

ARTICULATED VEHICLES

The present invention relates to articulated vehicles and in particular passenger carrying articulated vehicles such as street cars.

It is well known to articulate vehicles to enable them to negotiate a smaller radius curve than is available with a rigid chassis vehicle of comparable length. Conventionally such vehicles are articulated at the mid point of the vehicle so that the front and rear wheels of the vehicle follow the same curve.

In these passenger carrying vehicles it is generally desirable to have the two portions of the vehicle interconnected in a manner that allows movement of the passengers from one portion to another. This avoids the need for duplicate crew and entrance and exit doors. Such interconnection is usually achieved by means of a tunnel structure arranged at the articulation point to provide the required passageway. Such a tunnel structure must be designed to accommodate movement between the two vehicle portions while still providing an adequate passageway between the vehicles.

The vehicle must be able to accommodate horizontal curves; that is steering movement about a vertical axis and vertical curves, that is change of incline of the track being negotiated. There is also a
5 tendency for the two halves of the chassis to oscillate about the longitudinal axis relative to one another due to unevenness in the track or the spiralling of the track that is usually found at the start of a curve in a tracked vehicle. Such oscillation
10 tends to cause lateral displacement between the two passenger carrying portions of the vehicle and this is generally undesirable where a passageway is used to connect the two vehicles. Such displacement is usually prevented by means of the bearing assembly
15 which connects the two cars and permits the articulation between the cars. The forces which tend to produce the lateral displacement are reacted at this bearing to rigidly connect the cars about the longitudinal axis. However this requires the bearing
20 structure to be relatively large and heavy in view of the magnitude of the forces imposed. Further this bearing structure is necessarily accommodated beneath the tunnel structure where space is at a premium.

25 According to the present invention there is provided an articulated vehicle comprising a first chassis and a second chassis, each having an outboard end and an inboard end, coupling means interconnecting the inboard ends and including vertical pivot means to
30 accommodate relative steering movement of the two chassis about a vertical axis and horizontal pivot means to accommodate relative pivotal movement of the two chassis about a transverse horizontal axis, the coupling means further comprising linkage means ver-
35 tically spaced from the horizontal pivot means and

including a first link pivotally connected to one of the chassis for movement about a vertical axis and a pair of transverse links extending between the first link and the other chassis, the transverse links being
5 connected to the first link at spaced locations by vertical pivot connections to permit movement of the transverse links in a generally horizontal plane whereby the transverse links oppose pivotal movement of the first link to inhibit relative lateral displacement of the two chassis.
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By inhibiting relative lateral displacement of the two chassis at the vertically spaced location, the transverse links provide a degree of torsional rigidity which opposes
15 the aforesaid tendency of the two chassis to oscillate relative to one another about the longitudinal axis of the vehicle. The transverse links are preferably connected to the first link on opposite sides of the pivotal connection between the first link and the chassis.
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An embodiment of the invention will now be described by way of example only with reference to the accompanying drawings in which:

25 Fig. 1 is a general side view of an articulated street car;

Fig. 2 is a sectional elevation of the central portion of the street car shown in Fig. 1;
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Fig. 3 is a plan view of Fig. 2,

Fig. 4 is a schematic plan view showing the linkage of Fig. 3 in different operating positions of the street cars with Fig. 4a showing the linkage with the cars in a straight horizontal position, Fig. 4b showing the street cars negotiating a horizontal curve and Fig. 4c showing the street cars negotiating a vertical curve.

