United States Patent [19]

Wiebe

[11] **3,773,147**

[45] **Nov. 20, 1973**

[54] **TRUCK DAMPENING**

[76] Inventor: **Donald Wiebe,** R.D. No. 3, Sewickley, Pa. 15143

[22] Filed: **Oct. 28, 1971**

[21] Appl. No.: **193,498**

Related U.S. Application Data

[60] Division of Ser. No. 801,884, Oct. 23, 1968, Pat. No. 3,626,864, which is a continuation-in-part of Ser. No. 534,220, March 14, 1966, abandoned, which is a continuation-in-part of Ser. No. 468,850, July 1, 1965, abandoned, which is a continuation-in-part of Ser. No. 579,709, Sept. 15, 1966, abandoned.

[52] **U.S. Cl.** .... **188/33,** 29/434, 105/1 A, 105/197 D, 105/199 A, 188/284, 267/3, 267/8 R

[51] **Int. Cl.** **B61f 5/12,** B61f 5/14, B61h 11/00

[58] **Field of Search** .... 29/434; 105/1 A, 105/164, 193, 197 R, 197 D, 199 R, 199 C, 105/200, 199 A; 188/33, 284, 287; 213/8, 43, 213/223; 267/3, 4, 8 R, 34, 64 A, 65 R, 120, 122, 213/127; 280/124 F, 136, 405 R, 439, 440; 293/71, 78; 308/26, 136, 137, 138, 163, 184, 308 R, 184 A, 223, 226

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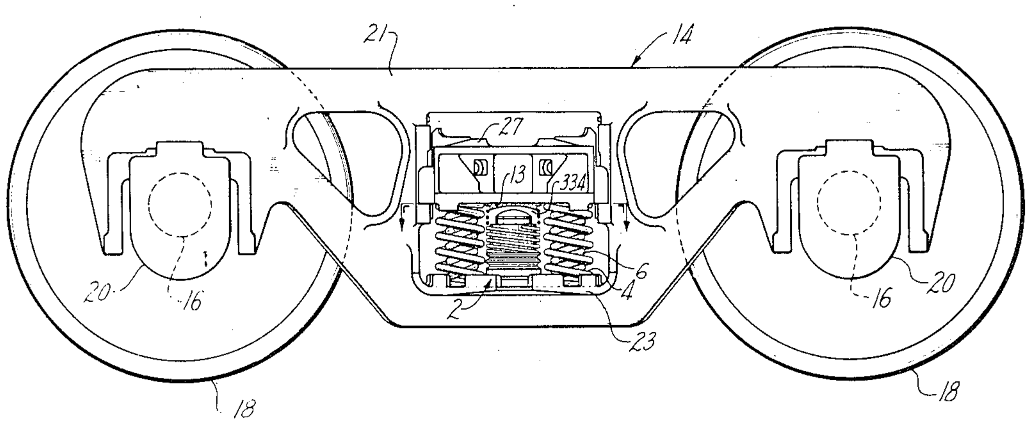
Assistant Examiner—Howard Beltran
Attorney—Howard E. Sandler

[57] **ABSTRACT**

A method of absorbing energy for railway freight cars and more particularly a method of damping the movement of a railway car with respect to the supporting trucks therefor, by the use of fluid snubbers.

9 Claims, 18 Drawing Figures



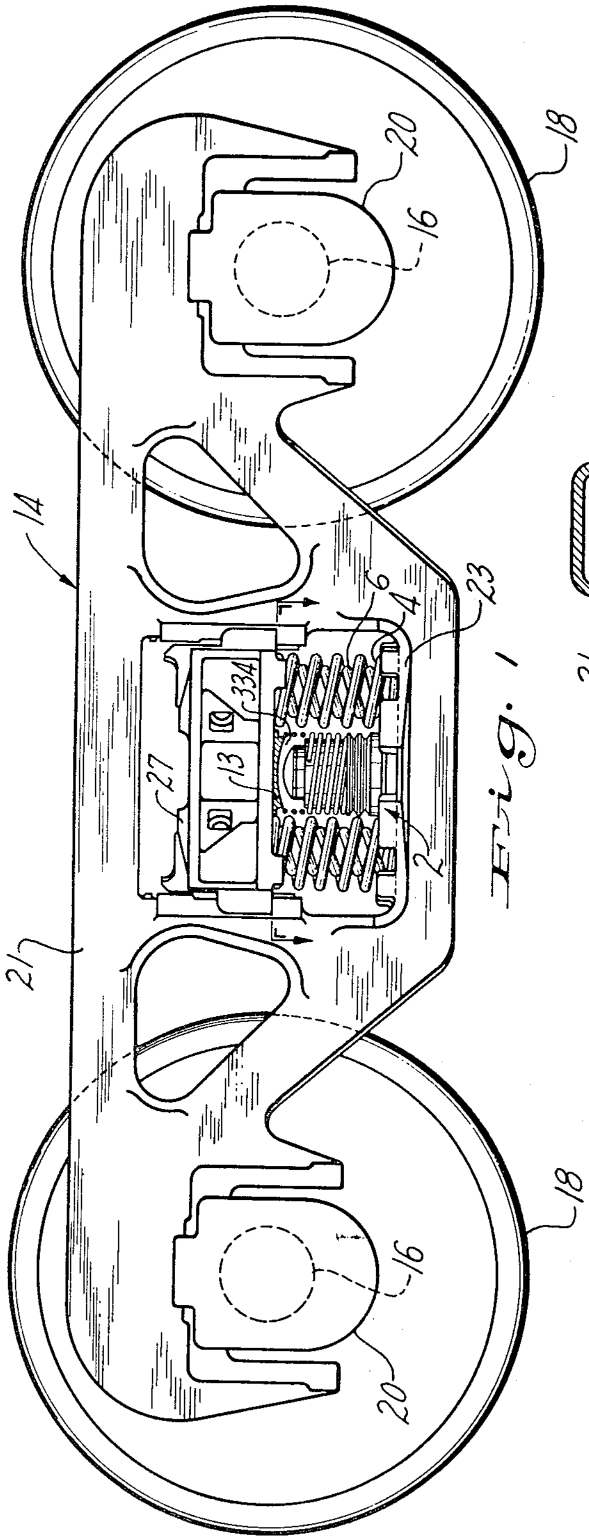


Fig. 1

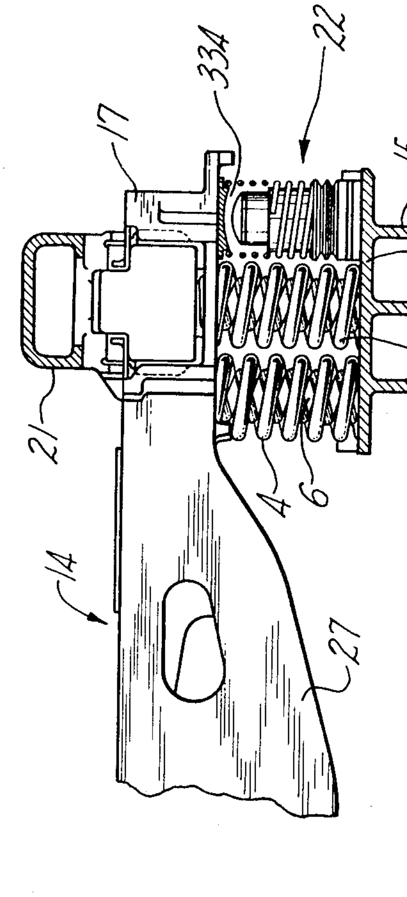


Fig. 2

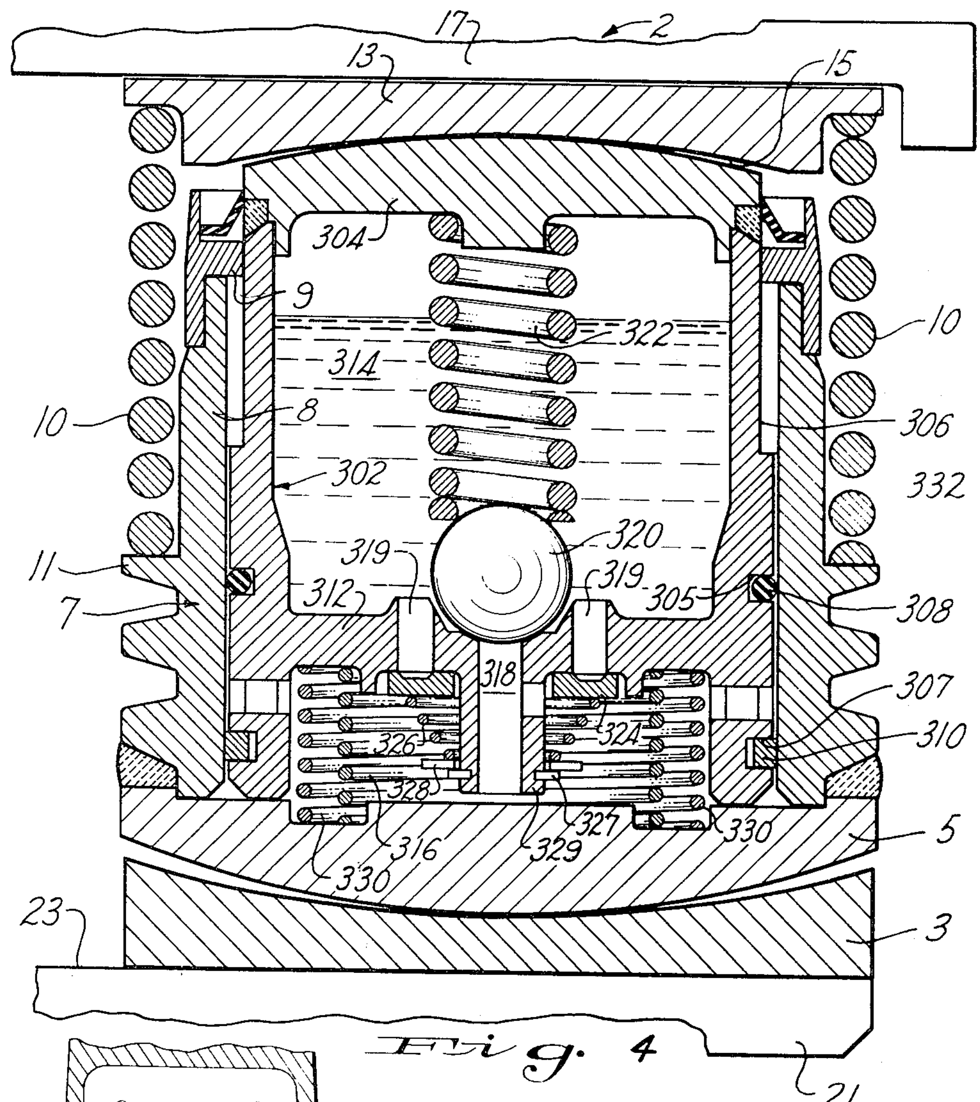

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Fig. 4

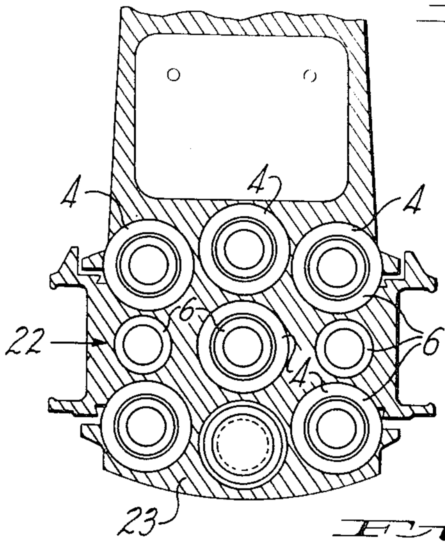
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Fig. 3

