United States Patent [19]

MacDonnell

[11] **3,762,694**

[45] **Oct. 2, 1973**

[54] **SPRING GROUP**

[75] Inventor: **Robert W. MacDonnell,** Crete, Ill.

[73] Assignee: **Unity Railway Supply Co. Inc.,** Chicago, Ill.

[22] Filed: **Apr. 6, 1970**

[21] Appl. No.: **25,973**

[52] **U.S. Cl.** .... **267/3,** 105/197 A, 105/197 D, 105/197 R, 248/358 R, 267/33

[51] **Int. Cl.** **B61f 5/06,** B61f 5/08, B61f 5/12

[58] **Field of Search** .... 105/197 A, 197 R, 105/197 D; 267/3, 4, 33, 35, 63, 152; 248/358 AA, 358 R

[56] **References Cited**

UNITED STATES PATENTS

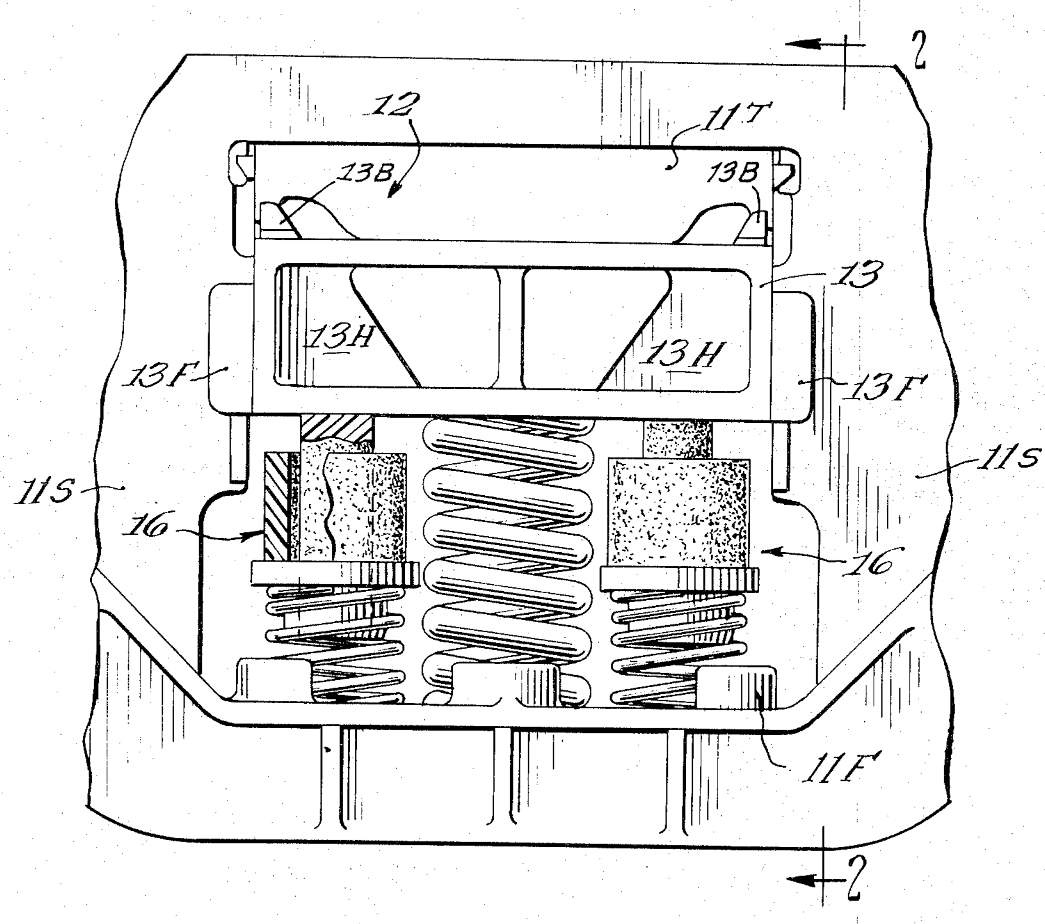
137,295	4/1873	Daniels	267/3
139,862	6/1873	Bridges	267/3
1,936,389	11/1933	Hallquist	267/4 X
2,322,879	6/1943	Piron	267/3 X
3,323,764	6/1967	Johnson	248/358 AA X

Primary Examiner—Gerald M. Forlenza
Assistant Examiner—Howard Beltran
Attorney—E. Manning Giles and J. Patrick Cagney

[57] **ABSTRACT**

A snubbed spring group comprising a tandem arrangement of first and second deflectable load bearing structures that interact in series for transmitting load forces therethrough. One of the structures is a solid body of elastomeric material, preferably polyurethane, having a hardness in the range from about 60 to about 90 Shore A. The other preferably is a coil spring having a spring rate that is a small fraction of that of the body of elastomeric material.

