

RAILWAY TRUCK ASSEMBLY

This invention relates to a railway truck assembly, and, more particularly, to a steerable bogie in a railway truck designed for a rapid-transit system.

5 Conventional railway trucks (bogies) have been designed to meet substantially less stringent requirements than those which have to be met by trucks for urban, rapid-transit systems now on the drawing boards and/or under development. Such urban
10 rapid-transit systems are required to be substantially less noisy, to be able to negotiate curves much sharper than those of conventional railways, and to be lighter and thus more compatible with energy conservation.

15 The ability for a railway truck to negotiate relatively sharp curves with a minimum of wear and noise has been provided by always steering the wheel axles radially to the curve. Such a truck includes
20 a pair of yokes pivoted together about a vertical axis, the yokes being connected respectively to the wheel axles. By pivoting the yokes, the wheel axles are each steered to a radial position relative to a curve.

25 In accordance with one aspect of the present invention there is provided a steerable bogie for a vehicle, the bogie comprising: a pair of transverse axle assemblies spaced along a longitudinal
30 axis; a pair of axle support frames each rotatably supporting an axle assembly, the axle support frames being interconnected for relative movement about

a substantially vertical pivot axis; a pair of side frames disposed on opposite sides of the pivot axis and each extending between and being supported upon the axle support frames, means to permit relative movement between the side frames and the axle support frames to accommodate relative pivotal movement of the axle support frames about said pivot axis; lateral link means extending between at least one of the axle support frames and the side frames to laterally locate the side frames relative to the axle support frames, the link means including connections which accommodate both relative longitudinal movement between the axle support frame and the side frames and independent vertical movement of one side frame relative to the other upon tilting of the respective axle support frame; a transverse bolster extending between and supported by the side frames intermediate the axle assemblies; and means for supporting the bolster upon the side frames to permit relative rotational movement therebetween.

The link connections involve small angular displacements and so may simply have swivelling rod ends to allow the necessary freedom of pivoting and twisting motions between the movable components.

The provision of independent vertical movement between one side frame and the other ensures torsional flexibility allowing one wheel to lift out of the general plane of the other three wheels. In a preferred arrangement the link means includes a pair of lateral links, each extending from a

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central portion of one of the axle support frames to a respective one of the side frames, each link being pivotally jointed to the axle support frame and to the respective side frame to provide a
5 universal connection accommodating relative movement about horizontal and vertical axes.

In accordance with a further aspect of the present invention there is provided a vehicle including a
10 body supported on a steerable truck, the truck comprising a pair of transverse axles spaced apart along a longitudinal axis, a pair of axle support frames each rotatably supporting one of the axles, the frames being connected to one another for
15 relative movement about a vertical pivot axis, a truck frame supported by the axle support frames, a transverse bolster rotatably mounted on the truck frame to support the vehicle body and permit rotation of the body relative to the truck frame,
20 a pair of transversely spaced parallel longitudinally disposed draft links connected at one end to the vehicle body and at the other end to opposite ends of a transverse link, the link being pivotally connected intermediate its ends to one of the axle
25 support frames whereby draft forces are transmitted directly from the axle frame to the body.

In a preferred arrangement the draft links are connected to the vehicle body by pivot connections
30 accommodating relative vertical movement between the body and the truck. The draft links are further connected to the transverse link by pivot connections which accommodate transverse displacement of the body relative to the truck.

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A link is preferably connected between the bolster and one of the draft links, the link being engageable with the draft link at a location spaced from the connection of the draft link to the transverse link so that it induces pivotal movement of the axle frames about the vertical axis in response to lateral displacement of the truck relative to the vehicle body, the pivotal movement steering the truck to reduce the lateral displacement.

In accordance with a further aspect of the present invention there is provided a vehicle including a body supported on a steerable truck, the truck having: a pair of transverse axles spaced apart along a longitudinal axis; a pair of axle support frames each rotatably supporting an axle, the axle support frames being pivotally interconnected for steering motion about a vertical pivot axis; a main frame supported on the axle support frames and connected thereto to permit pivotal movement of the axle support frames about the vertical axis; and a bolster supported on the main frame for movement in a generally horizontal plane relative thereto and connected to the body to provide support therefor; the vehicle further including a draft linkage extending between the body and one of the axle support frames to transmit draft forces from the axle support frame to the body, and link means connected between the bolster and the draft linkage whereby lateral displacement of the bolster relative to the body causes the draft linkage to induce rotation of the axle support frames to steer the truck in a direction to reduce the lateral displacement.

