March 18, 1952 E. H. PIRON 2,590,033

SPRINGS FOR RAIL TRUCKS

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Fig. 1.

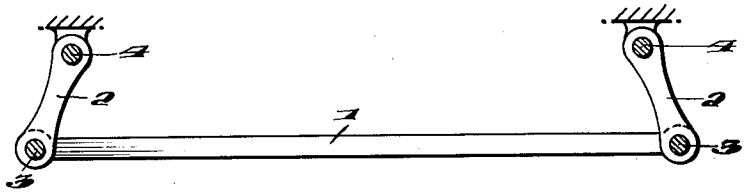


Fig. 2.

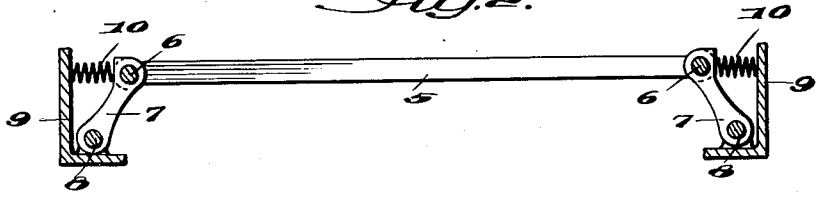


Fig. 3.

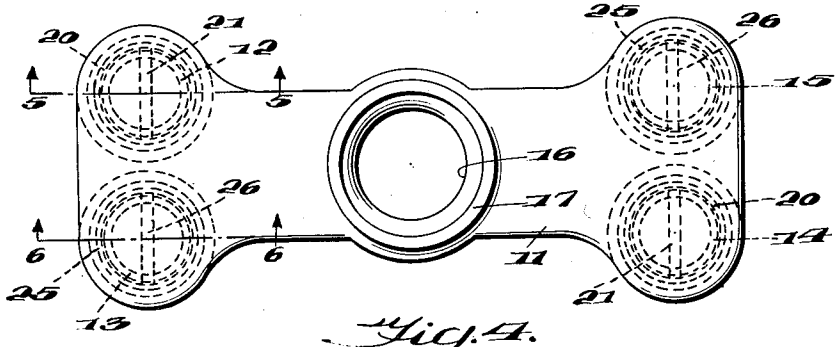
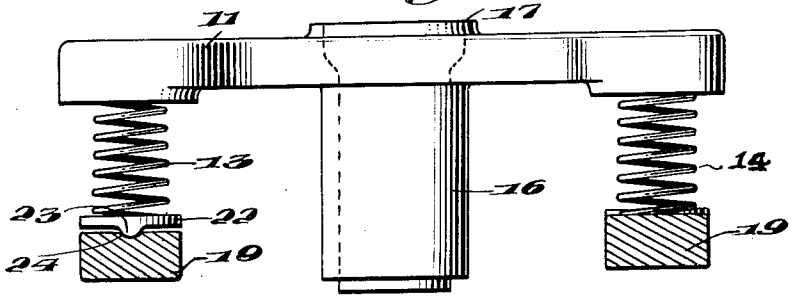


Fig. 4.



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SPRINGS FOR RAIL TRUCKS

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Fig. 5.

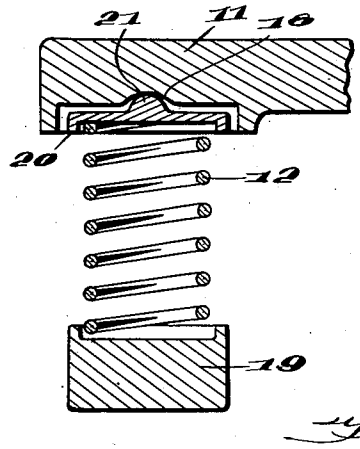


Fig. 6.

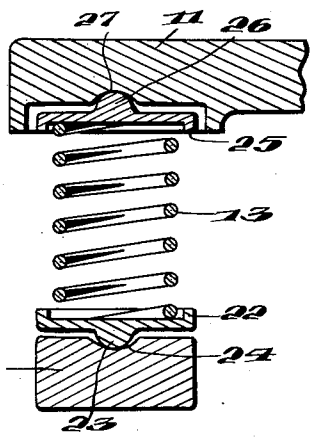


Fig. 7.

