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Willetts

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[54] **RAILRAOD CAR SUPSENSION SYSTEM**

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[51] **Int. Cl.** **B61f 5/30;** B61f 15/06; F16f 1/44

[58] **Field of Search** ..... 105/197 A, 197 R, 224.1; 267/3, 4, 63 A, 63 R; 280/104.5 R

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[57] **ABSTRACT**

The present invention includes a suspension system for use with railroad freight car trucks, or the like, wherein vertical, transverse and longitudinal movements of the car body sprung mass are restrained and dampened by captive elastomeric means having a progressively increasing spring rate in all three of said directions. This system is self-centering, self-dampening and provides progressive resistance to increased forces of maximum amplitude in said three directions, without requiring elastomeric shear forces to accomplish the aforesaid.

1 Claim, 7 Drawing Figures

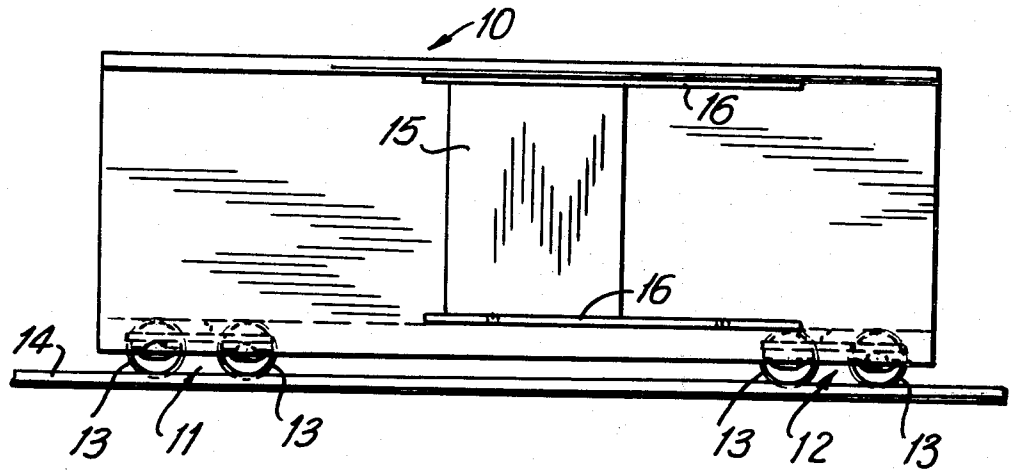


FIG. 1

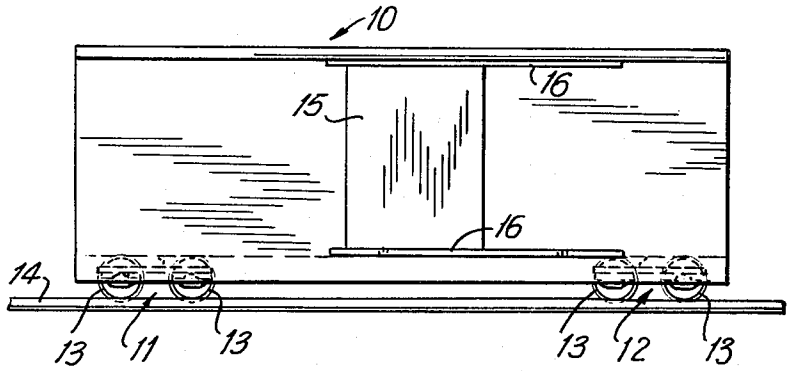
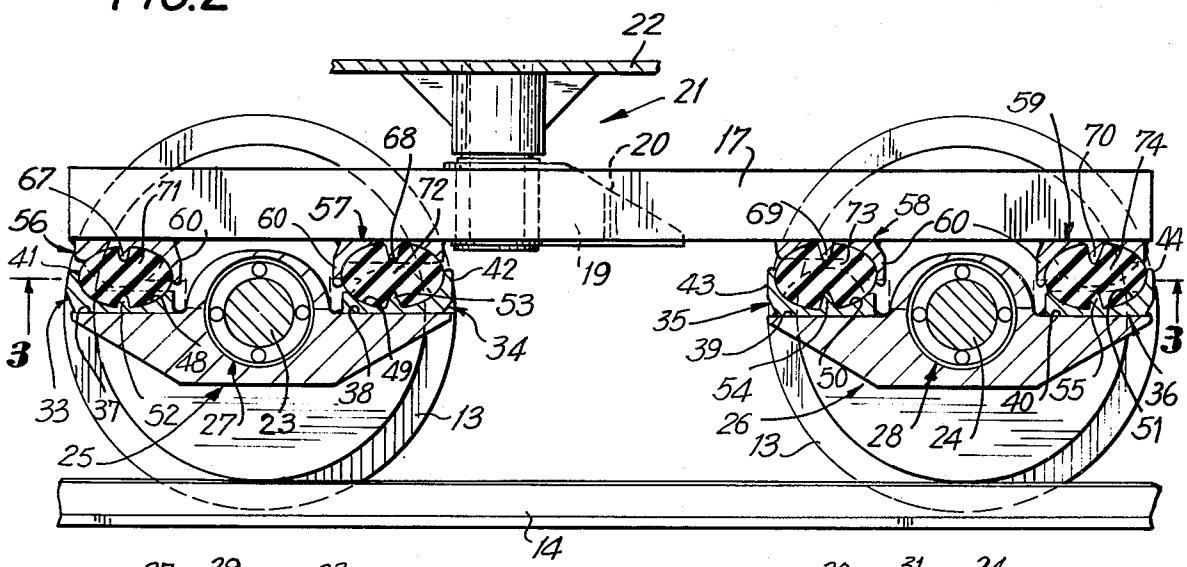


