Dec. 27, 1938. F. K. CLAR ET AL 2,141,592

SPRING SUSPENSION SYSTEM FOR CARS

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Fig. 1.

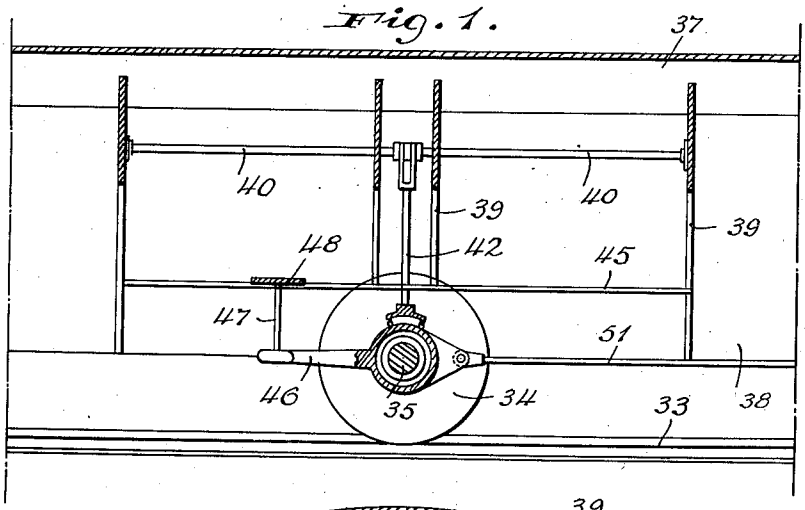


Fig. 2.

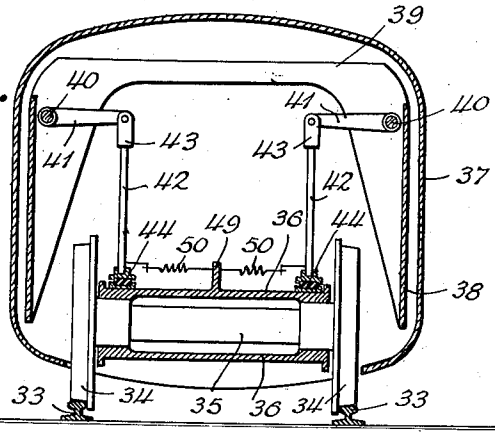
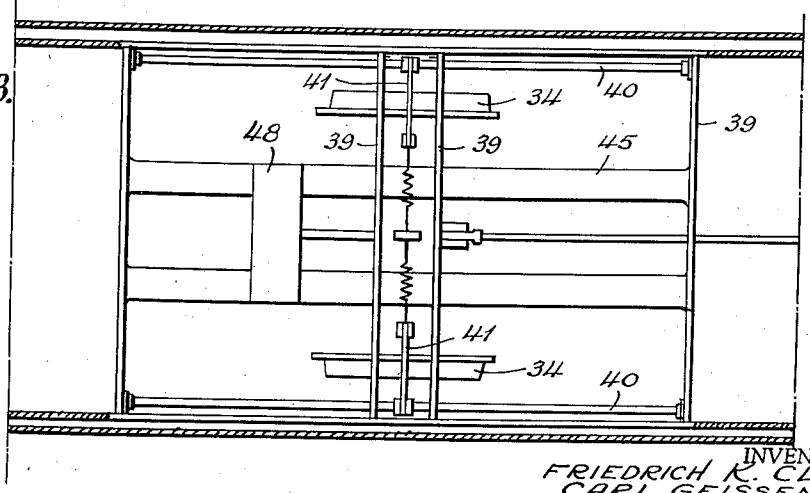


Fig. 3.



INVENTORS
FRIEDRICH K. CLAR
CARL GEISSEN

BY

Richards & Geier
ATTORNEYS

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Fig. 9.

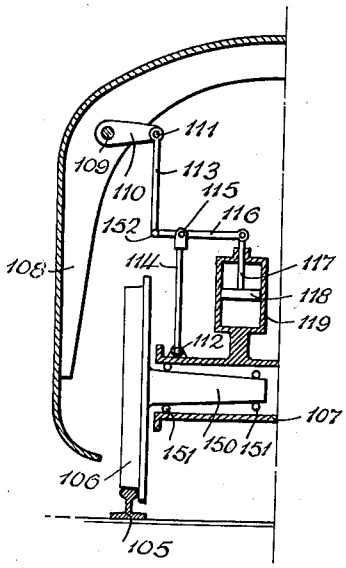


Fig. 10.

