Sept. 6, 1938. F. K. CLAR 2,129,118

SPRING FOR CARS

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Fig. 1.

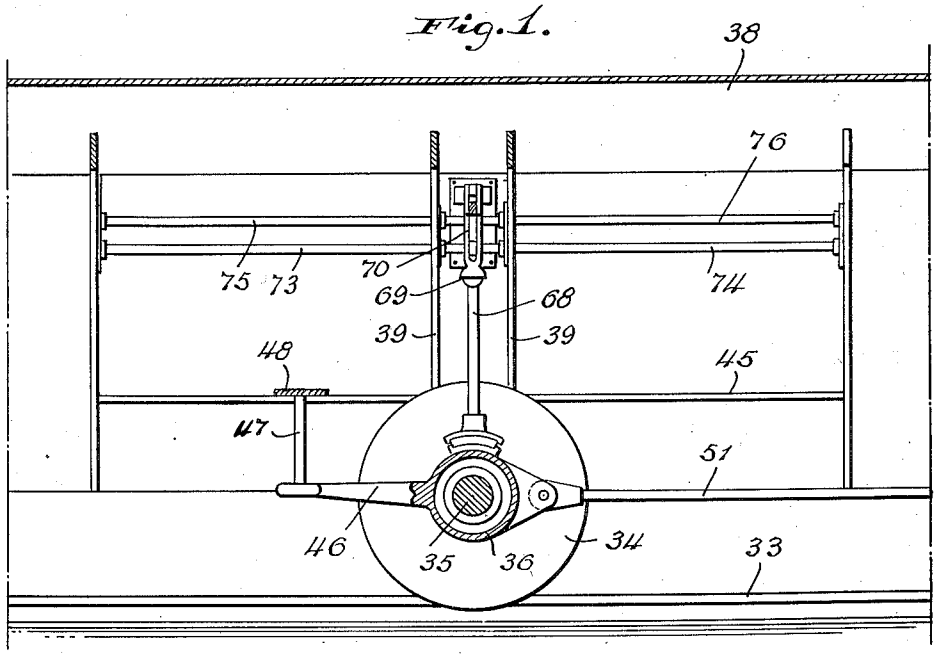
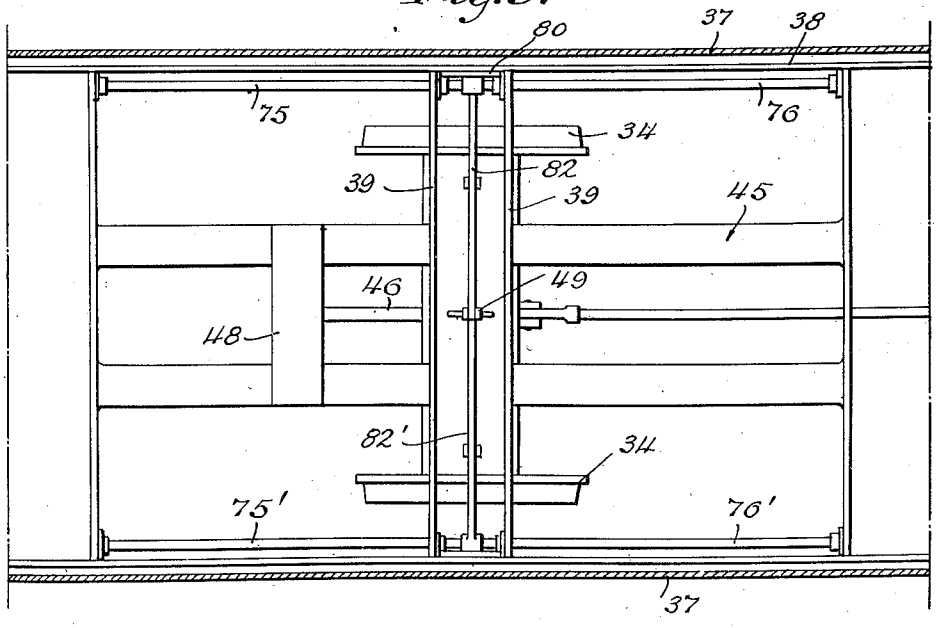


Fig. 3.



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SPRING FOR CARS

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Fig. 2.