FIG. 2



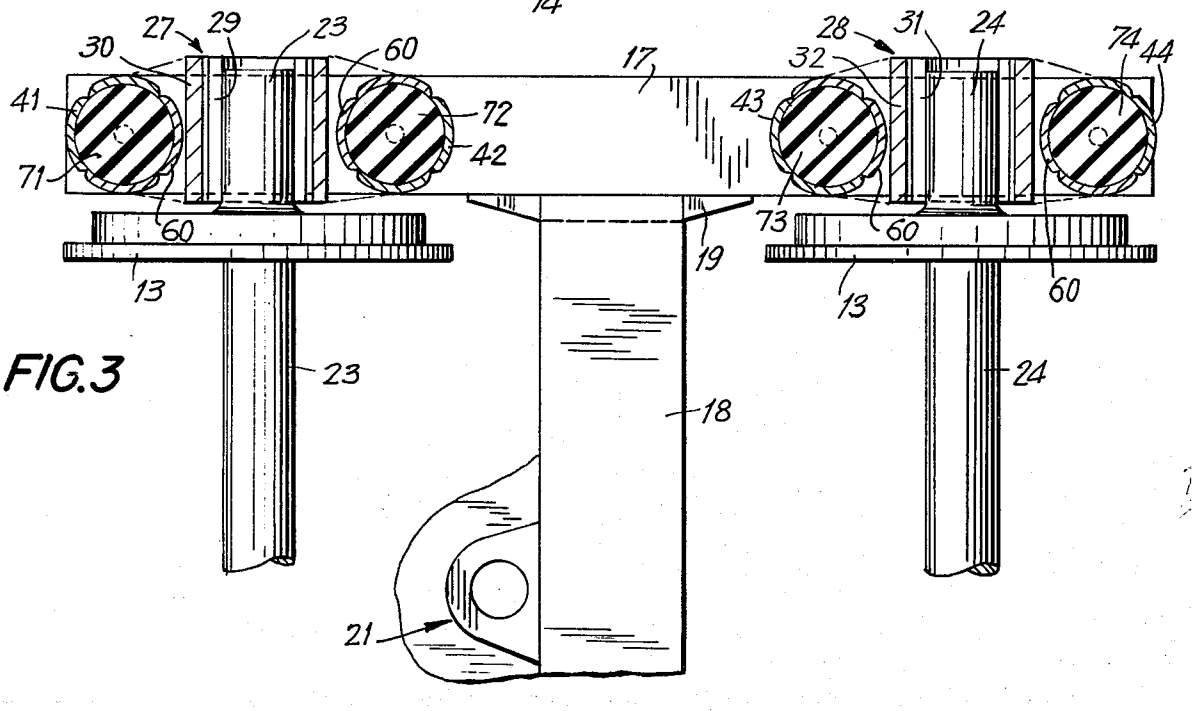


FIG. 3

FIG. 4

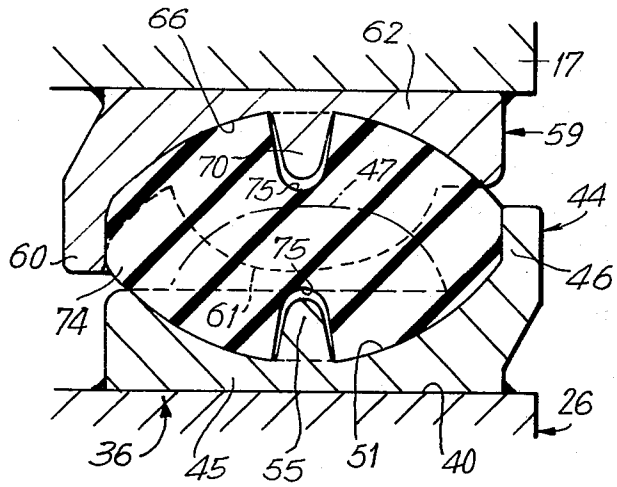


FIG. 5

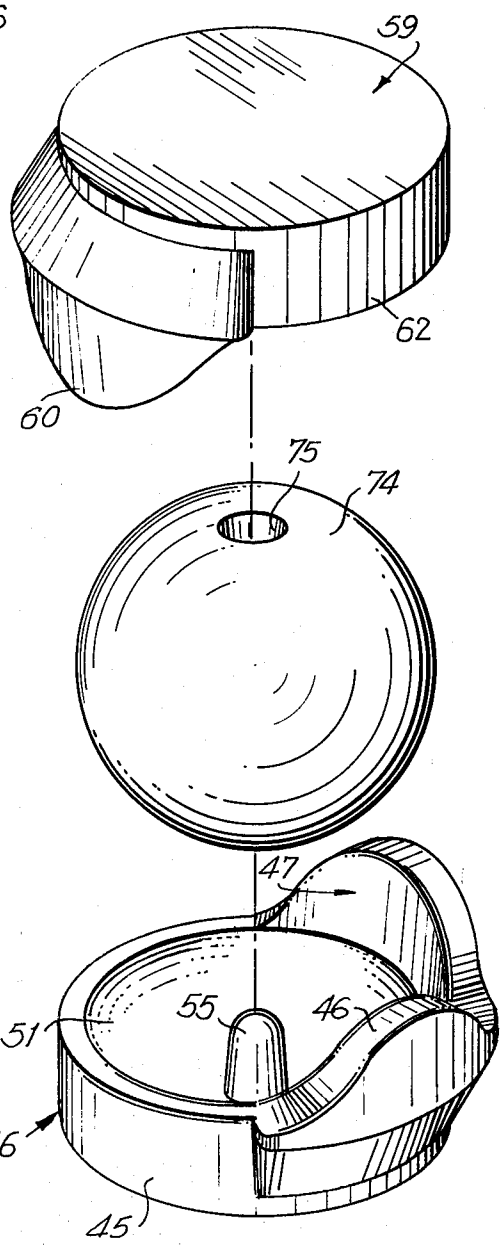


FIG. 6

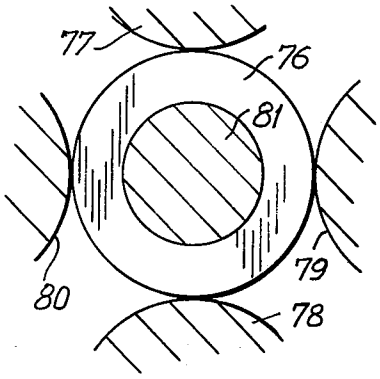
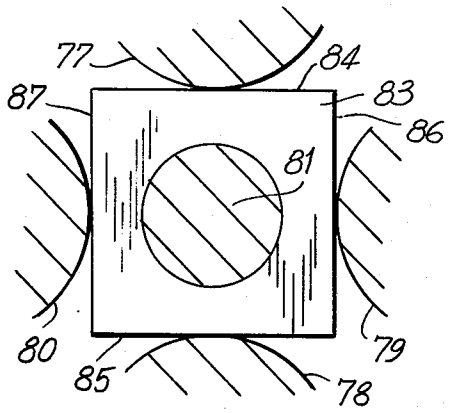


FIG. 7



RAILRAOD CAR SUPSENSION SYSTEM

This application is related to the structure of my copending applications Ser. Nos. **356,496,** filed May **2, 1973** and **293,648,** filed Sept. **29, 1972,** both of which are continuation-in-part applications of my application Ser. No. **123,581,** filed Mar. **12, 1971,** now U.S. Pat. No. **3,687,478** granted Aug. **29, 1972.** U.S. Pat. No. **3,687,478** further discloses improvements over the subject matter contained in my U.S. Pat. No. **3,572,745** dated Mar. **30, 1971.** U.S. Pat. No. **3,572,745,** itself, is a continuation-in-part of application Ser. No. **721,558,** filed Apr. **1, 1968,** now abandoned, and application Ser. No. **649,502,** filed June **28, 1967,** now abandoned. The subject matter of my aforementioned applications and my U.S. Pat. Nos. **3,572,745** and **3,687,478** is hereby incorporated by reference into the present specification.

This invention relates generally to vehicle suspension systems and more particularly to a vehicle suspension system for use with a railroad car truck or the like for isolating vertical, transverse and longitudinal forces that are normally encountered during operation from the sprung mass.

I have made many inventions which have solved the problems associated with isolating road-induced excitations from the sprung mass of various types of vehicles. The aforementioned list of patent applications and patents represent but a few of my efforts to protect inventions which overcome prior art problems associated with the isolation of forces and vibrations as between the driver or vehicle cargo, on one hand, and operationally induced vibrations, on the other hand. My efforts have been successful, as can be attested to in any number of tests conducted by me.