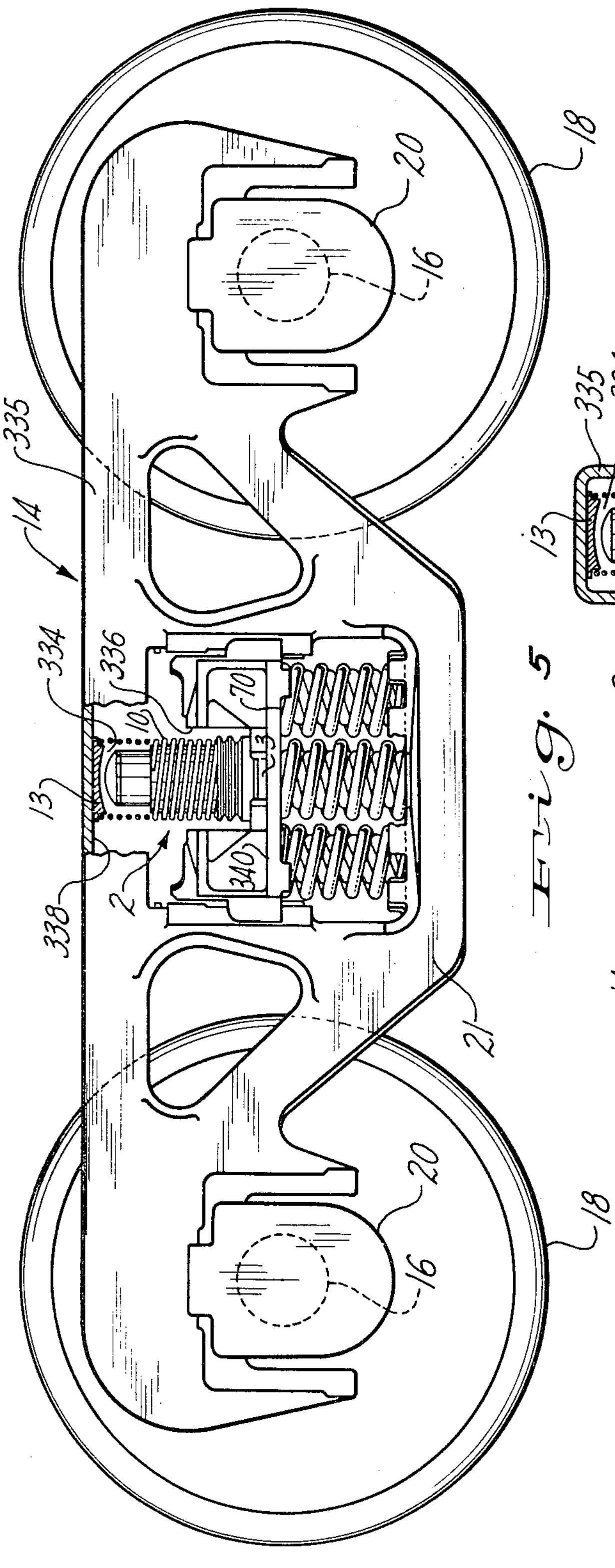
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Fig. 5

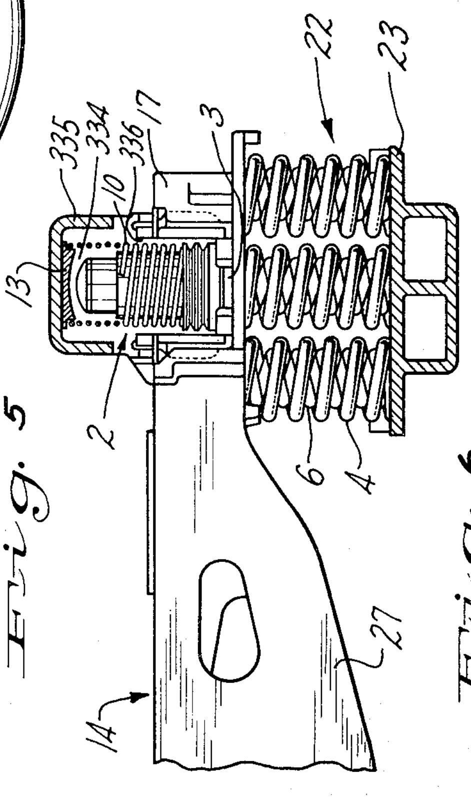
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Fig. 6