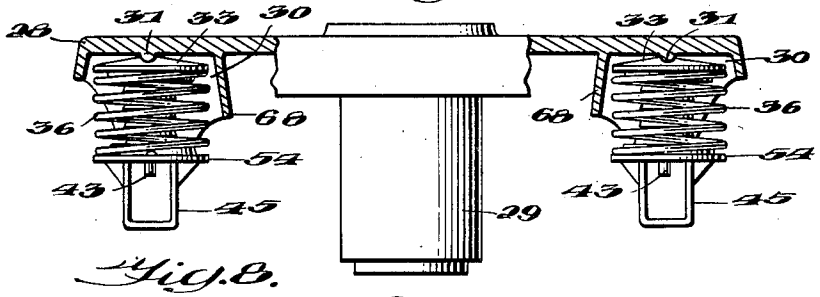
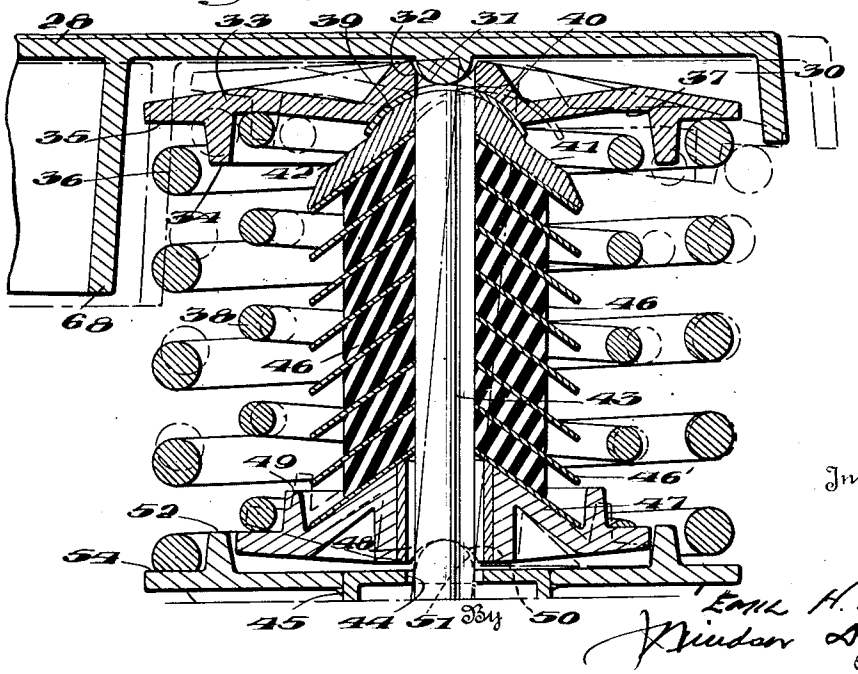


Fig. 8.



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Fig. 9.

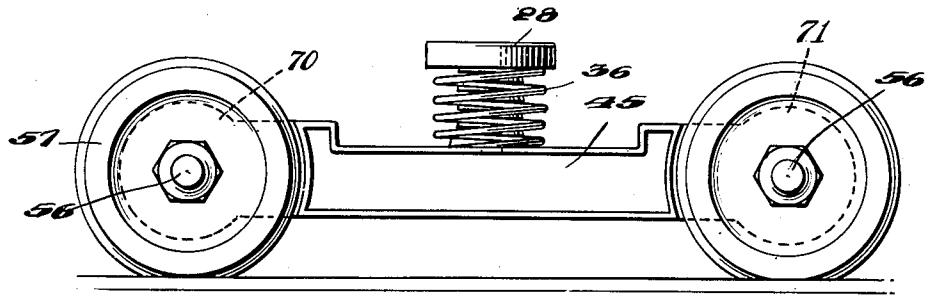


Fig. 10.

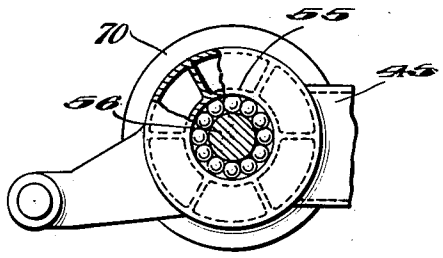


Fig. 11.