My more recent efforts to provide superior and economical suspension systems have included the provision of vehicle suspension systems utilizing one or more elastomeric members capable of exhibiting a progressively increasing spring rate under increasing loads. In the case of truck and trailer suspensions, for example, road-induced excitations are isolated as between neighboring axles as well as between these axles and the vehicle sprung mass. Unlike many known or prior art suspensions which, because of their structure, transmit these excitations to the vehicle sprung mass and to the vehicle driver himself, my suspension systems have been able to overcome this rather serious drawback which represents not only a health hazard to the vehicle driver, but rather great economic losses each year to the owners of damaged cargo. Suffice it to say that the vehicle industry is constantly on the alert and receptive to suspension structures capable of overcoming these problems.

Before proceeding further with a discussion of the present invention, it will be useful here to devote some words to the question of "vibrations" of the type normally exhibited in vehicles and their associated suspension structures. The occurrence of vibrations is obviously quite widespread. While many uses of vibrations harness this energy to cause favorable or helpful uses, such as using vibrations to relieve internal cooling stresses in castings and to study the process of aging, there are a large number of rather bad effects caused by vibrations. The phenomenon of resonance or near-resonant conditions create high stresses and very often hasten the time when eventual structural failure may occur. Moreover, vibration has a bad psychological effect on people in the vicinity in that it is tiring, slows production and creates a generally undesirable condition.

Basically speaking, vibrations occur in elastic systems that consist of one or more masses connected to each other or to a fixed member by springs. The phenomenon of vibration is the motion of a body or system that is repeated after a given interval of time known as the "period." The number of cycles of motion per unit of time is called the "frequency." The maximum displacement of the body or some part of the system from the equilibrium position is commonly referred to as the "amplitude" of the vibration at that point.