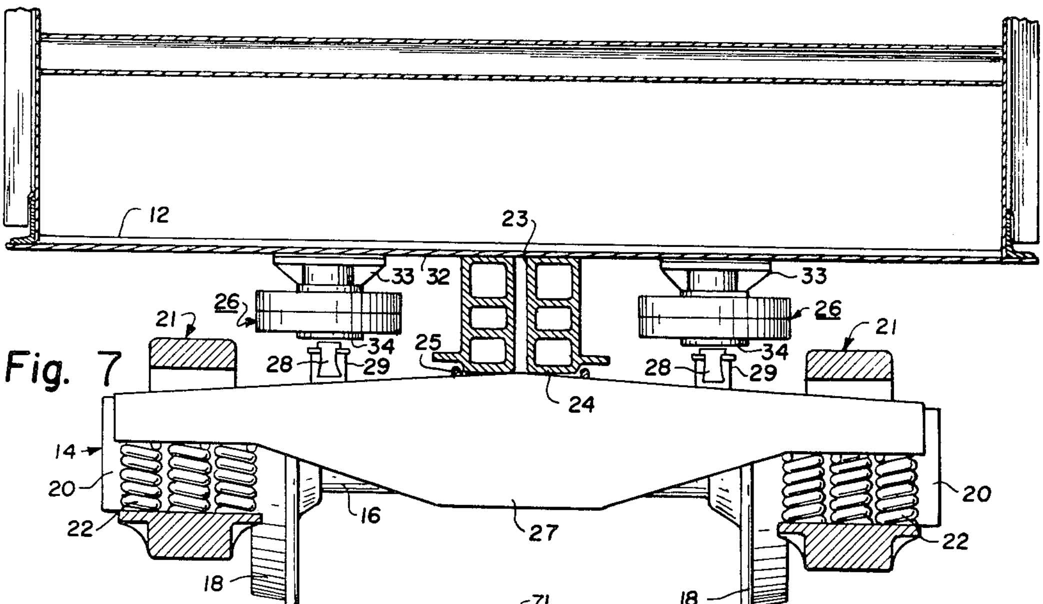

Fig. 7

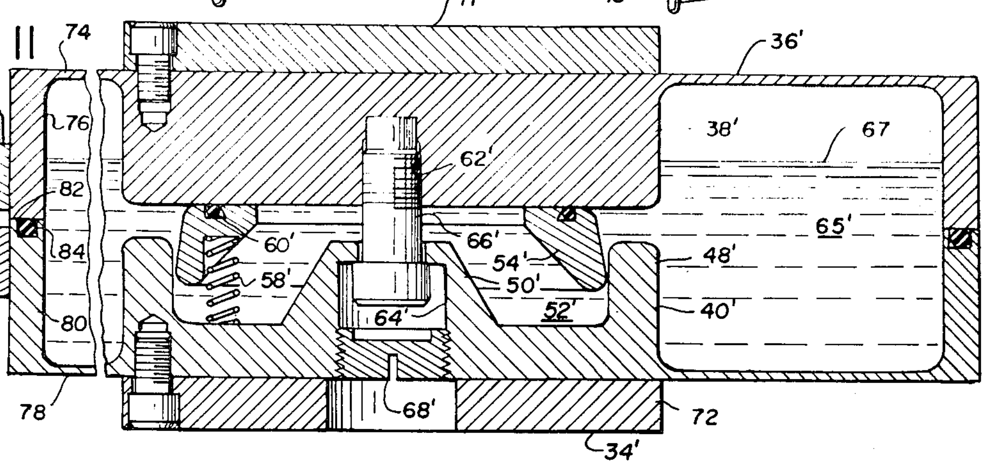

Fig. 11

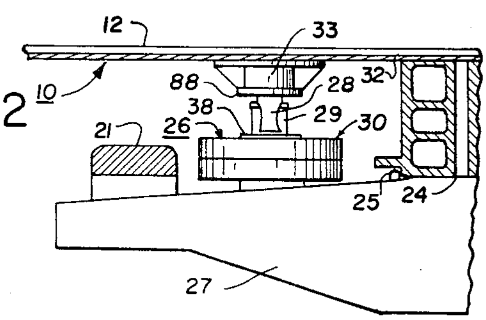

Fig. 12

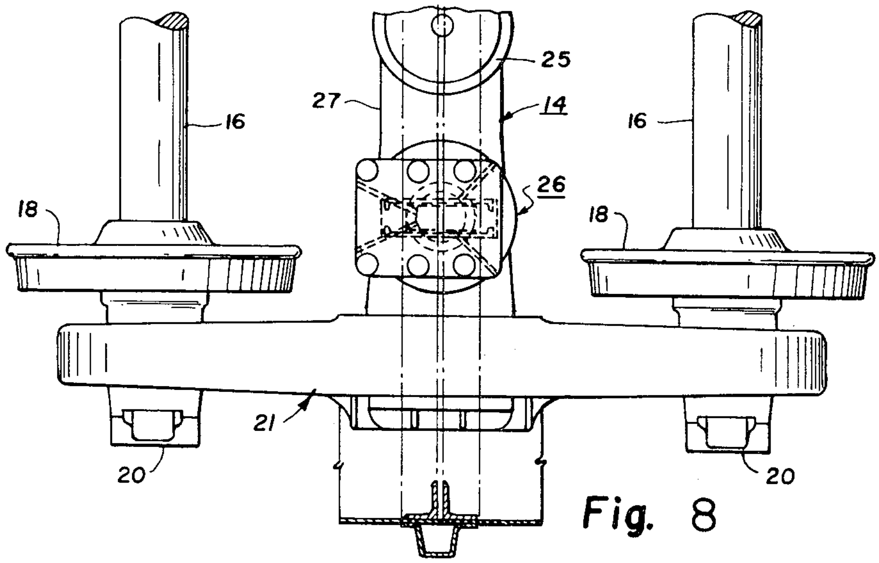

Fig. 8

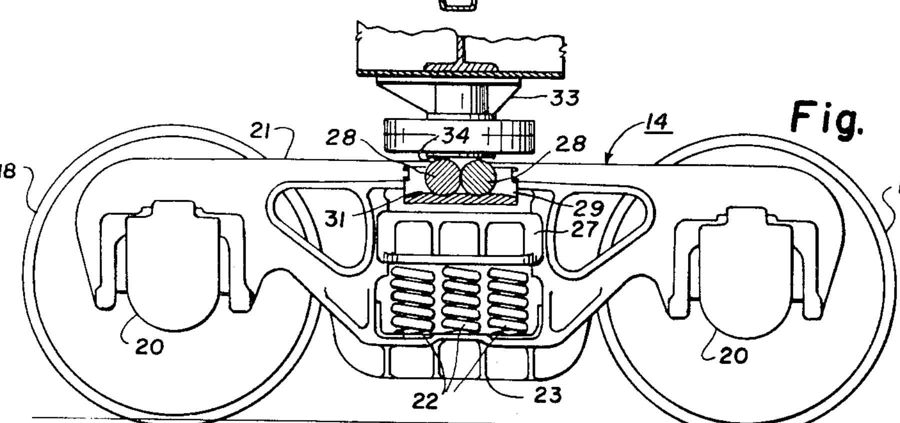

Fig. 9

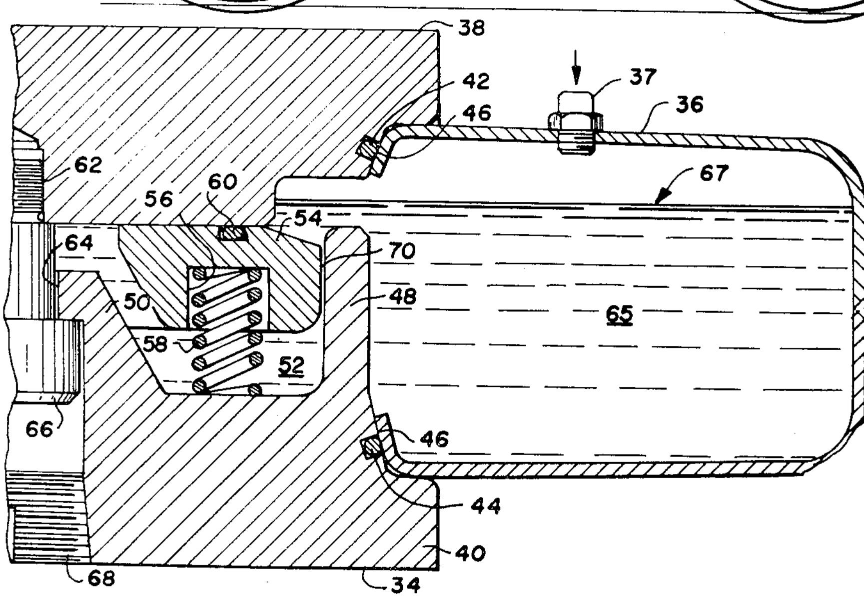

Fig. 10

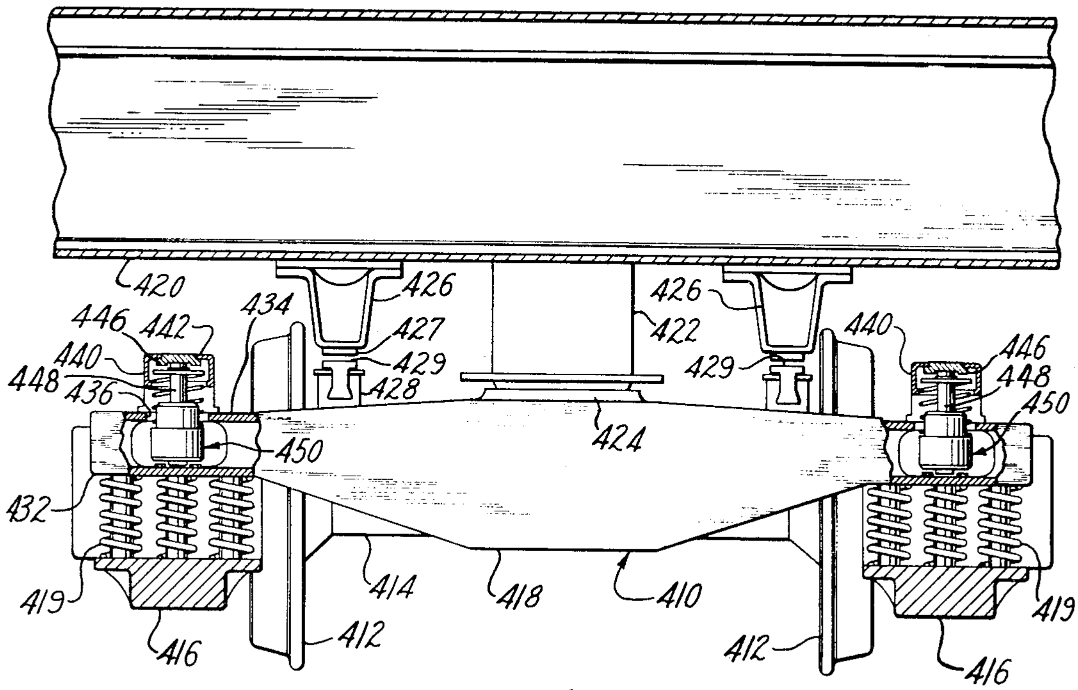
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Fig. 13

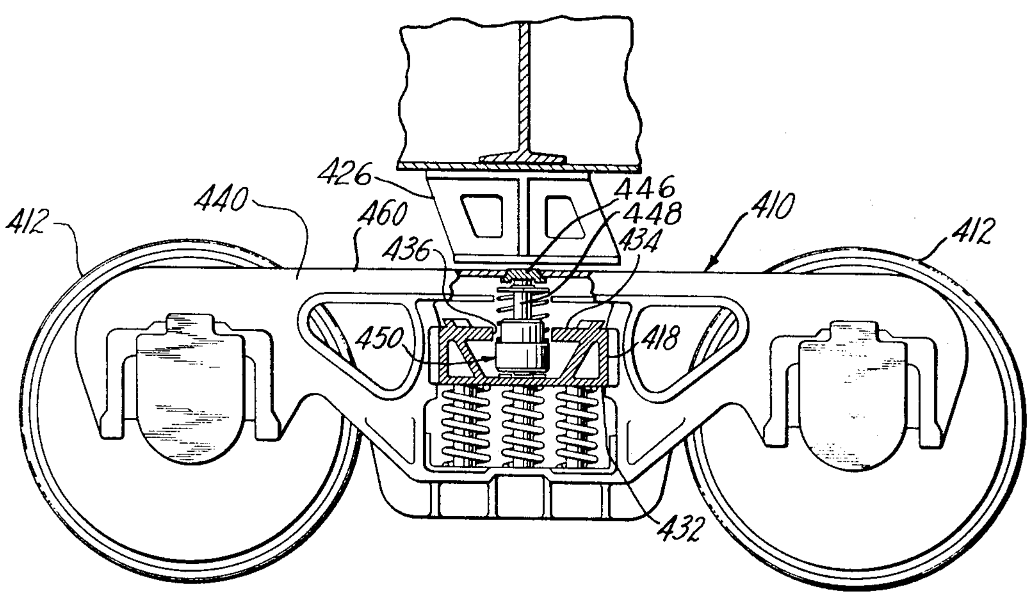
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Fig. 14

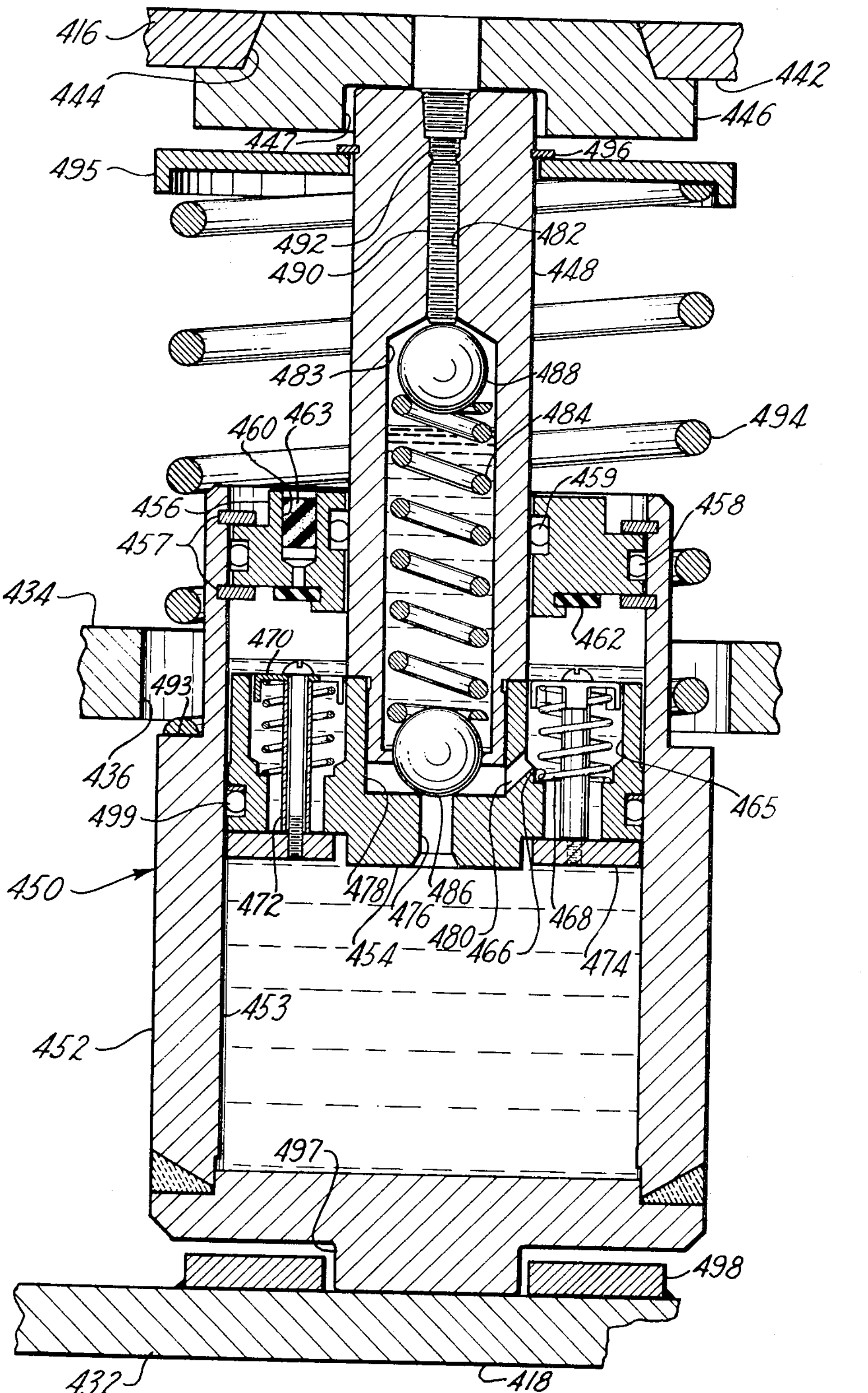
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Fig. 15