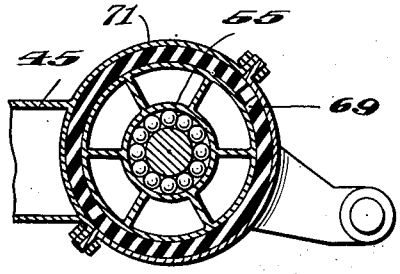
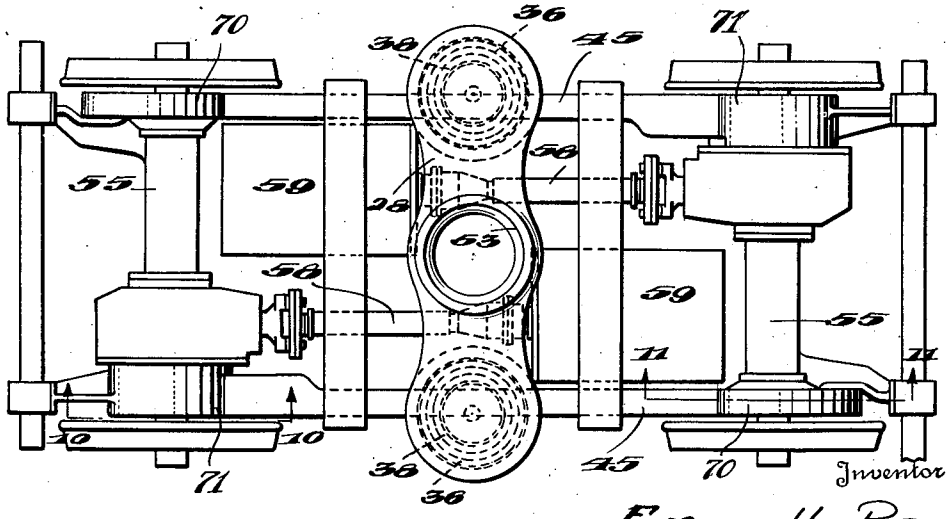


Fig. 12.



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Fig. 14.

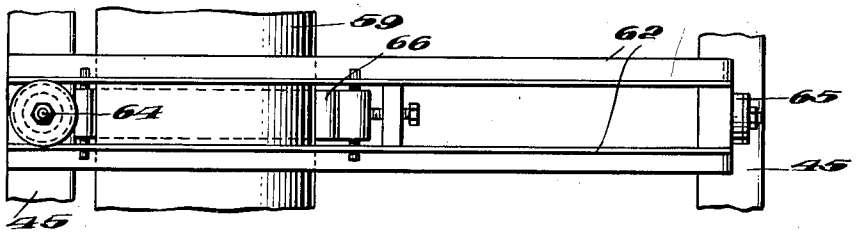


Fig. 13.

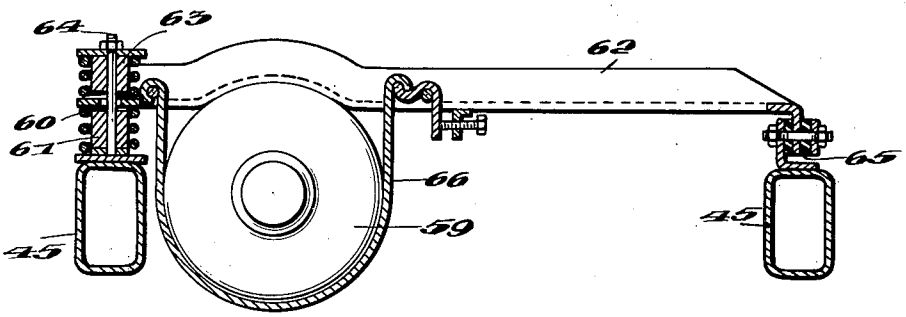
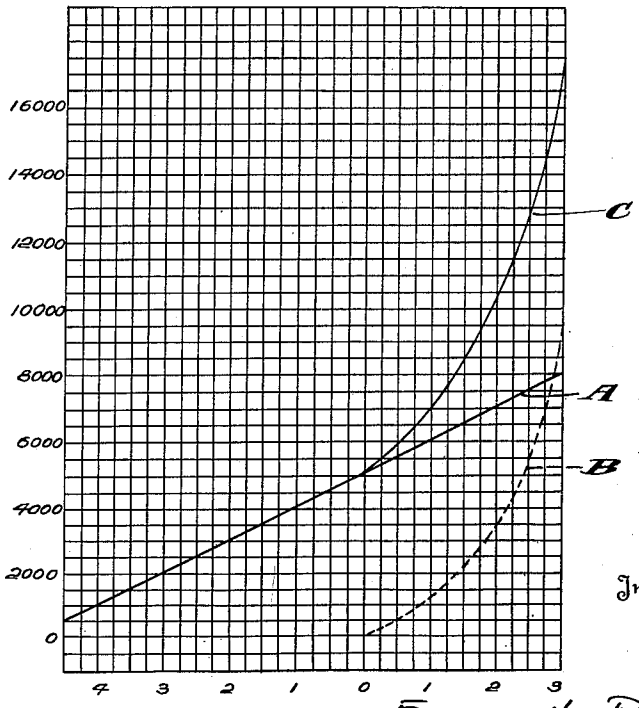