There are two general types of vibration, namely: rectilinear and torsional. Rectilinear vibrations appear in two basic forms: the longitudinal form is the axial compression and extension of bars and wires and include the compression and extension of springs of the coiled type, for example; the transverse rectilinear vibration is seen in the motion of beams perpendicular to their centerline. The motion of torsional vibrations is one of oscillation or twisting, as in the case of shafts, and their amplitude is measured in radians or degrees, as opposed to inches in the case of rectilinear vibrations.

When a body or system is given an initial displacement from the equilibrium position and released, it will vibrate with a definite frequency known as its "natural frequency." This vibration is said to be "free" since no external forces act upon it after the initial displacement. The body vibrates with decreasing amplitude until it comes to rest. This reduction in amplitude is caused by a loss of the total energy in the system, known as "damping" and may be due to friction or resistance, etc. In some cases where the amount of damping is very large, the body will not vibrate but may merely creep back to the equilibrium position and its motion is said to be "aperiodic."

In conditions of the type normally associated with vehicles and vehicle suspension systems, an unbalanced vibrational system is created where the body or system is subjected to periodic external forces of the type normally associated with operational excitations induced by road or rail conditions. In such cases a "forced vibration" occurs and if the frequency of this external force is the same as the natural frequency associated with the mass involved, *resonance* takes place. The body or system then vibrates with large amplitudes, which result in high stresses and possible interference of parts. Problems associated with resonant vibrational conditions are greatly increased in cases where transient or temporary vibrations are super-imposed upon steady-state vibrations, since the resultant motion is the vector sum of the two motions considered independently.

The foregoing discourse concerning vibrations is meant only to familiarize the reader with the terminology normally used in connection with vibrational problems and to render an outline of the elements making up resonance, which is an undesirable phenomenon sought to be overcome by this and many of my previous inventions.

The present invention concerns itself with a vehicle suspension system which will be described for use with railroad car trucks. However, I wish to emphasize here that the present invention may be equally well suited for many other applications involving vehicles other

than railroad cars. The use of a railroad car truck as an example in describing this invention should in no way limit in the mind of the reader this vehicle suspension system, since it is equally well suited in concept and structure for use with other types of vehicles.

It is an object of the present invention to provide a vehicle suspension system featuring a progressively increasing spring rate and capable of isolating vertical, transverse and longitudinal impacts and loads.

Another object of the present invention is to provide a vehicle suspension system capable of reducing and eliminating undesirable results associated with vertical, transverse and longitudinal dynamic impacts, static transverse roll, and resonance (and metallic noise) resulting from lost motion.

A further object of the present invention is to provide a suspension system, as above, which includes demountable truck side bearings on which all load is carried, without the use of a centerplate. This suspension system will provide a plate which serves as a bolster, with an offset kingpin carried inboard of a shortened wheel base car truck.

A further object of this invention is to provide a vehicle suspension system which will weigh less than conventional suspension systems, will reduce cargo damage in transit, will reduce wheel and rail wear, will reduce or eliminate resonance and their associated derailments, and which will reduce noise.

Yet another object of the present invention is to provide a vehicle suspension system which will provide to the user improved operational characteristics, including, without limitation, the isolation of vertical, transverse and horizontal impacts of rail joints, switch points, curves and brake forces from the truck frame.

Another object of this invention is to provide a vehicle suspension system which exhibits a progressively increasing spring rate by use of a substantially spherical elastomer captively housed between upper and lower spring seat members, each of which include vertically extending walls or flanges which provide a boundary within which the spherical elastomer is situated. Optional pilot members associated with either one or both of the upper and lower spring seat members may extend into axially aligned cavities or recesses formed in the elastomeric member itself, thereby maintaining the desired alignment between these seat members and the elastomer captively held therebetween.

Yet a further object of this invention is to provide a vehicle suspension system for use with railroad freight car trucks, or the like, wherein vertical, transverse and longitudinal movements of the car body sprung mass are restrained and dampened by a captive spherical elastomeric member exhibiting a progressively increasing spring rate in all three of said directions, and in which the system is self-centering, self-dampening and provides progressive resistance to increased forces of maximum amplitude in said three directions, without requiring elastomeric shear forces to accomplish the aforesaid.

Another object of this invention is to fulfill all of the aforementioned objects and overcome the limitations and disadvantages of prior art suspension structures and systems. According to one aspect of the concept of the present invention, the novel means or steps which are employed to overcome the disadvantages of the prior art include a vehicle suspension system for use with a railroad freight car equipped with car trucks having at least one axle, and comprising a journal box disposed at each transverse end of the axle. Left and right longitudinally extending vehicle side frame members are disposed at each transverse side of the freight car. A pair of lower seat members are disposed fore and aft of the axis of the axle and are each supported by the journal box. A cooperative pair of spaced upper seat members are secured such that they are integral with the left frame member, for example, during use. A pair of elastomeric members of spherical cross section are disposed intermediate and captively held between each pair of upper and lower seat members such that each of the elastomeric members provides a progressively increased resistance to vertical, transverse and longitudinal operating forces transmitted between the sprung mass of the vehicle and the axle referred to above.