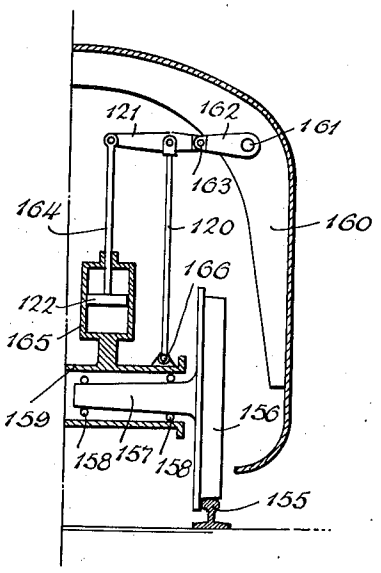


Fig. 4.

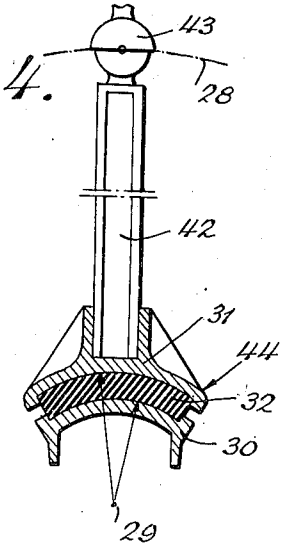
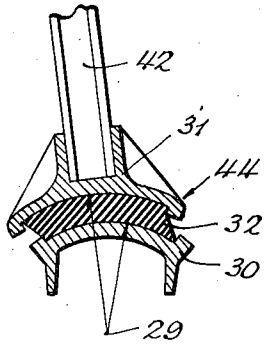


Fig. 5.



INVENTORS
FRIEDRICH K. CLAR
CARL GEISSEN

BY Richards & Geier
ATTORNEYS

Dec. 27, 1938. F. K. CLAR ET AL 2,141,592

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Fig. 6.

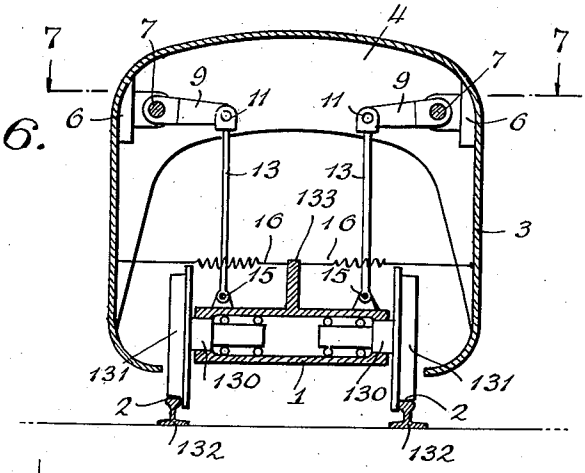


Fig. 7.

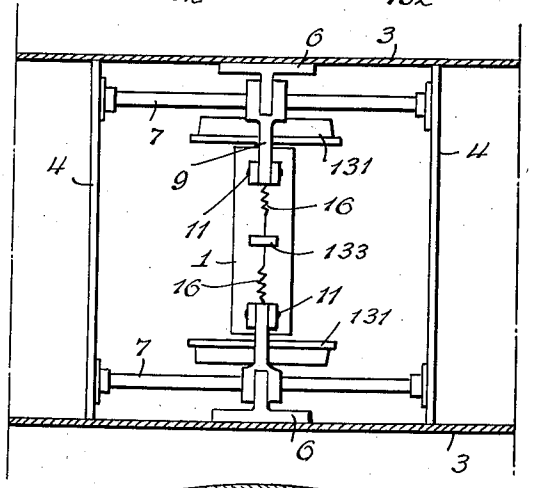
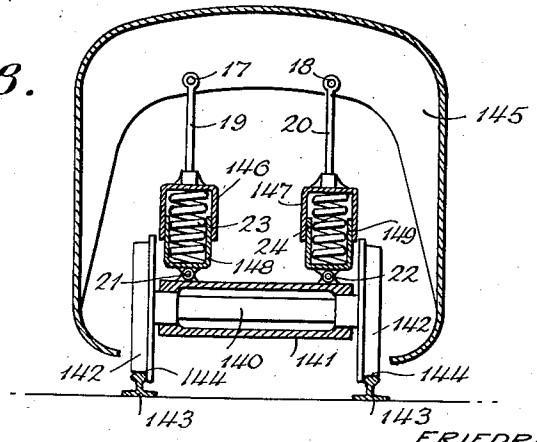


Fig. 8.