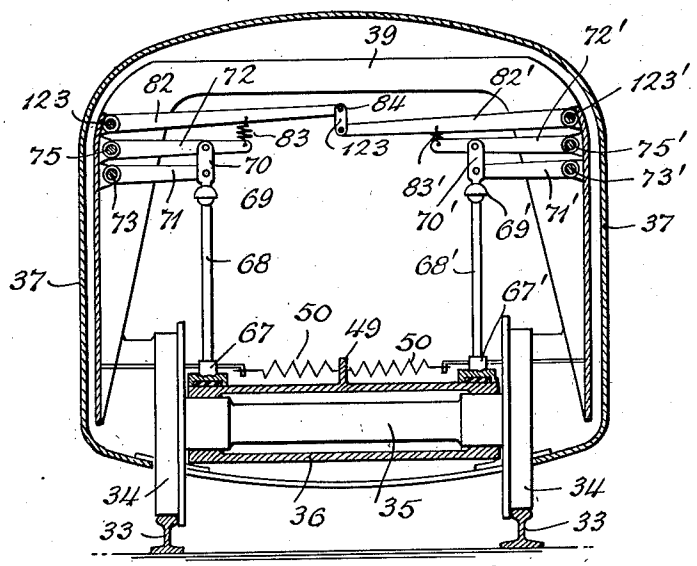
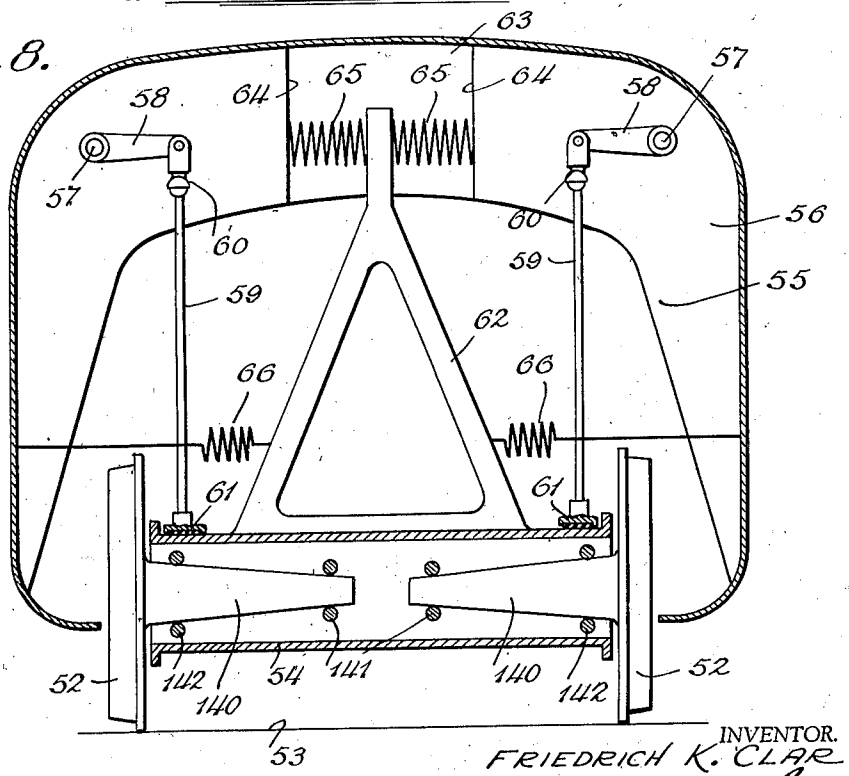


Fig. 8.



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SPRING FOR CARS

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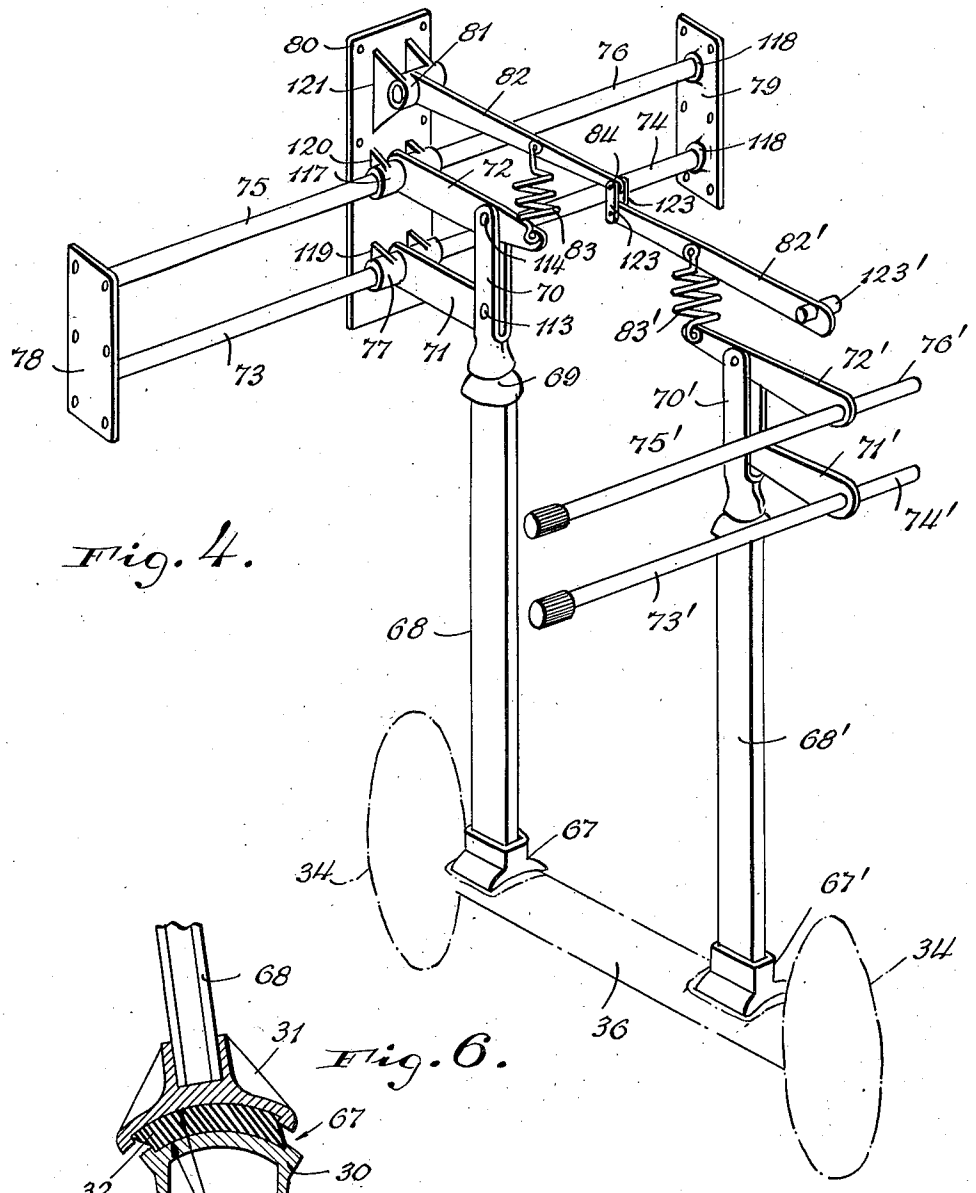


Fig. 4.

