United States Patent

Pocklington et al.

[15] **3,682,102**

[45] **Aug. 8, 1972**

[54] **DAMPENED RAILWAY TRUCK**

[72] Inventors: **Arthur Ronald Pocklington; Geoffrey Richard Mahy,** both of London, England

[73] Assignee: **British Railways Board,** London, England

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[21] Appl. No.: **823,280**

[52] **U.S. Cl.**.....**105/157 R,** 105/165, 105/171, 105/199 S, 105/222, 105/224

[51] **Int. Cl.**.....**B61f 3/00,** B61f 5/02, B61f 5/30

[58] **Field of Search**.....105/157, 165, 167, 169, 199, 105/182 R, 197 R, 224.1, 222, 223, 224, 157 R, 171, 199 S

[56] **References Cited**

UNITED STATES PATENTS

2,843,057	7/1958	Markestein et al.	105/199 X
2,900,924	8/1959	Furrer et al.	105/199
2,907,283	10/1959	Markestein et al.	105/199
2,953,994	9/1960	Furrer et al.	105/199 X
R5,452	6/1873	Higley	105/224.1
2,118,345	5/1938	Fries	105/182 R
2,901,983	9/1959	Lich	105/182 R X
3,151,575	10/1964	Dickey et al.	105/182 R X
3,286,653	11/1966	Weber	105/197 R X
2,921,540	1/1960	Williams	105/224 R
3,394,662	7/1968	Weber	105/224 R X

FOREIGN PATENTS OR APPLICATIONS

1,125,104	8/1968	Great Britain	105/197 D

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Assistant Examiner—Howard Beltran
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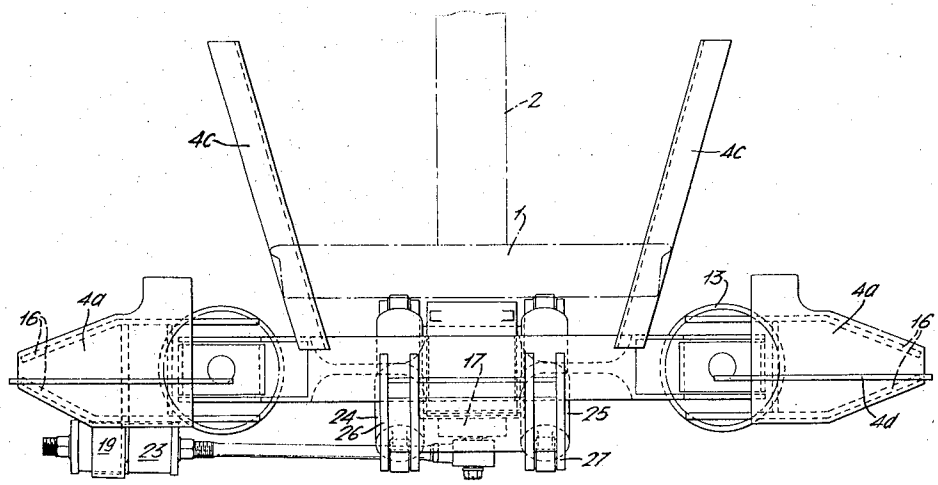
[57] **ABSTRACT**

A four-wheeled two axle railway vehicle has its body mounted on each wheel-set through a suspension arrangement comprising multi-stage vertical springing means, a swing-link lateral suspension, a resilient yaw suspension comprising traction rods extending longitudinally of the vehicle between their connections with the wheel-set and body and incorporation rubber springs, and dampers disposed to provide viscous damping for vertical, lateral and roll motions.

