

RAILWAY TRUCK AND LIM PROPULSION ASSEMBLY

(16)

This invention relates to a railway truck, and more particularly, to a railway truck of the steerable type designed for propulsion by a linear induction motor or LIM.

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It is known that a linear induction motor or LIM requires to be maintained with a precise and constant gap above a reaction rail to assure efficient operation and propulsion by the LIM. For a conventional railway truck even without steering of the wheel axles, there is resilient suspension of the truck frame elements relative to the wheel axles and this results in undesirable up and down motion of the truck frame elements relative to the rails; thus the truck frame elements cannot provide suitable support for the LIM. In such case, the LIM would undergo unacceptable up and down springing relative to the reaction rail causing the air gap to vary beyond acceptable limits.

20 Further, in a railway truck wherein the wheel axles are steered radially to a curve, the mobility of the frame elements or yokes to achieve such steering increases the difficulty to achieve the aforementioned precisely controlled gap.

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The problem is even greater where the basic truck configuration is not only inherently flexible to allow for the steering motions but is also able to accommodate displacement of the wheels out of a planar configuration as they enter banked curves. In any event, whatever the truck configuration, it is necessary to ensure that the linear induction motor is not subjected to unnecessary forces and does not affect the dynamic stability of the truck.

In accordance with the present invention there is provided a steerable truck comprising a main frame for connection to a vehicle body, a pair of axle assemblies supporting the main frame and connected thereto at locations spaced apart along the longitudinal axis of the truck for steering movement about respective generally vertical steering axes, a linear induction motor extending between the axle assemblies for co-operation with a reaction rail to propel the truck, and suspension means extending between the motor and the axle assemblies to vertically locate the motor, the suspension means comprising first link means connecting the motor to one of the axle assemblies to inhibit relative pivotal movement between the motor and the said one axle assembly about the longitudinal axis of the truck whilst permitting relative pivotal movement between the motor and the said one axle assembly about its steering axis, and second link means connecting the motor to the other of the axle assemblies to permit relative pivotal movement therebetween about the longitudinal axis and about the steering axis of the other axle assembly, the suspension means thereby permitting steering motion and torsional flexibility between the axle assemblies whilst inhibiting the application of torsional loads to the motor..

The motor is preferably suspended at three points, two of which are located on one of the axle assemblies so that the motor moves with that axle while the third suspension point allows pivoting movement of the motor relative to the other axle assembly. In this manner the motor is not subjected to torsional loads.

Moreover, the two suspension links associated with the first axle assembly permit fore and aft displacement of the axle relative to the motor so that the axle may adopt a steering position.

To avoid lateral movement of the motor relative to the truck, centering means are preferably provided between the motor and the axle assemblies. The centering means may include a pair of lateral struts, each strut extending between the motor and a respective one of the axle assemblies, and each strut lying on a line passing through the steering axis of its respective axle assembly. The struts thereby exercise a minimum restraint to steering motion as the axle assemblies pivot relative to the motor.

The struts are preferably placed on opposite sides of the longitudinal axis so that yaw motion of the motor tends to produce equal and opposite steering forces that balance one another and maintain the truck in the desired steered position.

Thrust from the motor is preferably transmitted to a first of the axle assemblies by means of a strut connected to the first axle assembly adjacent its steering axis. This strut is preferably positioned slightly above the connection of draft links provided on the axle assemblies to transmit draft loads from the truck to the vehicle body. In this manner a couple is produced on the truck by the thrust from the motor, the couple tending to force the leading

wheels of the truck into the track. This assists in neutralising the effect of the rearward movement of the centre of force of the motor as the vehicle accelerates.

5 The use of link connections to restrain the motor is possible because of the minute angular displacements involved. At least the main suspension links preferably have swivel pivot connections at each end which allow the necessary

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20 freedom of pivoting and twisting motions between the LIM and the supporting truck frame elements.

The above and other ~~objects and~~ advantages of the present invention will be better understood with reference to the following detailed description of a preferred embodiment thereof which is illustrated, by way of example, in the accompanying drawings; in which:

10 Figure 1 is a side elevation view of a railway car embodying a pair of railway truck and LIM propulsion assemblies according to the present invention;

Figure 2 is a side elevation view of a railway truck and LIM propulsion assembly as encircled by the arrow 2 in Figure 1;

Figure 3 is a plan view as seen along line 3-3 in Figure 2 and with parts broken away to better show the LIM unit;

Figure 4 is a cross-sectional view as seen along line 4-4 in Figure 3;

20 Figure 5 is a perspective view of the linear induction motor or LIM unit with the associated restraining links connected thereto and shown for some only in part; and

Figure 6 is a partial end view of the railway truck and LIM propulsion assembly.