5 Claims, 12 Drawing Figures



PATENTED OCT 2 1973

3,762,694

Fig. 1

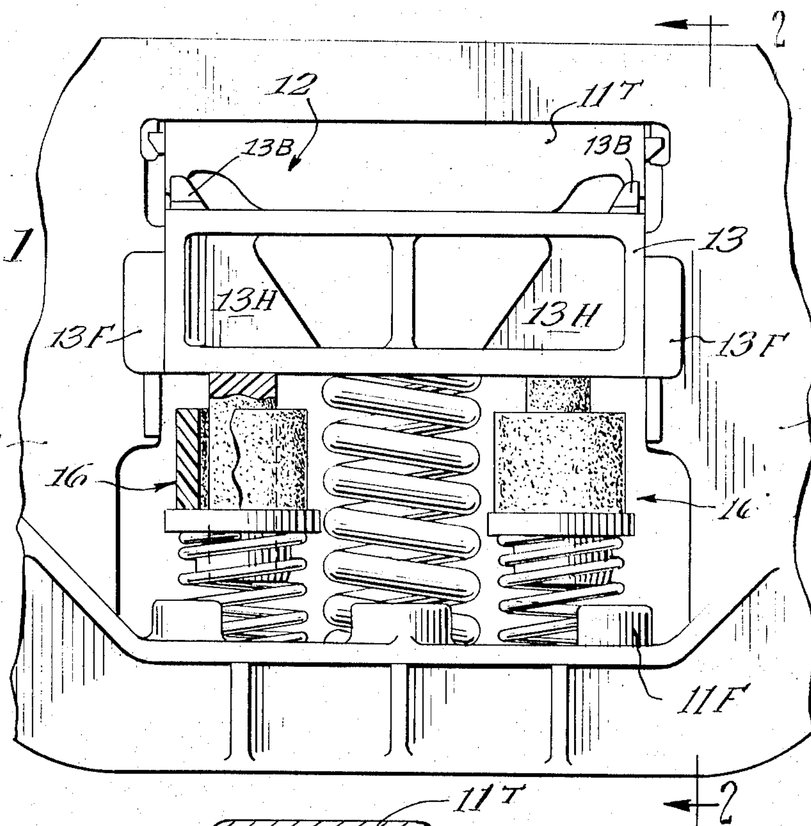
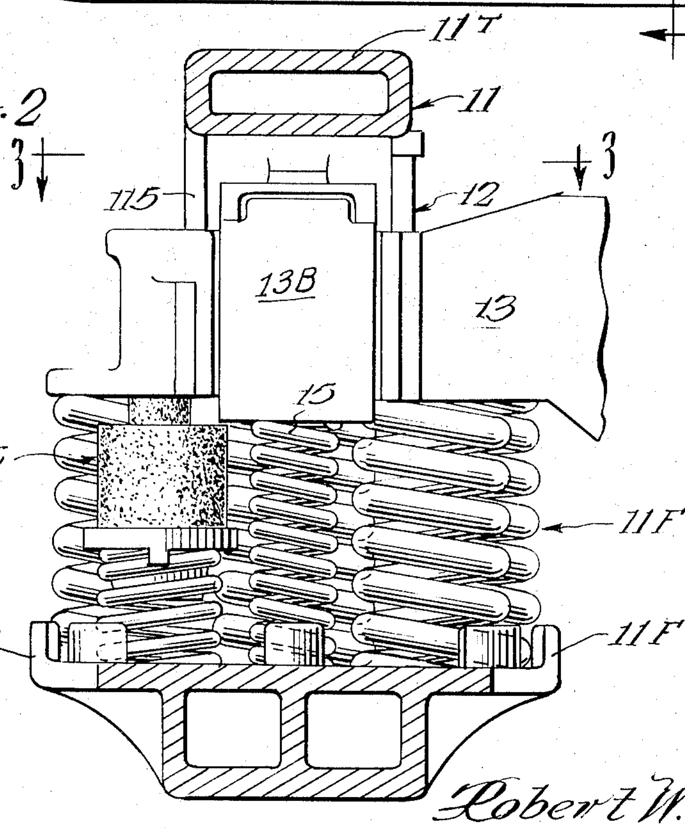