My invention will be more clearly understood from the following description of specific embodiments of the invention, together with the accompanying drawings, wherein similar reference characters denote similar elements throughout the several views, and in which:

FIG. 1 is a side elevational view of a railroad freight car equipped with the vehicle suspension system according to the present invention;

FIG. 2 is an enlarged fragmentary sectional elevational view illustrating the vehicle suspension system provided by this invention;

FIG. 3 is a fragmentary sectional plan view looking along line 3—3 of FIG. 2;

FIG. 4 is an enlarged fragmentary sectional elevational view illustrating the relationship between the elastomeric member according to this invention and its associated upper and lower spring seat members;

FIG. 5 is an enlarged, perspective, exploded view illustrating the elastomeric member and the upper and lower spring seat members of FIG. 4;

FIG. 6 is a fragmentary sectional plan view illustrating a truncated cylindrical elastomeric member according to an alternate embodiment of this invention; and

FIG. 7 is a view similar to that of FIG. 6 wherein a cubical or rectilinear-shaped elastomeric member is illustrated.

Before describing this invention in detail with respect to the drawings annexed hereto, it should be noted that following the description of the drawings and the components of the invention disclosed therein, various structural features of my invention will be amplified and expounded upon both with respect to the drawings and with respect to their characteristic features.

Referring now in more detail to the drawings, FIG. 1 illustrates a railroad freight car 10 of a conventional type normally used to transfer cargo, which is equipped with car truck assemblies 11 and 12. Each of these car truck assemblies 11 and 12 include a plurality of wheels 13 of a conventional type, usually 33 inches in diameter, and which are adapted to ride upon rail 14. While it is not necessary in this specification to describe in detail the features of conventional railroad freight car such as freight car 10, suffice it to say that freight car 10 is of the type having a slidable door 15 which is guided between its open and closed positions by tracks 16. It is intended that the present invention be capable of use with conventional box cars of the type manufactured by the Pullman-Standard Division of Pullman Incorporated of Chicago, Ill.

FIGS. 2 and 3 illustrate in more detail the interrelationships between the elements of my invention. A vehicle side frame member **17** is shown in FIGS. 2 and 3 extending in a longitudinal direction with respect to the longitudinal axis of railroad freight car **10.** Side frame member **17** represents one of a pair of side frame members, located at transverse sides of freight car **10,** respectively. A plate bolster member **18** represents the freight car truck bolster and is secured by bolts or other conventional fastening means, via bracket assembly **19** to each of side frame members **17.** Where greater structural integrity or an increased moment of inertia is required or desired, one or more ribs **20** may be added to bolster member **18.** Bolster member **18** is sufficiently strong to more than adequately support vehicle braking gear (not shown) along its length and intermediate side frame members **17.** A six inch pin-kingpin trunnion assembly **21** of a conventional type is shown in FIGS. **2** and **3** pivotally secured to a car center sill **22.** Kingpin trunnion assembly **21** is located inboard of bolster member **18,** as labeled in FIG. **3,** and may alternatively be of a ball bushing type capable of accommodating oscillation only, without vertical load.

Axles **23** and **24** are shown in plan view in FIG. **3** extending between wheels **13** and their opposing wheels on the opposite side of each of axles **23** and **24.** The journalling of the ends of axles **23** and **24** is also seen in FIGS. **2** and **3** as being accommodated by journal box assemblies **25** and **26,** respectively. For purposes of convenience, the stub ends of axles **23** and **24** have been given the same reference characters as their associated axles, and are shown extending into journal box assemblies **25** and **26,** respectively, in FIG. **3.** Journal box assemblies **25** and **26** house and support journal bearing assemblies **27** and **28,** respectively. In a preferred embodiment of the invention, the inner race **29** of journal bearing assembly **27** turns with axle **23,** while the outer or stationary race **30** is integral with the base of journal box assembly **25.** Similarly, the inner bearing race **31** of journal bearing assembly **28** turns with axle **24** while its associated outer bearing race remains stationary and is normally integral with journal box assembly **26.** It is contemplated by the present invention that journal bearing assemblies **27** and **28** may be removable and/or interchangeable.

Turning now to the structural configuration of the present invention which provides a progressively increasing spring rate with increasing loads in all three of the vertical, transverse and longitudinal directions, it is seen if FIGS. **2, 4** and **5** that journal box assemblies **25** and **26,** respectively, support pairs of lower spring seat members **33** and **34,** and **35** and **36,** each of which is secured such as by welding or other conventional fastening means to upper surfaces **37, 38, 39** and **40** of journal box assemblies **25** and **26,** respectively. Each of lower spring seat members **33, 34, 35** and **36** is formed with upstanding, substantially vertically extending walls or flanges **41, 42, 43** and **44,** respectively. Walls or flanges **41, 42, 43** and **44** are each preferably arched such that adjoining portions thereof extend halfway aboout the periphery of the base thereof. For purposes of illustration only, FIG. **5** represents an exploded view of the interrelationship between the members being described now and is representative of each of the combination of elements associated with lower spring seat members **33, 34, 35** and **36.** Thus, each of said lower spring seat members includes a base portion **45** thereof (FIG. **5**) above which wall portions **46** and **47** comprise wall or flange **44,** for example. Wall portions **46** and **47** extend in an arched manner and at certain points thereof extend substantially **90°** with respect to one another.