A centreless pivot connection between the bolster and the truck frame elements cooperates with direct transmission of the load to the truck frame through the opposite ends of the bolster to permit the use of a relatively thin and centrally non-bulging bolster. Thus, more space is made available between the central portion of the bolster and the top of the rails, this space being advantageously used to install equipment such as a linear induction motor.

In accordance with a still further aspect of the present invention there is provided a steerable bogie for a vehicle comprising a pair of transverse axle assemblies spaced along a longitudinal axis, a pair of axle support frames each rotatably supporting an axle assembly, the axle support frames being interconnected for movement about a substantially vertical pivot axis, a pair of side frames disposed on opposite sides of the pivot axis and each extending between and being supported upon the axle support frames, one end of each side frame being pivotally connected to one of the axle support frames for movement therewith and the other end of each side frame being slidably supported on the other axle support frame, a pair of lateral links connected between the said other axle support frame and the said other ends of the side frames, each of the links being connected to the side frames and the axle support frames by universal joint means permitting pivotal movement about three mutually perpendicular axes to accommodate relative movement between the side frame and the said other axle frame whilst laterally locating the side frames, and a transverse bolster supported on said side frames intermediate said axle assemblies to rotatably support a vehicle body, the side frames thereby being independently movable to accommodate torsional displacement of one of the axle assemblies relative to the other.

A railway car incorporating railway truck assemblies constructed in accordance with the invention will now be described, by way of exmaple, with reference to the accompanying drawings, in which:

5 Figure 1 is a side elevation of the railway car which is provided with a pair of railway truck assemblies constructed in accordance with the invention;

 Figure 2 is a side elvation of one of the railway truck assemblies of Figure 1;

10 Figure 3 is a plan view of the railway truck assembly of Figure 2;

 Figures 4 and 5 are cross-sections taken respectively on lines 4-4 and 5-5 of Figure 3;

15 Figure 6 is an enlarged detail view of a suspension link-and-pin assembly;

 Figure 7 is a schematic plan view showing the pivotal relationship between the pivoting elements the pair of truck assemblies and the railway car body carried by the truck assemblies; and

20 Figure 8 is an enlarged view of the left-hand truck assembly of Figure 7.

 Referring to the drawings, Figure 1 shows a pair of railway trucks 1 which are used to carry a car body 2 of any desired construction . Each
25 railway truck 1 forms part of a railway truck assembly

also comprising a bolster 3 and associated elements to support the car body. As each railway truck assembly is identical, only one of them (that is to say that ringed by the dash-dot lines 2 in Figure 1) will be described.

The bolster 3 includes a central portion 4 of tubular, square cross-section, as best shown in Figures 3 and 4. Each end of the bolster 3 includes a baseplate portion 5 which is positioned lower than the central bolster portion 4. Stiffening ribs 6 are secured against the base of each baseplate portion 5, and extend longitudinally of the bolster 3. Each baseplate portion 5 is provided with a pair of side plates 7 upwardly extending edgewise along the opposite sides thereof. A generally C-shape top plate 8 is fixed to the upper edges of each of the adjacent side plates 7 to co-operate with the latter and with the corresponding baseplate portion 5 to form a protected recess for an air spring unit 9, which may be of any appropriate and known construction. The two air spring units 9 of each bolster 3 are fixed to the railway car body 2 by bolts 10, and carry the load of the corresponding end of the car body. The two side plates 7 on the inboard side of the bolster 3 are connected to the car body 2 by means of a pair of bolster drag links (or rods) 11. More specifically, each bolster drag link 11 has one end pivoted to the corresponding side plate 7 of the bolster 3, and the other

end pivotally connected to a bracket 12 fixed to, and downwardly projecting from, the base of the railway car body 2. The opposite ends of each bolster drag link 11 are vertically pivotable to accommodate the springing movement between the car body 2 and the bolster 3, and they are also provided with resiliently twisting rod ends to accommodate the very small transverse displacement of the car body relative to the bolster.

The railway truck assembly further includes an outboard yoke 13 and an inboard yoke 14. The outboard yoke 13 includes a main frame 15, while the inboard yoke 14 includes a main frame 16. Each main frame 15 and 16 includes a pair of laterally-spaced projections 17, to which is secured a journal housing 18. Each main frame 15 and 16 is formed with an underlying transverse beam portion 19. The journal housings 18 of each yoke 13 and 14 rotatably retain a respective wheel axle 20 having a flanged wheel 21 on each of the two opposite outer ends thereof. Thus, the flanged wheels 21 are adapted to roll on rails 22 and to carry the yokes 13 and 14 and the remainder of the railway truck assembly.