Fig. 6.

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SPRING FOR CARS

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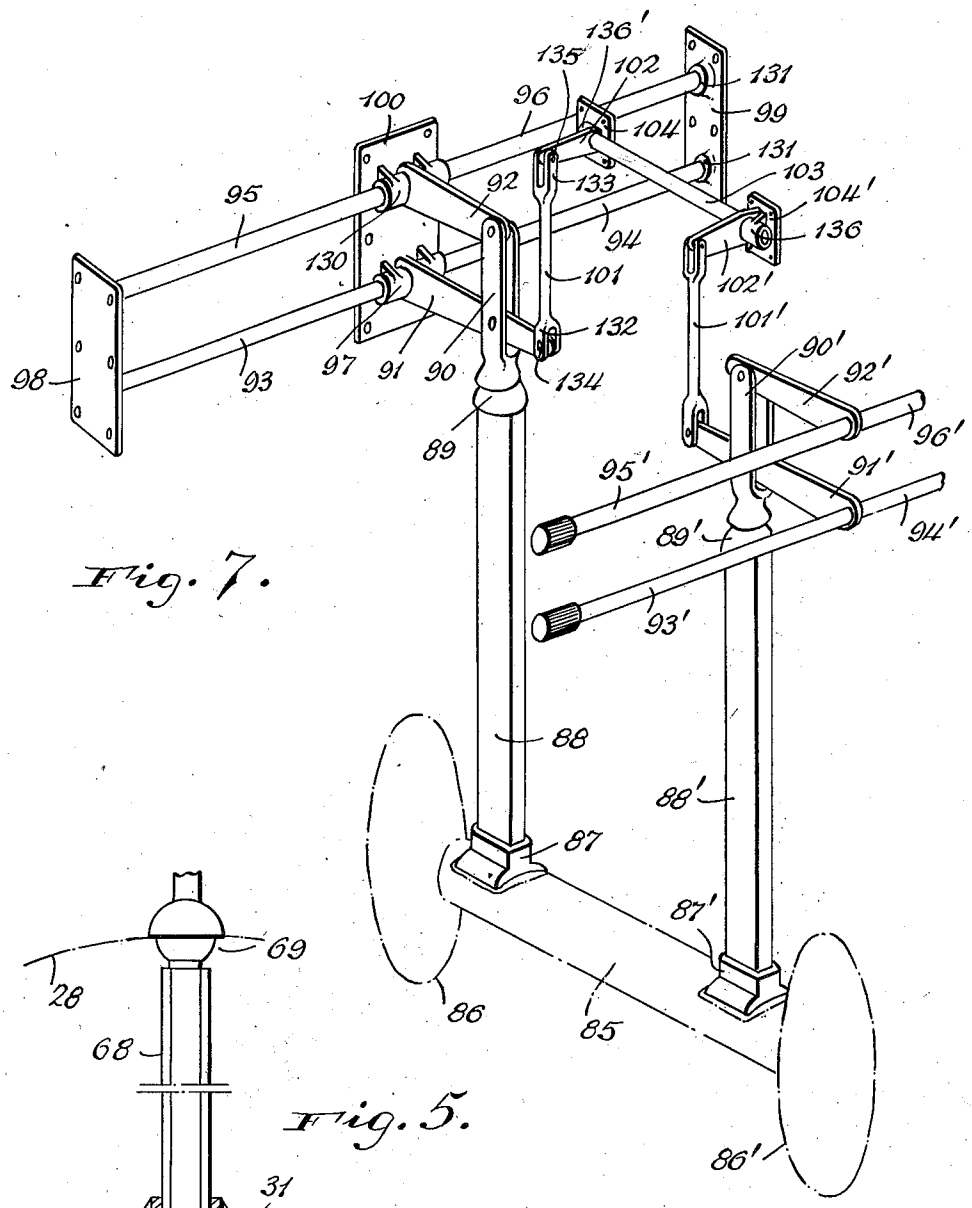


Fig. 7.

Fig. 5.

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UNITED STATES PATENT OFFICE

2,129,118

SPRING FOR CARS

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Application February 10, 1937, Serial No. 125,105
In Germany February 11, 1936

11 Claims. (Cl. 105—453)

This invention relates to springs and refers more particularly to resilient means used in cars travelling along rails and similar vehicles, such as express train cars.

Heretofore, spring systems were arranged underneath or adjacent the lower part of a car frame. Since cars, particularly express cars having a low floor surface, must be built as compactly as possible, constructors of such cars have considerable difficulty in arranging the car spring systems or finding a proper place for them.

In addition to flat or leaf springs which provide a vertical spring action, it is also customary to arrange coiled springs or twist-action springs underneath the vehicular frame, which are operative only during an oblique position of the vehicle, particularly when the latter moves along a curve, said springs tending to oppose the inclination of the vehicle.

An object of the present invention is the provision of spring systems for vehicles which are comparatively inexpensive and will occupy little space and which at the same time will effectively absorb various forces acting upon the vehicles in the course of the movements thereof.