Fig. 5 is a section on the line 5-5 of Fig. 2

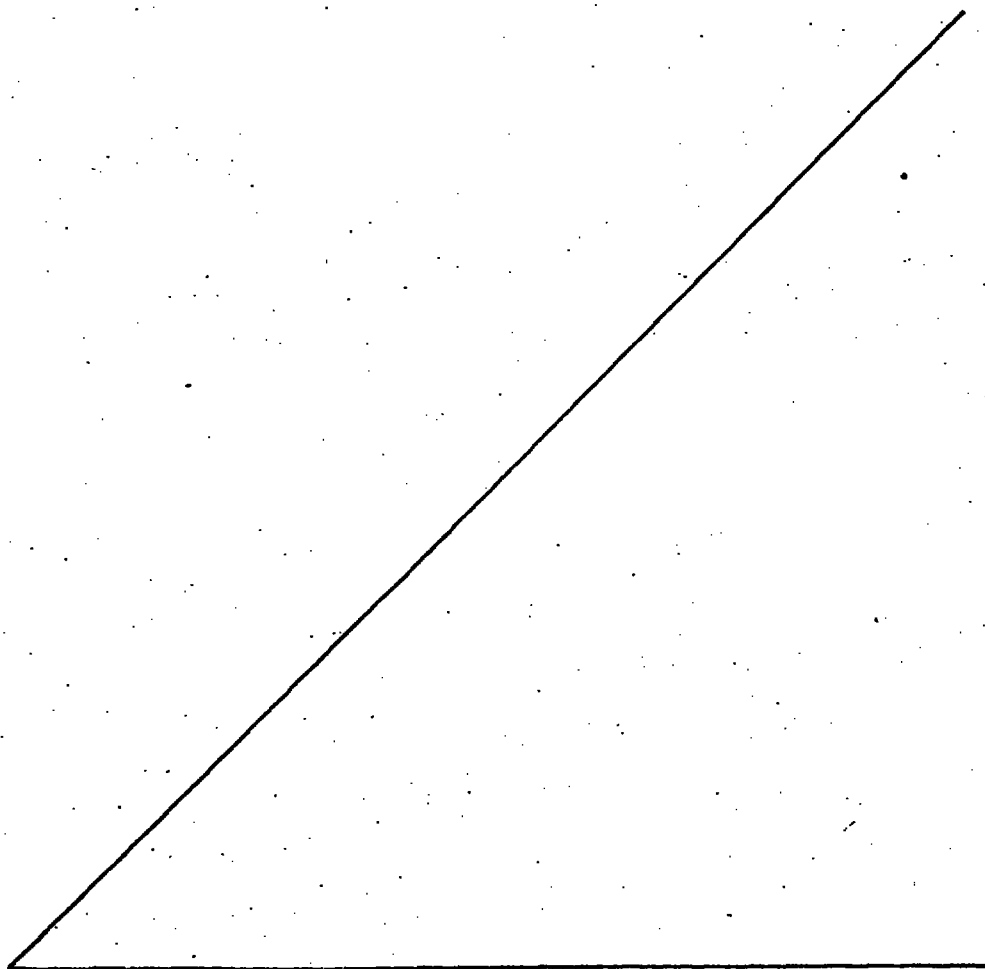


FIGURE 6 is a section on the liner 6-6 of figure 5

FIGURE 7 is a series of diagrammatic representation showing in plan and elevation the operation of portions of the tunnel structure shown in figure 2 with figure 7a showing the street car in a generally horizontal disposition, figure 7b showing the street car negotiating a concave vertical curve and figure 7c showing the street car negotiating a convex vertical curve,

FIGURE 8 is a section on the line 8-8 of figure 2.

FIGURE 9 is a section on the line 9-9 of figure 8.

FIGURE 10 is view on an enlarged scale on the line 10-10 of figure 9.

Referring now to the drawings and in particular figure 1, an articulated vehicle, in this case a street car, generally designated 10 comprises a leading car 12 and a trailing car 14. The cars 12 and 14 are supported on leading and trailing bogies 16, 18 respectively and by an intermediate bogie 20 positioned between the two cars. The intermediate bogie 20 also supports a tunnel structure generally designated 22 which interconnects the interiors of the two cars 12, 14 to allow movement of passengers between the cars. The cars 12 and 14 are connected to a turntable 24 to accommodate relative movement about a vertical axis designated VV on figure 2 to provide steering movement and about a horizontal axis designated H in figure 6 to accommodate changes in elevation.