Fig. 15



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Patented Mar. 18, 1952

2,590,033

UNITED STATES PATENT OFFICE

2,590,033

SPRINGS FOR RAIL TRUCKS

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Application September 4, 1945, Serial No. 614,374

4 Claims. (Cl. 105—187)

1

This invention relates to rail trucks and has for its object to provide a truck which will provide improved riding quality, which lends itself readily to alteration of proportion for adaptation to slow speed work as encountered in street car operations or to high speed work as is encountered in interurban operation, which is of greatly simplified construction in that it incorporates a single set of main springs, which will be more economical to construct, which materially reduces the number of places to be lubricated and which will have long life with low maintenance.

An object is to provide a truck having a single set of main springs, these springs acting not only as the springing system between the car body and the axles of the wheels but, being interposed between the truck frame and the bolster, serve also to perform the functions of swing links.

Another object is to provide a truck in which the main springs act as swing links and in order to make this possible, to provide means by which the resistance of the springs to lateral motions of the body with respect to the trucks may be varied according to requirements and independently of the characteristics of the springs under vertical deflections.

Another object is to provide springs which will have uniformly good riding qualities whether under light or heavy loading by designing them according to a compound deflection curve such that the angle of the tangents increases with the loads. The relation of the spring to the ridability of the car is such that with springs which have a curved load deflection ratio the reactions take place in the same manner as if the springs had a straight line deflection tangent to the compound curve at the point corresponding to the load. At that point the characteristic of the riding is defined by the deflection of the straight line deflection spring. Therefore in the case of a compound deflection curve the riding quality is indicated by the projection of the tangent of that curve on the axis of zero load. We call the length of that projection the "equivalent deflection" because it is the deflection of a straight line spring having equivalent characteristics.

If the load were solid the load deflection curve which would produce the same riding quality

2

independent of the value of the load would be a curve such that its "equivalent deflection" would be the same at any load. However, in the mass transportation of people the load is not solid but has a resiliency such that if springs of constant equivalent deflection were employed they would ride softer under heavier load. It is an object of this invention to provide springs having a constant riding quality for passengers and therefore to provide springs having increasingly smaller equivalent deflection under increasing loading. I have found that the equivalent deflection may be reduced proportionately with the ratio of the passenger load to the dead weight of the sprung mass. For example, when the passenger load equals the weight of the car body and thus doubles the total load on the springs it is permissible to make the equivalent deflection under that total load one-half of the equivalent deflection of the empty vehicle.

A compound curve can be obtained in numerous ways as by using variable pitch coil springs, by combinations of leaf springs, by using groups of springs some of which come into action after others, etc. I choose a combination of coil and rubber springs because it permits a compact and economical arrangement, because the rubber has hysteresis providing inherent damping of oscillations and noises, because the rubber does not react as fast as coil springs so that the reactions of the combination are not exactly superposed, because the coil can unload the rubber under empty car conditions thus protecting the life of the rubber, and because this combination lends itself readily to carrying out the other objects of the invention.