Fig. 2



INVENTOR

Robert W. MacDonnell

BY J. Patrick Cagney

ATTORNEY

Fig. 3

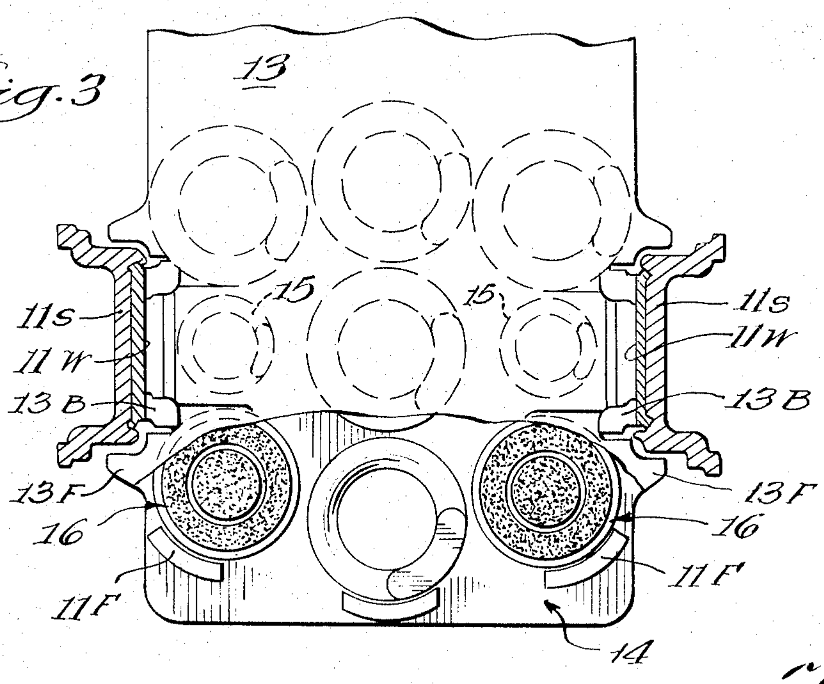