INVENTORS
FRIEDRICH K. CLAR
CARL GEISSEN

BY

Richards & Geier
ATTORNEYS

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Fig. 11.

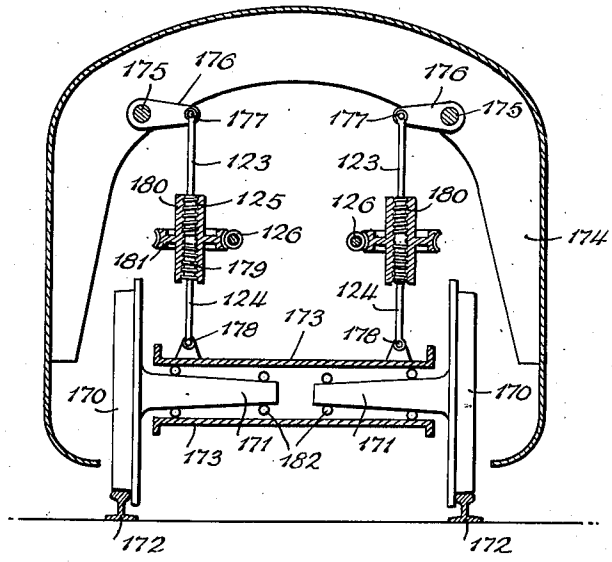
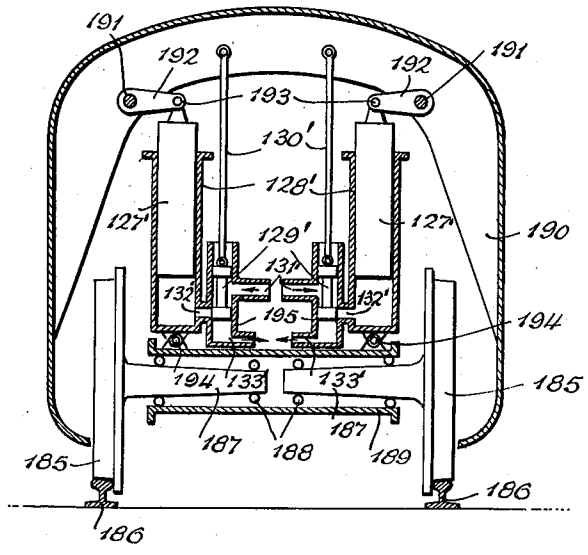


Fig. 12.



INVENTORS
FRIEDRICH K. CLAR
CARL GEISSEN

BY Richards & Geier
ATTORNEYS

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UNITED STATES PATENT OFFICE

2,141,592

SPRING SUSPENSION SYSTEM FOR CARS

Friedrich Konrad Clar, Berlin-Hermsdorf, and Carl Geissen, Berlin-Schoneberg, Germany; said Clar assignor to Rheinmetall-Borsig Aktiengesellschaft/werk Borsig Berlin-Tegel, Berlin-Tegel, Germany, a corporation of Germany

Application February 19, 1937, Serial No. 126,662
In Germany February 20, 1936

3 Claims. (Cl. 105—453)

This invention relates to spring suspension systems for cars traveling along rails and similar vehicles, such as express train cars.

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

In addition to flat or leaf springs which provide a vertical spring action, it was customary to arrange coil springs or twist-action springs underneath the vehicular frame, these last-mentioned springs being operative only during an inclined position of the vehicle, particularly when it moves along a curve, and tending to oppose the tilting of the vehicle.

An object of the present invention is the provision of spring suspension systems 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 frame-work 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 the surfaces to increase the elasticity of the system. 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 transmitted to 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 torsion levers the opposite ends of which are resiliently carried through the medium of the long supports, by the axle casing of the vehicle.