13 Claims, 12 Drawing Figures



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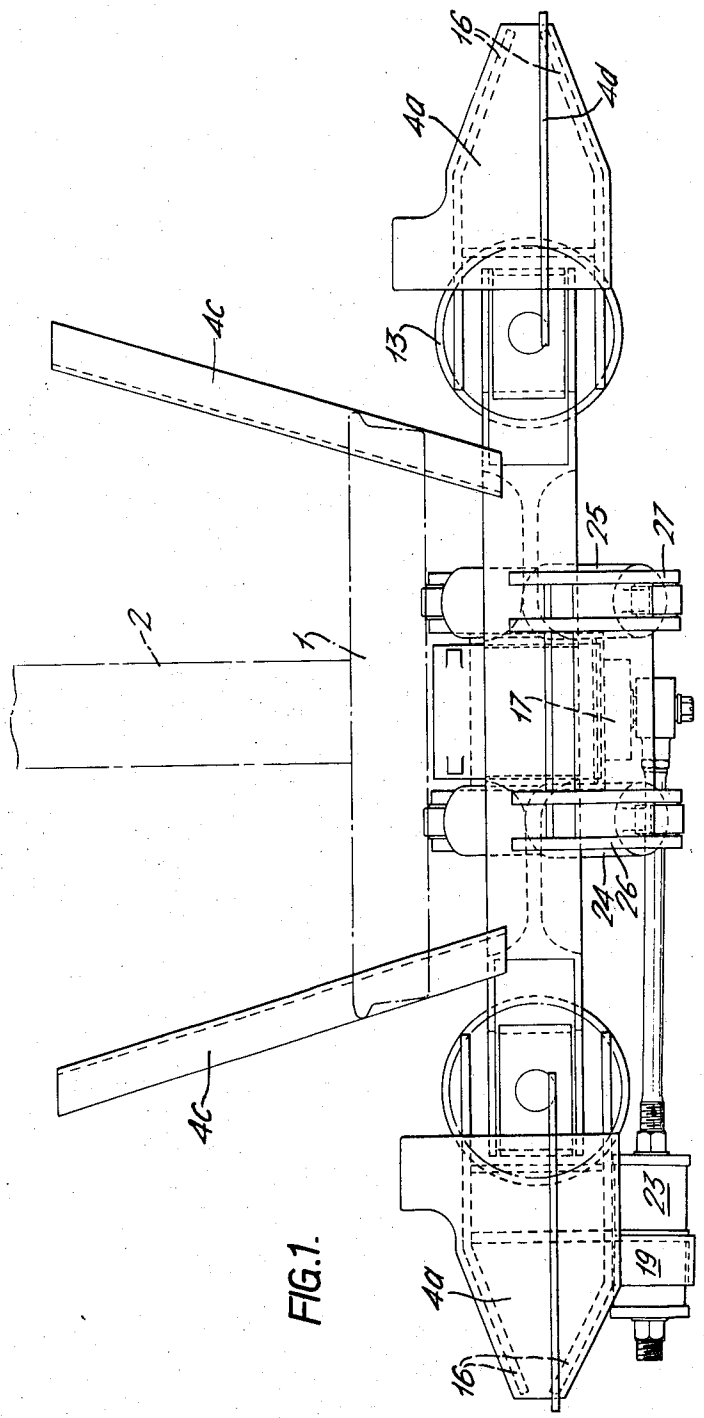

FIG.1.

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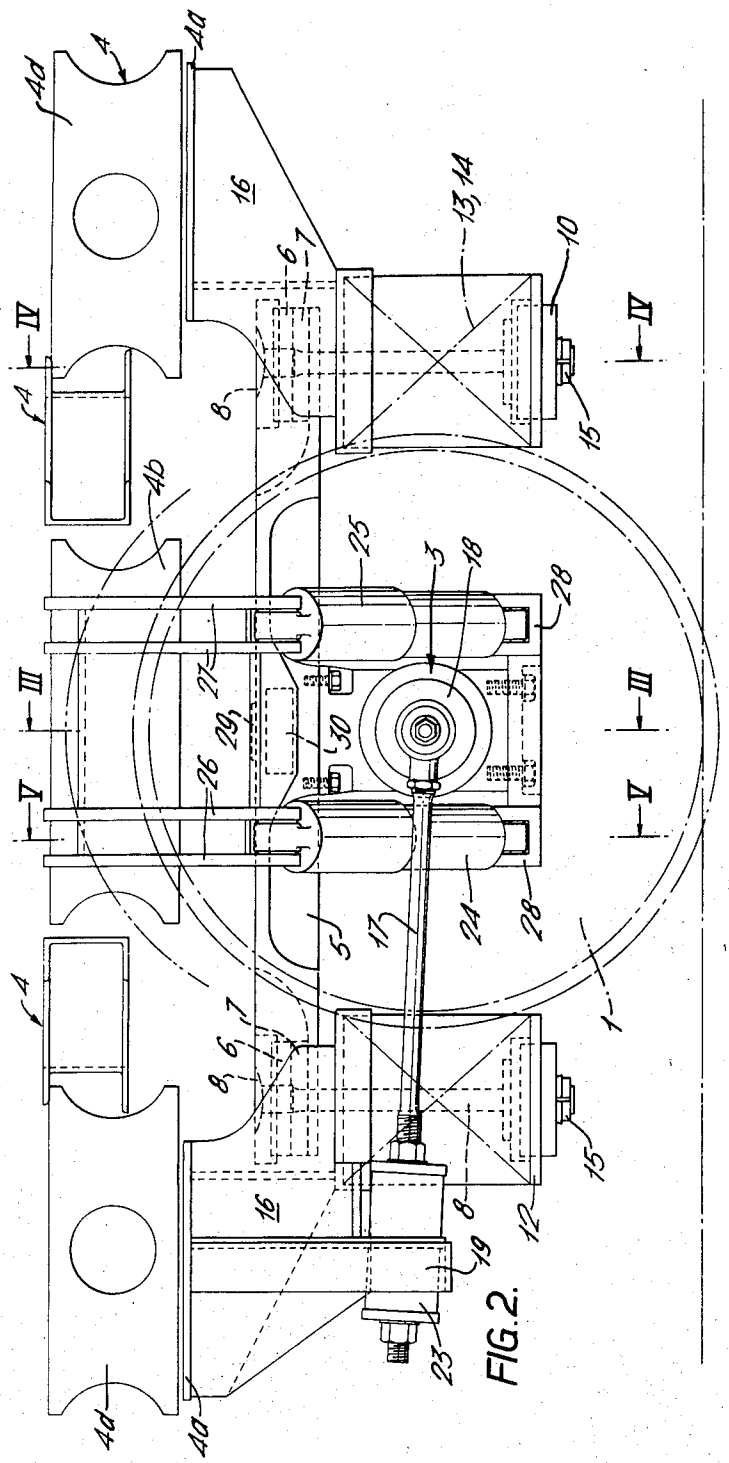