The details of the turntable 24 and the connection of the cars 12, 14 thereto can best be seen in figures 2 and 5. The turntable 24 comprises of transverse bolster 26 to which are rotatably mounted the wheel sets of the bogie 20. A bearing assembly 28 is also mounted on the bolster 26 and comprises an outer ring 30, intermediate ring 32 and an inner ring 34. A pair of races 36, 38 connect the outer and intermediate and the inner and intermediate rings respectively. The rings 30, 32 and 34 may therefore rotate relative to one another about a generally vertical axis.

The intermediate ring 32 is connected to the transverse bolster 26. The leading car 12 is provided with a pair of support beams 40 which project rearwardly from the car below the general level of the passenger carrying compartment and are bolted to the outer ring 30. The trailing car 14 also includes a pair of support beams 42 which project forwardly from the car in spaced parallel relationship. The ends of the support beams 42 are bored to receive self-aligning bearing assemblies 44 which comprise an outer race 46 and an inner race 48. Each of the races has a spherical bearing surface so that the inner race can adopt a wide range of positions relative to the outer race. The inner race 48 is bored as indicated at 50 to receive a transverse shaft 52. The ends of the shaft 52 are supported in upstanding ears 54 which are bolted to the inner ring 34 of the bearing assembly 28. The two cars 12, 14 may therefore rotate

relative to one another about a generally vertical axis which will result in relative movement between the inner and outer rings. At the same time, the self-aligning bearing assemblies 44 permit the trailing car 14 to rotate about a generally horizontal axis relative to the leading car and intermediate bogie to accommodate vertical curves.

The cars 12, 14 are also connected at roof level by means of a linkage generally designated 60. The linkage 60 inhibits relative lateral displacement between the two cars at roof level and thereby provides torsional rigidity to inhibit relative twisting of the two cars about a longitudinal axis through the lower coupling.

As can best be seen in Figure 3, the leading car 12 includes a longitudinal beam 62 which projects rearwardly from the roof of the car 12 on the centre line of the car. The trailing car 14 also includes a pair of longitudinal beams 64, 66 which are spaced on opposite sides of the centre line of the car 14. The longitudinal beam 62 is pivotally connected to a cross-over link 68 by a pin 70 positioned midway along the link 68. One end 72 of the link 68 is pivotally connected by a connection 74 to a first transverse link 76. The link 76 is connected by a connection 78 to the beam 64. Similarly the other end 80 of the link 68 is connected by connection 84 to a second transverse link 82 which in turn is connected by a connection 86 to the beam 66. The first and second transverse links 76, 82 lie generally parallel to one another and the connections 74, 78, 84 and 86 are all arranged to permit pivoting movement about a generally vertical axis. The pin 70 is coincident with the vertical axis V of the turntable.

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Upon the cars 12, 14 negotiating a horizontal curve, the cross over link 78 will rotate about the pin 70 to permit displacement of the cars 12, 14 about the vertical axis V. The orientation of the cross over link 68 with the transverse links 76, 82 remains constant so that a simple pivoting movement is achieved about the pin 70. This arrangement can best be seen in Figure 4b in which the cars 12, 14 are negotiating a left hand curve. Upon the cars entering a vertical convex curve, the leading car will drop relative to the trailing car. This movement is accommodated about the transverse shaft 52 and causes a displacement in the position of the pin 70 relative to the rear car 14. This displacement is accommodated by pivotal movement of the transverse links relative to the support beams 64, 66 and by rotation of the cross over link 68 about the pin 70. Because the transverse links 76, 82 are substantially parallel and of equal length, the displacement of the connection 74 and 84 to either side of the centre line of the vehicle is equal and opposite which is accommodated by rotation of the link 68 about the pin 70. This arrangement is shown in Figure 4c in which it will be seen that the cross over link 68 is rotated in a clockwise direction about the pin 70 to allow the car 12 to rotate about the horizontal axis H relative to the trailing car 14. Thus the roof level linkage 60 does not inhibit the articulation of the cars about the horizontal and vertical axis.

