable as a function of the angular position of an element (42) of the articulated coupling (18) with respect to the undercarriage (14).

2. The articulated coupling device of claim 1, wherein the abutment means (44) is such that the amount of transverse play decreases when the element (42) of the articulated coupling (18) moves away from an angular mid position relative to the undercarriage (14), said angular mid position corresponding to an alignment of the first and second vehicle unit (10, 12) on a straight track.

3. The articulated coupling device of claim 1 or claim 2, wherein the abutment means comprises a stop element (46) cooperating with a counter-stop element (48, 49), the stop element (46) being supported by the coupling (18) and the counter-stop element (48, 49) being supported by the undercarriage (14).

4. The articulated coupling device of claim 3, wherein the stop element (46) is movable in a vertical plane with respect to the coupling (18).

5. The articulated coupling device of claim 4, wherein the stop element (46) is articulated to the coupling (18) so as to pivot about a horizontal longitudinal pivot axis.

6. The articulated coupling device of any one of the preceding claims, wherein the abutment means further comprises a guiding means (62) for guiding the stop element (46) towards the counter-stop element (48, 49) in the vertical direction.

7. The articulated coupling device of any one of the preceding claims, wherein the abutment means comprises opposed curved walls (48, 49) bordering an open space (54) and a follower (46) inserted into the open space (54) and limited in motion by the curved walls (48, 49).

8. The articulated coupling device of any one of the preceding claims, further comprising a shock absorber (70) between the coupling (18) and the undercarriage (14) for absorbing kinetic energy in the transverse direction.

9. An articulated track-bound vehicle comprising:

   - a first vehicle unit (10);
   - a second vehicle unit (12);
   - an undercarriage (14) having a frame (20) supported on at least one pair of right and left wheels;
   - a secondary suspension (16) for supporting the first and second vehicle units on the frame (20) of the undercarriage (14);
   - an articulated coupling (18) for connecting the first and second vehicle units and for allowing the first and second vehicle units to rotate with respect to each other;

- an abutment means (44) for limiting motion of the coupling (18) relative to the undercarriage (14) in a transverse direction in relation to the undercarriage and allowing predetermined transverse play between the coupling (18) and the undercarriage (14), wherein the abutment means is such that said predetermined transverse play is variable as a function of the angular position of an element (42) of the articulated coupling with respect to the frame (20) of the undercarriage.

10. The articulated track-bound vehicle of claim 9, wherein the abutment means (44) is such that the amount of transverse play decreases when the element (42) of the articulated coupling moves away from an angular mid position relative to the undercarriage, said angular mid position corresponding to an alignment of the first and second vehicle unit on a straight track.

11. The articulated track-bound vehicle of claim 9 or claim 10, comprising a first pair of left and right wheels (28) located under the first vehicle unit (10) and a second pair of left and right wheels (30) located under the second vehicle unit (12).

12. The articulated track-bound vehicle of any one of claims 9 to 11, wherein the secondary suspension comprises a first secondary suspension unit (34) for supporting the first vehicle unit (10) on the frame (20) of the undercarriage and a second secondary suspension unit (36) for supporting the second vehicle unit (12) on the frame (20) of the undercarriage.

13. The articulated track-bound vehicle of claim 12, wherein the first and second secondary suspension units (34, 36) provide springing at least in the vertical direction and in the horizontal transverse direction.

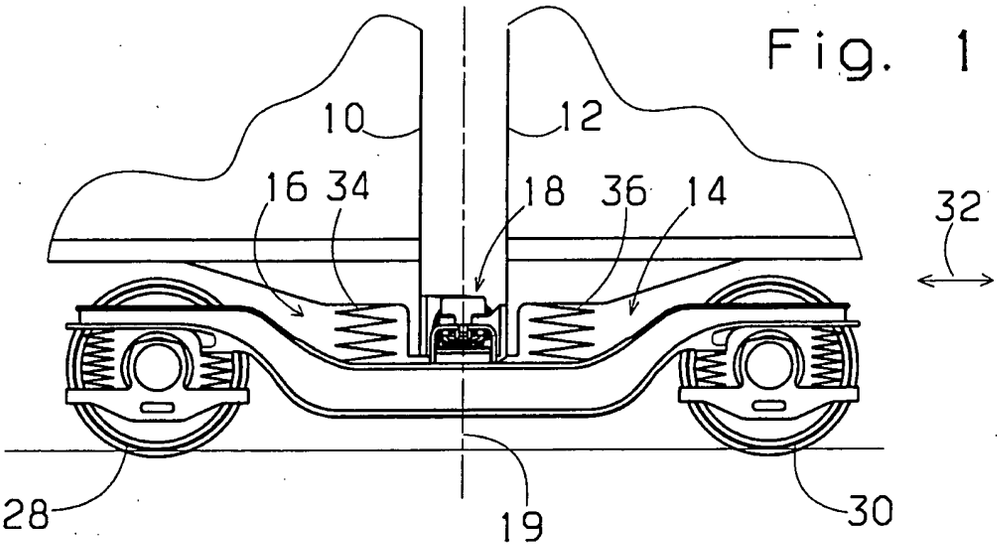
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Fig. 1