In accordance with another preferred form of the present invention no rod-springs are used, but the upper ends of the long supports are directly connected with the beams or other portions of the vehicular frame by means of ball and socket joints, said long supports comprising springs the action of which extends in the direction of the longitudinal axis of the long supports, while the lower ends of these long supports are connected with the axle casing by means of similar ball and socket joints.

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 in longitudinal 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, with the roof removed;

Figure 4 shows in section a ball and socket joint constituting the lower end portion of a long support;

Figure 5 is similar to Figure 4 and shows the joint in an inclined position;

Figure 6 is a vertical cross-section through a vehicle provided with long supports and torsion springs upon which the vehicle frame is suspended;

Figure 7 is a section along the line 7—7 of Figure 6.

Figure 8 is a vertical cross-section through a vehicle the long supports of which are provided with coil springs; and

Figures 9, 10, 11 and 12 are vertical cross-sections through different types of vehicles the long supporting means of which are provided with means for adjusting the operative lengths thereof.

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 horizontal 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 frame-work of the vehicle. The axle casing **36** is provided with a projecting member **49** which is connected with two ends of the springs **50**. The device is provided with an axle guide **51** of the usual type.

The vehicle frame is supported upon the axle casing by a number of long vertical supports **42**.

The lower ends of the supports **42** have the form of ball and socket joints **44**, which are carried by the axle casing **36**, while the upper ends of the supports **42** are provided with the ball and socket joints **43**.

The beams **39** of the vehicular frame carry rod-springs **40** which are firmly connected with the torsion levers **41**. The free ends of the torsion levers **41** are connected with the ball and socket joints **43**. Due to this arrangement the position of the long supports **42** is fixed relatively to the

vehicular frame and the axle casing by the connection of their upper ends to the torsion levers 41 and also by means of the lower joints 42, as well as the springs 50, the turning-moment support 46 and the axle guide 51. These elements thus serve as a connection between the vehicular frame and the axle support.

Figures 4 and 5 show in greater detail the construction of the ball and socket joint 44 of the support 42.

The lower end of the support 42 is situated in a sleeve constituting a part of the upper joint member 31 of the ball and socket joint 44. The rubber lining 32 is situated between the upper member 31 and the lower member 30 of the joint 44. The member 30 is carried by the axle casing 36 and is connected to one end of the spring 50 (Figure 2).

The form of the two joints 44 and 43 of the support 42 is such that the upper joint 43 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 being operated, the pressure forces acting upon the support 42 are transmitted to it through the rubber lining 32. When, however, the joint 43 is moved upon the spherical surface 28 within certain pre-determined limits the rubber lining 32 will be subjected also 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 a 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 42, is illustrated more clearly in Figure 5 of the drawings. When the support 42 is moved to the inclined position shown in Figure 5 the upper member 31 moves along with the support 42 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 5.

The ball and socket joint 43 at the upper end of the support 42 may be similar in construction to the joint 44. The arrangement may be such that the center 29 of the spherical surfaces of the joint 44 is movable within certain limits upon the spherical support, the center of which coincides with the center of the spherical surfaces of the joint 43 in the position shown in Figure 4 of the drawings. It is advisable to provide a permanent connection between the lower member 30 of the joint 44 and its supporting casing 36, so that the direction of the axis of the support 30 will always be the same, irrespective of the inclination of the support 42. In order to achieve that the rubber lining 32 will be subjected only to shearing forces in addition to the vertical pressure, the relationship of the diameter of the rubber lining 32 to the radial thickness of the lining should be at least 6 to 1.

Figures 6 and 7 show a vehicle having a spring suspension system of a slightly different type. The vehicle comprises a divided axle 130 situated in an axle casing 1 and firmly connected with two wheels 131 which are carried by the rails 132 having an upper edge surface 2.

The vehicle frame 3 comprises beams 4 which carry the roof structure of the vehicle. The vehicular frame 3 is firmly connected with the supports 6 which carry the rod-springs 7. Torsion levers 9 are firmly connected with the rod-springs 7. The free ends of the torsion levers 9 are firmly connected with the upper ends of the long supports 13 by means of the upper ball and socket joints 11. The lower ends of the long supports 13 are firmly connected with the vehicle casing 1 by means of the ball and socket joints 15.