FIG. 2.

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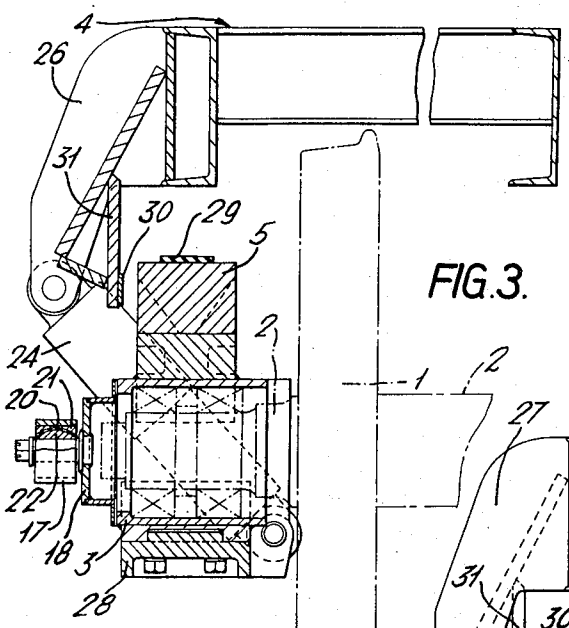

FIG.3.

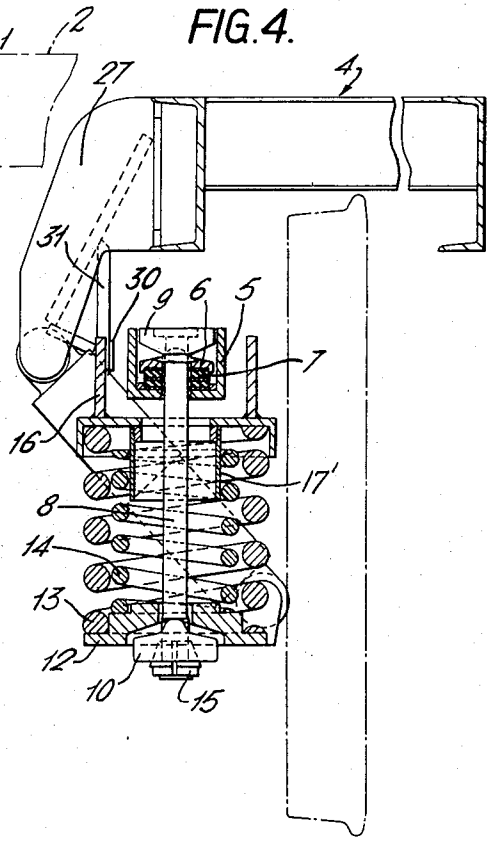

FIG.4.

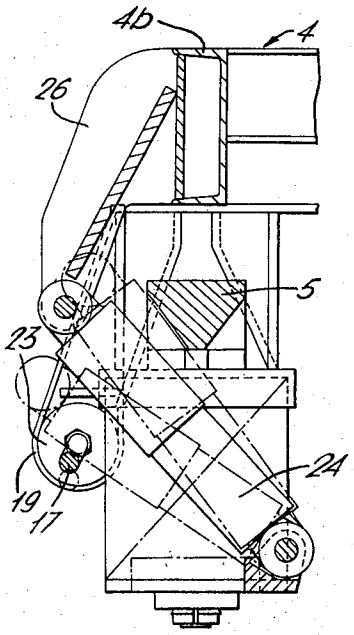

FIG.5.