Fig. 5

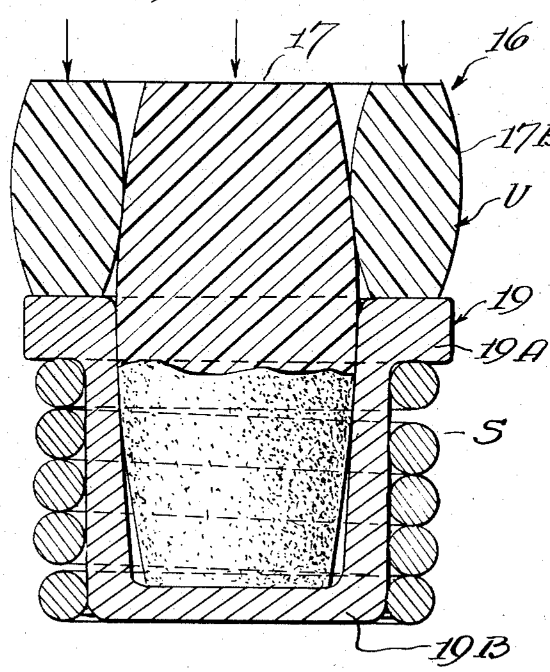
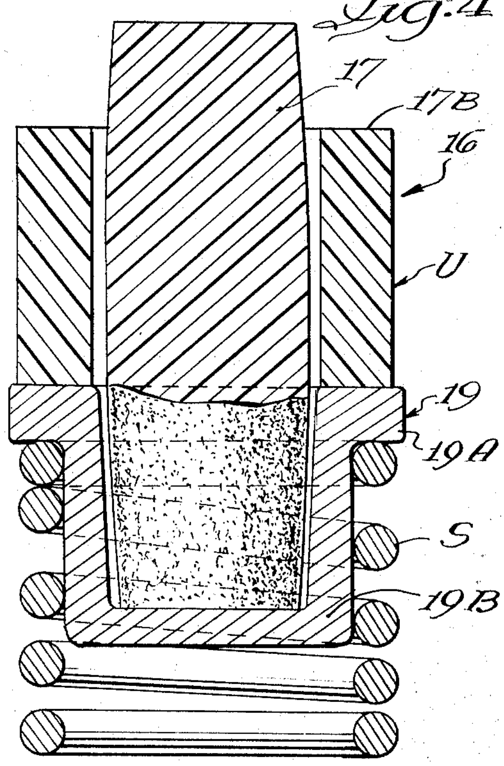
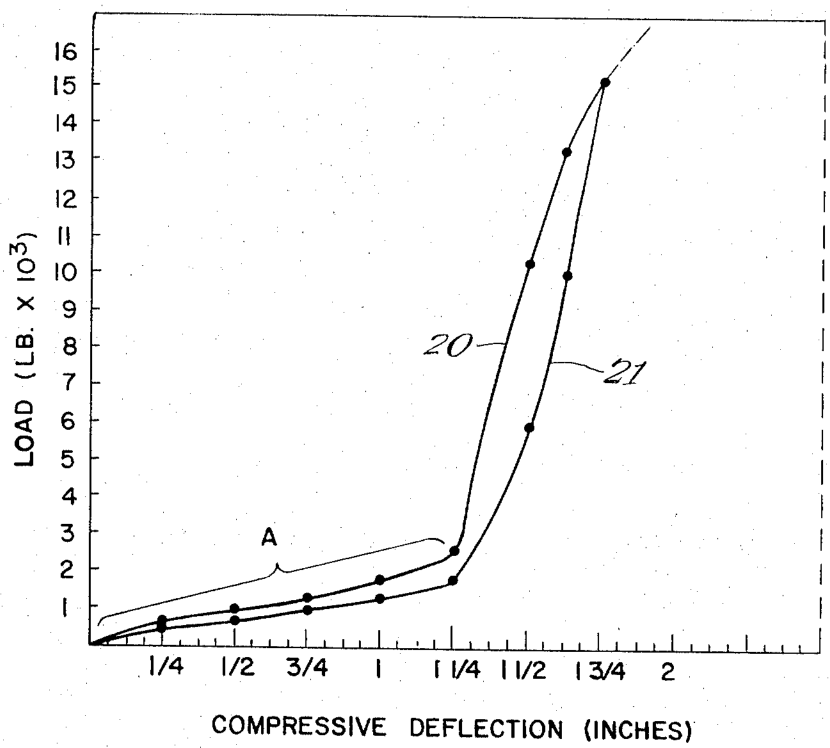