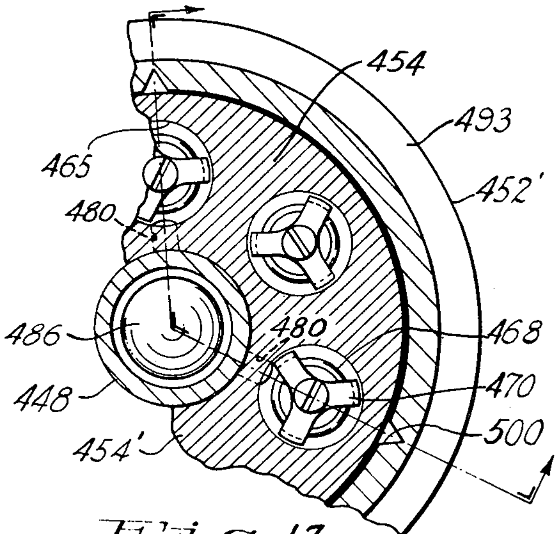

Fig. 17

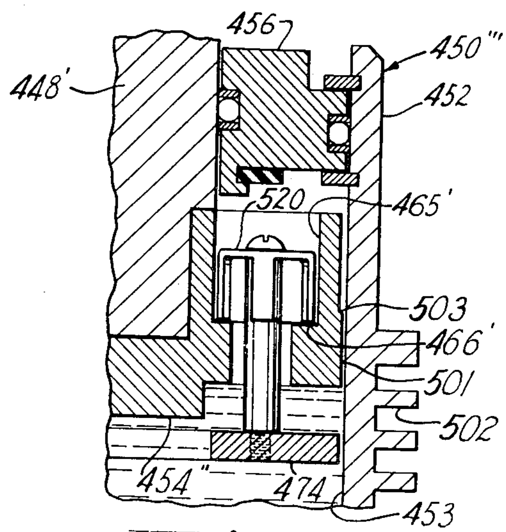

Fig. 18

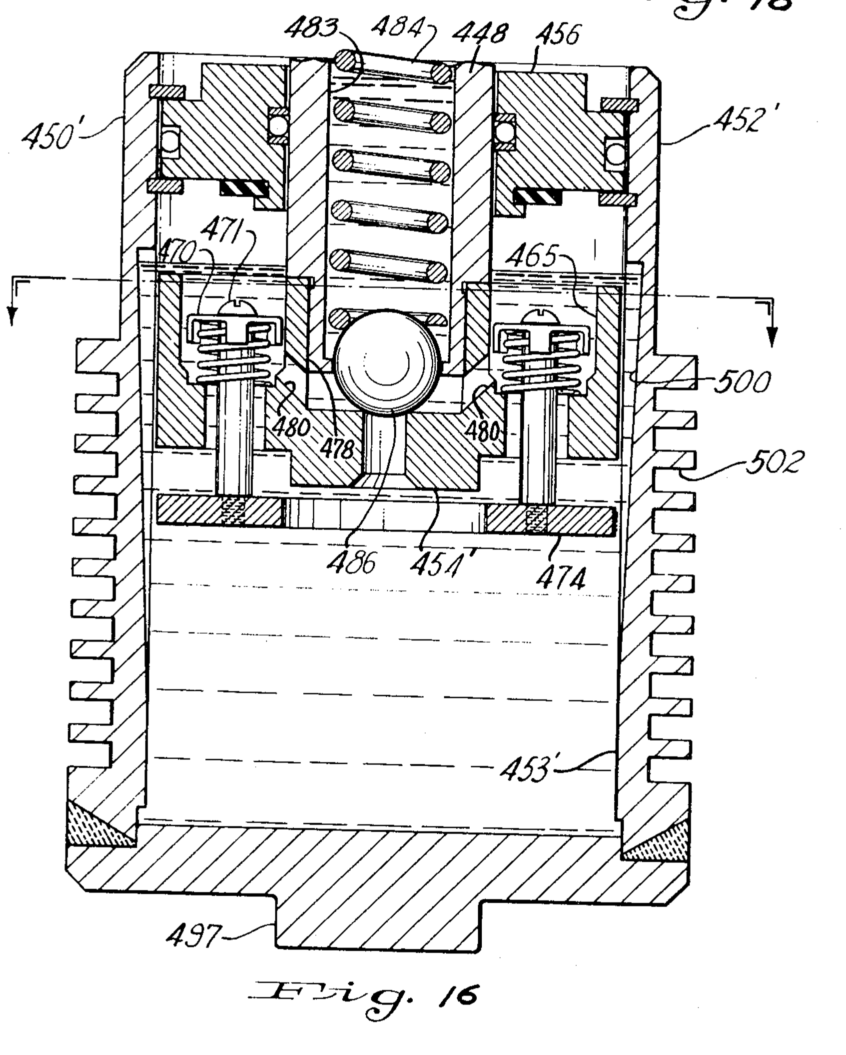

Fig. 16

TRUCK DAMPENING

This application is a division of application Ser. No. 801,884, filed Oct. 23, 1968, now U.S. Pat. No. 3,626,864, issued Dec. 14, 1971, which was a Continuation-In-Part of application Ser. No. 534,220, filed Mar. 14, 1966 (now abandoned), which application was a Continuation-In-Part of application Ser. No. 468,850 filed July 1, 1965 (now abandoned) and was also a Continuation-In-Part of application Ser. No. 579,709, filed Sept. 15, 1966 (now abandoned).

The lateral instability of freight cars and the derailments caused thereby are well known in the art and the resonance environment that results when freight cars, including the newer types known as high center of gravity cars, traverse track with cross level differences changes are set forth in the paper entitled "The Effects of the Lateral Instability of High Center Gravity Freight Cars" presented Mar. 27, 1968 to the 1968 Joint ASME-IEEE Railroad Conference on Mar. 27, 1968 in Chicago, Ill. and which has been published under the same title by the American Society of Mechanical Engineering, Journal of Engineering for Industry, November 1968 issue.

The various objects and advantages of this invention will become more readily apparent upon consideration of the following description and drawings, in which:

FIG. 1 is a side elevational view of a railway car truck having snubber therein which is constructed, located and operable in accordance with the principles of this invention;

FIG. 2 is a cross-sectional view of the end of a bolster, the supporting spring group, and the side frame as shown in FIG. 3;

FIG. 3 is a partial sectional view taken substantially along line 3—3 of FIG. 1;

FIG. 4 is an enlarged cross-sectional view of the snubber shown in FIG. 1;

FIG. 5 is a view similar to FIG. 1 having a snubber of this invention located above a bolster supporting spring group;

FIG. 6 is a view similar to FIG. 2 showing the snubber shown in FIG. 5;

FIG. 7 is an end elevational view of a portion of a railway car and truck support therefor having a snubber of this invention located therebetween;

FIG. 8 is a top plan view of one end of the truck support as shown in FIG. 7;

FIG. 9 is a side elevational view of the structure shown in FIG. 8;

FIG. 10 is an enlarged sectional view of the snubber shown in FIG. 7;

FIG. 11 is a sectional view similar to that of FIG. 10 of another embodiment of this invention;

FIG. 12 illustrates an arrangement wherein a snubber of this invention is mounted on the truck bolster;

FIG. 13 is a fragmentary partially sectional and elevational view of a car body under frame and the supporting truck therefor incorporating the side frame snubber of this invention;

FIG. 14 is a side elevational partially sectional view of the structure of FIG. 13;

FIG. 15 is a sectional view of a portion of the structure of FIG. 13 on an enlarged scale showing a snubber constructed according to the principles of this invention;

FIG. 16 is a fragmentary sectional view similar to a portion of FIG. 15 taken substantially on the line 16—16 of FIG. 17 and showing another embodiment of the principles of this invention;

FIG. 17 is a fragmentary sectional view taken substantially on line 17—17 of FIG. 16; and

FIG. 18 is a fragmentary sectional view of still another embodiment of the present invention.

As illustrated best in FIGS. 7 to 9 the conventional railway freight car comprises an elongated car body 12 supported upon four wheel truck assemblies 14 (only one of which is shown) adjacent the ends of the car body 12. Each truck assembly has a pair of parallel axles 16 extending transversely of the body 12 with spaced journal wheels 18 being carried by each axle 16 to properly engage railroad tracks of a known gage. The outer ends of the axles 16 are suitably rotatably supported in known journal boxes 20 and each pair of adjacent boxes 20 at opposite sides of each truck assembly 14 is connected by known truck side frames 21. Each side frame 21 has a formed opening intermediate the axles 16 which provides a lower support portion 23 for supporting the lower ends of a suitable spring group 22 comprised of a plurality of vertically extending springs. A bolster 27 extends between each pair of opposed side frames 21 with the undersurface of the opposite ends thereof being supported by engagement with the upper ends of opposed spring groups 22. Longitudinally spaced portions of the body 12 adjacent the ends thereof are supported by the longitudinally spaced bolsters 27 by means of suitable center sill assemblies which illustratively comprise circular center plates 24 extending downwardly of the body 12 which are received within an upwardly open cup-shaped bearings 25 rigidly carried centrally by the bolsters 27, respectively. Inasmuch as the structure of truck assemblies for railway freight cars and their structural cooperation with components of freight car bodies are well known in the art the description herein of such structures is of a general nature as a detailed description is not essential to the understanding of this invention by one skilled in the art to which it pertains.

With such known suspension the weight of the body 12 is supported by the abutting engagement of the center plates 24 with the surfaces of bearings 25 and the truck assemblies 14 are capable of rotating with respect to the center plates 24 when negotiating a curve in the track. The body 12 is thus normally supported upon a narrow area as compared to the width of the body 12 and accommodates for small differences in track profile raising or lowering one end or the other of the bolsters 27 without severe or undue twisting the body 12. To prevent the body 12 from tilting too far in either direction, suitable known side bearing assemblies are provided such as those wherein a pair of rollers 28 is mounted on the top surfaces of the bolsters 27 at some distance on either side of the center plate 24 and wear plates (not shown) are fixed to the bottom of the body 12 above the rollers 28, respectively, with a space of one-quarter to three-eighths of an inch between the bottom surface of the wear plate and the top surface of the rollers 28. When the body 12 is tilted or rocked to one side or the other, one of the wear plates contacts a side bearing assembly or pair of rollers 28 to arrest further relative motion between the bolsters 27 and the body 12 while maintaining the ability of the truck to rotate about the center plate 24 as needed.

When a body 12 is traveling over track the normal rocking of the body 12 is readily arrested by the side bearing assemblies with perhaps slight compression of the spring groups 22 supporting that end of the bolster 27 toward which the body 12 is swaying. Due to the yielding of the spring groups 22, the body 12 rebounds from the extreme tilted position and under certain conditions will swing over to tilt in the opposite direction and strike the side bearing assembly on the other side of the truck assembly 14 to produce a series of oscillations between the extreme positions of the body 12. As is known, a resiliently mounted body has a natural period of vibration associated with its mass, the position of its center of gravity, the resilient characteristics of the mounting member and the geometry of the whole system. In many instances the energy of the first tilting motion is absorbed in the internal and external friction of the various members involved, but when a body 12 is traveling along a track the energy of the first impulse provided by the rising of a pair of wheels on one side of the truck assembly 14 will initiate a rocking motion to the body 12 and such rocking motion is often augmented by a second impulse produced by the opposite pair of wheels 18 passing over a high portion of track at or near the time of the rebound from the first oscillation. Since such augmentation may well be much greater than the energy absorbed during the first swing, the second swing may well be more violent than the first. In an extreme case, a number of impulses occurring at intervals of time almost exactly equal to the period of oscillation of the body 12 will be added together to produce extreme and dangerous rocking of the body 12.

One preferred form of this invention as presently contemplated is shown in FIGS. 1–4 wherein a snubber is located in the position of one of the springs of the prior art spring groups 22. A typical prior art arrangement of the springs in a spring group 22 is shown in FIG. 3 with the snubber 2 replacing one of the springs and comprises seven large springs 4 and nine smaller springs 6 with each of the large springs 4 having a smaller spring 6 internally coaxial therewith to provide a maximum of spring force for the space available. In such conventional spring groups 22 three of the large springs 4 are located in a slightly outwardly curved row at the extreme outer end of the bolster 27 (only two being shown) and three other large springs 4 are located in a similar slightly oppositely curved row at the portion of the bolster 27 in juxtaposition with the inner side of the side frame 21. A single large spring 4 is located between the center springs 4 of the inner and outer rows and a pair of small springs 6 are located between the ends of the inner and outer rows of springs. As shown the center spring 4 and the spring 6 encompassed thereby of the outer row of springs 4 has been replaced by a spring group snubber 2. Although one typical prior art arrangement of springs 22 has been shown other prior art spring group arrangements are modifiable to incorporate the snubbers of this invention.

Snubber 2 (FIG. 4) extends vertically in use and comprises a bottom platen 3 having a substantially flat bottom surface supported upon a central area of the bottom portion 23 of the side frame 21. The upper surface of the platen 3 is substantially spherically concave on a large spherical radius and supports thereon a bottom end portion 5 of a lower member 7. Member 7 has a tubular cylinder portion 8 extending upwardly from the end 5 with the upper end thereof terminating in a ring shaped stop element having an inwardly extending stop portion 9. The bottom surface of end 5 is convexly spherical with a spherical radius substantially shorter than the radius of the upper surface of the platen 3, and cooperates with the upper surface of the platen 3 in a manner very similar to that described in U.S. Pat. No. 3,595,350. The upper portion of cylinder 8 is encompassed by the lower portion of a compression type helical spring 10 with the lower end of spring 10 being supported on an outwardly extending flange portion 11 of cylinder 8 having a suitable upwardly facing supporting surface engaged by the lower end of spring 10.

A top platen 13 having a substantially spherical concave bottom surface 15 of generally the same spherical radius as the spherical radius of platen 3 is biased into engagement with a downwardly facing outer area of the bolster 27 by the spring 10. Spring 10 has a free length such that when installed, by separating one end of the bolster 27 from the adjacent bottom portion 23 of the side frame 21 the maximum amount permitted by the interfitting of such parts, the compression of spring 10 will bias platens 3 and 13 into firm engagement with the opposed upwardly facing surfacing surface on the bottom portion 23 and the under surface of the end portion of the bolster 27, respectively. The outer periphery of platen 13 provides an outwardly and downwardly open notch 19 for receiving the upper end of spring 10 such that the spring 10 is retained coaxially with the central axis of the snubber 2.