The inside lower surfaces of lower spring seat members **33, 34, 35** and **36** are each formed with concave or cup-shaped surfaces **48, 49, 50** and **51,** respectively. The specific shape of cup-shaped surfaces **48, 49, 50** and **51** may be predetermined and, thus, may be spherical, elliptical, or any predetermined or desired shape. Lower pilot members **52, 53, 54** and **55** are integral with cup-shaped surfaces **48, 49, 50** and **51,** respectively, and may be either integrally formed with these surfaces or may be separately formed and secured thereto. Each of these pilot members extend substantially vertically from the center of its associated cup-shaped surface a distance substantially short of the height of the wall or flange associated with the same cup-shaped surfaces. Each of the pilot members **52, 53,** 54 and **55** is somewhat tapered such that they terminate in a rounded diameter which is substantially lesser in magnitude than the diameter of the pilot members at the point of juncture with its associated cup-shaped surface.

FIGS. **2, 4** and **5** further illustrate the existence of two pairs of upper spring seat members **56, 57, 58** and **59,** associated with journal box assemblies **25** and **26,** respectively. As in the case of each of the lower spring seat members **33, 34, 35** and **36** described in detail above, each of upper spring seat members **56, 57, 58** and **59** may be and preferably are of identical structure or structural configurations. This provides for standardization and accompanying reductions in cost. It should be further noted that all of the lower and upper spring seat members may likewise be identical in structural configuration for these same reasons. Thus, as in the case of the lower spring seat members just described, each of upper spring seat members **56, 57, 58** and **59** is formed with a pair of arched, adjoining wall portions **60** and **61** which extend halfway around the peripheral of a base portion **62** of each. Wall portions **60** and **61** depend vertically from their respective base portions which, in turn, are each secured, such as by welding or other conventional means, to the underside of side frame member **17.**

As in the case of the lower spring seat members, each of the upper spring seat members is formed with a concave or cup-shaped surface **63, 64, 65** and **66,** with respect to members **56, 57, 58** and **59,** respectively. Upper pilot members **67, 68, 69** and **70** similarly extend vertically from their associated cup-shaped surfaces **63, 64, 65** and **66,** respectively and are axially aligned with respect to lower pilot members **52, 53, 54** and **55,** respectively. In this way it can now be seen and further illustrated in FIG. **2** that lower spring seat members **33, 34, 35** and **36** are in opposing and aligned spaced relationship with respect to upper spring seat members **56, 57, 58** and **59,** respectively. A spherical elastomeric member is captively disposed between each of the aforesaid opposing pairs of upper and lower spring seat members.

More specifically, elastomeric member **71** is disposed intermediate and captively held between lower spring seat member **33** and upper spring seat member **56.** Elastomeric member **72** is disposed intermediate and captively held between lower spring seat member **34**

and upper spring seat member 57. Elastomeric members 71 and 72 are associated with journal box assembly 25 associated with axle 23. Referring now to journal box assembly 26 which is associated with axle 24, elastomeric member 73 is disposed intermediate and captively held between lower spring seat member 35 and upper spring seat member 58. Likewise, elastomeric member 74 is disposed intermediate and captively held between lower spring seat member 36 and upper spring seat member 59.

Each of elastomeric members 71, 72, 73 and 74 is preferably formed in a substantially spherical shape when in an unloaded or free condition. Axially aligned recesses 75 formed in diametrically opposite ends of each of these elastomeric members accommodate the entry of a pilot member associated with the aforementioned upper and lower spring seat members. Thus, when assembled, lower and upper pilot members 55 and 70 associated with spring seat members 36 and 59 will coaxially extend into recesses 75 associated with elastomeric member 74 to keep the interrelationship of these members aligned. The same is true for each of the other elastomeric members 71, 72 and 73 referred to above.

In operation, each of elastomeric members 71, 72, 73 and 74 provides the equivalent of a spring having a progressively increasing spring rate with progressively increasing loads. What is even more significant about the present invention is the fact that each of these elastomers is able to dampen and absorb loads in all three and combinations of the vertical, transverse and longitudinal directions. Referring, as an example, to elastomeric member 74, shown in FIG. 4 as being representative of each of the elastomeric members described above, it is seen that vertical forces transmitted between upper and lower spring seat member 59 and 44 are absorbed by the compression of elastomeric member 74 against the spherical or concave or cup-shaped surfaces 66 and 51 of these same seat members. During this compression of elastomeric member 74, the opposing and surrounding wall portions 46, 47, 60 and 61 associated with the respective upper and lower spring seat members prevent elastomeric member 74 from deforming in an arbitrary and uncontrolled manner. On the contrary, the presence of these wall portions serves to limit the deformation of elastomeric member 74 and to control the spring rate characteristic exhibited by this same elastomeric member. During this compression, for example, pilot members 70 and 55 associated with upper and lower spring seat members 59 and 44, respectively, maintain alignment between the upper and lower spring seat members and the elastomeric member captively held therebetween. In addition to defining the extent of deformation of elastomeric member 74, wall portions 46, 47, 60 and 61 further prevent the undesirable escape of this elastomeric member during other than vertical compressive forces.

These same vertically extending wall portions 46, 47, 60 and 61 further serve to provide bearing surfaces against which elastomeric member 74 may come to bear during times when transverse or longitudinal forces are exerted between upper and lower spring seat members 59 and 44. More specifically, transverses forces result in a compression of elastomeric member 74 against wall portions 47 and 61, while longitudinal forces result in compression of elastomeric member 74 against wall portions 46 and 60. Of course, during operation of a railroad freight car, combinations of vertical, transverse and longitudinal forces occur and elastomeric member 74 is able to accommodate each and all of these forces separately and simultaneously, while exhibiting a progressively increasing spring rate.