The outboard yoke 13 is provided with a longitudinal bar 23 rigidly secured centrally to the main frame 15 and projecting inboard therefrom.

Similarly, the main frame 16 is provided with a longitudinal bar 24 which is rigidly secured centrally thereto and projects outboard therefrom. The two bars 23 and 24 have their free ends pivoted to one another at equal distances from the wheel axles 20, that is to say centrally under the bolster 3.

A bracket 25 (see Fig. 6) is fixed to the outboard side of the bolster 3 and at the centre thereof. A pair of yoke suspension links 26 are pivoted, at their upper ends, to the bracket 25, and, at their lower ends, to the head of a vertical pivot pin 27. The pin 27 pivotally suspends the free end of the bar 23 of the outboard yoke 13. Owing to the pivotal connection between the free ends of the bars 23 and 24, the pivot pin 27 effectively supports both bars relative to the bolster 3.

A steering crossbar 28 transversely extends through the yoke bar 23, and is centrally pivoted therein by the pivot pin 27 (see Fig. 6). A pair of yoke drag links (or rods) 29 are pivotally connected, at one end, to a corresponding end of the steering crossbar 28, and at the other end, to a bracket 30 rigidly depending from the car body 2 (See Fig. 3). Each end of each of the links 29 is pivotally connected by a resiliently twistable rod end to allow restricted twisting as well as rotation. It must be noted that

the inboard end of each drag link 29 is pivoted about a horizontal axis to permit the resilient suspension between the car body 2 and the yokes 23 and 24. The other (or outboard) end of each drag link 28 is pivoted about a vertical axis relative to the steering crossbar 28.

A pair of parallel, longitudinally-extending side frames 31 and 32 are positioned on the opposite sides of the railway truck 1. Each side frame 31 and 32 has its inboard end pivoted, at 33, on the corresponding journal housing 18 and rests on a resilient pad 34. Each side frame 31 and 32 has its outboard end resting on a slide pad 35. Each end of the bolster 3 rests on a slide pad 36 at the centre of the corresponding side frame 31 or 32. Thus, the load of the railway car 2 is transmitted directly through the air spring units 9, and the opposite ends of the bolster 3, onto the slide pads 36 at the centre of the side frames 31 and 32. The slide pads 35 and 36 allow relative longitudinally displacement between the journal bearings 18 (or between the yokes 13 and 14), and between the bolster 3 and the side frames 31 and 32. Such displacement occurs in a curve upon angular displacement of the car body 2 (and hence the bolster 3) relative to the side frames 31 and 32 and the

railway truck 1 as a whole. As will be explained later, the angular displacement of the truck 1 relative to the car body 2 steers the yokes 13 and 14 to align the wheel axles 20 radially to the curve. Such steering displacement of the yokes 13 and 14 results in relative sliding between the yoke 13 and the side frames 31 and 32 on the slide pads 35.

10 A lateral stabilisation link (or rod) 37 extends laterally of the truck 1 and is pivotally connected to the central portion 4 of the bolster 3, and to the side frames 31 (see Fig. 5). This anchor rod 37 accurately restrains the side frame 31 in a lateral direction. A pair of yoke centring links 38 extend laterally from, and are pivotally connected at one end to, the outboard end of the yoke 13. The other ends of the links 38 are pivotally connected to the corresponding side frames 31 and 32. A third yoke centring link 39 extends laterally from, and is pivotally connected at one end to, the inboard end of the yoke 14. The other end of the link 39 is pivotally connected to the side frame 31. These links 38 and 39 are provided to centre the side frames 31 and 32 while the pivotal connections at the ends of each link provide torsional flexibility by accommodating both independent vertical movement of the side frames relative to one another and relative longitudinal movement between the axle support frame 15 and the side frames 31, 32. The side frames are therefore tied to the truck but at the same time can distort to accommodate both the steering motion of the trucks and tilting of the trucks. The pivot connections may alternatively comprise swivel joints permitting

movement about three mutually perpendicular axes.