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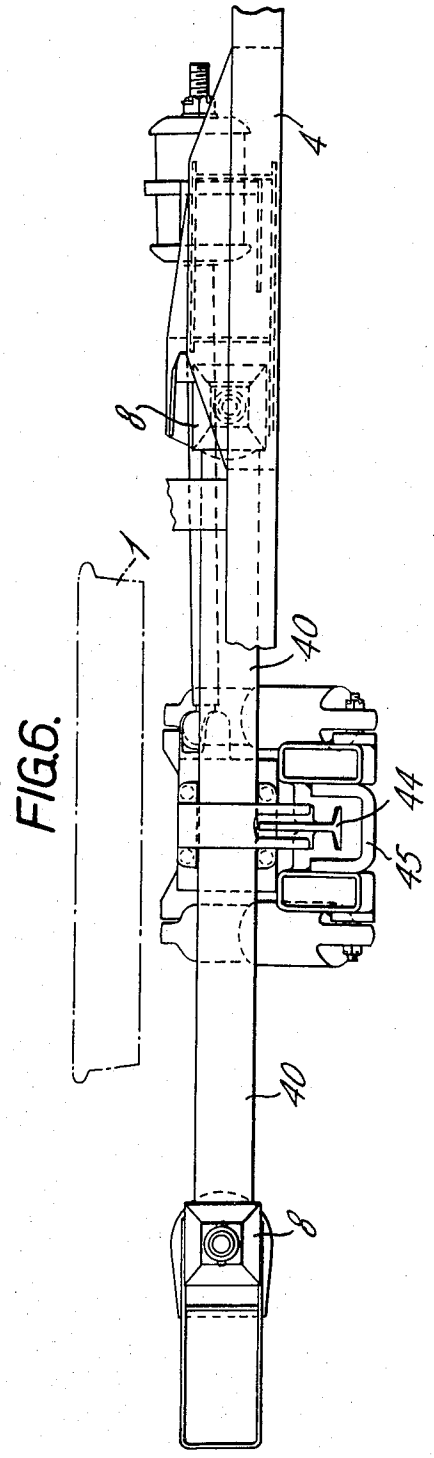

FIG6.

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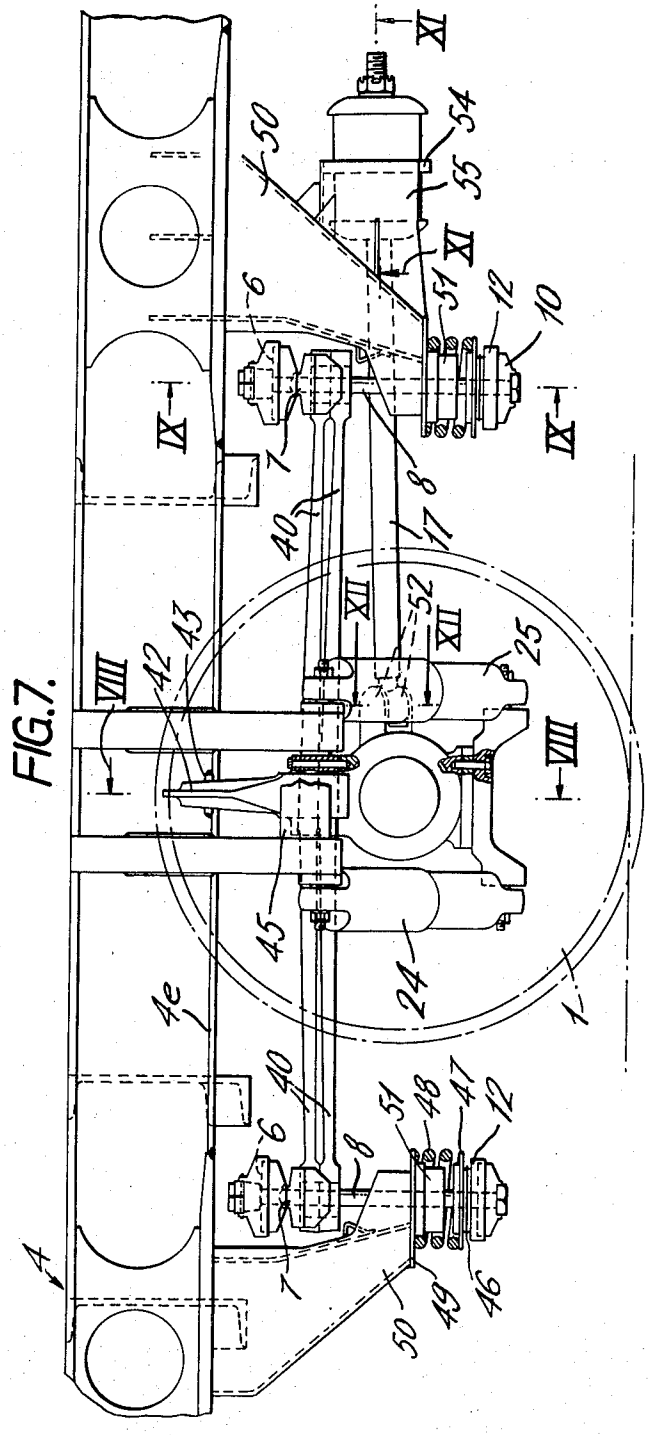

FIG.7.