Another object is to provide a king pin and king pin bearing construction of sturdy type which may be relied upon to retain the bolster in proper driving position whereby a single spring or single nest of springs may be used at each end thereof.

A further object is to provide a truck frame including side frames adapted for attachment to axle housings, the attachments being resilient at two diagonally opposite sides of the frame and rigid at the other two sides.

A still further object is to provide a main frame secured to the axle housings, a bolster supported by main springs from the main frame

and driving motors resiliently suspended from the main frame independently of the bolster and the main springs.

The problem of replacing the usual swing links by main truck springs will be better understood with following explanation: The essential function of swing links is to permit relative lateral movement of the supporting trucks without a corresponding movement of the body. For instance, in one well-known type of street car truck the swing links are eleven inches long and each pair supports a body weight of 13,200 pounds without passengers. A one inch lateral displacement of one truck with respect to the body develops a lateral force of

$$\frac{13200}{11}=1200$$

pounds, approximately, on the corresponding half of the body. Without the swing link action the body would be moved laterally very suddenly with the truck and the lateral accelerating force transmitted to the body might reach several thousand pounds causing derailment or fracture of parts.

While the transmission of lateral forces is dependent almost entirely on the length of the swing links, it is also affected by the disposition of the links. For instance, they are generally installed in street cars so that, in normal position of rest, they converge upwardly at an inclination of one-eighth inch per inch of length so that when the body is displaced laterally with respect to the truck its side towards the direction of displacement is raised with respect to its other side. This action is intended to correct the position of the body when the lateral displacements are caused by lateral winds or centrifugal effect in rounding curves which tend to tip the body. The correction, however, is efficient only as long as the lateral forces are limited to the value producing the maximum lateral displacement permitted by the swing links. When they become larger the correction is no longer sufficient as witnessed by the tipping of the bodies of fast trains while rounding curves. Furthermore, this correction does not occur in the proper direction when the lateral displacements of the body are caused by lateral movements of the truck. Instead of decreasing the tipping of the body in this case they increase the tipping. The effect of the convergence of the swing links is thus secondary to the effect obtained by their length and the most important function of the links is to reduce the transmission of lateral forces developed by the truck. Their main characteristic is the value of the restoring force they develop to bring the body back to normal or central position when lateral swinging movements cause a displacement. An object of this invention is to provide main springs which will support the body directly from the truck and which will provide the necessary restoring force without the necessity of swing links.

This problem and the invention as a whole will be better understood by reference to the accompanying drawings in which

Figure 1 is a diagrammatic illustration of a conventional bolster supported by swing links,

Figure 2 is a similar diagrammatic view of a bolster supported by swing links hingedly supported at their lower ends,

Figure 3 is a top plan view of a bolster and bolster springs constructed according to my invention,

Figure 4 is a front elevation of the bolster and springs of Figure 3,

Figure 5 is a vertical section taken along the line 5—5 of Figure 3,

Figure 6 is a vertical section taken along the line 6—6 of Figure 3,

Figure 7 is a vertical section of a bolster supported by a single nest of springs in replacement of the two springs illustrated in Figures 5 and 6,

Figure 8 is an enlarged vertical section through the nest of springs at the right side of Figure 7,

Figure 9 is a side elevation of a truck constructed according to my invention,

Figure 10 is a fragmentary detail side elevation of one end of one side frame member showing rigid attachment thereof to the axle housing,

Figure 11 is a fragmentary detail side elevation of the other end of the side member of Figure 9 showing resilient articulation between the side member and the axle housing.

Figure 12 is a top view of the truck of Figure 9,

Figure 13 is a front view of a motor showing the motor supporting springs and the truck side frames in section,

Figure 14 is a top plan view of the construction of Figure 13, and

Figure 15 is a diagram showing the load-deflection curve of my improved springs under vertical loading.

In Figure 1 a conventional type of swing bolster is illustrated in which 1 refers to the bolster plank and 2 indicates the swing links pivotally connected thereto at 3 at their lower ends and pivotally connected at their upper ends to main frame members 4. The center bearing is not shown but is carried by the plank 1 and receives a king pin by which the car body is operatively attached to the plank. As illustrated, the swing links 2 converge upwardly as is found in many installations.

