A resilient suspension arrangement for a railway vehicle is disclosed, which separates the vertical suspension system from the roll suspension system. The system employs a bogie (truck) and a bolster means suspended from the bogie (truck) frame through a pair of swing links. A bolster structure is arranged to transmit the weight of the vehicle body to a suspension link which is hinged on a transverse horizontal axis below the bogie frame. A vertical suspension means is disposed between the bolster suspension link and the bolster structure.

7 Claims, 10 Drawing Figures
This invention relates to suspension arrangements for railway vehicles, the suspension arrangements incorporating a) a swing link lateral suspension providing a restraint to lateral displacements of the vehicle body relative to the wheelsets, b) a roll suspension providing a restraint to lateral rolling motions of the vehicle body relatively to the wheelsets and c) a vertical suspension providing a restraint to vertical movement of the vehicle body relatively to the wheelsets.

In known suspension arrangements the roll and vertical suspension interact through common vertical springing between the vehicle body and the wheelsets. With such a suspension arrangement it is therefore not possible to give the roll and vertical suspensions the independent characteristics often desired for safe and comfortable riding of the vehicle. For example it may be desired to provide a stiff roll suspension but a soft vertical suspension.

The object of this invention is to provide a suspension arrangement which enables the functioning of the vertical and roll suspensions to be separated.

According to this invention a suspension arrangement comprises a bogie having a bogie frame supported on at least two wheelsets, a bolster means suspended from the bogie frame through a pair of swing links, a bolster structure through which the weight of the vehicle body is transmitted to a bolster suspension link, the bolster structure being hinged to the bolster link on a horizontal axis extending transversely of the bogie and displaced longitudinally of the bogie from the connections of the swing links to the bolster suspension link, and a vertical suspension disposed between the bolster link and the bolster structure.

By reason of the hinged connection between said bolster structure and the bolster link, the roll suspension comprises at least in part the bolster link itself, and the stiffness of the roll suspension will be determined by the torsional stiffness of the bolster link between the hinge and swing link connections under turning moments applied by the body through the hinged connection. By appropriate choice of bolster link structures a wide range of roll stiffness can be obtained.

Said bolster structure may comprise an integral part of a vehicle body or it may support the vehicle body through tilting means, such as hydraulic jacks, which are arranged to tilt the vehicle body laterally to counteract the effects of centrifugal force when the vehicle is negotiating curves at high speed. Alternatively said bolster structure may comprise a rigid beam interconnecting two adjacent vehicle bodies, which beam is connected at its ends to the vehicle bodies through universal joints which permit the bodies to perform angular movements relative to the beam about the universal joints.

The invention will now be further explained by way of example with reference to the accompanying diagrammatic drawings, in which:

FIG. 1 is a plan view of a first suspension arrangement in accordance with the invention,
FIG. 2 is a side view of the suspension arrangement shown in FIG. 1,
FIG. 3 is a sectional end view of the suspension arrangement shown in FIG. 1,
FIG. 4 shows in side view an alternative manner to that shown in FIGS. 1 to 3 of connecting the suspension arrangement to the vehicle body,
FIG. 5 is an end view of the connecting arrangement shown in FIG. 4,
FIG. 6 shows a plan view of a further alternative form of connection between the suspension arrangement and vehicle body,
FIG. 7 is a side view of the connecting arrangement shown in FIG. 6.
FIGS. 8 and 9 show in side and plan view the manner in which a suspension arrangement in accordance with the invention is used to support the adjacent ends of a pair of vehicle bodies through a rigid steering beam,
FIG. 10 shows in side view the manner in which a bogie construction embodying a suspension arrangement in accordance with the invention is used to support directly the adjacent ends of two vehicle bodies.

Throughout the drawings the same reference numerals have been used, as far as possible, to indicate corresponding parts.