Slidably received within the cylinder 8 is a formed hollow piston 302 having an upper end portion 304 which has a spherical convex upper surface of shorter radius than the bottom surface of the top platen 13 and related to that surface in the same manner as the two aforementioned spherical surfaces. End 304 is rigidly secured to a downwardly extending tubular side portion 306 which for the major axial extent thereof from the location thereof is closely telescopically received within the cylinder 8. With the snubber 2 in the collapsed position the lower end of side 306 engages an upper flat inner surface of the platen 5. The piston 302 is provided with axially spaced external circumferential grooves 305 and 307 upwardly adjacent the lower end thereof which grooves 305 and 307 are respectively suitably dimensioned to receive suitable sealing elements such as an O-ring 308 and a metallic piston ring 310 of a type well known in the art of hydraulic cylinder construction. Piston 302 has an integral partition portion 312 extending across the interior of the piston 302 axially inward from the lower end thereof which divides the interior of the piston 302 into an upper closed chamber portion or reservoir 314 and a lower open chamber portion 316.

Hydraulic communication between the reservoir 314 and the lower chamber 316 is through a central bore or passageway 318 centrally coaxial with the piston 302 and a plurality of smaller bores or passageways 319 circumferentially spaced on a common diameter of piston 302 and radially spaced from and parallel to passageway 318. Chamber 314 and 316 are substantially filled with a suitable hydraulic fluid and passage of fluid from the lower chamber 316 to the reservoir 314 is controlled by a ball valve 320 seated on a suitable seat at the upper end of passageway 318 which valve 320 is biased into engagement with the seat therefor by a compression type helical spring 322 interposed between the underside of the upper end 304 and the upper surface of the valve 320 to provide a high pressure check valve structure. Extending over and slightly beyond the bottom ends of the passageways 319 is a ring shaped flat valve 324 which is biased lightly against the area of the partition 312 adjacent the bottom ends of the passageways 319 by a slightly compressed helical compression spring 326. Spring 326 is supported by a suitable snap ring 327 and washer 328 mounted on a downward extension or center post 329 of the central portion of the partition 312 in a suitable snap ring groove or by other suitable removable connections. Passageway 318 extends upwardly through the post 329.

Radially outwardly of the ring valve 324 and interposed between the bottom surface of the partition 312 and the upper surface of the bottom end 5 is a pair of spring 330 applying a moderate upwardly biasing force on the piston 302 to cause the piston 302 to be extended from the cylinder 8 whenever the cooperable bolster end moves upwardly in a direction away from the portion 23 of the side frame 21. The amount of extension of the piston 302 from the cylinder 8 is limited by an external circumferential shoulder 332 extending outwardly of the side 306 which is engageable with the underside of the stop 9. After shoulder 332 engages the stop 9 further separation of the bolster 27 from the bottom portion 23 causes a gap, clearance or space 334 to occur (FIG. 1) between the top member 304 and the top platen 13 since spring 10 maintains the upper and lower platens in engagement with the opposed surfaces on the bolster 27 and the portion 23.

The vertical extent of the clearance 334 is such that the distance the spring groups 22 are compressed when supporting a loaded body 12 during travel over typical track profile which does not cause or result in severe or dangerous rocking is somewhat less than the vertical extent of the clearance 334 and the snubbers 2 are not activated during such travel. A typical clearance 334 dimension of three-sixteenths inch is sufficient to accommodate approximately 90 percent of all the permissible spring movements with a loaded body 12. Consequently the snubbing action of the embodiment is limited to cycles of spring movement where the motion of a loaded body 12 causes compression of a spring group 22 greater than the extent of clearance 334.

During the movement of a body 12 over railway tracks the top platens 13 move upwardly and downwardly with extension and compression of spring groups 22 and increase and decrease the vertical dimension of the clearances 334 without moving the pistons 302 within the cylinders 8 as long as the distance the spring groups 22 are axially compressed is not greater than the vertical extent of clearances 334. When either spring group 22 is axially compressed a distance greater than the clearance 334 the associated top platen 13 contacts the top member 304 of the associated piston 302 and forces the piston 302 downwardly into the cylinder 8. As the piston 302 begins to move downwardly within the cylinder 8 compression of the hydraulic fluid within the lower chamber 316 is initiated and, as the piston 302 continues its descent increases the pressure within the hydraulic fluid until a sufficient hydraulic force is effective upon the lower hydraulically effective area of valve 320 to overcome the bias of spring 322. When such hydraulic force is obtained in the lower chamber 316 the spring 322 is compressed and the valve 320 moved upwardly off the seat therefor at the upper end of passageway 318 and the pressurized hydraulic fluid flows from the lower chamber 316 through the passageway 318 into the reservoir 314. The given, specific or constant pressure of the hydraulic fluid at which the valve 320 moves upwardly is dependent upon the downward biasing force of the force of the spring 322 and the area of the valve 320 to which the hydraulic fluid is applied. At any time the pressure of the hydraulic fluid in chamber 316 falls below such constant pressure value the valve 320 is biased into engagement with the seat therefor.

Passageway 318 is preferably of a cross section to permit flow of pressurized hydraulic fluid therethrough from lower chamber 316 at a rate that the pressure of the hydraulic fluid remaining in the chamber 316 remains substantially constant during continued descent of the piston 302. Thus, this preferred embodiment is directed to a snubber for a railway car which is located in a spring group and is only operable when a given pressure is developed within a hydraulic fluid in a chamber of decreasing volume and, thereafter the hydraulic fluid within such chamber as the volume continues to decrease remains substantially at such specific or constant pressure. Accordingly, the cross-sectional area of passageway 318 is determined by the relative velocity of the piston 302 with relation to the cylinder 8 which occurs during movement of a loaded body 12 over a generally encountered or normal section of track. Further in such a constant pressure snubber the cross-sectional area of passageway 318 is of a magnitude to permit free flow of hydraulic fluid therethrough without incurring any viscous drop to any substantial degree and permit substantially all the pressure drop in the hydraulic fluid to occur in the passageway defined by the displaced valve 320. In practice a passageway 318 of three-sixteenths to one-half inch diameter has been satisfactory.

During the flow of pressurized hydraulic fluid into the reservoir 314 the passageway 318 functions as a submerged orifice and such flow causes a large portion of the energy required to pressurize the hydraulic fluid to be converted into heat. In order to obtain the desired flow of hydraulic fluid the fluid contained within the snubber 2 is of a quantity to provide a submerged orifice at the upper end of passageway 318 for all relative axial positions of the lower member 7 and the piston 302.

After the completion of any downward motion of the piston 314 and the end portion of the bolster 27 thereafter moves upwardly with respect to the top platen 13, the piston 314 thereafter moves upwardly due to the bias of springs 330. As the piston 314 moves upwardly the volume of the open chamber 316 increases and a slight decrease in pressure of the hydraulic fluid therein occurs so that passageway 318 is closed by valve 320. As the piston 314 continues to move upwardly the pressure of the hydraulic fluid within the lower chamber 316 becomes lower than the pressure of the hydraulic fluid within reservoir 314 and the pressure of the hydraulic fluid within the reservoir 314 is effective upon the top surface of the valve 324 to move the valve 324 downwardly away from the bottom ends of the passageways 319 and hydraulic fluid from the reservoir 314 flows into the lower chamber 316 to maintain the open chamber 316 full of hydraulic fluid for all relative positions of the lower member 7 and the piston 302 whereby the snubber 2 is in a position to again be operational as described upon any downward movement of the piston 302 occurring after the gap 334 has been traversed.

Snubbers 2 have a collapsed height which includes the height of the platens 3 and 13 equal to or preferably slightly less than the collapsed height of spring groups 22 so that the spring groups become solid before the snubbers 2 are fully collapsed whereby no further forces are applied to the snubbers 2, thus preventing damage from possible overstressing.

The use of snubbers 2 as described results in snubber force being additive with the closing force being applied to the spring group 22 in which the snubber 22 is located. Although the platens 3 and 13 are preferred either or both may be omitted in which event the end of the top member 304 engages the under surfaces of the end portions 17 of the bolsters 27 and the bottom surfaces of the bottom ends 5 engage the upper facing surfaces of support portions 23. With such modification the springs 10 of the snubbers are of a length to hold the ends of the snubbers firmly in engagement with such surfaces throughout the greatest separation of the end portions 17 from the bottom portions 23 and the surfaces engaged are preferably provided with spherical surfaces corresponding to the spherical surfaces or platens 3 and 13.

As indicated the typical clearance 334 of a loaded car is approximately three-sixteenths of an inch however when a car is unloaded the clearance 334 increases to about 1-11/16 inches due to the unloaded condition of the spring groups 22. With such unloaded condition clearance snubbing action does not occur until the end portions 17 of the bolster 27 move a distance greater than increased clearance. Such limiting of the snubbing action to potentially damaging cycles of spring excursion is a highly desirable feature since it greatly reduces wear and heat production of the snubber of this invention as compared to continuously acting snubbers. If desired, snubbers 2 can be utilized as described without a clearance 334 and in such event a snubbing force would be obtained upon all movements of the ends of the bolsters 27 towards the support portions 23. Although a standard truck assembly 14 has been shown and described a modified truck assembly 14 having longer springs 4 and 6 in the spring groups 22 is a desired alternate structure. In such alternate structure larger snubbers 3 are utilized and larger clearances 334 are obtainable.

FIGS. 5 and 6 illustrate another preferred embodiment in which like parts have been identified by like reference numerals. In this embodiment the spring groups 22 of the prior art described are utilized and snubbers 2 are located between the outer end portions 17 of the bolsters 27 and the upper portions 23 of the side frame 21. Bolster 27 is of any conventional structure and a known bolster 27 having a hollow rectangular end portion 17 with suitable internal bracing and external guide or retaining means is illustrated. The upper cross extending portion of the bolster 27 at each end portion 17 is provided with an opening 336 in alignment with the central spring 4 of the spring group 22 therebelow. The upper portion 335 of the side frame 21 is of known construction such and the inverted U-shaped member shown with the opening between the downwardly extending side portions thereof being vertically aligned with the opening 336. A snubber 2 extends vertically between an inner downwardly facing surface 338 on the upper bight portion of the upper portion 335 and the inner upwardly facing surface 340 of the lower cross member of the outer end portion 17 of the bolster 27 each side of each truck assembly 14. As installed the upper surface of the top platens 13 engage the inner downwardly facing surfaces of the upper portions 335 and the lower surfaces of the lower platens 3 engage the inner upwardly facing surfaces of the lower cross members of the end portion 17. Snubbers 2 are of the structure previously described; however, snubbers 2 in this embodiment are of an overall length to function upon movement in the same manner as previously described. In order to so function the length of the snubbers 2 can vary dependent upon the distance existing between the surfaces between which the ends of the snubbers 2 operates. Such distances are known for various prior art structures of side frames 21 and bolsters 27. As before, spring 10 has a free length such that when snubbers 2 are installed by separating the bolsters 27 from the upper portions 335, and the bolster 27 thereafter moves upwardly due to the force of the spring groups 22 and the bolster 27 is supported with the body 12 at rest, the platens 3 and 13 are biased into firm engagement with the surfaces 338 and 340, respectively, and a clearance 334, typically of three-sixteenths inch, is provided between the upper surface of top member 304 and the lower surface of the top platen 13 which clearance 334 is sufficient to accommodate approximately 90 percent of the spring movements of a loaded railway car. The operation of the snubbers 2 located above the spring groups 22 is the same as previously described; however, the energy input to the snubbers 2 is different due to locating the snubbers 2 above the spring groups 22. In this embodiment the snubbers 2 operate in series with the spring groups 22, respectively, during the periods the spring groups 22 are extending, that is, the period any one spring group 22 is rebounding and releasing the energy stored therein during the prior period of compression thereof due to the movement of the bolster end portion 17 towards the bottom portion 23 causing compression of the spring group 22 therebetween. For the same reasons previously stated the clearance 334 when a body 12 is fully loaded permits the spring groups 22 to extend a distance equal to that of the clearance 334 without causing the snubbers 2 to operate to absorb the rebound energy. When the spring groups 22 move the end portions 17 of the bolster 27 upwardly a distance greater than the clearance 334 of the snubbers 2 are subjected to a compression force whereby energy is absorbed as previously described. In such operation the extending spring groups 22 remain in engagement with the lower surface of the end portion 17 of the bolster 27 and the movement of the bolster 27 towards the upper cross portion 335 after the clearance 334 has been traversed causes compression of the snubbers.