It is advisable to provide supporting springs 16 having ends which are connected to a projecting member 133 constituting an integral part of the axle casing 1. The opposite ends of the spring 16 are firmly connected to the vehicle frame 3.

This arrangement prevents an excessive inclination of the lower portion of the vehicular frame. Furthermore, the inclinations of the supports 13 about their lower ends are also limited in a manner which is similar to prior art constructions limiting the movements of the axle casing by means of its turning-moment support.

The vehicle shown in Figure 8 of the drawings comprises an axle 140 which is situated within a casing 141 and which is firmly connected with the two wheels 142. The wheels 142 are carried by rails 143 having an upper edge surface 144.

The vehicular frame comprises beams 145 which carry the roof structure of the vehicle.

The supporting means which carry the frame upon the axle casing, comprise rods or long supports 19 and 20 the upper ends of which are provided with ball and socket joints 17 and 18, respectively. The upper ends of the ball and socket joints 17 and 18 are firmly connected with the beam 145. The lower ends of the supports 19 and 20 have the form of downwardly extending cup shaped casings 146 and 147 which enclose the upper ends of coil springs 23 and 24, respectively. The lower ends of the coil springs 23 and 24 are carried by upturned cup-shaped casings 148 and 149, which are surrounded by the lower portions of the casings 146 and 147, respectively. The casings 148 and 149 are supported upon the axle casing 141 by means of the ball and socket joints 21 and 22.

The ball and socket joints 17 and 21 of the supporting means 19, 146, 148 and 23, or at least one of these joints, should have the form of the joint 44 shown in Figure 4 and be provided with a rubber lining situated between two, preferably metallic spherical joint members. This rubber lining is subjected only to shearing forces in addition to the vertical pressure, when one of the joint members is inclined relatively to the other joint member.

Spring systems shown diagrammatically in Figures 9 to 12 are used to prevent the tilting of the vehicular frame, when, for example, the vehicle is moving along a curve, or even to cause an inclination of the frame in a direction opposite to the direction of inclination of the vehicle. This is accomplished by varying the operative lengths of the supporting means, the ends of which are connected by means of ball and socket joints with the axle casing and the vehicular frame, respectively.

The variations in the operative distances between the joints of the supporting means may be carried out by providing the supporting means with several interconnected elements which can be moved to the desired extent in directions toward and away from an imaginary straight line interconnecting the two end joints. Constructions of this type are shown in Figures 9 and 10.

It is also possible to provide supporting means consisting of several rods which can be moved relatively to each other in the vertical direction by means of screw threads, as shown in Figure 11.

Another preferred form of the inventive idea which is shown in Figure 12, consists in that the supporting means comprise a cylinder and a piston which are movable relatively to each other by hydraulic means, by means of compressed air or by any other suitable means. To prevent an inclination of the vehicular frame in the case of an unequal distribution of the load it is advisable to adjust the operative lengths of the supporting means situated on both sides of the vehicle, depending upon the position of the vehicular frame above the axle of the vehicle. If, for instance, a vehicle is inclined toward one side due to an unequal distribution of its load, then the operator can operate contacts which actuate auxiliary motors or steering means which in their turn, adjust the operative lengths of the supporting means until the frame has assumed a desired position relatively to the axle of the vehicle.

It is particularly advantageous to operate each supporting device separately depending upon the position of the frame. When the vehicle is moving along a curve it is possible to lengthen the outer supporting means of the vehicle and to shorten correspondingly the inner supporting means thereof, so that the frame would be inclined in a direction toward the center of the curve.

These changes in the operative lengths of the supporting means at a time when the vehicle is moving along a curve can be made dependent upon the extent of the centrifugal forces, for example, through the use of an automatically operable device comprising a centrifugal pendulum which operates electrical contact switches.

Figure 9 shows the rails 105 carrying wheels 106 which are connected with a divided axle 150. The axle 150 is supported in bearings 151 situated within the axle casing 107.

The vehicular frame 108 carries rod-springs 109 which are firmly connected with torsion levers 110. The free end of each torsion lever 110 carries a ball and socket joint 111. Other ball and socket joints 112 are firmly connected with the axle casing 107.