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FIG.8.

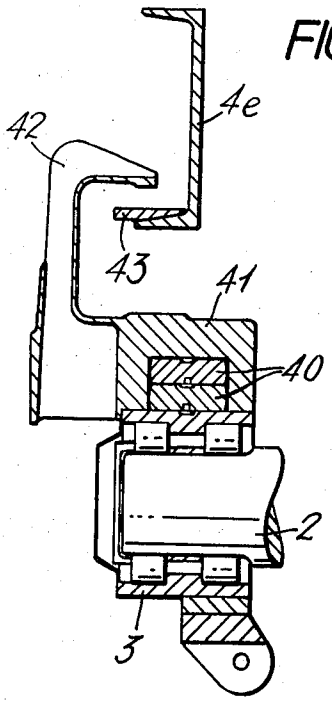

FIG.9.

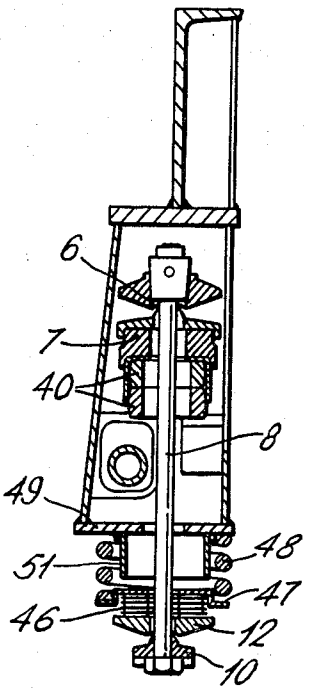

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FIG.10.

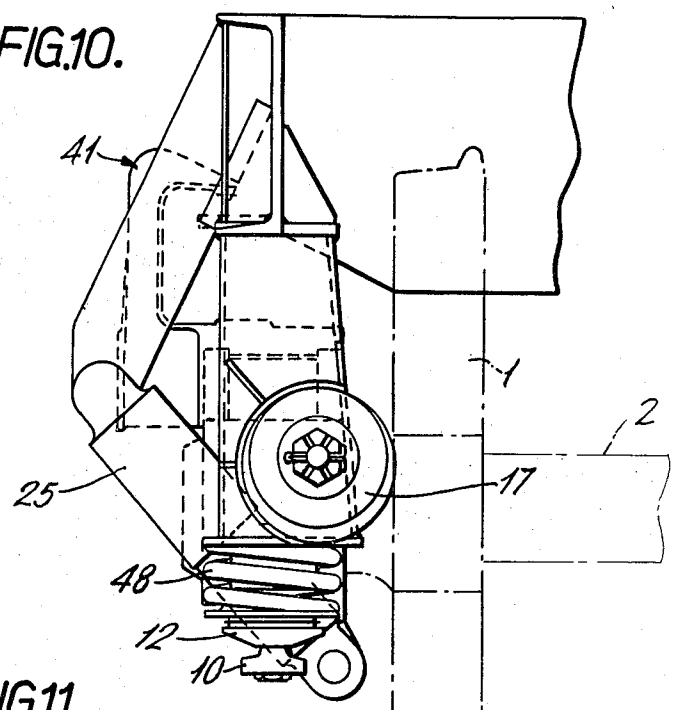


FIG.11.

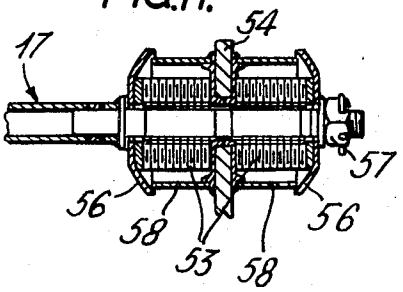
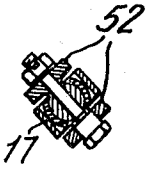


FIG.12.



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DAMPENED RAILWAY TRUCK

This invention relates to four-wheeled two axle railway vehicles in contrast to bogie-type vehicles.

The object of the invention is to provide a suspension arrangement for a four-wheeled two axle railway vehicle, which has a combination of suspension elements capable of providing the correct stiffnesses and degrees of damping, with absence of friction and clearances, to render the vehicle safe in operation and possess good riding qualities up to high speeds, the transmission of forces from the wheel-sets to the vehicle body being reduced to a minimum and body hunting and wheel-set hunting being suppressed.

According to this invention there is provided a four-wheeled two axle railway vehicle wherein the vehicle body is mounted on each wheel-set through a suspension arrangement which comprises vertical springing, lateral suspension means providing a low stiffness in the lateral direction, yaw suspension means incorporating resilience to provide a predetermined yaw stiffness and connected to the wheel-set and body without lost motion, and dampers disposed to provide damping in both the vertical and lateral directions.