During the exertion of transverse and longitudinal forces upon elastomeric member 74, for example, the presence of pilot members 70 and 55 becomes increasingly important in that substantially vertical alignment between upper and lower spring seat members 59 and 44 is maintained. It should also be noted that because of the substantially spherical shape of elastomeric member 74, for example, forces and vibrations exerted in directions which are other than strictly vertical, transverse and longitudinal are easily accommodated due to the arched upstanding and depending presence of wall portions 46, 47, 60 and 61 associated with upper and lower spring seat members 59 and 44. What has just been described for elastomeric member 74 and its associated upper and lower spring seat members is equally true for each of elastomeric members 71, 72, 73 and their respective upper and lower spring seats.

The present invention further contemplates the use of elastomeric members which are of a shape other than spherical and which are compressively restrained between other than concave or cup-shaped seats. FIGS. 6 and 7 illustrate but two variations of elastomeric member configuration contemplated by the present invention. In FIG. 6, a vertically upstanding solid cylindrical elastomeric member 76 is illustrated disposed intermediate and between opposing pairs of convex surfaces 77 and 78, and 79 and 80, respectively. These convex surfaces 77, 78, 79 and 80 bear against the outer convex cylindrical surfaces of elastomeric member 76 in a substantially horizontal plane, while upper and lower convex bearing surfaces 81 and 82 (not shown) bear against the substantially flat upper and lower surfaces of cylindrical elastomeric member 76. By providing this configuration, it is possible to provide an elastomeric configuration which yields differing and varying spring rate characteristics in a horizontal plane than that exhibited in the vertical plane. Thus, different spring rates are achieved with the use of elastomeric member 76 to counteract compressive vertical forces and vibrations than the compressive transverse and longitudinal forces accommodated. The abutting convex surfaces of elastomeric member 76 and any one of convex surfaces 77, 78, 79 or 80 will result in a relatively higher or greater deformation initially than in cases where the load is less concentrated.

FIG. 7 illustrates an elastomeric member 83 disposed between and intermediate the aforesaid convex surfaces 77, 78, 79, 80, 81 and 82 (not shown) described above for elastomeric member 76. Elastomeric member 83 represents an illustration of yet another shape of elastomer which may be utilized according to the present invention. In this case four substantially flat vertically extending sides or faces 84, 85, 86 and 87 bear against and are compressively resistant to movement between convex surfaces 77, 78, 79 and 80. Likewise, upper and lower substantially flat faces which have not been designated by reference character abut and interact with convex surfaces 81 and 82 (not shown).

Thus, as just described in the present specification, it is seen that significant improvements and novel structure distinguish the present invention from that disclosed and described in my previous U.S. Pat. Nos.

3,572,745 and 3,687,478, wherein the combination of elastomers and seats are mounted such that axial compression of the elastomer in a single direction is its sole purpose. In these previous applications and patents, transverse forces are not resisted by this same elastomeric member but rather by large radial bearings, and at the same time longitudinal forces are resisted by torque rods of a conventional type. In the present invention, on the other hand, the use of a single elastomer between cupped seats is expanded to include not only vertical forces but also transverse and longitudinal forces as well. In the present invention, the use of pairs of elastomeric members between cupped seat members is utilized on either side of railroad freight cars, for example.

Vertical loads deform the elastomeric members radially, increasing the diameter of the respective elastomers such that contact is made with the opposing arched walls integral with the upper and lower spring seat members. Yet further increases in vertical loads result in further flattening of the outer diameter of the elastomer toward a squared contour at these retaining walls.

It is important to note here that the suspension according to the present invention is applicable to a single axle car truck, as well as the double axle car truck described in FIGS. 1–7 above. In the case of the use of the present invention with a single axle car truck, the upper spring seat members are fixed to the car body bolster, without kingpins, centerplate or side bearings since there is no oscillation between the car body and the single axle car truck. It is also important here to note that where the present invention is applied to a tandem axle car truck, the upper spring seats are affixed to the side frame member on either side of the car as described above. In these cases, the load is directly over the midlength of the side frame without transfer of weight to the truck bolster and the body centerplate. Thus, the truck bolster merely serves to tie the opposing side frames together to preserve longitudinal parallelism of the opposing axles and side frames, while simultaneously affording a 5° or 6° vertical variation between diagonal wheels. To reduce transverse forces at switch points and curves, the kingpin is offset inboard of the car truck center, as shown in FIG. 3. The truck bolster 18 thus serves to position the car truck in a swivel-type relationship to the car body, and transmits the brake forces therebetween.

Another point of novelty of the present invention resides in the absence of lost motion, clearance or transverse backlash between the journal box assemblies 25 and 26 and the car body itself. The umdamped columnar helical springs of existing structures results in transverse shimmy of low frequencies which can be dampened out on a perfectly straight level test tract by insertion of steel-faced rubber isolators between the centerplates and the side bearings of such suspensions. This dampening comes into play as the car body rolls transversely on the car truck.