Referring to FIGS. 1 to 3 of the drawings, the bogie has two wheelsets 1 and 2 (represented in FIG. 1 by their axle centre lines) supporting a bogie frame 3 in a conventional manner for example through a primary vertical and yaw suspension (not shown). A bolster suspension link 4 is suspended from the bogie frame 3 by swing links 5 which are connected at their ends to the bogie frame 3 and the bolster link 4 through universal joints permitting swinging movements of the swing links 5 both laterally and longitudinally of the bogie.

Hinged to the bolster link 4 on horizontal axis 6 is the bolster structure 7 which extends above the bolster link 4 and through which the weight of the vehicle body, partly indicated in outline at 8 in FIG. 2 is supported on the bogie. Mounted between the bolster link 4 and bolster structure 7 is a vertical suspension for the vehicle body. The vertical suspension is represented by vertical spring assemblies 9 which are connected at their ends to the bolster link 4 and bolster structure 7 through universal joints which permit the requisite vertical deflection of the spring assemblies 9 but prevent them from otherwise interfering with the relative movements between the bolster link 4 and structure 7.

With the arrangement of FIGS. 1 to 3 a relatively flexible bolster link 4 would be appropriate to give the suspension arrangement the required roll stiffness.

A traction connection is provided between the bogie frame 3 and the bolster structure 7. This takes the form of a traction rod 10 extending along the longitudinal centre line of the bogie and connected to the bogie frame 3 and bolster structure 7 through a universal joint so that the structure 7 and hence the body 8 is freely pivotable about a vertical axis relatively to the bogie frame 3.

If desired a yaw suspension can be incorporated into the bogie frame 3 and the structure 7 as illustrated diagrammatically in chain-dotted line in FIG. 1. This yaw suspension will provide a controlled restraint to the pivoting movement of the bolster structure 7 about said vertical axis relatively to the bogie frame 3. To accommodate the yaw suspension, arms 11 and 12 rigid with the bolster structure 7 extend laterally to overlie the longitudinal side frame members 3a of the bogie frame 3. Dampers 13 are connected between the arms 11 and 12 and the longitudinal side frame members 3a of the
bogie frame 3. Instead of simple dampers the members 13 could be combined dampers and springs in series, to provide a relaxation type yaw suspension.

It will be appreciated that the bolster structure 7 of FIGS. 1 to 3 could comprise part of the underframe of the vehicle body. However if it is desired to positively tilt the vehicle body to counteract the effects of centrifugal force it is necessary to provide a connecting arrangement which permits the tilting movement. One form of connecting arrangement is shown in FIGS. 4 and 5.

Referring to FIGS. 4 and 5, the body 8 is pivotally connected to the bolster structure 7 through trunnion mountings 14 disposed on the longitudinal centre line of the vehicle body 8 so that the vehicle body can tilt about longitudinal axis 15. The vehicle body 8 is supported on the bolster structure 7 through hydraulic tilting jacks 16 disposed on each side of the trunnion mountings 14 and having universal joints 16a at their ends through which connection is made with the bolster structure 7 and body 8.

Springs 17 may be connected in series with the jacks 16 to provide a component of the roll suspension, the other component comprising the bolster link 4 which provides a stiff roll suspension between the bolster structure 7 and bolster link 4.

Referring now to FIGS. 6 and 7, a further alternative form of connection of the body 8 to the suspension arrangement is shown.

The arrangement of bogie frame 3, bolster link 4, swing links 5, structure bolster 7 and vertical springing 9 is similar to that of FIGS. 1 to 3.

In this form of connection the vehicle body 8 is supported on the bolster structure 7 through centre pivot 18 permitting relative horizontal rotation between the body 8 and bolster structure 7. Side bearers 19 are mounted on outrigger arms 20 rigid with the bolster structure 7, and are symmetrically disposed on either side of the centre pivot 18.

The traction connection between the bogie frame 3 and the bolster structure 7 is provided by traction rods 21 connected between the bogie frame 3 and outrigger arms 20.

The suspension arrangements as described above can be used to support the adjacent ends of two adjacent vehicle bodies of an articulated train. This can be effected in the manner shown very diagrammatically in FIGS. 8 and 9.