The vertical springing may be provided by coil springs which may be multi-stage to give a low natural frequency of bounce over a wide range of pay-load. Alternatively, it may be provided at least in part by cantilever springs. As a further alternative to coil springs, rubber springs may be used.

The lateral suspension means may comprise swing links having knife edge mounting arrangements at both their tops and bottoms.

The dampers may be hydraulic and compensated for load variation, that is to say their degree of damping may increase with load.

Further features of the invention will become apparent from the two examples of vehicle construction in accordance with the invention now to be described with the aid of the accompanying drawings, in which:

FIG. 1 is plan view of the arrangement at one wheel of a wheel-set,

FIG. 2 is a side view of the apparatus at one wheel of a wheel-set,

FIG. 3 is a sectional view on the line III—III of FIG. 2, illustrating particularly the means for supporting an axle,

FIG. 4 is a sectional view on the line IV—IV of FIG. 2, showing in particular the use of coil springs and resilient pads,

FIG. 5 is a sectional view on the line V—V of FIG. 2, showing the use of a rubber spring and hydraulic dampers,

FIG. 6 is a plan view at one wheel of a wheel-set of a modified form of vehicle.

FIG. 7 is a side view of the apparatus of FIG. 6,

FIG. 8 is a section on the line VIII—VIII of FIG. 7, showing the use of a cantilever leaf spring and a stop which limits upward vertical movement of the vehicle body.

FIG. 9 is a section on the line IX—IX of FIG. 7, illustrating a series arrangement of rubber units and coil spring,

FIG. 10 is an end view of the apparatus of FIG. 6,

FIG. 11 is a section on the line XI—XI of FIG. 7 particularly illustrating the means for attaching one end of traction rod 17 and,

FIG. 12 is a section on the line XII—XII of FIG. 7 illustrating the means for attaching the other end of traction rod 17.

As far as possible common parts of the two forms of vehicle shown in the drawings have been designated with the same reference numbers.

Referring now to FIGS. 1 to 5 the drawings, only the arrangement at one wheel 1, of one wheel-set has been shown, the arrangement at the other wheels being substantially similar. The wheels of each wheel-set are solidly mounted on a live axle 2 (FIG. 3) supported at each end in a roller bearing axle box 3. The frame members of the vehicle body shown in the drawings have been referenced generally as 4 and where it is necessary to refer to a particular frame member this is given a suffix letter *a*, *b*, *c*, or *d*.

The axle box 3 has a rigid beam 5 bolted to its top side. The beam 5 extends horizontally and longitudinally of the vehicle and is of a length such that its ends are beyond the wheel periphery. Inserted in the beam 5 at both ends thereof are knife edge members 6 supported on pads 7 of low hysteresis rubber (see particularly FIG. 4). Eye bolts 8 constituting swing links hang on these knife edge members 6 through their 'T' shaped upper ends 9 and pass downwardly through apertures in the associated knife edge members 6 and pads 7 and in the beam 5. The 'T' shaped ends 9 of the bolts 8 facilitate bedding down of the knife edge members through the rubber pads 7 on to the beam 5 and permit longitudinal movement of the wheel-set relatively to the vehicle body by rocking on their rounded under-surface. The upwardly facing knife edges proper formed on members 6 permit frictionless lateral rolling movement of the vehicle body relatively to the wheel-set. The rubber pads 7 permit angular rotation of the knife edges to accommodate yaw movements originating at the axle 2.

The transverse suspension comprises swing links constituted by the eye bolts 8 having knife edge members 10 at their lower ends whose knife edges co-operate with base members 12 supporting the lower ends of nests of coil springs, each comprising coil springs 13 and 14 (see FIG. 4). The swing links 8 are of adequate length to give a low frequency of natural movement of the body relatively to the wheel-sets. Adjustment for length is provided by nuts 15 at the lower ends of the swing links which engage the threaded shanks of the eye bolts 8 to enable raising and lowering of the associated knife edge members 10 to permit equalization of the wheel loads. The lower knife edges are constrained to remain in correct alignment with the upper knife edges by engagement of squared portions of the eye bolt shanks within the knife edge members 10.

As previously mentioned, each coil spring nest comprises springs 13 and 14 supported at their lower ends on base member 12. The springs 13 and 14 are co-axially arranged, with the spring 13 surrounding the shorter inner spring 14. The spring 13 abuts at its upper end against the undersurface of scroll iron bracket 16. A sleeve 17' extending downwardly from the scroll iron bracket 16 locates in the inner spring 14 and guides it into abutment with the underside of the scroll iron bracket 16. The scroll iron bracket 16 transmits the load from the top of the coil springs 13 and 14 to the underframe of the vehicle body via frame member 4*a*.

With this arrangement of springs 13 and 14 the inner spring 14 will only become effective at part load; until then, only the spring 13 is effective. There is adequate room inside the coil spring nests to permit the required amount of lateral movement between the swing links 8 and spring nests and any lateral deflection of the coil springs 13 and 14 increases the lateral flexibility of the arrangement.