A steering actuation device is provided to actuate the steering crossbar 28, the steering actuation device comprising an arm 40 which is fixed to the central portion 4 of the bolster 3, and which arm extends longitudinally of the railway car body 2. This arm 40 and the adjacent drag link 29 are each provided with a series of longitudinally-spaced adjustment holes 41. An adjustable link 42 is pivotally connected, at each end, in any one of the holes 41 of both the arm 40 and the link 29. With the link 42 connected as shown in the drawing, rotation of the bolster 3 about the central pivot axis is transmitted to the steering cross-bar 28 to produce a corresponding pivoting of the axle support frame 15 about its central pivot. If however the vehicle body (represented by connections 30) is merely shifted laterally relative to the axle support frame, no steering motion is induced, the drag links 29 merely pivoting about their connections with the steering cross-bar. On the other hand, with link 42 connected between another pair of holes 41 located inwardly of the cross-bar 28, lateral motion of the vehicle body will cause link 42 to exert a lever force on the cross-bar 28 with the connection between link 42 and drag link 29 acting as a fulcrum. The resulting steering motion will be in a direction tending to oppose the lateral motion inducing it. A stabilising link 43 (see Fig. 5) is connected parallel to, and beneath the crossbar 28 to stabilise the pivot pin through the end of the crossbar and to resist the action thereon by the link 42.

The detailed operation of the railway truck assembly will now be explained in detail with particular reference to Figures 7 and 8. When the railway car is on a curve, the body 2 thereof is at an angle "a" relative to the longitudinal axis of each railway truck 1. Since the bolsters 3 are restrained relative to the car body 2, they also make the same angle relative to the trucks 1.

The link 42 of each truck assembly acts to keep the steering cross-bar 28 laterally centred with respect to the car body 2. This will shift the yokes sufficiently with respect to the truck centre line to pivot the yokes 13 and 14 in opposite directions, so that

both the wheel axles 20 will take a radial alignment relative to the curve.

Although the curves of a rapid transit system may be sharper than those of conventional railway, the maximum steering angle of each wheel axle 20 is limited to about $2\frac{1}{2}$ degrees. Figures 7 and 8 exaggerate the relative angular pivoting between the pivotable components. In fact, the bars 23 and 24 shift only slightly laterally and thus the vertical pivot between the two shifts only slightly sideways out of alignment with the pivot centre of the trucks 1 relative to the car body 2.

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CLAIMS

1. A steerable bogie for a vehicle, the bogie comprising: a pair of transverse axle assemblies spaced along a longitudinal axis; a pair of axle support frames each rotatably supporting an axle assembly, the axle support frames being inter-
5 connected for relative movement about a substantially vertical pivot axis; a pair of side frames disposed on opposite sides of the pivot axis and each extending between and being supported upon
10 the axle support frames, means to permit relative movement between the side frames and the axle support frames to accommodate relative pivotal movement of the axle support frames about said
15 pivot axis; lateral link means extending between at least one of the axle support frames and the side frames to laterally locate the side frames relative to the axle support frames, the link means including connections which accommodate both
20 relative longitudinal movement between the axle support frame and the side frames and independent vertical movement of one side frame relative to the other upon tilting of the respective axle support frame; a transverse bolster extending
25 between and supported by the side frames intermediate the axle assemblies; and means for supporting the bolster upon the side frames to permit relative rotational movement therebetween.

2. A steerable bogie according to claim 1 wherein
30 the link connections include a universal connection between the side frames and the respective axle support frame.



3. A steerable bogie according to claim 1 or
claim 2 wherein the link means includes a pair
of lateral links, each extending from a central
portion of one of the axle support frames to a
5 respective one of the side frames.
4. A steerable bogie according to claim 3 wherein
each of the links is pivotally jointed to the
axle support frame and to the respective side frame
10 to accommodate relative movement about horizontal
and vertical axes.
5. A steerable bogie according to claim 1 wherein
one end of each of the side frames is pin jointed.
15 to the other of the axle support frames for
longitudinal and lateral movement therewith.
6. A steerable bogie according to claim 5 wherein
the other end of each side frame is slidably
20 supported on the said one of the axle support frames.
7. A steerable bogie according to claim 1 wherein
a strut extends between one of the side frames and
a central portion of the bolster to laterally locate
25 the bolster relative to the side frame.
8. A steerable bogie according to claim 7 wherein
the strut is pivotally connected to the bolster
for rotation about an axis substantially coincident
30 with the pivot axis.