In this embodiment the snubbers 2 result in the snubber force being applied to dissipate the rebound or extension energy of a spring group 22; that is, the snubbing force is a constant pressure force which retards the extension of a spring group 22 and which snubbing force is opposed to the extension force. Further the modifications previously mentioned regarding snubbers 2 are applicable to this embodiment. In this embodiment the increase in clearance 334 for unload bodies 12, as previously described, is not obtained and when bodies are unloaded the snubbers 2 are effective at all times.

Although preferred embodiments have been heretofore described the principles of this invention can also be employed in other type of snubbers or at other locations of a railway car at which snubbing action is desired. Further although the previously described embodiments have been designated as preferred embodiments it is quite possible that some of the hereinafter described embodiments will in fact be the preferred embodiments dependent upon experience gained over periods of actual use.

FIGS. 7 to 10 illustrate another type of snubber 26 of this invention. In this embodiment prior art spring groups such as spring groups 22 are utilized and the snubbers 26 are cooperable with the spaced roller bearings 28 mounted in channel sections 29 secured to the truck bolster 27 intermediate the spring groups 22 and the center plate 24, respectively, in each truck assembly 14. Snubbers 26 are secured to suitable structural supports 33 depending downwardly in alignment with the bearings 28, respectively, with the lower surface 34 of each snubber 26 constituting a bearing plate. A clearance space is preferably provided between the bearing plates and the roller bearings 28 cooperable therewith, respectively, and roller bearings 28 are adapted to roll on cam surfaces 31 formed on the lower surfaces of channel sections 29, as best shown in FIG. 9. The clearance between the lower surfaces 34 and the rollers 28 permit the truck assemblies 14 to negotiate small profile differences between the two supporting rails therefor with only minor motion influence on the body 12.

Each snubber 26 (FIG. 10) includes an upper body member 38 suitably rigidly secured to a support 33 which is normally upwardly spaced from a lower body member 40 having the lower surface 34 previously identified. The upper member 38 has a centrally located upwardly extending threaded bore 62 and the lower member 40 has a central through bore vertically aligned with the bore 62. Suitable fastening means such as a cap screw 66 extends through the central bore 64 and is threadedly engaged with the threaded bore 62 to provide means to limit the upper and lower members 38 and 40 from separating from each other but which allows members 38 and 40 to move together under compressive forces. A cap 68 is threaded into the outer threaded end of the bore 64 to prevent fluid from escaping from a chamber 52 through the bore 64.

Opposed surfaces of members 38 and 40 define opposite vertically located ends of a chamber 52 therebetween with the lower member 40 having an inwardly extending annular upwardly open portion formed therein outwardly adjacent the central portion thereof through which screw 66 extends. The outer peripheral portion of chamber 52 is formed by the inner surface of an integral upwardly extending annular flange portion 48 on the outer portion of member 40. An annular ring 54 is located within chamber 52 which has a vertically extending outer surface located throughout the length thereof closely adjacent the inner surface of flange 48 to form an elongated open-ended passageway 70 therebetween. The central opening of ring 54 is located to permit the central upwardly extending portion of member 40 to travel therewithin during movement of the members 38 and 40 towards each other as hereinafter described. As shown, the upper edge of flange 48 is generally horizontally aligned with the central portion of the lower surface of the upper member 38 when the snubber 26 is not subjected to compressive forces. Ring 54 has a downwardly facing surface of a configuration to be freely received within the annular portion of cavity 52 and an upper flat surface which is biased towards or into engagement with the lower surface of member 38 by a plurality of suitable biasing means such as springs 58. As shown, a plurality of circumferentially-spaced downwardly open blind bores 56 extend upwardly in the annular ring 54, with the upper ends of springs 58 being received therein, respectively. Springs 58 extend downwardly beyond bores 56 with their lower ends engaging the upwardly facing inner surface of the annular portion of cavity 52 of lower body member 40. An O-ring 60 is desirably employed on the upper portion of ring 54 to provide a seal between the annular ring 54 and the lower surface of the upper member 38 when such members are engaged.

A fluid casing or reservoir 36 is provided which encompasses the annular opening between the upper end of flange 48 and the portion of member 38 opposed therefrom in all relative positions of the members 38 and 40. As shown, reservoir 36 is of U-shaped cross section with the sidewalls or arms thereof extending generally horizontally with the outer ends thereof being received in suitable vertically spaced cooperable portions on the members 38 and 40. The upper and lower inwardly extending sidewalls of the reservoir 36 extend along slightly convergent lines outwardly from the center of the snubber 26 such that the sidewalls, combined with a given radial dimension and a particular wall thickness, control the stress magnitude and establishes the proper spring constant to separate the members 38 and 40 at a desired rate with the approximate size and geometry of the unit shown in FIG. 10. A slope of approximately 5° to the horizontal has been found to be satisfactory. For such purposes reservoir 36 is formed of a suitable flexible material such as steel and the outer ends of the arms are preferably sealed to the members 38 and 40 by suitable sealing means, such as O-rings 42 and 44 respectively. Prior to use each snubber 26 is substantially filled with a suitable liquid, hydraulic fluid or oil 65 such that the oil level 67 in the reservoir is above the upper end of passageway 70 in all relative positions of the members 38 and 40.

With snubbers 26 supported on supports 33 at each end of each bolster 27, as a car body 12 travels over supporting tracks as are generally encountered the rocking motion of the body 12 does not cause any operations of the snubbers 26 inasmuch as the surfaces 34 do not contact the rollers 28. Under more severe conditions which cause a body 12 to rock the snubbers 26 are effective to damp such rocking movement after the snubbers 26 have traversed the clearance distance between the surfaces 34 and the rollers 28 and engage the rollers 28. When surface 34 of any snubber 26 engages a roller 28 the member 40 is restrained by the roller 28 in engagement therewith and further movement of such snubber 26 towards such engaged roller 28 forces the upper members 38 with ring 54 in engagement therewith towards the lower member 40 and the ring 54 descends further downwardly into cavity 52. Inasmuch as the rollers 28 are supported by bolsters 27 which are supported by spring groups 22 the movement of ring 54 into cavity 52 is dependent upon the relative motion of the bolster 27 with respect to the body 12. Such movement of the ring 54 into the cavity 52 exerts a compressive force upon the fluid contained within cavity 52 and, since liquids are incompressible and passageway 70 is open ended, forces pressurized fluid from the cavity 52 through passageway 70 into reservoir 36. Thus, the application of a compressive force to a snubber 26 dissipates the energy input thereto by flow of hydraulic fluid through a restricted passageway. During such restricted flow of pressurized fluid a large amount of energy applied to a snubber 26 is converted to heat and dissipated to the surrounding ambient air or the heat conducting means to which the snubbers 26 are connected and in particular to the lower portion of the body 12 which constitutes a heat sink. In addition, in order to obtain large energy dissipation, the passageway 70 is of a length and cross section to obtain a large pressure drop during flow of pressurized fluid therethrough at a given rate. Under extreme conditions of rocking motion such a pressure drop is of a magnitude varying between 3,000 to 5,000 pounds per square inch; however, other pressure drops can be obtained as desired. Since heat energy is dissipated during operation of a snubber 26 the components of snubbers 26 are subjected to thermal expansion and it is preferable that the pressure drop obtained in snubber 26 be substantially constant regardless of the operating temperature thereof or the viscosity of the hydraulic fluid. Consequently ring 54 is preferably formed of a material, such as brass or aluminum, having a higher coefficient of thermal expansion than that of member 40 to maintain the flow of fluid through passageway 70 to obtain the same pressure drop notwithstanding the decrease in viscosity of the fluid due to the heating thereof occurring during operation of a snubber 26. Also since the viscosity of a hydraulic fluid decreases with increased temperature a slight decrease of the cross section of passageway 70 is desirable to compensate for such decreased viscosity.

With a lower member 40 engaged by a roller 28 relative movement of upper member 38 with respect to member 40 will continue as long as the body 12 continues to have relative movement towards the engaged roller 28. Under full compression of members 38 and 40 the upper end of flange 48 engages the upwardly adjacent downwardly facing surface of the upper member 40 at which time snubbers 26 no longer are effective to absorb energy. Consequently, snubbers 26 are designed with relation to the maximum loads which are applied thereto to absorb a maximum amount of energy during their compression stroke which is less than the force which causes fatiguing or structural failure of the components of the snubbers 26 or side frames.

After the completion of a compression stroke of a snubber 26 and regardless of the extent thereof, relative movement of the body 12 subsequently occurs away from the previously engaged roller 28 such that the member 38 moves relatively upwardly with the body 12 away from the lower member 40. When the body 12 initially has relative motion away from a roller 28 engaged by a member 40, the sidewalls of the reservoir 36 bias the members 38 and 40 away from each other until there has been sufficient relative movement of the body 12 to permit the members 38 and 40 to be fully extended from each other. Thus, the lower member 40 can remain in engagement with a roller 28 for a period even though the body 12 has relative movement away from such roller 28. Also, during the prior compression stroke of a snubber 26 the springs 58 are compressed and capable of reextending upon upward movement of member 38. During upward movement of member 38 relative to member 40 the pressure of the fluid within the cavity 52 decreases constantly and the fluid within reservoir 36 is effective upon the upwardly facing outer peripheral portion of ring 54, which is at a relatively higher pressure, to bias the ring 54 downwardly. In order to provide a sufficient area of ring 54 for the hydraulic fluid in reservoir 36 to be hydraulically effective thereon, a downwardly and outwardly open circumferential recess is provided at the lower outer portion of member 38 to permit flow of fluid from the reservoir 36 over the upwardly facing outer peripheral portion of ring 54. The downwardly facing portion of such recess is spaced upwardly from the upper end of flange 48 and limits the movement of the members 38 and 40 toward each other. Thus, when there is no relative movement between member 38 and 40 or during upward movement of member 38 relative to member 40 opposed forces are effective upon ring 54, and for this invention the springs 58 provide an upward bias on ring 54 which is less than the hydraulic force biasing ring 54 downwardly. Consequently, when member 38 starts upward movement relative to member 40 the ring 54 is biased away from the upper member 38 and hydraulic fluid flows from the reservoir 36 over the top of ring 54 through the center thereof into the cavity 52 to maintain the cavity 52 full of fluid during such upward movement of member 38. Separation of the ring 54 from member 38 establishes communication of the entire periphery of cavity 52 to reservoir 36 to obtain rapid return flow of fluid into cavity 52. In addition, during relative movement of member 38 away from member 40 a certain viscous drag is developed between the ring 54 and flange 48 due to fluid in passageway 70 which also retards the upward movement of ring 54.

In filling the snubber 26 with fluid a quantity of air exists above the level 67 which is retained at atmospheric or slightly higher pressure to provide a positive pressure within the reservoir 36. When ring 54 separates from member 38, as heretofore described, a faster rate of return flow of fluid is obtained when a pressure greater than atmospheric pressure exists above level 67 than when atmospheric pressure exists above the level 67. In order to prevent a pressure less than atmospheric from existing above level 67 a suitable check valve 37 is located in the upper sidewall of reservoir 36 which permits air to pass therethrough into the reservoir 36 above the level 67 and which prevents reverse flow of air out of reservoir 36. If desired, suitable valve means can be provided in the upper sidewall of reservoir 36 to limit the pressure of the above level 67.

Annular flange 48 preferably has a strength such that pressures higher than desired in chamber 52 are prevented by expansion of the flange 48, under pressure, slightly increasing the size of the passage 70 to prevent increase in the pressure drop therethrough. Such construction permits the snubber to respond at a more or less constant force.