An elastic link constituted by a traction rod 17 is attached to each axle box cover 18 at one end and extends from this attachment longitudinally of the vehicle towards the transverse center line of the vehicle. At its other end the traction rod 17 is secured to a bracket 19 extending downwardly from the underframe of the vehicle. The traction rod 17 has a spherical connection to the axle box cover 18 (see FIG. 3) and this includes a spherical rubber bushing 20 bonded to spherical seat part 21 connected to the traction rod 17 and spherical boss part 22 connected to the axle box cover 18. The spherical rubber bushing 20 is of low torsional and conical stiffness and high radial stiffness and is manufactured of low hysteresis rubber to reduce the effect of low amplitude stiffening. At its connection to the bracket 19 the traction rod terminates in a differential rubber spring 23, through the rubber of which the traction rod 17 transmits its forces to the bracket 19 and thus to the vehicle body. This differential rubber spring 23 is designed in minimum hysteresis rubber with the required degree of axial stiffness and low conical stiffness. The traction rod 17 because of the low conical stiffness of its ends, causes little interference with the lateral displacement of the body relatively to the wheel-sets.

Between each axle box 2 and frame member 4*b* of the vehicle underframe are disposed two hydraulic dampers 24 and 25 of the load conscious type. These hydraulic dampers 24 and 25 are disposed in vertical transverse planes of the vehicle and are inclined to the vertical and horizontal to provide both lateral and vertical damping. Since they are load conscious, this damping will increase with increase in pay-load. The dampers 24 and 25 are disposed in such a way that roll movements about either upper or lower sway axes of the vehicle are adequately damped. By arranging the dampers in pairs at each axle box, redundancy against failure is provided.

At their upper ends the dampers 24 and 25 are mounted to brackets 26 and 27 depending from frame member 4*b*. At their lower ends the dampers 24 and 25 are connected to bracket 28 secured to the bottom of the axle box. The ends of the dampers 24 and 25 are fitted with spherical rubber bushings of adequate axial stiffness and low conical stiffness.

The above described wheel-set and suspension arrangement is designed to fit under a standard wagon framework and to permit the employment of wheel mounted disc brakes with their associated calipers and linkages. The vehicle frame members 4*c* and 4*d* are stiffening members additional to the normal underframe of a four-wheeled vehicle.

Adjustment for wheel wear can be made by removing packing pieces from between the axle box 3 and the lower damper mounting bracket 28 and placing them between the axle box 3 and top beam 5.

Longitudinal movement of the suspension is limited by the clearance between the ends of beam 5 and the adjacent surfaces of the scroll iron brackets 16. A vertical bump stop 29 can be provided between the beam 5 and the vehicle body underframe. A lateral bump stop 30 can also be attached to extension 31 between the upper damper supporting bracket 26 and 27 for engagement with the beam 5 after an appropriate amount of lateral movement.

Referring now to FIGS. 6 to 12, in the modified form of vehicle shown the wheels 1 of each wheel-set are again solidly mounted on a live axle 2 (FIG. 8) supported at each end in a roller bearing axle box 3.

Extending in pairs, substantially horizontally and longitudinally of the vehicle, from either side of the axle boxes 3 are cantilever springs in the form of tapered leaf springs 40. The leaf springs 40 are located on their associated axle box 3 by member 41 which is bolted to the axle box 3. The member 41 also extends upwardly in hook fashion at 42 (FIG. 8) to form a stop for engagement by co-operating stop member 43 on vehicle body frame member 4*e* to limit upward vertical movement of the vehicle body. Web 44 on member 41 (see FIG. 6) forms a stop co-operating with 'U' shaped member 45 attached to the vehicle body to limit movement of the body laterally of the wheel-set.

Each pair of leaf springs 40 at their other end support knife edge members 6 and 7 at 90° to each other (see particularly FIG. 9). Swing links 8 hang on the knife edge members 6 and pass downwardly through apertures in the knife edge members 6 and 7 and springs 40. The rounding of the knife edge of the co-operating recess at the upper end of each swing link 8 as can be seen in FIG. 2 permits movement of the wheel-set longitudinally of the vehicle body.

At their lower end the swing links 8 have knife edge members 10, whose knife edges co-operate with members 12 supporting the lower ends of rubber units 46 which abut plates 47 at their upper end and whose purpose is to permit the slight inclination and plan view rotation of the swing links caused by movements of the axle in the horizontal plane. The plates 47 support springs 48, which are thus in series with rubber units 46, the upper ends of springs 48 abutting against platforms 49 at the lower ends of brackets 50 extending downwardly from the vehicle body. Extending downwardly from platform 49 is a sleeve 51 for guiding spring 48 and which also acts as a stop to render spring 48 ineffective after a predetermined compression. Thus the leaf springs 40 and coil springs 48 provide the vertical springing of the vehicle body. At light loadings the coil springs 48 and the leaf springs 40 are in operation. At part loading the coil springs 48 are rendered inactive by sleeve 51 engaging platform 47 which is then hard up against member 12 and remain inactive for heavier loads.