Fig. 4



INVENTOR
Robert W. MacDonnell
BY J. Patrick Cagney
ATTORNEY

Fig. 6



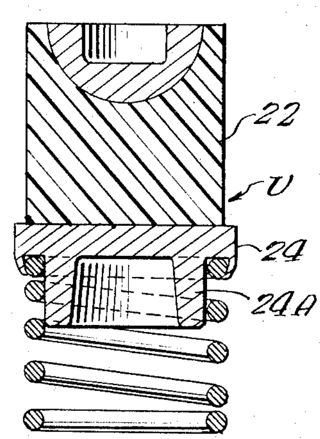


Fig. 7

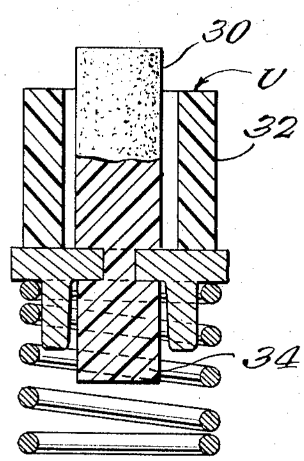


Fig. 9

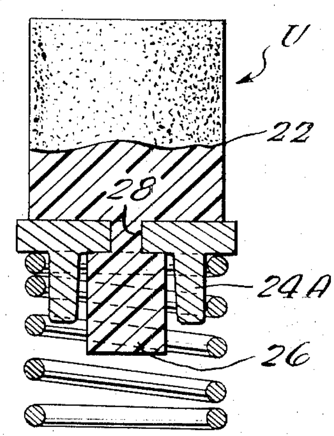


Fig. 8

INVENTOR
Robert W. MacDonnell
BY J. Patrick Cagney
ATTORNEY

Fig. 10

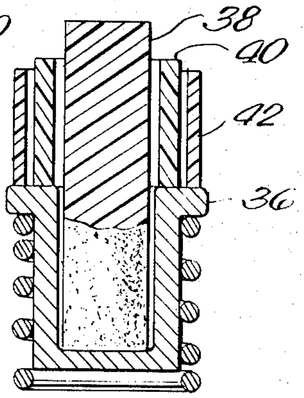


Fig. 11

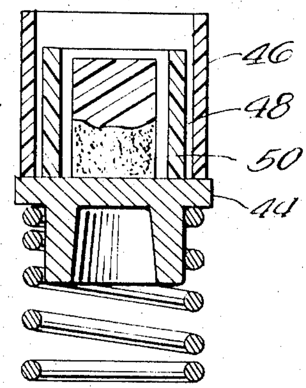
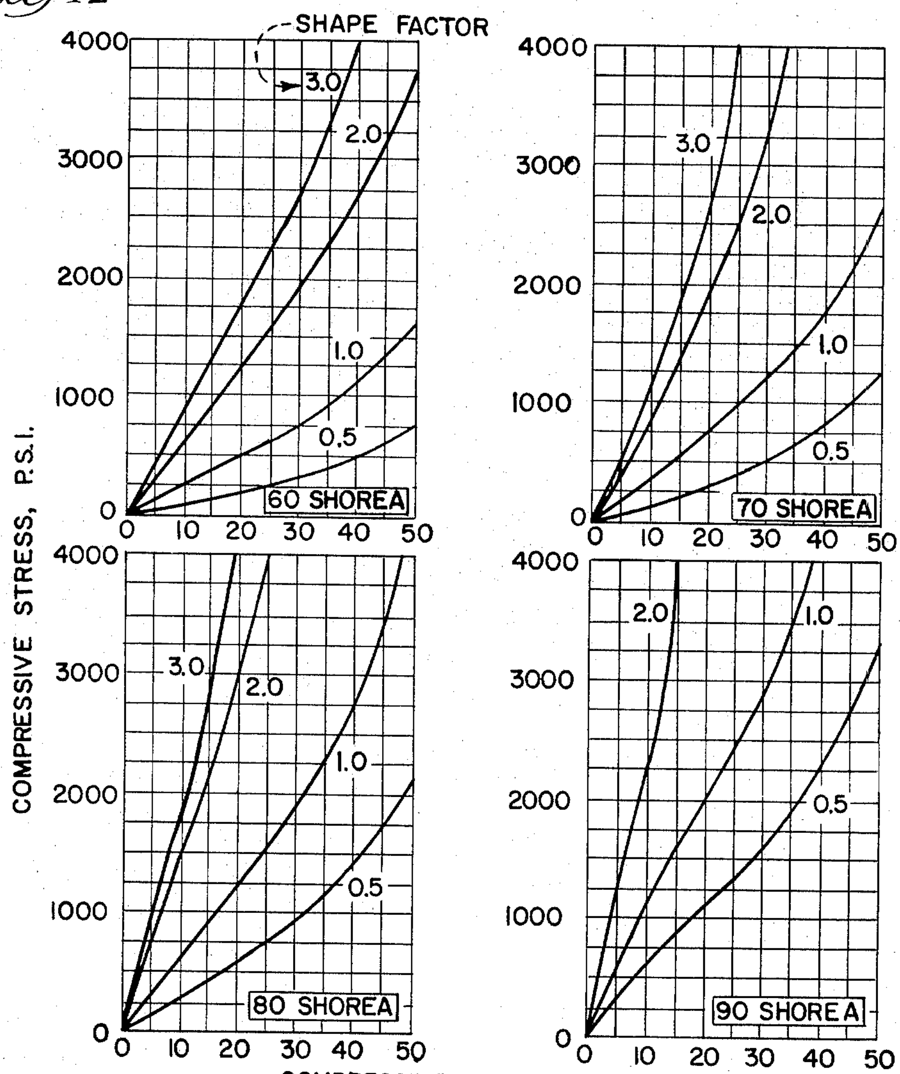


Fig. 12

COMPRESSION-DEFLECTION CHARACTERISTICS OF SOFT URETHANES



INVENTOR
Robert W. MacDonnell
BY J. Patrick Cagney
ATTORNEY

SPRING GROUP

BACKGROUND OF THE INVENTION

This invention relates to energy dissipating cushioning mechanisms and more particularly is concerned with a snubber for stabilized freight car trucks.