The two adjacent vehicle bodies are indicated at 8a and 8b and are articulated at joint 23. A rigid beam 24 extends between the two vehicle bodies 8a and 8b and is connected through universal joints 25 at its ends to the two vehicle bodies 8a and 8b at a distance along the vehicle bodies 8a and 8b from the articulation joint 23. The bogie is represented in block form at 26 and takes the form shown in FIGS. 1 to 3. Thus on curved track the adjacent vehicle bodies 8a and 8b and the rigid steering beam 24 will take up the configuration shown in FIG. 9.

The tilting jacks 16 are connected between the steering beam 24 and the vehicle bodies 8a and 8b and the universal joints 25 will serve the purpose of the trunnion mountings 14 when lateral tilting of the bodies 8a and 8b is effected to counteract centrifugal force. Where the passive roll suspension in the form of springs 17 (FIGS. 4 and 5) are connected in series with the jacks 16, the bolster link 4 provides the necessary stiff roll suspension between the beam 24 and the bogie frame 3 via the swing links 5.

FIG. 10 illustrates one way in which a suspension arrangement in accordance with the invention can be used to support the adjacent ends of two adjacent vehicle bodies 8a and 8b which are non-articulated but which have a conventional inter-vehicle coupling represented at 28.

The suspension arrangement comprises a single bogie frame 3 supported on two wheelsets 1 and 2. Each vehicle body 8a, 8b is supported on the bogie frame through a respective bolster structure 7, bolster link 4, vertical spring 9 and swing links 5 corresponding to those shown in FIGS. 1 to 3.

The connections between the bolster structures 7 and the vehicle bodies are shown diagrammatically at 29. If the vehicle bodies 8a and 8b are to be tilted to counteract centrifugal force, then the connections 29 will comprise the trunnion mountings 14 shown in FIGS. 4 and 5 and hydraulic tilting jacks will be provided also as shown in FIGS. 4 and 5.

As an alternative to mounting the bogies 4, bolster structures 7 etc. out-board of the wheelsets 1 and 2 they could be mounted between the wheelsets 1 and 2.

We claim:

1. A suspension system for supporting an end of a railway vehicle, said system comprising:
   a. a bogie having a bogie frame supported on at least two wheel sets,
   b. a bolster means suspended from said bogie frame through a pair of swing links disposed in a transverse plane of the bogie, said bolster means including:
      i. a bolster structure arranged to bear the weight of the vehicle,
      ii. a bolster suspension link hinged to said bolster structure at one end thereof, said swing links connecting said bogie frame and said bolster suspension links
   iii. a resilient suspension means arranged between said bolster structure and said bolster suspension link,
   c. said bolster links and said swing links arranged to provide flexure of said resilient suspension means for vertical movements of said vehicle, and torsional stressing of said bolster link for roll movements of said vehicle.

2. A railway vehicle having a suspension arrangement as claimed in claim 1, wherein said bolster structure forms an integral part of the vehicle body.

3. A railway vehicle having a suspension arrangement as claimed in claim 1, wherein said bolster structure supports a vehicle body through tilting jacks with said vehicle body pivotedly connected to said structure for tilting movement about a longitudinal axis of the vehicle body.

4. A suspension arrangement as claimed in claim 1, wherein said bolster structure comprises a rigid beam for inter-connecting two adjacent vehicle bodies.

5. A pair of adjacent railway vehicle bodies supported at their adjacent ends by a suspension arrangement as claimed in claim 4, wherein the adjacent ends of vehicle bodies are articulated together and the ends of said rigid beam are respectively connected to the two adjacent vehicle bodies at a distance longitudinally of the adjacent vehicle bodies from their articulation
and in a manner permitting relative angular movement
between the adjacent vehicle bodies.
6. A suspension system as claimed in claim 1,
wherein two of said bolster links are suspended from a
common bogie frame, with a separate bolster structure
and vertical suspension means individually associated
with each bolster.
7. A pair of adjacent railway vehicle bodies sup-
ported at their adjacent ends by a suspension arrange-
ment as claimed in claim 6, wherein each vehicle body
is mounted on a respective one of said structure.

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