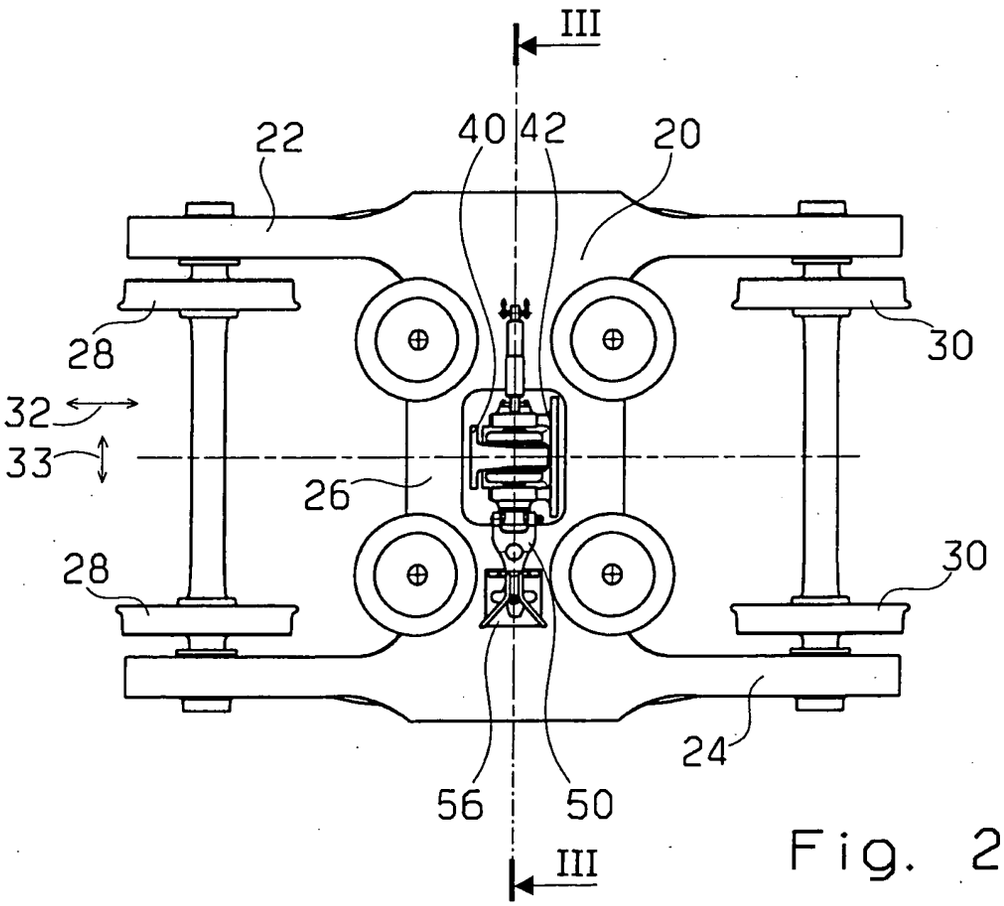
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Fig. 2

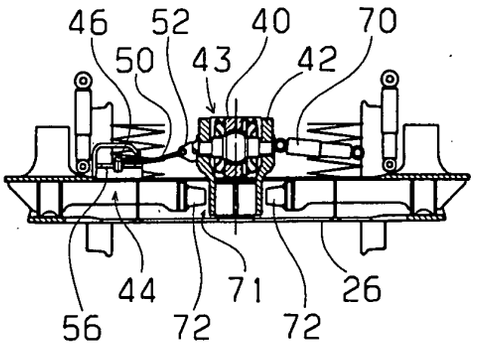

Fig. 3

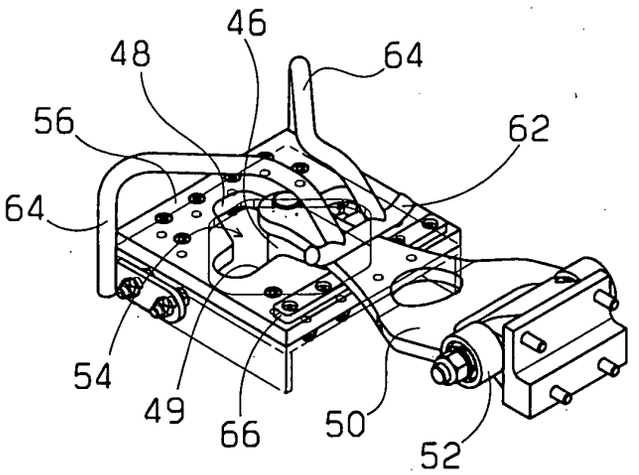

Fig. 4

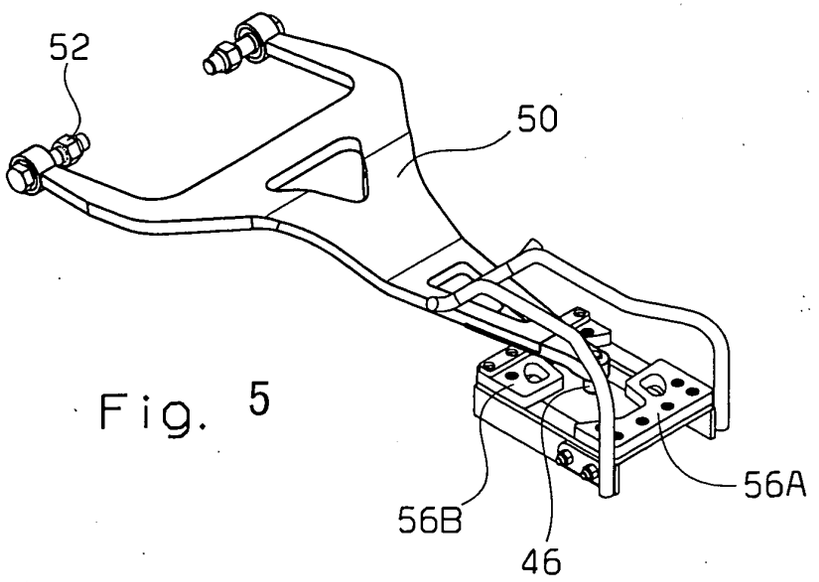

Fig. 5

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 01 2154

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TECHNICAL FIELDS SEARCHED (Int.Cl.7)

B61G
B61F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	24 June 2004	Ferranti, M

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