As in the first described form of vehicle, an elastic link constituted by a traction rod 17 is attached to each axle box 3. The attachment is through lugs 52 on the axle box 3 and at this attachment the traction rod 17 has a spherical connection as shown in FIG. 12. At its other end the traction rod 17 is provided with a series of rubber discs 53 which sandwich between them a plate 54 secured to the vehicle body through member 55 and bracket 50. The discs 53 are compressed

between end plates **56** and the compression is adjustable through nut **57**. Cylindrical members **58** co-axial with rod **17** and secured to plate **54**, extend to within a predetermined distance of the end plates **56** to give a longitudinal bump clearance.

The two hydraulic dampers **24** and **25** are disposed between each axle box **3** and frame **4** and each lies in a transverse plane of the vehicle and is inclined to the vertical and lateral directions. In the drawings the two dampers at one axle box have the same inclination and both are inclined outwards from the axle box. In an alternative form, one damper may be inclined outwards and the other inwards, or both may be inclined inwards.

We claim:

1. In a suspension arrangement for a railway vehicle of the four-wheeled two axle type wherein the vehicle body is supported on a pair of wheel-sets through the suspension arrangement, the improvement comprising:

vertical springing means coupling the body to each wheel-set and having at least two springs, said vertical springing means providing a low spring rate when the payload is below a predetermined value and a high spring rate when the payload is above the predetermined value,

transverse suspension means coupling the body to each wheel-set and providing a low stiffness in the lateral direction which stiffness increases substantially in proportion with increase in payload,

traction rods extending longitudinally of the vehicle between the vehicle body and each wheel-set and having resilience to provide a predetermined stiffness to horizontal yawing movements of the wheel-sets,

and damper means disposed between the vehicle body and the wheel-sets to provide viscous damping for vertical, lateral and roll motions.

2. The improvement of claim **1** wherein the vertical springing means comprises nests of coil springs, each nest comprising inner and outer concentric coil springs arranged such that one is inactive between no-load and part-load.

3. The improvement of claim **1** wherein the vertical springing means is provided in part by cantilever springs.

4. The improvement of claim **3** wherein said vertical springing means comprises said cantilever springs and coil springs in combination, which coil springs are arranged to be inactive between a predetermined part-load and full load by reason of abutting parts on the body and wheel-set respectively forming solid connections in parallel with said coil springs.

5. The improvement of claim **1** wherein said lateral suspension means comprises vertically extending swing links having knife edge mountings at both their lower and upper ends.

6. The improvement of claim **5** wherein the mountings at one end of said swing links incorporate resilient pads.

7. The improvement of claim **5** wherein the knife edge mounting at one end of each swing link has a rounded knife edge to permit rocking movement of the swing link in the longitudinal direction of the vehicle.

8. The improvement of claim **1** wherein said vertical springing means comprises coil springs and said lateral suspension means comprises swing links which extend axially through said coil springs, a knife edge mounting at the upper end of each said swing link being supported on the wheel-set through a rubber pad and a knife edge mounting at the lower end of said swing link supporting the lower end of the coil springs, which at their upper end abut against the vehicle body, the knife edge mountings at the upper ends of the swing links permitting by the rounding of the knife edges rocking movement of the swing links in the longitudinal direction of the vehicle.

9. The improvement of claim **1** wherein said vertical springing comprises a plurality of cantilever springs and said lateral suspension means comprises swing links, each cantilever spring being secured at one end to a respective wheel-set and supporting a swing link at its other end through a knife edge mounting, the swing link having a knife edge mounting at its lower end supporting the vehicle body through a resilient pad and a coil spring in series.

10. The improvement of claim **1** wherein a pair of said traction rods are connected with each wheel-set, said traction rods extending longitudinally of the vehicle between their connections with the wheel-set and vehicle body and being disposed symmetrically about the longitudinal center line of the vehicle, one said connection of each traction rod being through a rubber spring providing low conical stiffness and relatively high stiffness axially of the traction rod and the other said connection being a spherical connection permitting universal movement at the other said connection.

11. The improvement of claim **10** wherein said spherical connection incorporates a spherical rubber bushing of low conical stiffness and relatively high radial stiffness bonded to adjoining spherical parts of said connection.

12. The improvement of claim **1** wherein the damper means comprise telescoping hydraulic dampers, each of which is mounted in a vertical transverse plane of the vehicle and inclined to the vertical and horizontal directions.

13. A railway vehicle as claimed in claim **9** wherein said knife edge mounting at one end of said swing link comprises a pair of knife edge arrangements at right angles to each other.

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