The supporting means which are situated between the joints 111 and 112 and which support the vehicular frame upon the axle casing, comprise an upper rod 113, a lower rod 114 and a horizontal double-armed lever 116 which is pivotally connected at 115 with the lower rod 114. One end of the double-armed lever 116 is pivotally connected with the upper rod 113, while the opposite end of the lever 116 is pivotally connected with a piston rod 117. The piston 118 which is firmly connected with the piston rod 117, is situated with a cylinder 119 carried by the axle casing 107.

The piston 118 and the cylinder 119 constitute an auxiliary motor which is operated by any suitable means not shown in the drawings.

The operative length of the supporting means, i. e., the vertical distance between the ball and socket joints 111 and 112 is changed by actuating the piston 118, whereby the end 152 of the double-armed lever 116 will be moved upward or downward.

When the vehicle is moving along a curve and the frame 108 is tilted, for example, to the left (looking in the direction of Figure 9), then the operator should lower the lefthand piston 118, the extent of the movement of this piston depending upon the angle of inclination of the vehicle. Then the end 152 of the double-armed lever 116 will move upward and the operative distance between the two left hand joints 111 and 112 will then be increased, so that the left side of the frame 108 will be raised relatively to the right side.

As already mentioned, the operative distances between the joints 111 and 112 can be varied depending upon the extent of the centrifugal forces, exerted upon a vehicle while it is traveling along a curved path, and these distances may be so adjusted that the frame will be inclined in a direction toward the center of the curvature of the path traversed by the vehicle.

Automatically operable or hand operated means may be provided to prevent further inclination of the frame as soon as the latter has assumed the desired inclined position.

Figure 10 shows rails 155 supporting the wheels 156 which are firmly connected with a divided axle 157. The axle 157 is carried by bearings 158 which are situated within the axle casing 159. The frame 160 of the vehicle carries rod-springs 161 which are firmly connected with torsion levers 162. The free ends of the torsion levers 162 are connected by means of ball and socket joints 163 with the ends of two-armed levers 121 which are supported intermediate their ends by rods or supports 120. The opposite ends of the two-armed levers 121 are firmly connected with piston rods 164. Each piston rod 164 is connected with a separate piston 122 situated within a cylinder 165. The cylinders 165 are carried by the axle casing 159. The lower ends of the supports 120 are connected with the axle casing 159 by ball and socket joints 166.

The operative distance between the ball and socket joints 163 and 166 can be changed by changing the position of the pistons 122 within the cylinders 165. The up and down movement of a piston 122 will lower or raise the adjacent ball and socket joint 163 and thereby increase the operative length of the supporting means, so that one end of the vehicular frame 160 will be raised or lowered relatively to the axle 157.

The vehicle shown in Figure 11 of the drawings comprises wheels 170 which are firmly connected with a divided axle 171. The wheels 170 are carried by rails 172. The divided axle 171 is carried by bearings 182 which are situated within the axle casing 173.

The vehicular frame 174 carries rod-springs 175 which are firmly connected with torsion levers 176. The free ends of the levers 176 carry ball and socket joints 177. Ball and socket joints 178 are carried by the axle casing 173. The supporting means situated between the joints 177 and 178 comprise an upper rod 123 and a lower rod 124. The lower end of the rod 123 is provided with screw threads 125. The upper end of the rod 124 is provided with screw threads 179. The screw threads 125 and 179 engage the inner screw threads of a sleeve 180, the outer portion of which has the form of a worm wheel 181 which meshes with the worm 126. The screw threads 125 and the screw threads 179 extend in opposite directions. When the worm 126 is operated by any suitable motor (not shown), the wheel 181 and the sleeve 180 will be rotated and will turn the threaded portions 125 and 179 of the rods 123 and 124. Since the screw threads 125 and 179 extend in opposite directions, the rotation of the sleeve 180 will cause the rods 123 and 124 to move in directions toward or away from each other, thereby changing the operative distance between the ball and socket joints 177 and 178.

The wheels 185 of the vehicle shown in Figure

12 are carried upon rails 186 and are firmly connected with a divided axle 187 which is supported in bearings 188 situated within the axle casing 189. The frame 190 of the vehicle carries rod-springs 191 which are firmly connected with torsion levers 192. The free ends of the torsion levers 192 are connected with ball and socket joints 193. Other ball and socket joints 194 are carried by the axle casing 189.