The railroad field has many applications requiring cushion arrangements that can provide both high load bearing ability and high energy dissipating characteristics. The environment imposes fixed constraints such as short cushion travel (typically 2 to 5 inches) and small mounting pockets for most railway cushioning devices including particularly snubbers of the type that are incorporated in the spring groups that support the trunk bolster from the side trains in the case of stabilized freight car trunks. There is a growing need for a snubber of more effective load bearing and energy dissipating characteristics occasioned by the trend in the railroad industry to employ faster and longer freight trains with more heavily loaded cars. Because the car load capacity and travel speeds have increased aggressively over the years, the cyclic bolster ride forces can exceed the load capacity of the spring groups with or without the use of conventional snubbers within such spring groups. When the ride forces exceed the support capacity of the spring groups, the coil springs go solid, thus causing high shock loading at the bolster and spring group mounting locations. Such shock loading reduces spring life requiring frequent replacement and greatly increases the danger of service failure of the bolster.

SUMMARY OF THE INVENTION

The present invention provides a snubber capable of dissipating a substantial portion of the ride energy while satisfying the environmental constraints of a deflection range limited to 2 to 4 inches and dynamic bolster load forces in excess of 100,000 pounds. In addition, the snubbers exhibiting these high performance characteristics are arranged to provide a soft ride under light load conditions.

In accordance with the present invention, a snubber includes first and second deflectable load bearing structures mounted in tandem for interaction in series for transmitting load forces therethrough. One of the structures includes one or more bodies of polyurethane material having hardnesses within the range from about 60 to about 90 Shore A. The other structure preferably is a coil spring but can be any resiliently deflectable structure characterized in having a spring rate that is a small fraction of the spring rate of polyurethane body or bodies. The coil spring provides for a soft ride under light load condition. Under heavier load conditions the coil spring deflects full stroke and the polyurethane body or bodies alone provides cushioning.

Other features and advantages of the invention will be apparent from the following description and claims and are illustrated in the accompanying drawings which show structure embodying preferred features of the present invention and the principles thereof, and what is now considered to be the best mode in which to apply these principles.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings forming a part of the specification, and in which like numerals are employed to designate like parts throughout the same:

FIG. **1** is a fragmentary side elevational view of a stabilized freight car truck of 100 ton capacity;

FIG. **2** is a fragmentary sectional view taken as indicated on the line **2—2** of FIG. **1**;

FIG. **3** is a fragmentary plan sectional view taken as indicated on the line **3—3** of FIG. **2** to better disclose the mounting locations of the snubber units;

FIG. **4** is an enlarged vertical sectional view illustrating one embodiment of a snubber constructed in accordance with the present invention;

FIG. **5** is similar to FIG. **4** and shows the snubber under static fully loaded conditions;

FIG. **6** is a graph depicting the load-deflection characteristics of the snubber of FIGS. **4** and **5**;

FIGS. **7–11** are each vertical transverse sectional view showing additional snubber embodiments; and

FIG. **12** is a series of graphs showing compression-deflection characteristics of urethane of various hardnesses and shapes.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring now to the drawings, and specifially to FIGS. **1–3,** the invention as disclosed herein is embodied as a snubber that is shown incorporated in a bolster spring group of a stabilized freight car truck to increase the load bearing capacity thereof and to increase the energy dissipation characteristics thereof.

The truck is of any conventional type and for purposes of disclosure a 100 ton, Type S-2-C, stabilized freight car truck is shown as including a side frame **11** having a top compression section **11T**, a bottom tension section **11B** and spaced side columns **11S** defining a bolster window opening **12.** A bolster **13** is bridged between a pair of side frames **11** and has its opposite ends projecting into the bolster openings to ride on a spring group, generally designated at **14,** disposed within each bolster window opening. The bottom tension section **11B** of the side frame serves as a lower spring seat and includes a number of flange portions **11F** for locating and retaining the lower ends of the springs that make up the bolster spring group **14.** The underface of the bolster **13** serves as an upper spring seat.