The above and other objects of the present invention may be realized through the provision of a vehicle the framework of which is carried by long supports, one end of each support being carried by an axle casing, while the other end is situated directly underneath the roof structure of the vehicle. The ends of the supports have, preferably, the form of ball and socket joints, each joint comprising spherical metal surfaces and a rubber lining situated between these surfaces to increase the elasticity of the device. This rubber lining in the course of the relative movement of the spherical surfaces is subjected only to shear forces in addition to the usual pressure exerted by the support.

In accordance with a preferred form of the present invention the upper portion of the vehicular frame is attached to or suspended from rod-springs adjacent the roof structure of the vehicle, said rod-springs being connected with levers the opposite ends of which are resiliently carried by means of long supports by the axle of the vehicle.

In addition to the long supports which act as springs to diminish the vertical movements of the vehicle frame relatively to the vehicle axle, other springs are situated close to the roof of the vehicle, such springs being operative only during an inclined or oblique position of the vehicle frame. It is particularly advantageous to arrange rod-springs directly under the roof on both sides of the vehicle, said rod-springs absorbing vertical and side oscillations of the frame and being provided with levers which are connected with long supports carried by the vehicle axles; the vehicle is also provided with coiled springs which are connected by a leverage system with the rod-springs and with each other and which are operative only when the vehicle frame is shifted sideways relatively to the axle.

The described construction may be changed by providing guiding members which are connected with a lever of each of said rod-springs and with two levers of another transverse rod-spring situated directly underneath the roof of a vehicle, this last-mentioned spring being free from tension in the neutral position of the vehicle frame.

The invention will appear more clearly from the following detailed description when taken in connection with the accompanying drawings showing by way of example preferred embodiments of the inventive idea.

In the drawings:

Figure 1 shows a portion of a vehicle partly in side view and partly in section and illustrates means preventing an excessive inclination of the supports;

Figure 2 is a vertical cross-section through the vehicle shown in Figure 1;

Figure 3 is a horizontal view of the vehicle shown in Figures 1 and 2;

Figure 4 is a perspective view of the spring arrangement on a larger scale and shows auxiliary springs which are operative only during an oblique position of the vehicular frame;

Figure 5 shows in section a ball and socket joint constituting the lower end portion of a support;

Figure 6 is similar to Figure 5 and shows the joint in an inclined position;

Figure 7 is a perspective view of a device which is somewhat similar to that shown in Figure 4 and which comprises several rod-springs; and

Figure 8 is a vertical cross-section through a vehicle the upper portion of which is provided with springs preventing an inclination of the vehicle.

The vehicle shown in Figures 1 to 3 is carried upon rails 33 by wheels 34 interconnected by an axle 35, which is supported in a casing 36. The vehicle comprises side frames 37 and wall supports 38 as well as beams 39 supporting the roof structure. The lower framework of the vehicle is designated by the numeral 45 in the drawings. The vehicle is provided with a turning-moment

support 46 and a guide member 47 connecting the support 46 with a transverse beam 48 constituting a part of the framework of the vehicle. 49 is a projection of the axle casing 36 and is connected with two ends of the springs 50; 51 is an axle guide of the usual type. The vehicle frame is supported upon the axle casings by a number of long vertical supports 68 and 68' two of which are illustrated in the drawings.

The purpose of the turning-moment support 46, the guide member 47, and the transverse beam 48 is to prevent the casing 36 from rotating around the central axis of the axle 35. The members 46, 47, and 48 constitute a torque support, and spherical joints are usually provided at both ends of the guide member 47. This construction is well known in the art, so that it is shown merely diagrammatically in the drawings. Due to the spherical joints connected to the guide member 47, the floor of the vehicle can swing in the direction of its movement and also transverse thereof.

As shown more clearly in Figures 4 to 6, the lower end of the support 68 has the form of a ball and socket joint 67, while the lower end of the support 68' is provided with a similar ball and socket joint 67'. The vertical members 68 and 68' are thus supported upon the axle casing 36 by the joints 67 and 67'.

The upper end 69 of the support 68 has the form of a ball and socket joint 69 which serves as a support for the lever 70. As shown in Figure 4 the lever 70 is bifurcated and carries pins 113 and 114 which support the two torsion levers 71 and 72. The lever 72 is situated above the lever 71 and these two levers are movable relatively to each.

The torsion lever 71 is used for tensioning the rod-springs 73 and 74, while the torsion lever 72 is used for tensioning the rod-springs 75 and 76. The rod-springs 75 and 76 are in alignment with each other and extend parallel to the rod-springs 73 and 74.

A plate 80 carries three sets of supports 119, 120 and 121 which are provided with sleeves 77, 117 and 81, respectively. The torsion levers 71 and 72 are in engagement with the sleeves 77 and 117, respectively. The rod-springs 73 and 74 are rotatably mounted in the sleeve 77 adjacent the operative surfaces of the torsion lever 71 while the rod-springs 75 and 76 are rotatably mounted in the sleeve 117 adjacent the operative surfaces of the torsion lever 72.

Two plates 78 and 79 are provided with sleeve portions 118 which hold firmly the opposite ends of the rods 73 and 76.

The three plates 78, 79 and 80 are firmly connected with the framework of the vehicle by means of bolts, rivets or the like. Due to this arrangement the vehicle frame is supported upon the axle 35 by means of the supports 68 and 68', the plates 78, 79 and 80 and the leverage systems interconnecting these elements.