Figure 2 illustrates a bolster plank 5 pivotally connected at 6 to two columns 7, each pivotally supported at 8 on the truck side frames 9. Springs 10 between the ends of the plank 5 and the side frames 9 restore the plank to central position after a lateral displacement.

The conditions of equilibrium for the plank 1 in Figure 1 and the plank 5 in Figure 2 are exactly the same and, with proper selection of the rate of the springs 10, the value of the restoring forces, after lateral displacement, will be exactly the same in the structures of Figures 1 and 2. This may be readily demonstrated mathematically, the equations being omitted here in the interests of brevity.

The construction of Figure 2 has no advantage over the construction of Figure 1 and is included here to call attention to the fact of their equivalency. The construction of Figure 2 can have great and substantial advantages over the conventional construction of Figure 1 if the columns are resilient and if they can serve as main truck springs which they do, according to this invention, since swing links may then be omitted, thus omitting their articulations and permitting other advantages herein stated.

The bolster springs when functioning also as swing links, must be designed for proper vertical elasticity and they may not then provide for proper lateral reaction. In general it will be found desirable and perhaps necessary to employ more than one spring at each end of the bolster, some of the springs being calculated to provide the proper lateral reaction while the others can be calculated so as to complete the necessary

vertical elasticity without developing lateral reactions. A construction fulfilling these requirements is illustrated in Figures 3 to 6 in which 11 indicates a bolster supported at each end by two springs 12 and 13, and 14 and 15 respectively. The springs all seat upon side frames 19 of a main truck frame. The bolster includes a deep socket 16 having a center bearing 17 to receive the king pin of a car body (not shown).

The diagonally opposite springs 12 and 14 are identical and are illustrated in Figure 5 while the other two springs 13 and 15 are identical and illustrated in Figure 6.

In Figure 5 it will be seen that the spring 12 seats firmly on the side frame 19 while its other end seats in a cap 20 having an integral trunnion 21 fulcrumed in a depression 18 formed in the bolster 11.

In Figure 6 the spring 13 is contained at its lower end by a cap 22 having an integral trunnion 23 fulcrumed in a trough 24 in the side frame 19. Its upper end is similarly contained by a cap 25 having an integral trunnion 26 fulcrumed in a trough 27. All trunnions 21, 23 and 26 have their axes normal to the direction of swing of the bolster 11.

All springs 12, 13, 14 and 15 resist vertical deflection and participate jointly in vertical springing movements of the bolster 11 with respect to the side frames 19. When relative lateral displacement between the bolster and side frames occurs, the lower coils of the springs 12 and 14 remain in contact with the side frames 19 while the caps 20 and the top coils of these springs follow the lateral displacement insofar as the trunnions 21 and troughs 18 permit thus bending the axes of the helix of the coils and developing an elastic lateral reaction which resists the distortion and sets up a force to restore the bolster to its original position. The coils 13 and 15 do not develop a similar lateral reaction, however, because both caps 22 and 25 fulcrum on their trunnions and remain parallel with each other so that the axis of each helix remains straight.

The correcting action of the convergence of the swing links can be duplicated by converging the axes of the four springs that this is not believed necessary.

In Figures 7 and 8 is illustrated a modification and preferred form of bolster support in which the two springs at each end of the bolster of Figures 3 to 6 is replaced by a single nest of springs. In this case the bolster 28 is provided with a center socket 29 to receive a car body king pin and single spring receiving pots 30 at each end thereof. Each pot 30 has an integral trunnion 31 which is received by a trough 32 formed in a spring cap 33, the cap 33 being thus capable of rocking movements with respect to the bolster under relative lateral but not relative fore and aft movements.

The underneath side of each pot 30 is substantially horizontal over the major portion of its area whereas the upper sides of the cap 33 slope downwardly away from the edges of depression 32 in order to allow for the rocking movements mentioned above.

The underneath side of the cap 33 has a flange 34 near the periphery thereof which separates a seat 35 for a coil spring 36 from a seat 37 for a second coil spring 38. Centrally of the underneath side of the cap is a friction surface 39 in the shape of a segment of a sphere which receives a liner 40 of some suitable friction material against which a second cap 41 fits.