In this device the supporting means interconnecting the ball and socket joints 193 and 194 are formed by pistons 127' and cylinders 128'. The ball and socket joints 193 connect the upper ends of the pistons 127' with the torsion levers 192, while the lower ends of the cylinders 128' are supported upon the ball and socket joints 194.

Auxiliary pistons 129' are firmly connected with the lower ends of rods 130' the upper ends of which are attached to the vehicular frame 190. Each piston 129' is movable within a casing 195 which is connected with the casing 128' through a passage 132'. The piston 127' is operated by a liquid which flows into the casings 195 and 128' through an opening 131'. The liquid leaves the casings 128' and 195 through the opening 133'.

The amount of liquid situated within a cylinder 128' underneath the piston 127' determines the position of the piston and thus determines the operative distance between the adjacent joints 193 and 194. The amount of liquid flowing into the cylinder 128' is determined by the position of the auxiliary piston 129'. If, for example, the vehicular frame 190 tends to incline to the right (looking in the direction of Fig. 12) while the vehicle is moving along a curve, then the right-hand rod 130' will move its auxiliary piston 129' downward so that the liquid will be able to flow through the right-hand passage 131', the interior of the casing 195 and the passage 132' into the right-hand casing 128'. The liquid will raise the right-hand piston 127' and thereby prevent any further tilting of the vehicle in that direction.

On the other hand if the right-hand side of the vehicle is moved upward, then the right-hand piston 129' will also move upward along with its rod 130' and will close the passage 130', while the passages 132' and 133' will remain open. The liquid situated within the right-hand cylinder 128' will then leave it through the passage 132', the casing 195 and the passage 133', thereby lowering the position of the right-hand piston 127' within the casing 128'. Since the lowering of the piston 127' will shorten the operative distance between the two right-hand joints 193 and 194, the right-hand side of the frame 190 will move downward until the vehicle frame assumes a desired position in relation to the axle casing 189.

An advantage of the spring systems constructed in accordance with the present invention is that the vehicles can be constructed lower than those known in prior art. Heretofore 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 having a low floor surface will, obviously be much lower and nearer the roadbed than that of prior art constructions. 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 or supporting means which reach to the roof of the vehicle a further advantage is attained in that comparatively small side forces are transmitted to the axles.

The described spring systems can be used conveniently in connection with cars having steered axles since in such cars the axles are moved to a considerable extent relatively to the car frame and since the shifting of the frame caused by these movements can be easily taken in by the long supports or supporting means without causing any excessive inclination of said supports.

Certain features of the present invention are further described and claimed in the patent application of F. K. Clar relating to Springs for cars, Serial No. 125,105, filed February 10, 1937, which has matured into U. S. Patent No. 2,129,118, granted September 6, 1938.

What is claimed is:

1. In a vehicle, a roofed vehicle frame, at least one axle support, a pair of elongated supporting means for each axle support, said supporting means extending within the vehicle frame substantially close to the roof thereof, a pair of ball and socket joints carried by said axle support and connected with the lower ends of said supporting means, another pair of ball and socket joints connected with the upper ends of said supporting means, a plurality of rod-springs, a plurality of torsion levers adjacent the vehicle roof, each of said torsion levers having an end connected to one of said rod-springs and another end connected to one of the last-mentioned ball and socket joints, and means connected to said vehicle frame and supporting said rod-springs.

2. In a vehicle, a roofed vehicle frame, an axle support, supporting means comprising a cylinder connected with said axle support, a piston within said cylinder and means connected with said cylinder for supplying a fluid thereto to vary the position of said piston relatively to said cylinder, thereby varying the operative length of said supporting means; a rod-spring carried by said vehicle frame, a torsion lever situated adjacent the vehicle roof and having one end connected with said rod-spring, and means connecting the other end of said torsion lever with said piston.

3. In a vehicle, a roofed vehicle frame, an axle support, at least two separate supporting means situated on opposite sides of said frame each of said supporting means having at least two members movable relatively to each other to vary the operative length of said supporting means; and automatically operable means for moving said members depending upon the position of said frame relatively to said axle support; a rod-spring carried by said vehicle frame, a torsion lever situated adjacent the vehicle roof and having one end connected with said rod-spring, means connecting the other end of said torsion lever with one of said members, and means connecting the other one of said members with said axle support.

FRIEDRICH KONRAD CLAR.
CARL GEISSEN.