The sleeve 81 carries one end of a lever 82. The upper end of a vertical coil spring 83 is attached to the middle portion of the lever 82, while the lower end of the spring 83 is connected to the free end of the lever 72. The free end of the lever 82 carries a pin 84 which is connected with two link members 123. The opposite ends of the links 123 are connected with the free end of a lever 82'. The opposite end of the lever 82' carries a pin 123 which is supported in a bearing not shown in Figure 4. The coil spring 83' is connected with the lever 82' and with one end of a lever 72' which is rotatably supported by a bifurcated lever 70'. The lever 72' carries the two rod-springs 75' and 76', one of which constitutes the continuation of the other. A lever 71' is situated underneath the lever 72'. One end of the lever 71' is rotatably mounted on the lever 70', while the other end of the lever 71' carries the two rods 73' and 74'. The lower end of the lever 70' is connected by a ball and socket joint 69' with the support 68'.

When the vehicle is moving along a straight path the ball and socket joints 67, 69, 67' and 69' reciprocate uniformly in vertical directions. The levers 70 and 70', 71 and 71' as well as the levers 72 and 72' transmit these movements to the rod-springs 73 to 76. In the course of the movement of the vehicle the free ends of the levers 72 and 72' move continuously and uniformly up and down and the ends of the springs 83 and 83' which are attached to them are moved along with these levers. However, the levers 82 and 82' are also moved in a similar manner, so that the springs 83 and 83' are not subjected to tension.

When the vehicle is moving along a straight line, the vehicle frame swings only in a vertical direction. The rod springs 73 to 76, shown in Figure 4 oppose these movements, while the levers 82 and 82' as well as links 123 are uniformly moved up and down by the torsion levers 72 and 72' and the springs 83 and 83'. In that case, the levers 82 and 82' are loose and act only by their weight upon the springs 83 and 83'.

However, when the vehicle is inclined, for example, when it is moved along a curve, then the springs 83 and 83' are subjected to tension. If the vehicle is inclined toward the left (looking in the direction of Figure 4), then the free end of the lever 72 will move upward while the free end of the lever 72' will move downward. Due to the provision of the links 84, which prevent the separation of the levers, they will assume an intermediate position in which the spring 83 will be subjected to compression while the spring 83' will be subjected to expansion. These forces are opposed to the inclination of the vehicle and tend to restore it to its original position.

If the springs 83 and 83' are sufficiently strong, then in spite of the soft spring suspension of the vehicle frame no great inclinations of this frame can take place when the vehicle is moving along a curve. Obviously, the springs 83 and 83' must be so constructed that they can be subjected to compression and expansion forces without lateral deflection. The springs 83 and 83' become operable not only in the course of a movement along a curve, but also when due to an uneven roadbed one of the supports 68 or 68' should be raised above the other.

The plates 78, 79 and 80 used as supports for the rod-springs 73 to 76 and for the torsion levers connected therewith are fixed to one side wall of the vehicle. As indicated diagrammatically in Figure 2, similar plates carrying the rod-springs 73' to 76' are fixed to the opposite side wall of the vehicle. It is important for the proper operation of the described construction, that the torsion levers be connected with the rod-springs adjacent the sleeves supporting said rod-springs and connected with the plates.

In the described construction there are two pairs of rod-springs which are situated upon both sides of the vehicle, and which are connected in parallel with each other. Obviously the number

of the rod-springs may be increased whenever necessary.

As shown in Figures 1 and 2, the springs 83 and 83' are arranged directly underneath and close to the roof of the vehicle. The movements of the axles and the axle casings are transmitted vertically by the supports 68 and 68' to the vehicle frame, said supports extending from points close to the vehicle axles to points close to the roof structure of the vehicle.

The advantage of the described construction is that it is possible to provide a vehicle having a very low floor surface which is situated very close to the ground. While a construction of this type may be used for any kind of cars or vehicles, it is particularly suitable for rapidly moving trains cars or cars of express trains.

A characteristic feature of the described construction is that the same springs are used to take in a vertical swinging of the car frame as well as the side inclinations thereof, particularly when the car is moving along a curve. However, the two additional springs 83 and 83' are automatically connected in parallel with the first-mentioned springs when the latter are subjected to tension caused by the side inclination of the vehicular frame.

Another advantage of this construction is that the spring action is comparatively weak, while the vehicle is moving along a straight line, but that the spring action is greatly increased when the vehicle is inclined sideways, thereby preventing an excessive side inclination of the vehicle. As already mentioned, the vertical and sideways swinging of the vehicle is taken up by the rod-springs 73 to 76 and 73' to 76' arranged directly underneath the roof structure of the vehicle, while additional springs 83 and 83' which are coupled one with the other and which are connected with the rod-springs by a leverage system, operate in relation to the vehicle axle only during a sidewise inclination of the vehicle frame.

As shown in Figures 1 to 3, the upper joints 69 and 69' of the long supports 68 and 68' are connected with the torsion levers 71 and 72, or 71' and 72' through the medium of the levers 70 and 70', respectively, while their lower joints 67 and 67' are connected with the ends of the springs 50, the opposite ends of the springs 50 being attached to the projection 49. The lever 46 and the axle guide 51 also increase the stability of the long supports 68 and 68'.

Figures 5 and 6 show in greater detail the construction of the ball and socket joint 67 of the support 68. The joint 67' of the support 68' is constructed in a similar manner.

The lower end of the support 68 is situated in a sleeve constituting a part of the upper joint member 31. A rubber lining 32 is situated between the upper member 31 and the lower member 30 of the joint 67. The member 30 is carried by the axle casing 36 (Figure 2) and is connected to one end of the spring 50.

The form of the two joints 67 and 69 of the support 68 is such that the upper joint 69 is movable along a substantially spherical surface 28, the center of which coincides with the center of the spherical surfaces of the members 30 and 31.