The railway truck 1 according to the present invention, as shown in Figure 1, is used in a pair to carry a car body 2 of any desired construction. This railway truck 1 is connected to the car body 2 by means of a bolster 3 and associated elements to support the car body.

30 The bolster 3 includes an intermediate portion 4 of tubular construction having a uniform rectangular cross section. Each end of the bolster 3 includes a baseplate portion 5 which is positioned lower than the intermediate bolster portion 4.

Stiffening ribs 6 are secured against the bottom of each baseplate portion 5 and extend longitudinally of the bolster. 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 on the upper edge of each pair of adjacent side plates 7 to cooperatively form with the latter and with the corresponding baseplate portion 5 a protected recess for an air spring unit 9. The latter may be of any appropriate and known construction currently used in the art. The two air springs 9 of each bolster 3 are fixed to the railway car body 2, such as 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 or rod 11 has one end pivoted to the corresponding side plate 7 of the bolster and the other end pivotally connected to a bracket 12 fixedly secured to and downwardly projecting from the bottom of the railway car body. The opposite ends of each bolster drag link 11 are vertically pivoted to accommodate the springing movement between the car body and the bolster 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 includes an outboard and an inboard yokes 13 and 14 respectively. 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 apart projections 17 to each of 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 retains a wheel axle 20

28 having a flanged wheel 21 on each of the two opposite outer ends thereof. Thus, the flanged wheels 21 are adapted to carry the yokes and the remainder of the railway truck assembly rollably on rails 22.

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 end pivoted one to the other at equal distances from the wheel axles 20 and thus, centrally under the bolster 3.

The bars 23 and 24 are pivotally suspended to the bolster at 25 by a pivot connection which also pivotally supports a steering crossbar 26 which pivots at 25 about a vertical axis. A pair of yoke drag links or rods 27 are pivotally connected at one end to a corresponding end of the steering crossbar 26 and at the other end to a bracket 28 rigidly depending from the car body 2.

A pair of side frames 29 and 30 are positioned on the opposite sides respectively of the railway truck and longitudinally extend parallel one to the other. Each side frame has its inboard end pivoted on the corresponding journal housing 18 by means of resilient pad. Each side frame has its outboard end resting on a sliding pad over the corresponding journal housing 18. Each end of the bolster 3 rests on a sliding pad at the center of the corresponding side frame. Thus, the load of the railway car 2 is transmitted directly through the air springs 9, and the opposite ends of the bolster 3 onto the sliding pads at the center of the side frames 29 and 30. Thus, the sliding pads allow relative longitudinal displacement between the journal bearings 18 or yokes 13,14, the bolster 3 and the side frame. Such displacement occurs in

a curve upon angular displacement of the car body 2 and bolster 3 therewith relative to the side frames and the railway truck as a whole. As will be explained later, this angular displacement of the car body steers the yokes 13, 14 to align the wheel axles 20 radially to the curve. Such steering displacement of the yokes results in relative sliding between the yokes and the side frames 29, 30 on the corresponding sliding pads.

10 A lateral stabilizing link or rod 31 extends laterally of the truck and is pivotally connected to the central portion of the bolster 3 and to the side frame 29. This anchor rod or link 31 accurately restrains the lateral position of the side frame 29 relative to the bolster 3. A set of three yoke centering links 32, 32, 33 extend laterally and are pivotally connected at one end to one end of a side frame and at the other end, near the center line of the corresponding yoke. These links 32, 32, and 33 are provided to laterally restrain the lateral position of the side frames 29, 30 relative to the yokes 13 and 14.

20 The steering crossbar 26 is connected to an arm 34 which is fixedly secured to the central portion 4 of the bolster and extends longitudinally of the railway car body by an adjustable link 35 which is pivotally connected to the arm 34 and the adjacent drag link 27 which extends generally parallel to the steering crossbar 26.

30 When the railway car traverses a curve, the car body 2 and the bolster 3 slightly pivot relative to the yokes and to the longitudinal axis of the railway truck. As a result, the arm 34 and adjustable link 35 act on the yoke drag links 27 and the crossbar 26 to keep it relatively fixed with respect to the car body centerline. The latter acts at 25 on the yoke 13 to steer the corresponding wheel axle 20 to a position which is essentially to the curve in the rails 22. The aforementioned

(24) pivot connection between the two yokes 13 and 14 causes the yoke 14 to be also steered to a radial position relative to the track curve.

To allow for such steering action and to provide for vertical irregularities in the rails 22, the yokes 13 and 14 and the side frames 29 and 30 are provided with mobility relative to each other. The yokes 13 and 14 are stiffly sprung relative to the wheel axles 20. By a resilient bushing, not shown, around the bearing in each journal housing 18. Consequently, the yokes 13 and 14 at the wheel axles 20 remain at practically the same constant height relative to the rails 22.