Thus, snubbers 26 are of a structure to provide an unidirectional resistance to motion which absorb energy throughout their entire compression stroke. Further, although a clearance between the wear plates 34 and rollers 28 is preferred, the snubbers 26 are equally suited to absorb energy upon initial movement of members 37 and 40 towards each other. Thus, if desired, the wear plates 34 can be located in engagement with rollers 28 such that any movement of the bolsters 27 towards the body 12 will cause the members 38 and 40 to move towards each other and be effective immediately to absorb energy. If further desired the snubbers 26 can be preloaded by compressing the snubbers 26 a distance such that the wear plates 34 engage the rollers 28 and the members 40 are displaced, with respect to the spacing of members 40 from members 38 previously described, towards the members 38. For such purposes rings 54 can be displaced up to one half of the distance through which they travel. With such preloading the snubbers 26 are effective throughout the entire relative motion between the body 12 and the bolster 27 and immediately effective to absorb energy when members 38 and 40 are moved towards each other.

With reference now to FIG. 11, an alternative embodiment of the invention is shown in which a reservoir 36′ similar to reservoir 36 is formed from upper and lower halves, the upper half being an integral part of an upper member 38′ and the lower half being an integral part of the lower member 40′. (Like parts having the same reference numerals and similar parts having the same number primed). In this embodiment the lower body member 40′ has an annular flange 48′ and a raised center section 50′ defining the lower surface a fluid cavity 52′. Likewise, an annular ring 54′ having a higher thermal coefficient of expansion than the surrounding parts projects into the fluid cavity 52′ and is biased upwardly into engagement with the underside of member 38′ by coil springs 58′. O-ring 60′ seals the annular rings 54′ against the upper body member 38′ and the member 38′ has a centrally located threaded bore 62′ which receives the threaded end of a cap screw 66′ extending through a central bore 64′ in the lower member 40′. Cap 68′ is threaded into the lower end of bore 64′.

Secured to the upper surface of member 38′ is a plate 71 which, for example, is connected to support 33 shown in FIG. 7. A second plate 72 is secured to the lower member 40′ and has a lower bearing surface 34′ adapted to contact the bearings 28.

Annular casing 36′ is formed from upper and lower halves formed integrally with the members 38′ and 40′, respectively. Thus, the upper half of the annular casing 36′ comprises a circular plate 74 formed integrally with the member 38′ and extending outwardly therefrom in cantilever beam relationship. Depending downwardly from the edge of the circular plate 74, and formed integrally therewith, is a cylindrical flange 76. In a similar manner, a circular plate 78 is formed integrally with the lower member 40′ and is provided with an upwardly projecting cylindrical flange 80 arranged to abut the edge of flange 76 as at 82. An O-ring seal 84 is interposed between the mating surfaces of the flanges 78 and 80. The entire upper assembly comprising member 38′, plate 74 and flange 76 is secured to the entire lower assembly comprising member 40′, plate 78 and flange 80 by suitable means such as bolts 86. As shown, each bolt 86 passes through an opening in a boss 88 which is welded or otherwise securely fastened to the upper flange 76, and is threaded into a cooperating boss 90 welded or otherwise securely fastened to the lower annular flange 80.

The device shown in FIG. 11 operates as before described however the ring 54′ has a tapered outer surface ending in portion of a spherical surface on the lower edge thereof which is of a curvature to maintain the annular dimension of the passage between the ring 54′ and the flange 48′ substantially unchanged even though the ring 54′ is tipped about a diameter thereof in relation to the annular flange 48′.

FIG. 12 illustrates an alternative arrangement wherein the snubbers 26 are mounted on, and carried by, the truck bolsters 27. The channel sections 29 and roller bearings 28 are, in turn, carried on the upper members 38, the bearings 28 being arranged to contact bearing plates 88 mounted on the lower surface of supports 33 in alignment therewith. The operation of the invention in this case is, of course, similar to that previously described with the exception that the snubbers 26 are carried by the bolsters 27. Also, if desired a clearance space between the rollers 28 and the bearing plates 88 can be provided to obtain other operation of the snubbers 26 as previously described.

For a description of still other embodiments of snubbers operable according to the principles of the present invention reference is hereby made to my hereinabove copending application Ser. No. 801,884.

As heretofore described some snubbers of this invention include clearance spaces to permit limited movement of the members with which they are cooperable without absorption of energy. Also described, some snubbers of this invention are preloaded to be immediately effective to absorb energy upon relative movement of the members with which such snubbers are cooperable. In addition other embodiments of this invention are located between members having relative movement in the manner as such preloaded snubbers and in addition are provided with integral means to permit limited movement of the members in the manner as such clearance spares. Thus other preferred embodiments of this invention are shown in additional FIGS. 13 to 18.

FIGS. 13 and 14 illustrate a freight car truck having four wheels 412 adapted to rest upon rails (not shown) and mounted in pairs on two car axles 414 rotatably mounted in and supporting a pair of side frame 416 in a manner well known in the art. A set of truck springs 419 in each side frame, respectively, support one end of an elongated bolster 418 extending from the interior of one side frame 416 to the interior of the other side frame 416. A freight car body 420, partially shown in section, has a centrally located downwardly depending center plate 422 mounted for limited rotation and rocking motion on a suitable flat center portion 424 of the bolster 418 to support the weight of the car body and load therein. A pair of brackets 426 downwardly depending from portions of the car frame, equally transversely spaced on either side of the center plate 422, carry on their bottom surfaces wear plates 427 slightly upwardly spaced from a pair of side bearings assemblies 428 with a side bearing clearance 429 provided between the bearing assemblies 428 and the wear plates 427 to provide for a slight amount of rocking motion between the car body 420 and the bolster 418 without activating the springs 419 as is well known. Located above and resting upon the spring set 419 are flattened end portions of the bolster 418 of a generally rectangular shape having a solid bottom elements 432 and a top element 434 upwardly spaced therefrom and having therein a centrally located recess or bore.

Each side frame 416 comprises a pair of formed vertically extending horizontally spacedside elements 440 usually made integral with and joined together by a top element 442 which extends over and is spaced upwardly from the respective end portion of the bolster 418 supported by a particular side frame 416. Centrally located in the top element 442 is a bore 444 (best seen in FIG. 15) in which is rigidly secured as by welding a flanged mounting element 446 having its flange located within and contacting the bottom surface of the top element 442 for a purpose to be described. Centrally located in its bottom surface the mounting element 446 is provided with a shallow blind bore 447 within which is received the end portion of an elongated cylindrical piston rod 448 of a snubber assembly 450 constructed according to the principles of this invention. The snubber assembly 450 further comprises a solid bottom elongated, hollow cylindrical body member 452 having a cylindrical inner surface 453 and slidably mounted therein a cylindrical piston element 454 completely surrounding and rigidly secured to the bottom end of the piston rod 448 which extends upwardly through and is slidably received in a disk-like closure element 456 suitably removably mounted in the top end of the cylinder 453 as by suitable snap rings 457 and maintained in fluid tight relationship with the cylinder 453 and the piston rod 448 by resilient members such as O-rings 458 and 459, respectively. In a radially intermediate portion of the closure element 56 there is a plurality of stepped bores 60 (only one of which is shown) extending downwardly through the closure element 456 with its larger portion beginning at the upper surface of the element 456 and continuing downwardly for nearly the whole thickness of the element 456 with a shorter small portion extending through the bottom surface of the closure element 456. A flattened ring shaped resilient valve element 462 suitably mounted in a groove in a downwardly extending central portion of the closure element 456 covers the bottom ends of the bores 60 to provide check valve action between the ambient atmosphere and the interior of the cylinder 453 so that ambient pressure higher than the pressure between elements 456 and 454 can cause air to flow through the bores 460 into the interior of the cylinder 453. Within the bores 460 in the enlarged portion there are suitable porous filter elements 463 through which air entering the cylinder 453 must pass, thereby preventing the introduction of dust or other solid particles into the cylinder 453.

In a radially intermediate portion of the piston element 454 there is provided a plurality of stepped cylindrical bores 465 extending downwardly through the piston element 454 and having a shoulder 466 in an axially intermediate portion of the bores 465 marking the transition between the enlarged upper portion and the smaller lower portion of the bore 465 while providing a seat for a valve spring 468 which is slightly compressed between the shoulders 466 and a three legged spider type spring retainer 470 which is in turn rigidly removably secured by a bolt or cap screw 471 to the upper end of a hollow cylindrical spacer 472 extending downwardly through the bore 465 to a ring type valve element 474 rigidly removably secured to the bottom ends of the cap screws 471 extending through spacers 472 similarly mounted in all of the bores 465. It is to be noted that the springs 468 are of suitable design to provide a total amount of upward bias on the valve element 474 only slightly greater than the weight of the element 474 for a purpose more readily apparent upon consideration of the description of the operation of this device as hereinafter set forth.

The piston element 454 also contains a central bore 476 extending upwardly therethrough in communication with an enlarged central bore portion 478 in which is rigidly secured the bottom end of the piston rod 448. Smaller substantially radial bores 480 communicate between the enlarged portion 478 and some of the radially intermediate bores 465 to allow the passage of fluid from the bottom portion of the cylinder 453 upwardly through the bore 476, the enlarged bore portion 478, the radial bores 480, and the radially intermediate bores 465 to the upper side of the piston element 454 under conditions to be described.

The piston rod 448 has a stepped axial bore with variously sized portions extending downwardly from its upper surface through the lower end of the piston rod 448 and having in an enlarged portion 483 of the bore 482, a pair of metal balls spaced apart and biased in opposite directions by a valve spring 484 applying a downward force to the lower ball 486 acting as a check valve in conjunction with the central bore 476 by maintaining the bore 476 in a closed condition until a predetermined amount of pressure has been developed in the lower portion of the cylinder 453 which is enough to compress the spring 484 and develop an orifice between the lower ball 486 and the edges of central bore 476. The upper ball 488 forms a seat for the upper end of the spring 484 and is adjustably maintained in position by two locking set screws, 490, 492 in the small upper portion of the bore 482 and adjustably threadedly positioned in bore 482 so that adjusting screw 490 downwardly increases the force of the spring 484 and upwardly decreases the same spring force if desired.

Since the upper portion of the cylinder 453 will never be subjected to high pressure in contradistinction to the high pressures which will be developed in the lower portion of the cylinder 453 the wall thickness of the body 452 is reduced in its upper portion by an amount substantially equal to the wire diameter of the snubber return spring 494 surrounding the small diameter portion of the body member 452, seated upon the shoulder 493 formed by the transition from the large diameter portion of the body member 452 to its smaller diameter portion. The spring 494 extends upwardly from the shoulder 493 to a seating surface within an inverted cup-shaped piston rod cap 495 mounted about a portion of the piston rod 448 downwardly adjacent its upper end and maintained in this position as by a suitable snap ring 496.

The bottom end of the body member is formed with a downwardly extending cylindrical center portion 497 freely received within the central bore of a ring shaped bolster mounting element 498 suitably secured in the central portion of the bottom element 432 of the bolster 418 so that the snubber assembly 450 extends between the bottom element 432 of the bolster 418 and the top element 442 of the side frame 416. The snubber assembly 450 is maintained in constant contact with the bolster 418 and the snubber 416 by action of the snubber return spring 494 which is designed to provide enough force to move the piston 454 rapidly upwardly even against slight pressure differential as hereinafter described. It is to be noted that in this embodiment the piston element 454 is maintained in fluid tight contact with the cylindrical surface 453 by resilient piston ring structure such as the O ring 499.

Operation of the snubber assembly 450 is as follows: When the car body 420 rocks over to the right, as seen in FIG. 13, the right hand side bearing bracket 426 will strike the side bearing 428 on the right hand end of the bolster 418 forcing that end of the bolster 418 downward, compressing the right hand truck springs 419. Since the side frame 416 is solidly supported by the wheels it will be maintained at a fixed height above the rails and the snubber 450 will lengthen to maintain contact between the bolster 418 and the side frame 416. Lengthening of the snubber 450 is caused by the snubber spring 494 pushing upward on the piston rod 495 and lifting the piston 454 relative to the cylinder 453. As the piston 454 begins to rise, the pressure in the upper portion of the cylinder 453 is increased while pressure in the lower portion is decreased. The pressure differential acting on the piston valve ring 474 compresses the valve springs 468, lowers the valve ring 474 and opens the piston passageways 465 (as shown in FIG. 16) allowing fluid to be displaced from the upper cylinder portion to the lower portion.