The cap 41 has a top central portion 42 having the shape of a segment of a sphere which has a radius slightly less than that of the surface 39. The underneath side of the cap 41 is of frusto conical shape to receive the top one of a stack of pieces 46 of rubber, or other similar material, each of which has the interior and exterior shape of a frusto-cone and each of which is separated from the adjacent piece by a layer of thin metal 46'. Extending centrally through each piece of rubber and each separating metallic layer is a pin 43 which extends through the cap 41 and is welded thereto. The pin has a rounded top for engagement with the liner 40. The pin 43 projects downwardly through an opening 44 in the main frame member 45, the opening being substantially larger than the diameter of the pin in order that the pin may freely tilt with the cap 41.

The lowermost one of the rubber pieces 46 seats on a third cap 47 which has an enlarged central opening 48 therethrough to permit free passage and relative lateral tilting of the pin 43. The top of this cap is of frusto conical shape at its central portion so that the adjacent rubber piece 46 will fit thereagainst, and outwardly thereof I provide a retaining flange 49 outwardly of which the spring 38 seats.

The lower surface of the cap 47 has an integral rounded depression or trough 50 interrupted along its length by the opening 48. The remainder of the bottom surface of the cap 47 diverges upwardly from the trough 50.

The trough 50 is received by semi-cylindrical trunnion members 51, which are carried by the side frame 45 on opposite sides of the opening 44 therein. Outwardly of the opening 44, concentric therewith and integral with the side frame 45 is a spring retaining flange 52 outwardly of which the lowermost coil of the spring 36 seats on the rim or seat 54.

Operation of the bolster

The operation of the bolster is as follows: under static vertical loading the weight of the car body is transferred from the king pin onto the bolster 28 at the center bearing 53 (Fig. 12) of the center pot or king pin socket 29. This loading and all relative vertical movements between the side frames 45 and the bolster 28 causes a deflection of the springs 36, 38 and 46. There is no movement of the caps 33 relative to the spring pots 30 and no relative movement of the caps 47 relative to the side frames 45. When the car body thereabove is empty the rubber springs may be largely or, preferably, entirely unloaded so that all load is carried jointly by the springs 36 and 38. With increasing vertical load all three springs act jointly, their load deflection curve being illustrated in Figure 15 in which the horizontal axis represents deflection, the vertical axis represents load, the line A represents the combined load deflection curve of the springs 36 and 38. The curve B represents the load deflection curve of the springs 46 and the curve C is the composite vertical load deflection curve of the entire spring. It will be observed that the projection of a tangent from any point on the curve to the intersection of the tangent with the horizontal axis becomes progressively shorter under larger loading in the manner previously described. The behavior of the springs under recoil is not illustrated. Suffice to say that the hysteresis of the rubber absorbs some of the energy of compres-

sion and a portion of the remainder is absorbed by shock absorbers (not shown).

Horizontal driving and retarding forces between the car body and truck are transmitted through the upper and lower trunnion members 31 and 51, through the upper and lower caps 41 and 47 and through the springs 36, 38, and 46. Additional means may also be provided. There will be no relative movement between the cap 33 and the bolster nor between the cap 47 and the side frames in that direction.

When lateral forces cause relative lateral movement of the bolster 28 with respect to the side frames 45, the trunnions 31 cause corresponding lateral movement of the caps 33. Since the seats 54 and the trunnions 51 are relatively stationary the caps 33 tilt on the trunnions 31, the radius of the trough 32 being greater than that of the trunnion to permit this movement partially by rolling instead of by sliding only. If the caps 33 tilt to their limits a portion of the upper inclined surface of each will contact the surface of the pot 30 as is illustrated in dotted lines in Figure 8. Up to this position, however, neither the springs 38 nor the springs 46 resist the lateral movement since tilting of the caps 33 causes similar tilting of the lower caps. There will be no actual contact between the caps 33 and the pots 30 except under very severe lateral movements of the bolster. The rim of each pot 30 depends into a lip formation 68, as illustrated, thus providing a positive stop for the bolster by contacting one of these lips against its spring 36. This contact may be simultaneous with or slightly before possible contact of either cap 33 with a pot 30. It is not intended that the caps 33 will ever tilt with respect to the lower caps 47 so that only the reactions of the springs 36 to bending are the restoring forces for the bolster.