When the vehicle is in motion, the pressure forces acting upon the support 68 are transmitted to it through the rubber lining 32. When, however, the joint 69 is moved upon the spherical surface 28 within certain predetermined limits the rubber lining 32 would be also subjected to a shearing force. These movements can take place when a car of an express train is being shaken in the course of its movement along the track or they can be also caused by centrifugal forces.

The effect of the shearing forces acting upon the rubber lining 32 and created by an inclination of the support 68 is illustrated more clearly in Figure 6 of the drawings. When the support 68 is moved to the inclined position shown in Figure 4, the upper member 31 moves along with the support 68 while the lower member 30 which is connected to the axle casing 36 retains its original position. Shearing forces created by this relative movement cause the rubber lining 32 to change its form, as is clearly shown in Figure 6.

The ball and socket joint 69 at the upper end of the support 68 may be similar in construction to the joint 67. The arrangement may be such that the center 29 of the spherical surfaces of the joints 67 is movable within certain limits upon a spherical support, the center of which coincides with the center of the spherical surfaces of the joint 69 in the position shown in Figure 5 of the drawings.

Figure 7 shows a spring system of a somewhat different type. The vehicle axle which is, preferably, an undivided one, is indicated diagrammatically by the numeral 85, the two wheels carried by the axle 85 being indicated by the numerals 86 and 86'. Two supports 88 and 88' extend from a point adjacent the axle 85 to a point close to the roof structure of the vehicle which is not shown in the drawings. The lower ends of the supports 88 and 88' are provided with ball and socket joints 87 and 87' which are connected in any suitable manner with the vehicle axle 85. The upper ends of the supports 88 and 88' are provided with ball and socket joints 89 and 89' which are connected with the bifurcated vertical levers 90 and 90'. Two torsion levers 91 and 92 are rotatably supported by the lever 90, while the torsion levers 91' and 92' are rotatably supported by the lever 90'. The plate 100 carries sleeves 97 and 130 which contain the ends of the rod springs 93, 94, 95, and 96. The levers 91' and 92' are connected with the rod-springs 93', 94', 95', and 96'. The lever 91 is used for transmitting the tension to the rod-springs 93 and 94, while the lever 92 is used for transmitting the tension to the rod-springs 95 and 96. The rod-springs 93 to 96 are free to rotate relatively to the sleeves 97 and 130, while the opposite ends of these rod-springs are rigidly connected with the sleeves 131 of the plates 98 and 99. The plates 98, 99 and 100 are firmly connected by bolts or rivets with the framework of the vehicle. Due to this arrangement the vehicle frame is supported upon the vehicle axle 85 by means of the plates 98, 99 and 100, the supports 88 and 88' as well as the leverage system interconnecting these elements.

A vertical rod 101 is provided with two bifurcated ends 132 and 133. The lower end 132 is connected by means of a pin 134 with the free end of the lever 91. The upper end 133 of the rod 101 is connected by means of a pin 135 with a torsion lever 102 which is firmly connected with a rod lever 103. The rod lever 103 which is normally not subjected to tension extends parallel to the vehicle axle 85 and is situated directly underneath the roof structure of the vehicle. One end of the rod spring 103 is carried by a sleeve 136' connected with the plate 104, which

is fixed to the framework of the vehicle. The opposite end of the rod spring 103 is connected with the torsion lever 102' and is carried by a sleeve 136 which is carried by the plate 104'. The plate 104' is fixed to the framework of the vehicle. The free end of the lever 102' is pivotally connected with the upper bifurcated end of the rod 101'. The lower bifurcated end of the rod 101' is connected with one end of the lever 91'.

When the vehicle is moving along a straight line the ball and socket joints 87, 89, 87' and 89' will reciprocate uniformly in vertical directions. The described leverage system will cause a tension of the rod springs 93 to 98 and 93' to 96', while the free ends of the levers 91 and 91', the rods 101 and 101', as well as the levers 102 and 102' will move up and down uniformly without subjecting the rod-spring 103 to tension.

When, however, the vehicle moves upon an uneven roadbed, or when it is moved along a curve, the joints 89 and 89' will not move uniformly any more, with the result that the vertical movements of the free ends of the levers 91 and 91' will also become non-uniform. Then the levers 102 and 102' will be moved relatively to each other, so that the rod-spring 103 will be subjected to tension.

It is desirable to provide vertical plates 100 supporting the rod springs 93 to 96 upon each side wall of the vehicle and to provide pivotal supports for the torsion levers adjacent these plates Then two pairs of rod-springs will be provided upon each side of the vehicle and will be interconnected in parallel.

Obviously, it is possible to provide any additional number of such springs.

While described spring system is similar to the one shown in Figure 4, an important distinction between the two systems is that in the arangement shown in Figure 7 only rod-springs are used in lieu of coil springs 83 and 83' of Figure 4. The construction shown in Figure 7 is also suitable for cars adapted to move at a very high speed, the floor surface of which should be situated as closely as possible to the ground. In this construction, as well as in that shown in Figure 4, the vertical swinging and the side swinging are taken up by rod-springs situated under the roof structure on both sides of the vehicle, said rod-springs being carried by the axle by means of vertical supports and levers connected with such supports. An important feature of the construction shown in Figure 7 as compared to that shown in Figure 4 is that in lieu of the leverage system and the two coil springs 83 and 83' operative only when the car frame is inclined sideways relatively to the axle, the construction shown in Figure 7 comprises guides or rods 101 and 101' connected on the one hand, with the torsion levers 91 and 91' of the rod springs 93, 94 and 93', 94', and on the other hand, with two torsion levers 102 and 102' of a transverse rod spring 103 which is normally not subjected to tension and which is situated directly underneath the roof of the vehicle.