It is significant to note that, of course, all tracks or rails are not straight or level or smooth, or even of a standard gauge. Thus car "hunting" is often suspected of causing some derailments of railroad freight cars. In the present invention, movement in vertical, transverse and longitudinal directions are progressively restrained in relation to the sprung mass of the car body and its load, with integral dampening through a relatively high hysteresis restrained elastomeric member. The application of an unbonded spherical elastomeric member compressively restrained between cupped seats may also be applied to replacement of conventional nests of helical undamped springs supported on the side of car frames and supporting the free floating truck bolster. The suspension system according to the present invention is self-centering, self-damping, and progressively resistant to increased forces in vertical, transverse and longitudinal directions. Thus, in addition to the objects of this invention previously set forth, it is a further principal object of this invention to provide a positive metallic seat between which the elastomer is compressively restrained vertically, transversely and longitudinally with respect to an opposing seat, without dependence upon shear forces in the elastomer to withstand forces of maximum amplitude in each of the vertical, transverse and longitudinal directions. Another principal object of this invention is to provide a relatively lower spring rate for an empty car structure than for a loaded car. yet another object of this invention is to avoid instability of ride which often results from undamped harmonic movements in what is recognized as being conventional transversely unstable car trucks. Finally, it is another object of this invention to provide a non-bottoming suspension system with inherent self-damping in transverse, vertical and longitudinal directions, for a loaded freight car.

The invention described above for FIGS. 1-7 is quite novel in that the structural design includes truck side bearings or assemblies not shown on which all of the load is carried directly, without the use of a centerplate. The truck side frames 17 are interconnected by a removable flat bolster 18, inboard of which is kingpin trunnion assembly 21 is trunnioned in a shortened wheel base truck to reduce transverse forces encountered at curves and switch points.

The vertical dynamic forces and the transverse-roll static forces are both absorbed by compression of spherical elastomeric members 71, 72, 73 and 74, each of which is restrained between pairs of cupped upper and lower spring seat members, whereby a progressively increasing spring rate is operationally achieved in suspensions of an empty car, a loaded car, and the transverse roll of a loaded car.

The vertically extending flanges or walls associated with the upper and lower spring seat members which captively hold each of the spherical elastomers are matched by similar flanges disposed 180 degrees transversely of its paired mate, to contact the perimeter of the then loaded elastomer in resisting the static forces of transverse roll, while at the same time the elastomer is compressed by weight of the loaded car. Otherwise, without the present structure described here, the static-induced deflection would result in 150 percent of the deflection caused by dynamic forces of the same amplitude. As the ratio of static to dynamic deflection is 1.5 to 1.0 in an elastomer of such high hysteresis damping quality, the present invention provides a novel and beneficial result. All four pairs of upper and lower spring seats on each side of a tandem car truck are disposed or located to resist transverse forces to the right as well as to the left of the line of travel of the railroad freight car.

Direct transverse forces, such as those created at switch points and curves, are likewise resisted by the above-mentioned spring seat vertical walls or flanges,

which augment the shear force resistance of the spherical elastomers disposed between the vertically spaced spring seats. The longitudinal forces, on the other hand, encountered in braking applications, are likewise resisted by similar pairs of flanges on all of the same spring seats, disposed at 90° from the adjacent flanges which resist transverse forces, and without interference therebetween.

While the range of progressively increasing spring rates obtainable with spherical elastomeric members which are restrained or captively held within and between cupped seats is greater than the ratio of static to dynamic deflections of this elastomer, it is to be noted that the location of the kingpin assembly has been established inboard to reduce the angle of approach to switch points and curves, thereby lessening the transverse forces encountered at these points.

The present vehicle suspension system will not provide a constant floor height with any load, as is presently available with air spring suspension systems. Thus, for a 7.5 inch free diameter elastomer utilized with a 70 ton railroad car, the empty car height will be 1.5 inches higher than the loaded car height, while the springs will reflect 0.75 inches to the free height of the elastomers. Thus, total working deflection of the elastomers is but 30 percent of their free diameter to provide long life thereof.

The embodiments of the invention particularly disclosed and described hereinabove are presented merely as examples of the invention. Other embodiments, forms and modifications of the invention coming within the proper scope and spirit of the appended claims will, of course, readily suggest themselves to those skilled in the art.

What is claimed is:

1. A railraod vehicle truck suspension structure for use with railroad freight cars having at least one axle, or the like, comprising, in combination: a journal box disposed at each transverse end of said axle; left and right longitudinally extending vehicle side frame members disposed at each transverse side of said freight car; first and second lower seat members disposed, respectively, fore and aft of the axis of said axle and each supported by a journal box; first and second spaced upper seat members, respectively, said upper seat members being integral with said left frame member during use; first and second elastomeric member disposed intermediate and captively held between each of said first upper and lower and said second upper and lower seat members, respectively, said elastomeric member providing progressively increasing resistance to vertical, transverse and longitudinal operating forces transmitted between the sprung mass and said axle; each of said lower seat members comprising a cup-shaped lower base portion thereof integral with upstanding, arcuately extending lower wall portions which collectively extend substantially half-way about said lower base portion, said lower base portion having bearing surfaces which engage one of said elastomers, said lower upstanding wall portions having curved surfaces which engage one of said elastomers; each of said upper seat members comprising a cup-shaped upper base portion thereof integral with depending, arcuately extending upper wall portions which collectively extend substantially half-way about said upper base portion, pairs of said upper and lower seat members being operatively located such that said upper and lower wall portions are disposed in opposite relationship with respect to each other about one of said elastomers, thereby captively limiting movement of the elastomer, said captive elastomer resisting horizontal movement of said upstanding and depending wall portions towards each other and further resisting vertical movement of said upper and lower base portions towards one another, thereby isolating rail-induced forces in each axle from the vehicle sprung mass.

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