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Upon a force to cause relative twisting between the cars 12, 14, about a longitudinal axis, due for example to an uneven track or to the banking of the track, the linkage 60 operates to prevent relative lateral displacement at roof level between the cars. The forces causing lateral displacement, diagrammatically indicated by arrows F in _____

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Figure 4a, act to move the longitudinal beam 62 toward one of the beams 64, 66. This would cause the pin 70 to move toward the beam, for example 66, so that the second transverse link 82 would tend to induce rotation of the cross over link 68 about the pin 70 in an anti clockwise direction. However, such rotation is resisted by the first transverse link 76 acting on the opposite side of the pin 70 so that the forces tending to laterally displace the cars 12, 14 are resisted by the linkage 60. Such forces are also resisted by transverse shaft 52 operating through the bearing assembly 28 so that the cars remain aligned on the centre line of the vehicle. The provision of the roof level linkage 60 thus enables the bearing assembly 28 to be designed to accommodate much smaller forces than would otherwise be the case.

The tunnel structure 22 is supported on a transverse beam 56 which is connected by pins 58 to the outer ends of the bolster 26 as seen in Figure 6. The pins 58 permit the beam to rotate about a generally horizontal axis to permit the tunnel structure to move back and forth along the longitudinal axis of the vehicle. The beam 56 also carries a pair of semi-circular floor plates 90 which are connected to the beam 56 by hinges

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92. The periphery of the floor plate rests on semi-circular recesses 94, 95 provided in the ends of the leading and trailing cars 12, 14 respectively. Upon rotation of the cars about the vertical axis, sliding movement between the floor plate 90 and the respective recess 94, 95 occurs and upon movement about the horizontal axis H, pivotal movement of the plates about the hinge 92 will occur. The periphery of the floor plates 90 is also covered by four part cylindrical shells 96, 98, 100, 102 which are connected in respective pairs to the leading and trailing cars 12, 14. The shells 96 to 102 define the entrance to the passageway between the cars and provide a smooth transition from the interior of the vehicle to the tunnel structure 22. It will be observed from figure 5 that the shells 96, 98 connected to the leading car 12 are of greater diameter than the shells 100, 102 connected to the trailing car 14. The shells are also inclined slightly to the vertical axis to provide a generally conical structure. The differing diameter of the shells permits them to overlap one another as the cars negotiate a horizontal curve.

The exterior of the cylindrical shells 96 to 102 is protected by a bellows 103 connected at opposite ends to the cars 12, 14 and supported intermediate the cars by a hoop 104. The hoop 104 is connected to the ends of the transverse beam 56 and includes a pair of vertical posts 106 and a horizontal beam 108. Depending from the horizontal beam is a hanger assembly

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110 comprising a pair of vertical supports 112 and a cross beam 114. A centering mechanism generally designated 116 is pivoted on a shaft 118 to the cross beam for movement about a vertical axis.

5 The centering mechanism 116 is best seen in figures 7 to 10 and comprises a base plate 120 rigidly connected to the shaft 118 for pivotal movement therewith. A pair of pivot pins 122 are mounted on the base plate 120 and each rotatably supports a pair of tooth levers 124, 126 respectively. Each of
10 the levers 124, 126 comprises a circular head 128 having teeth 130 formed over a portion of the periphery of the head. A lever arm 132 is integrally formed with the head 128. The levers 124, 126 are arranged in pairs on each of the pivot pins 122 with the lever arms 132 extending in opposite directions on either side
15 of the longitudinal axis of the vehicle. The spacing between the pins 122 is such that the teeth 130 of adjacent levers 124, 126 are meshed so that rotation of one of the levers about the pin 122 will induce equal and opposite rotation of the other lever about its pin 122. The extremities of each of the lever
20 arms 132 are connected by vertical pivots 134 to struts 136. The struts 136 are connected to a mounting lug 137 on respective ends of the cars 12, 14 by means of a vertical pivot pin 138. A top plate 140 is mounted in spaced relationship from the base plate 120 and is secured to the base plate by pins 142.