An advantage of the construction shown in Fig. 7 is the elimination of the comparatively strong moment of inertia to which the additional levers 82 and 82' of the construction shown in Fig. 4 are subjected. The construction shown in Fig. 7 has less weight, takes up less room, and can be more easily assembled. Another advantage of the construction shown in Fig. 7 is that the rod-spring 103 is safer in operation than the coil springs 83 and 83' (Fig. 4). Furthermore, the corridor of the car may be made higher, or if the height of the corridor remains the same, the floor surface of the car may be made lower, thereby lowering still further the center of gravity of the car structure.

The device shown in Figure 8 is used for preventing the tilting of the vehicle or for keeping it within reasonable bounds. The vehicle shown in Fig. 8 is provided with wheels 52 moving along a roadbed 53. Each of the wheels 52 is firmly connected with a separate half-axle 140 supported by the bearings 141 and 142 within the axle casing 54, so that the two wheels 52 rotate independently of each other. The frame 55 of the vehicle is connected with the beams 56 which support the rod-springs 57. The torsion levers 58 are firmly connected with the rod-springs 57, and are supported by means of the vertical supports 59 upon the casing 54 of the vehicle axle. The lower and upper ends of the supports 59 are provided with ball and socket joints 60 and 61. The casing 54 of the axle is firmly connected with the support 62 which can also be used for absorbing the turning moment and thus prevent the axle casing 54 from turning.

Springs 65 are used for preventing or diminishing the sidewise inclination or tilting of the vehicle. The springs 65 are situated in an upper portion 63 of the vehicle frame between the walls 64 which are attached to the beam 56. One end of each of the springs 65 is firmly connected to the upper portion of the support 62, while the other end of each spring is attached to a wall 64.

Additional springs 66 are used to prevent the sidewise movements of the lower part of the framework and are situated between the axle casing 54 or the axle frame and the frame of the vehicle. In the construction shown in Fig. 8 one end of each spring 66 is connected to the support 62, while its opposite end is connected to an adjacent side wall of the vehicle. The springs 66 are preferably more yieldable than the springs 65 situated in the upper portion of the car, so that when the vehicle is moved very rapidly and over a curve or is shaken by the unevenness of the roadbed the lower part of the vehicle will swing sidewise to a greater extent than the upper part of the car.

Due to this arrangement the force acting upon a vehicle moving along a curve, said force being a resultant of the forces of gravity and of the centrifugal forces, will be substantially parallel to the side walls of the vehicle. Due to this direction of the resultant force, articles situated within a vehicle will not be tilted or shifted, even though the vehicle is moving with great speed.

As shown in Figure 2 of the drawings, the upper ball and socket joint 69 of the support 68 has a definite position in space in relation to the vehicle frame, since the member 70 and the levers 71 and 72 as well as the rod springs 73 to 76 are firmly connected with the frame by means of their supports 78, 79, and 80, shown in Figure 4. The frame is supported in a similar manner by means of a second axle, which is not shown, or in case of a vehicle with a single axis, one end of such vehicle is supported by the adjacent end of another car. Consequently, the positions of the upper ball and socket joints 69 and 69' are determined in their relation to the vehicle frame.

The position of the lower ball and socket joints 67 and 67' is also determined, since they are carried by the axle support 36. However, as is apparent from Figure 1, the rotation of the axle support around the wheel axis is prevented by the members 46, 47, and 48. A movement of the axle support in a horizontal plane is prevented

by the axle guide **51**. Finally, the springs **50**, shown in Figure 2, prevent unlimited oscillations between the lower part of the vehicle frame and the axle support in the direction of the latter. Consequently, the axle support and the lower ball and socket joints **67** and **67'** carried thereby are prevented from moving freely relatively to the vehicle frame.

It should be noted also that the purpose of the rubber lining **32** of the ball and socket joint **67** shown in Figures 5 and 6 is to eliminate friction between two metallic parts in case of a sidewise inclination of the long support **68**, and not to provide a spring action in a vertical direction, since the springs **73** to **76** are used for that purpose.

As already mentioned, an advantage of the cars constructed in accordance with the principles of the present invention is that they can be made lower than those known in prior art. In prior art it was customary to arrange the floor surface of a vehicle at a height of about 1200 millimeters over the upper edge of the rails, while in the described constructions this distance can be diminished to 600 millimeters. The center of gravity of a vehicle constructed in accordance with the present invention will, therefore be much lower and nearer the roadbed. This is of great importance in the case of rapidly moving cars or vehicles subjected to considerable centrifugal forces.

Through the use of long supports reaching to the roof of the vehicle and connecting the vehicle axle with the roof structure a further advantage is attained in that the lateral components of the stresses in the long supports are comparatively small.

Spring systems constructed in accordance with the present invention can be used conveniently in connection with cars having steered axles since in such cars the axles of the car are moved to a considerable extent relatively to the car frames and since the shifting of the framework caused by these movements can be easily taken in by the long supports without causing any extensive inclination of such supports.

What is claimed is:

1. In a vehicle, an axle support, rod springs situated close to the roof of the vehicle, torsion levers connected with said rod springs, resilient supporting means connecting said torsion levers with said axle support, links, one end of each link being pivotally connected with one end of a separate torsion lever, another rod spring, means supporting the last-mentioned rod spring adjacent the roof of the vehicle, torsion levers connected with the last-mentioned rod spring, the other end of each link being pivotally connected with a separate one of the last-mentioned torsion levers, the last-mentioned rod spring being free from tension in the neutral position of the vehicle.