The railway truck and LIM propulsion assembly, according to the present invention, includes the aforescribed railway truck 1 and bolster 2 in combination with the hereinafter described linear induction motor or LIM unit 36 and associated connecting links. The railway truck 1 and bolster 2 are defined and shown in more details in the Applicant's copending patent application NO. now Patent No.

The linear induction motor or LIM unit 36 is shown in outline only, in Figures 3, 5 and 6 and may be of any appropriate construction, as known in the art to produce a propulsive action against a reaction rail 37 spaced between the rails 22. The LIM unit 36 is of relatively flat and elongated shape to find space under the yokes and the bolster.

A system of three vertical links support the LIM unit relative to the yokes and the side frames. This system of links includes a single suspension link 38 pivotally suspending the outboard end of the LIM unit 36 to the outboard steering yoke 13. The single suspension link 38 is centrally positioned transversely of the LIM unit 36 and yoke 13. The system of vertical links also includes a pair of suspension links 39 pivotally suspending the inboard end of the LIM unit 36 to the inboard steering yoke 14. Each suspension link 38,

39,39 is pivotally supported by the corresponding yoke and is pivotally connected at its lower end to the LIM unit. Each suspension link is pivoted longitudinally of the railway truck adjacent to the corresponding wheel axle 20 such that the vertical position of the LIM unit is relatively unaffected by deflection or pitching motion of the yokes. Swivelling pivot connections connect the ends of the suspension links to the yokes and to the LIM unit to allow some transverse swivelling of the suspension links relative to the LIM unit and/or to the yokes.

The lateral and longitudinal position of the LIM is established by a system of links in a generally horizontal plane. A drag link 40 extends lengthwise longitudinally of the LIM unit or railway truck and is pivotally connected at one end to a rail portion 41 of the inboard yoke 14 and at the other end to a bracket 42 rigidly projecting from the LIM unit. The outboard end of the drag link 40 is pivoted to the yokes 14 about a vertical axis while the inboard end is pivoted about a transverse axis. Both ends of the link 40 also allow for swivelling motion by appropriate rod end connection.

The system of horizontal links also includes a pair of lateral links 43 and 44 laterally restraining the LIM unit relative to the yokes 13, 14.

It will be understood that links 38, 39,39,40,43, and 44 restrain the LIM unit vertically, longitudinally, and laterally relative to the yokes 13 and 14 but are pivotally and swivelly connected to allow the relatively small angular steering of the yokes relative to the side frames. It must be noted that the lateral links 43 and 44 are connected to the yokes and the center line of each link is aligned as nearly as possible with the yaw rotation center of the yoke to minimize the error in alignment with the railway track when the yokes are steered. Thus, the LIM unit 36 is also kept in alignment

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with the reaction rail 37 beside being kept at a precise gap height C above this rail.

Because the lateral links 43 and 44 pass through the centre of rotation of the yokes 13 and 14, they exercise a minimum restraint to steering motion as the yokes pivot relative to the motor. The links 43, 44 are also placed on opposite sides of the longitudinal axis of the truck so that yaw motion of the motor tends to produce equal and opposite steering forces that balance one another and maintain the truck in the desired steered position.

However, in the event that a lateral force occurs sufficient to laterally displace the motor relative to the truck, the outboard placement of the links 43, 44 causes a steering motion of the yokes 13, 14 tending to steer the truck in a direction to counteract the lateral force. This improves both the response time and the stability of the truck.

It should also be noted that the pivotal connections of the drag link 40 are positioned slightly above the connection of the draft links 27 to the truck so that the thrust created by the motor produces a net couple on the truck tending to force the leading wheels into the track. This assists in neutralising the effect of the rearward movement of the centre of force of the motor as the vehicle accelerates.

The pivotal connection of the drag link 40 to the steering yoke 14 is located adjacent the steering axis of the yoke. This has the advantage of minimising the steering couple which is generated by the thrust forces on the motor when the yoke adopts a steering position and the pivotal connection is thereby displaced from the longitudinal axis of the truck.



C L A I M S

1. A steerable truck comprising a main frame for connection to a vehicle body, a pair of axle assemblies supporting the main frame and connected thereto at locations spaced apart along the longitudinal axis of the truck for steering movement about respective generally vertical steering axes, a linear induction motor extending between the axle assemblies for co-operation with a reaction rail to propel the truck, and suspensions means extending between the motor and the axle assemblies to vertically locate the motor, the suspension means comprising first link means connecting the motor to one of the axle assemblies to inhibit relative pivotal movement between the motor and the said one axle assembly about the longitudinal axis of the truck whilst permitting relative pivotal movement between the motor and the said one axle assembly about its steering axis, and second link means connecting the motor to the other of the axle assemblies to permit relative pivotal movement therebetween about the longitudinal axis and about the steering axis of the other axle assembly, the suspension means thereby permitting steering motion and torsional flexibility between the axle assemblies whilst inhibiting the application of torsional loads to the motor.