25 Upon the cars 12, 14 rotating relative to one another

about the horizontal axis H, the mounting lugs 137 will move either toward or away from each other to vary the distance between them. This movement is transmitted through the struts 136 and causes rotation of the respective two levers 124, 126 in opposite directions about the pins 122. Because the teeth 130 are in mesh, the equal and opposite rotation of the other pair of levers is induced which is only achieved if the cross beam 114 remains centered between the two lugs 137. Thus upon the cars 12, 14 negotiating a vertical curve, the centering mechanism 116 operates through the hanger assembly 110 to move the hoop 104 and the transverse beam 56 about the pins 58. In this way, the bellows remain centered between the two cars. Negotiation of a horizontal curve is accomplished by both of the links 124, 126 rotating about their respective pin 122 in the same sense, which is matched by equal and opposite displacement of the other pair of levers 124, 126. The centering mechanism therefore effectively rotates about the meshing teeth 130 to accommodate the horizontal curves.

A tunnel liner 144 is supported on the transverse beam 56 and by the hoop 104 to seal the area between the part cylindrical shells 96 to 102. The tunnel liner 144 includes a pair of side panels 146 which are connected to a pair of outriggers 148 mounted at opposite ends of the transverse beam 56. The side panels 146 are also supported by vertical posts 150 which converge to meet a horizontal roof truss 152. The

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roof truss 152 extends transversely across the tunnel liner 144 and is connected to a hanger 154 depending from the cross beam 114 of the hanger assembly 110. The side panels 146 are connected to a roof panel 156 which is also supported by the roof truss 152. The tunnel liner 144 therefore moves with the hoop 104 under the influence of the centering mechanism 116.

It will be noted that the tunnel structure 144 is displaced toward the leading car 12. This is to compensate for the different diameter of the shells 96, 98 and 100, 102 to equalise the spacing between side panels 146 and the adjacent shell.

It will be appreciated that as the street car 10 negotiates vertical curves, the side panels 146 and the cylindrical shells 96-102 will move relative to one another about the horizontal axis H. Under normal circumstances, such movement would cause the clearance between the panel 146 and the adjacent shell to vary along the height of the panel 146 due to the inclined line of contact of the panel 146 with the cylindrical surface of the shell. This has created a safety problem in that sufficient clearance must be left between the panels and the shells to allow for the maximum clearance which also results in a gap being left between the panels and the side walls to present a safety hazard. To overcome this problem, the side panels 146 are formed from a stationary portion 160 fixed to the outriggers 148 and to the roof panel 156. The stationary

portion 160 is of a generally triangular shape with the base of a triangle supported by the outriggers 148 and with the apex adjacent the roof truss 152. A pair of triangular fillet panels 162 are hinged along the inclined edge 163 of the stationary portion so as to be pivotable about an axis running parallel to the inclined edge 163 of the stationary portion. The outer edges 164 of the fillet panels are jogged so as to lie at an angle with respect to the remainder of the side panels 146. The outer edges 164 are biased against the cylindrical shells 96 to 102 so as to follow the shells during relative movement between the cars 12, 14.