2. In a vehicle, at least two rod springs situated close to the roof of the vehicle, separate torsion levers having ends connected with said rod springs, an axle support, resilient supporting means pivotally connecting said torsion levers adjacent the free ends thereof with said axle support, links having ends pivotally connected with the free ends of said torsion levers, another rod spring, and torsion levers having ends connected with the last-mentioned rod-spring, the free ends of the last-mentioned torsion levers being pivotally connected with the other ends of said links.

3. A vehicle having a frame and an axle support, said vehicle comprising at least two rod springs carried by said frame, separate torsion levers having ends connected with said rod springs, substantially vertical elongated supports extending close to the roof of the vehicle, elastic joints resiliently connecting said elongated supports with said axle support, levers, means resiliently connecting said elongated supports with the last-mentioned levers, the first-mentioned levers being pivotally connected adjacent the free ends thereof with the last-mentioned levers, links having ends pivotally connected with the free ends of the first-mentioned levers, another rod spring, and torsion levers having ends connected with the last-mentioned rod-spring, the free ends of the last-mentioned levers being pivotally connected with the other ends of said links.

4. In a vehicle, a vehicle frame, an axle support, two elongated substantially vertical supports extending substantially to the roof of the vehicle, resilient means connecting said vertical supports with said axle support, resilient means connecting said vertical supports with said vehicle frame, a spring situated close to the roof of the vehicle and having one end connected with said vehicle frame, and a vertical support firmly connected with said axle support, the opposite end of said spring being firmly connected with the last-mentioned support.

5. In a vehicle, a vehicle frame, an axle support, at least one elongated substantially vertical support extending substantially to the roof of the vehicle, resilient means connecting said vertical support with said axle support, resilient means connecting said vertical support with said vehicle frame, a spring situated close to the roof of the vehicle and having one end connected with said vehicle frame, a support firmly connected with said axle support, the opposite end of said spring being firmly connected with the last-mentioned support, and resilient means connecting the lower portion of said vehicle frame with the last-mentioned support.

6. In a vehicle, a vehicle frame, an axle support, at least one elongated substantially vertical support extending substantially to the roof of the vehicle, resilient means connecting said vertical support with said axle support, resilient means connecting said vertical support with said vehicle frame, a spring situated close to the roof of the vehicle and having one end connected with said vehicle frame, a support firmly connected with said axle support, the opposite end of said spring being firmly connected with the last-mentioned support, and a spring which is comparatively more yieldable than the first-mentioned spring, the last-mentioned spring connecting the lower portion of said vehicle frame with the last-mentioned support.

7. In a vehicle, a vehicle frame, at least one axle support, a pair of substantially vertical elongated supports for each axle support, said supports extending substantially to the roof of the vehicle, at least one pair of ball and socket joints, said axle support supporting said joints, each of said joints being connected with the lower end of a separate elongated support, at least one other pair of ball and socket joints, each of the second-mentioned joints being connected with the upper end of a separate elongated support, and being situated directly underneath the roof of the vehicle, a plurality of rod-springs, a plurality of torsion levers, each of said torsion levers having an end connected to one of said rod-springs, means connecting the opposite ends of said torsion levers with the second-mentioned

joints, means connected to said vehicle frame and supporting said rod-springs at the top portion of said vehicle, an auxiliary spring device, means connected with said auxiliary spring device and said vehicle frame for supporting said auxiliary spring device at the top portion of said vehicle frame, and means connected with said auxiliary spring device for automatically causing the operation thereof only during a side inclination of said vehicle frame.

8. In a vehicle, a vehicle frame, at least one axle support, a pair of substantially vertical elongated supports for each axle support, said vertical supports extending substantially to the top of the vehicle, at least one pair of ball and socket joints supported at a distance from each other by said axle support, each of said joints being connected with the lower end of a separate elongated support, at least one other pair of ball and socket joints, each of the second-mentioned joints being connected with the upper end of a separate elongated support, at least two rod-springs, at least two torsion levers, each of said torsion levers having an end connected to a separate rod-spring, means connecting the opposite ends of said torsion levers with the second-mentioned joints, means connected to said vehicle frame and supporting said rod-springs, two rods having ends connected to a separate torsion lever, another rod-spring, means connected with said vehicle frame and supporting the last-mentioned rod-spring horizontally and transversely to the vehicle frame at the top portion thereof, and other torsion levers interconnecting the last-mentioned rod-spring with the opposite ends of said rods, whereby the last-mentioned rod-spring is subjected to torsional stress during a side inclination of said vehicle frame.

9. In a vehicle, a vehicle frame, at least one axle support, a pair of substantially vertical elongated supports for each axle support, said vertical supports extending substantially to the top of the vehicle, at least one pair of ball and socket joints, said axle support supporting said joints, each of said joints being connected with the lower end of a separate elongated support, at least one other pair of ball and socket joints, each of the second-mentioned joints being connected with the upper end of a separate elongated support, a plurality of rod-springs, a plurality of torsion levers, each of said torsion levers having an end connected to one of said rod-springs, means connecting the opposite ends of said torsion levers with the second-mentioned joints, means connected to said vehicle frame and supporting said rod-springs, a vertical support carried by said axle support, and at least one spring situated close to the roof of the vehicle and connecting the last-mentioned support with said vehicle frame.

10. A device in accordance with claim 9, comprising resilient means situated at the lower portion of said vehicle frame and connecting the last-mentioned support with said vehicle frame.

11. A device in accordance with claim 9, comprising resilient means situated at the lower portion of said vehicle frame and connecting the last-mentioned support with said vehicle frame, said resilient means being weaker in resiliency than the last-mentioned spring.

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