2. A steerable truck according to Claim 1 wherein the first link means includes a pair of laterally spaced links each of which is connected at respective ends to the said one axle assembly and to the motor by pivotal connections permitting relative displacement between the axle assembly and the motor along the longitudinal axis of the truck.

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3. A steerable truck according to Claim 2 wherein an imaginary line connecting the laterally spaced links intersects the steering axis.

4. A steerable truck according to Claim 3 wherein the links are equally spaced on opposite sides of the longitudinal axis.

5. A steerable truck according to Claim 2 wherein the second link means is located adjacent the steering axis of the said other axle assembly.

6. A steerable truck according to Claim 5 wherein the second link means is pivotally connected at opposite ends to the motor and the said other axle assembly respectively to accommodate longitudinal displacement of the motor relative to the axle assembly.

7. A steerable truck according to Claim 5 wherein the first and second link means are universally connected to the motor and to the respective axle assemblies.

8. A steerable truck according to Claim 1 including thrust transmission means to transmit thrust from the motor to a first of the axle assemblies.

9. A steerable truck according to Claim 8 wherein the thrust transmission means includes a strut connected to the first axle assembly adjacent its steering axis.

10. A steerable truck according to Claim 9 wherein a draft connection is provided on the axle assemblies to transmit draft loads from the truck to the vehicle body and the strut is connected to the axle assembly at a location above the draft connection thereby to provide a couple to the truck about a transverse horizontal axis upon application of thrust from the motor.



11. A steerable truck according to Claim 2 wherein centering means act between the motor and the axle assemblies to inhibit lateral movement of the motor relative to the axle assemblies.
- 5 12. A steerable truck according to Claim 11 wherein the centering means includes a pair of lateral struts, each lateral strut extending between the motor and a respective one of the axle assemblies.
- 10 13. A steerable truck according to Claim 12 wherein the lateral struts lie on a line passing through the steering axis of its respective axle assembly.
- 15 14. A steerable truck according to Claim 13 wherein the lateral struts are inclined to the longitudinal axis of the truck and are attached to the respective axle assemblies at respective points displaced laterally and longitudinally from the respective steering axis.
- 20 15. A steerable truck according to Claim 14 wherein the struts are disposed on opposite sides of the longitudinal axis.
- 25 16. A steerable truck according to Claim 14 wherein, when measured along the longitudinal axis, the distance between the connections of the struts to the respective axle assemblies is greater than the distance between the steering axes so that a lateral force on the motor induces equal and opposite steering motion of the axle assemblies.
- 30 17. A steerable truck comprising a pair of wheelsets spaced apart along a longitudinal axis, a pair of yokes each associated with a respective one of the wheelsets, a main frame supported by the yokes and connected thereto to permit rotation of the yokes relative to the main frame about respective vertical steering axes, a linear induction motor located
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beneath the yokes for cooperation with a reaction rail, means for suspending the motor from the yokes such that the motor is maintained in a fixed vertical orientation relative to the yokes, thrust means to transmit longitudinal forces from the motor to the yokes, and centering means to inhibit lateral displacement of the motor relative to the yokes, the suspension means comprising three links each having universal connections at each end for connecting the motor to the axle assembly, two of the links being connected at spaced locations between one of the axle assemblies and the motor and the remaining link being connected between the other axle assembly and the motor, the links thereby permitting steering and torsional deflection between the axle assemblies whilst being vertically supported thereby.

18. A steerable truck according to Claim 17 wherein the centering means includes a pair of lateral struts each connected to the motor and to a respective one of the yokes by pivotal connections to accommodate steering motion of the yoke relative to the motor.

19. A steerable truck according to Claim 18 wherein the lateral struts are disposed on opposite sides of the longitudinal axis of the truck and are connected to the yokes at locations displaced from the steering axes along the longitudinal axis, whereby lateral forces applied to the motor are transmitted to the yokes to induce equal and opposite steering action of the yokes about their axes.

20. A steerable truck according to Claim 18 wherein the lateral struts are located on opposite sides of the longitudinal axis and are each connected to the yokes outboard of their respective steering axes, thereby to prevent steering action of the yokes upon yaw of the motor relative to the truck.



21. A steerable truck according to Claim 17 wherein the thrust means includes a longitudinal link connected between the motor and one of the said yokes and connected to said one yoke by a pivotal connection adjacent the steering axis of
5 said one yoke to accommodate steering motion of the yoke while minimising the steering couple generated by the thrust of the motor upon movement of the yokes to a steering position.

10 22. A steerable truck substantially as herein described with reference to the accompanying drawings.