Upon the car negotiating a horizontal curve, the cylindrical shells slide within one another at each side and the line of contact between the shells and the outer edges of the fillet panels 162 remains substantially vertical. However, upon the vehicle negotiating a convex vertical curve, the two cars rotate about the horizontal axis H which causes the upper edges of the cylindrical shells 96 to 102 to move away from each other. The movement of the upper edge of the shells is greater than that of the lower edge and, due to the cylindrical nature of the shells 96 to 102, the distance between the top edge of each side panel 146 and its respective shell will be greater than the distance between the bottom edge of the side panel and the shell. However by hinging the fillet panels 162 along an inclined edge, for a given angular displacement of the fillet panel relative to the stationary portion 160, the upper edge of the fillet panel will move a greater distance laterally than the lower edge. This therefore compensates for the variation in lateral spacing and enables the fillet panels to closely follow the walls of the shells and maintain an effective seal at all

times. This in fact is shown in Figure 7c and the converse situation where the vehicle negotiates a concave vertical curve is shown in Figure 7b. It has been found that by adopting the inclined hinged panels, the gap between the panels and the cylindrical shells can be effectively sealed at all times and therefore reduce the risk of entrapment of part of one of the passengers during movement of the vehicle.

The characteristic features of the illustrated tunnel structure 22 and of the centering mechanism 116 are separately claimed in our co-pending divisional applications 8412282 and 8412281 (GB 2139583A and GB 2139582A)



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CLAIMS

1. . An articulated vehicle comprising a first chassis and a second chassis, each having an outboard end and an inboard end, coupling means interconnecting the inboard ends and including vertical pivot means to
5 accommodate relative steering movement of the two chassis about a vertical axis and horizontal pivot means to accommodate relative pivotal movement of the two chassis about a transverse horizontal axis, the coupling means further comprising linkage means ver-
10 tically spaced from the horizontal pivot means and including a first link pivotally connected to one of the chassis for movement about a vertical axis and a pair of transverse links extending between the first link and the other chassis, the transverse links being
15 connected to the first link at spaced locations by vertical pivot connections to permit movement of the transverse links in a generally horizontal plane whereby the transverse links oppose pivotal movement of the first link to inhibit relative lateral dis-
20 placement of the two chassis.
2. An articulated vehicle according to Claim 1 wherein the transverse links are connected to the first link on opposite sides of the pivotal connection between
25 the first link and the said one chassis.
3. An articulated vehicle according to Claim 2 wherein the transverse links extend transversely on opposite sides of said first link, and are substantially
30 parallel when the two chassis are aligned with one another.



4. An articulated vehicle according to Claim 3 wherein the pivotal connection of the first link to the chassis lies on the said vertical axis.
5. An articulated vehicle comprising a first chassis and a second chassis, each having an outboard end and inboard end, coupling means interconnecting the inboard ends and including vertical pivot means to accommodate relative steering movement of the two chassis about a vertical axis and horizontal pivot means to accommodate relative pivotal movement of the chassis about a transverse horizontal axis, the coupling means further comprising linkage means vertically spaced from the horizontal pivot means and operable to inhibit lateral movement between the two chassis, the linkage means including a first link pivotally connected intermediate its ends to one of the chassis for movement about a vertical axis and a pair of transverse links extending between the first link and the other chassis, the transverse links being connected to the first link and to the other chassis by vertical pivot connections to permit movement of the transverse links in a generally horizontal plane.
6. An articulated vehicle according to Claim 5 wherein the transverse links extend in opposite directions from the first link.
7. An articulated vehicle according to Claim 6 wherein the transverse links are parallel when the two chassis are aligned with one another.
8. An articulated vehicle according to Claim 7 wherein the pivot connection of the first link to the said one chassis is concentric with the said vertical axis whereby upon steering of the vehicle the first



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link rotates relative to the said one chassis.

9. An articulated vehicle according to Claim 8 wherein each of the chassis carries a vehicle body, the horizontal pivot means being located adjacent the floor of the body and the linkage means being located adjacent the roof of the body.

10. An articulated vehicle according to Claim 9 wherein the first link is pivotally mounted on a beam extending from the roof of the vehicle body of the said one chassis and each of the transverse links is connected to a respective one of a pair of laterally spaced beams extending from the roof of the body of the other chassis.

11. An articulated vehicle substantially as herein described with reference to the accompanying drawings.

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