A truck equipped with my improved bolster and bolster supports is illustrated in Figures 9 to 12 in which the side frames 45 are sturdy rigid members each rigidly connected at one end 70 to an axle housing 55 as illustrated in Figure 10 and each connected at its other end 71 through a rubber or similar elastic material 69 to the other axle housing 55 as illustrated in Figure 11. The rigid connections are at diagonally opposite corners of the truck. This construction is more fully shown and described in my Patent No. 2,184,102 issued December 19, 1939.

The axles 56 are mounted in wheels 57 for rotation thereof by drive shafts 58 as is more fully shown and described in my Patent No. 2,335,080.

The shafts 58 are driven by two main motors 59 supported from the side frames 45 and not from the bolster. A suitable spring support for the motors is illustrated in Figures 13 and 14 in which one side member 45 is surmounted by a coil spring 60 having a block of rubber 61 concentric therewith and contained thereby. The motor supporting beam 62 rests, at one end on the spring and rubber block. Above the beam I provide a further block of rubber 63 which is retained in position jointly with the lower block 60 by a bolt 64 which passes freely through the beam 62. The other end of the beam 62 is supported from the other side frame 45 by means of two rubber pads 65 acting in shear to resist vertical loading. Each motor 59 is supported from a beam 62 by means of a strap 66, all as more fully shown and described in my Patent No. 2,358,279 issued September 12, 1944.

While the improved bolster assembly is illustrated as being incorporated in a particular kind and type of truck it is capable of use to great advantage in numerous other kinds and types of truck frame and other types of axle assemblies and either with or without driving motors. I therefore desire to be extended protection as defined by the appended claims.

What I claim is:

1. In a rail truck wherein a bolster is resiliently supported directly from the side rails of the frame of the truck, spring means supporting each end of said bolster each comprising a coil spring and another spring comprising rubber, said coil springs supporting the entire empty static loading of said body, said other springs jointly with said coil springs resisting all vertical loading in excess of empty static body loading, said other spring being composed of alternate vertical layers of metallic and rubber elements of conical interior and exterior shape whereby all of said springs act jointly in a vertical direction according to a load deflection curve such that the length of the projections of tangents from load points on said curve on the abscissa thereof decrease with increasing loads.

2. In a rail truck wherein a bolster is resiliently supported directly from the side rails of the frame of the truck, spring means supporting each end of said bolster each comprising a coil spring and another spring comprising rubber, said coil springs supporting the entire empty static loading of said body, said other springs jointly with said coil springs resisting all vertical loading in excess of empty static body loading, said other spring being composed of alternate vertical layers of metallic and rubber elements of conical interior and exterior shape whereby all of said springs act jointly in a vertical direction according to a load deflection curve such that the length of the projections of tangents from load points on said curve on the abscissa thereof decrease with increasing loads, said other springs being pivotally mounted with respect to said bolster whereby the resistance of said spring means to swinging movements of said bolster is performed by said coil springs.

3. A spring assembly comprising a first coil spring having a fixed base and a top cap, a second coil spring concentrically within said first coil spring the top of which contacts said top cap and the bottom of which seats in a lower rocking cap, a third spring of rubber-like material located concentrically within said second coil spring seated against said top cap and resting on said lower cap, and trunnion means on which said lower cap and said top cap may rock whereby only said first coil resists relative lateral movements between said top cap and said fixed base and whereby all of said springs resist relative vertical movements between said top cap and said base.

4. Spring means for supporting each end of a truck bolster on a truck frame comprising a nest of springs supporting each end of the bolster, each of said nests being composed of a large coil spring seated on the frame, a second coil spring concentrically within said first spring and seated in a lower cap, said lower cap being pivotally mounted on said frame for rocking movement through a vertical arc in a direction parallel to the length of said bolster, a third spring of rubber-like material located concentrically within said second coil also seated in said lower cap for movement therewith, and a common top cap for all of said springs, said top cap being pivotally mounted in said bolster for swinging movements

through a vertical arc in a direction parallel to the length of said bolster, and a positive stop associated with each of said nests of springs for limiting the possible swinging movement of said bolster with respect to said frame.

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