Suitable dimensions have been chosen for piston rod 448 and cylinder 452 so that the truck springs 419 will bottom out (become solid) before the top of the piston 454 comes in contact with the cylinder closure element 456. The relative amounts of air and liquid in the cylinder are such that when the piston is at maximum operating extension or height the level of liquid in the cylinder 452 is above the bottom of piston 454 so that the space below the piston is always completely filled with liquid during operation.

When the car body 420 rebounds toward the left, the right hand bolster end will begin to rise exerting pressure to shorten the right hand snubber 450. Shortening the snubber 450 results in increased pressure in the lower cylinder portion and decreased pressure in the upper cylinder portion. This pressure differential added to the force of the piston valve springs 468 holds the piston valve ring 474 tightly closed (as seen in FIG. 15) while the piston O-ring 498 prevents fluid flow between the periphery of the piston 454 and the cylinder wall 453. The fluid in the lower cylinder portion can only flow upward through the central piston bore 476 at a pressure high enough to compress the valve spring 484 and open the valve 486 whereupon fluid is forced through the opening between the valve 486 and seat under high pressure with consequent energy absorption and slowing of the bolster rebound rate. The snubber assembly 450 is of the constant pressure (or pressure relief) type and is purely motion sensitive as distinct from the velocity sensitive viscous type hereinafter described.

As in conventional snubber action large amounts of energy are absorbed in hydraulic friction and, with such action available at the two ends of the bolster alternately or simultaneously, damping the rythmic swaying of the car body 420 at slow speeds is effected.

When a railway car is traveling along a track at higher speeds the wheels respond vertically to uneven track and move up and down at a rate too rapid for the car body to follow, causing rapid compression and expansion of the truck springs 419 and concomitant rapid lengthing and shortening of the snubber 450 on both bolster ends. If large pressures were allowed to develop in the snubber 450 with repeated squirts of fluid through the orifices formed by the valves 486, a large amount of energy would be absorbed with consequent undesirable heating of the fluid and snubber parts resulting in possible early snubber failure, breakdown of the fluid with foaming and other deleterious effects. To avoid such effects the design of the snubber of this invention provides "dead band" operation according to the following description.

When at high car speed a high point in the rail causes the side frame 416 to rise allowing the snubber 450 to length rapidly the piston 454 starts to move in an upward direction very suddenly, the sudden upward acceleration of the piston 454, inertia of the piston valve 474 and viscous drag between the valve 474 and the cylinder wall 453, acting upon the low bias valve springs 468, cause the valve 474 to lag behind the piston motion (assuming the position shown in FIG. 15). The piston passageways 465 are momentarily open for fluid flow therethrough in either direction. When the piston 454 moves downward immediately after having suddenly moved upward, the piston passageways 465 will be open and fluid will flow freely therethrough with little energy absorption. In this manner "dead band" operation provides for extremely low energy absorption during rapid relative piston-cylinder motion with a minimum amount of heating and other deleterious effects. However, as soon as the car speed is reduced, the snubbers 450 are in condition to resume the energy absorbing mode of operation earlier described.

FIGS. 16 and 17 of the drawings illustrate a second embodiment of the principles of this invention wherein structural elements which are the same as those shown in FIGS. 13 through 15 are designated by the same reference numerals, respectively, as heretofore applied while structural elements similar to, but differing slightly from those of the earlier description are indicated by the same reference numerals primed. THe embodiment of FIGS. 16 and 17 is generally indicated as the snubber assembly 450′ comprising a cylindrical body member 452′ having an inner cylindrical surface 453′ in which is mounted for upward or downward motion a piston element 454′ which is the same as that piston element 454 best seen in FIG. 15 excepting only that the O-ring 498 and the groove therefor have been eliminated in the piston element 454′. The cylindrical surface 453′ slidably receiving the piston element 454′ is the same as the cylindrical surface 453 except for the provision of one or more tapered grooves 500 in the cylindrical surface 453′ and shown in FIG. 17 to be of triangular cross section with the apex of the triangle directed radially outwardly from the surface 453′ and the large end of the groove spaced downwardly from the closure element 456 but upwardly from the top of the piston 454′ at normal static height, while the remainder of the groove tapers downwardly to a point spaced upwardly from the bottom of the cylinder 452′ at which point the groove 500 runs out to zero dimension and the cylindrical surface 453′ becomes smooth.

It is to be noted that the larger diameter portion of the cylinder 452′ is formed with circumferential grooves 502 in its outer surface to provide more heat transfer area exposed to the ambient air. If desired, such grooves can be applied to any of the embodiments of this invention herein described.

The operation of the embodiment of FIGS. 16 and 17 is quite similar to that described for the embodiment of FIGS. 13 through 15 with the following differences. With the snubber assembly 450′ having the grooves 500 in the cylindrical surface 453′ the orifice between the central bore 476 and the lower ball 486 is supplemented by an orifice between the peripheries of the piston 454' and the cylindrical surface 453' to aid in the energy absorbing action of high pressure hydraulic fluid flow. Furthermore, the snubber assembly 450' is position sensitive in that, when the truck springs 419 are in their normal static position or compressed from that position, the piston 454' will be in the position shown in FIG. 16 with the piston 454' surrounded by the grooves 500, extending above the piston 454' and producing an enlarged orifice with little opportunity for energy absorption. However, when the truck springs 419 expand upwardly in rebound action the rising of the bolster end 418 will shorten the snubber assembly 450' so that piston 454' is active in the lower portion of the cylinder 453' where the grooves 500 are very small or non-existent and, in this position, which represents the upper portion of the rebound action by the truck spring 419, the snubber assembly will have almost the same energy absorption characteristics as the earlier described snubber assembly 450. However, in this case the damping force retarding the motion is of the viscous type (velocity sensitive) until pressures in 453 are developed sufficiently to raise check valve ball 486 and permit additional flow through bore 476.

It can be shown that the bolster and side frame relative velocities are considerably higher for purely vertical oscillations than for rocking motion. Since rapid vertical motion at high car speeds takes place almost entirely with the springs 419 in normal static loading position or only slightly compressed, the action of the snubber assembly 450' during this mode of operation will almost entirely take place with the piston 454' at or near the position shown in FIG. 16 with maximum effect of the grooves 500 still further reducing the energy absorption characteristics of the snubber assembly 450' beyond that provided by the dead band operation associated with sudden motions of the piston 454' as described with relation to the piston 454. The advantage of the grooves cylindrical surface design of the piston assembly 450' thus resides in the addition of position sensitivity to the motion sensitivity of the originally described snubber assembly 450. While the elimination of the O-rings 498 and formation of an orifice between the piston 452' and the cylinder wall 453' adds a portion of velocity sensitive operation to the original constant pressure type of operation.

FIG. 18 illustrates a snubber of the present invention similar to the embodiment described in FIGS. 13–15 with the primary distinction therebetween being the elimination of the spring 468 which is, in this embodiment, replaced by elongated leg portions of a spider type spacer element 420 very similar to the spring retainer 470 of the earlier described embodiment exception only that the spacer element 420 has elongated leg portions extending downwardly therefrom to engage a shoulder 466' intermediate the length of bores 465' to limit the amount of free motion between the valve 474 and the piston 454''.

With the elimination of the springs 468 as shown in FIG. 18 the valve 474 will, of course, remain open at all times except when the piston 454'' is moving downwardly. When the piston 454'' moves downwardly for a substantial distance the movement of hydraulic liquid through the space between the ring 474 and the lowest portion of the piston 454' will produce viscous drag to cause the ring 474 to close and provide the snubbing action desired. However, such closing of the valve 474 will not take place when very small motions of the piston take place so that in the above described high speed operation of the car the small rapid motions of the piston will not close the valve 474 on the bores 465 and the required dead band operation will thus be produced as occurred with the springs 468 in place as in the earlier embodiments.

It is to be noted that various modes of operation suitable for various conditions of car weight, train speed, track profile and ambient temperatures can be met by the use of valve springs 468 of different stiffness than those described for the first embodiment. Under some conditions the springs 468 being much stiffer than those described while under other conditions the springs 468 will be so light that they approach the effect of no spring at all as described for the embodiment of FIG. 18.

It is to be realized that although the structures for obtaining dead band operation, hereinabove described, all incorporate passageways through the piston, and a piston mounted valve, such structures are not necessary to the application of the principles of this invention. Any suitable structure allowing free flow through, around or by-passing, the piston for the first half inch of piston motion in either direction followed by forcibly restricted flow for further downward piston motion and unrestricted or nearly free flow for upward motion will apply the principles of dead band operation hereinabove set forth.

Such arrangements may be position sensitive, acceleration sensitive, rate of motion sensitive, or responsive to the duration of motion in a particular direction and can physically include time delay valves and external reservoirs or passageways.

Preferred embodiments of this invention having hereinbefore been described and shown it is to be realized that variations in these embodiments can be introduced without departing from the principle of this invention. It is therefore respectively requested that this invention be interpreted as broadly as possible and limited only by the claims appended hereto.

What is claimed is:

1. The method of damping relative movement between portions of a railway car structure comprising: maintaining a closed hydraulic system having relatively movable spaced portions between components of a railway car structure having repeated relative movement towards and away from each other by supporting one of said spaced portions on one of said components with the other of said spaced portions being moved towards said one spaced portion by the other of said components during movement of said components towards each other; maintaining a chamber between said spaced portions full of hydraulic fluid; restricting flow of hydraulic fluid from said chamber to another portion of said system upon relative movement of said spaced portions during which the pressure of the hydraulic fluid in said chamber increases; and maintaining said chamber full of hydraulic fluid by substantially unrestricted flow of the hydraulic fluid from said another portion of said system during relative movement of said spaced portions away from each other occurring subsequent to each movement of said spaced portions during which the pressure of the hydraulic fluid increased.

2. The method as defined in claim 1 wherein said restricting flow is initiated after the hydraulic fluid in said chamber is at a given pressure and continues thereafter at substantially said given pressure.

3. The method as defined in claim 1 additionally including dissipating at least a major portion of the heat generated during said restricted flow through at least a portion of a car body portion of said car structure.

4. A method as defined in claim 1 including maintaining continuous engagement of said other spaced portion with said other of said components.

5. The method as defined in claim 1 including maintaining a space between said other spaced portions and said other of said components when said components are in a normal relative position.

6. The method as defined in claim 1 wherein said restricting is of the flow of hydraulic fluid from said chamber to a hydraulic fluid reservoir maintained transversely of said chamber.

7. The method of damping relative movement between portions of a railway car structure comprising: maintaining a closed hydraulic energy absorbing system having relatively movable spaced portions between components of a railway car structure having repeated relative movement towards and away from each other by supporting one of said spaced portions on one of said components with the other of said spaced portions being moved towards said one spaced portion by the other of said components during movement of said components towards each other; absorbing energy created by said components movement by said system, during said absorbing heat energy is generated by said system; and dissipating at least a major portion of said heat energy generated through a path including a car body of said car structure.

8. The method of damping relative movement between a railway car body and the supporting wheeled trucks therefor comprising, maintaining a closed hydraulic system between structural parts of a railway car body and the supporting trucks therefor having cyclic relative movement towards and away from each other by supporting one of relatively movable spaced portions of said system on one of said structural parts with the other of said spaced portions being engaged by the other of said structural parts during movement of said structural parts towards each other, maintaining a chamber between said spaced portions full of hydraulic fluid, restricting flow of hydraulic fluid from said chamber to a remaining part of said system maintained transversely of said chamber upon movement of said structural parts towards each other while said other spaced portion is engaged by said other part of said structural parts and said spaced portions are moved to compress the hydraulic fluid therein at a rate to retard further movement of said structural parts towards each other, and said maintaining of said chamber full of hydraulic fluid being by substantially unrestricted flow of hydraulic fluid from said remaining part of said system during movement of said spaced portions away from each other.

9. The method as defined in claim 8 including dissipating into said car body at least a major portion of the heat generated during the period of said restricted flow of said hydraulic fluid to maintain said hydraulic fluid at a desired operating temperature.

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