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9. A steerable bogie for a vehicle comprising a pair of transverse axle assemblies spaced along a longitudinal axis, a pair of axle support frames each rotatably supporting an axle assembly, the axle support frames being interconnected for movement about a substantially vertical pivot axis, a pair of side frames disposed on opposite sides of the pivot axis and each extending between and being supported upon the axle support frames, one end of each side frame being pivotally connected to one of the axle support frames for movement therewith and the other end of each side frame being slidably supported on the other axle support frame, a pair of lateral links connected between the said other axle support frame and the said other ends of the side frames, each of the links being connected to the side frames and the axle support frames by universal joint means permitting pivotal movement about three mutually perpendicular axes to accommodate relative movement between the side frame and the said other axle frame whilst laterally locating the side frames, and a transverse bolster supported on said side frames intermediate said axle assemblies to rotatably support a vehicle body, the side frames thereby being independently movable to accommodate torsional displacement of one of the axle assemblies relative to the other.
10. A steerable bogie according to claim 9 wherein the bolster is laterally located with respect to the side frames by means of a strut extending between one of the side frames and the bolster.

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11. A steerable bogie according to claim 10 wherein a lateral link is connected between the said one axle support frame and the said one side frame.

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12. A steerable bogie according to claim 11 wherein the connections of the lateral links and the strut are located in a common horizontal plane.

10 13. A steerable bogie according to claim 12 wherein the strut is pivotally connected to said bolster for movement about an axis substantially coincident with the vertical pivot axis.

15 14. A vehicle including a body supported on a steerable truck, the truck comprising a pair of transverse axles spaced apart along a longitudinal axis, a pair of axle support frames each rotatably supporting one of the axles, the frames being
20 connected to one another for relative movement about a vertical pivot axis, a truck frame supported by the axle support frames, a transverse bolster rotatably mounted on the truck frame to support the vehicle body and permit rotation of the body relative
25 to the truck frame, a pair of transversely spaced parallel longitudinally disposed draft links connected at one end to the vehicle body and at the other end to opposite ends of a transverse link, the link being pivotally connected intermediate its
30 ends to one of the axle support frames whereby draft forces are transmitted directly from the axle frame to the body.



5 15. A vehicle according to claim 14 wherein the draft links are connected to the body by horizontal pivot connections which permit movement about a horizontal axis to accommodate relative vertical movement between the body and the truck.

10 16. A vehicle according to claim 15 wherein the draft links are connected to the transverse link by vertical pivot connections which permit movement between the transverse link and the draft links about a vertical pivot axis thereby to accommodate transverse displacement of the body relative to the truck.

15 17. A vehicle according to claim 14 wherein the connections of the draft links to the body and to the transverse link are universal connections and define a parallelogram, the connections thereby accommodating displacement of the body relative to
20 the truck without inducing relative pivotal motion between the axle support frames through the transverse link.

25 18. A vehicle according to claim 17 including link means operatively connected between the bolster and one of the axle support frames, the link means inducing steering motion of the axle support frames about the vertical axis upon rotation of the bolster relative to the truck frame.

30 19. A vehicle according to claim 18 wherein the link means is connected between the bolster and one of the draft links, the link means being engageable



(42)

with the draft link at a location spaced from the said universal connections so that upon lateral displacement of the truck relative to the body, the link means induces pivotal movement of the axle frames about the vertical axis to steer the truck to reduce the lateral displacement.

20. A vehicle according to claim 19 wherein the link means includes a link connected at one end to the bolster and at the other end to the draft link and extending generally parallel to the transverse link.

21. A vehicle including a body supported on a steerable truck, the truck having: a pair of transverse axles spaced apart along a longitudinal axis; a pair of axle support frames each rotatably supporting an axle, the axle support frames being pivotally interconnected for steering motion about a vertical pivot axis; a main frame supported on the axle support frames and connected thereto to permit pivotal movement of the axle support frames about the vertical axis; and a bolster supported on the main frame for movement in a generally horizontal plane relative thereto and connected to the body to provide support therefor; the vehicle further including a draft linkage extending between the body and one of the axle support frames to transmit draft forces from the axle support frame to the body, and link means connected between the bolster and the draft linkage whereby lateral displacement of the bolster relative to the body causes the draft linkage to induce rotation of the axle support frame to steer the truck in a direction to reduce the lateral displacement.



22. A vehicle according to claim 21 wherein the draft linkage includes a pair of longitudinal draft links transversely spaced from one another and connected at one end to the body and at the other end to opposite ends of a transverse link, the transverse link being pivotally connected intermediate its ends to the axle support frame.

23. A vehicle according to claim 22 wherein the link means is connected to one of the draft links intermediate its ends.

24. A vehicle according to claim 23 wherein the link means includes a link member connected between the bolster and the draft link and disposed generally parallel to the transverse link.

25. A steerable bogie substantially as herein described with reference to the accompanying drawings.

26. A vehicle substantially as herein described with reference to the accompanying drawings.

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