In the illustrated arrangement, each end of the bolster is provided with a pair of friction housings **13H** arranged in back-to-back relationship and each mounting a friction block **13B** to be loaded against a wear plate **11W** on the corresponding side column **11S** to provide a frictional dissipation of energy during bolster movement. Integral guide flanges **13F** on the bolster flank the side columns **11S.**

The bolster spring groups for the 100 ton car have nine spring positions in a 3 × 3 array as best shown in FIG. **3.** The center row end positions are occupied by stabilizing springs **15** that act to load the friction blocks **13B** against the wear plates **11W** on the side columns in a well known fashion. The seven remaining spring positions are normally occupied by D-5 springs which offer a maximum travel of 3-11/16 inches but snubbers are frequently used to replace one or more of the D-5 springs. Currently, such snubbers have a load capacity of up to about 15,000 pounds per unit and about a 50 percent dissipation, whereas the loading of the cars frequently imposes substantially greater loads than can be handled by conventional snubbers.

For example, taking the case of the typical 100 ton car, the car weight empty is about 68,000 pounds and with full revenue load is about 150,000 pounds. These values are distributed over four spring groups so that each group must handle an empty load of 17,000 pounds and a revenue load of 54,500 pounds. These values are for static conditions and are increased several fold under the dynamic conditions of high speed service. Each spring position of each spring group, assuming use of D-5 outer and inner coil springs offers a solid capacity of about 12,000 pounds. Therefore, in the illustrated arrangement, the seven spring positions provide a solid capacity of 84,000 pounds. If conventional snubbers (15,000 pound capacity) are used at two of these seven spring positions, the solid capacity of the group is increased to 90,000 pounds.

Under high speed conditions, the stabilizing friction blocks and the conventional snubbers exert an energy dissipating function for controlling the bolster ride but the bouncing or rocking energy imparted to the bolster exceeds the energy dissipation and leads to excessive compression and recoil action tending to drive the bolster springs solid and to overstress the snubbers.

In accordance with the present invention, an improved snubber unit **16** is provided offering greatly increased load capacity and energy dissipation. In the illustrated arrangement, a pair of these snubber units **16** occupy the endmost positions in the outer row of springs. Alternatively, a pair of snubbers can be located in diametrically opposite corners of each spring array of a single snubber can be located in any one of the central positions. In general, any symmetrical mounting arrangement can be employed and is contemplated in the practice of the present invention.

Briefly, a snubber of the present invention will be seen to comprise a tandem arrangement of cushioning structures interacting in series. A main cushion element, generally indicated by the letter U, comprises solid elastomeric material capable of exhibiting high strength and energy dissipation characteristics such as polyurethane. A second element is illustrated as a coil spring S having a spring constant that is a small fraction of the spring constant of the elastomeric or main cushion U so that the coil spring cushion S reaches substantially full stroke deflection before any substantial compression of the main cushion. A floating spring seat connects the main cushion in tandem relation with the coil spring cushion.

Turning to FIGS. **4** and **5**, a preferred snubber embodiment is disclosed herein for application in 100 ton freight cars in which the conventional springs of the spring group **14** are of the **D-5** type, having a free height of 10-¼ inches. Therefore, the snubber unit has a normal free height of 10-¼ inches plus approximately ⅛ inch to allow for initial permanent setting of the unrethane comprising the main cushion structure.

The snubber embodiment shown in FIG. **4** employs a spring seat **19** in the form of an inverted hat-shaped metal casting which defines a well open at the top and bounded by an annular rim or shoulder **19**A. The well, which is of natural draft, is 3 inches deep, 2-¾ inches in diameter at the base, and 3 inches in diameter at the top. A coil spring S encircles the well and supports the underface of the spring seat at a distance of 1-½ inch above the floor as defined by the side frame. The main cushion U comprises a center cylinder **17** of 60 to 70 Shore A durometer hardness urethane, and an auxiliary sleeve **17B** of 80 to 90 Shore A durometer urethane. The center cylinder **17** is 8 inches in height and 2-½ inches in diameter, it being formed in place so that its load face is securely adhered to the inner face of base wall **19B** of the well. The auxiliary sleeve **17B** is shown mounted upon the rim **19**A to extend alongside and encircle an intermediate length region of the center cylinder **17.** The sleeve **17B** has a free height of 3-½ inches, an outer diameter of 5¼ inches, and an inner diameter of 3¼ inches, to provide a nominal clearance gap under free load of ⅜ inches for radial expansion of the center cylinder cushion **17.** The contact face of the aleeve **17B** is securely adhered to the shoulder **19**A to maintain a constant load area and the upper extremity of the sleeve **17B** terminates 1½ inches below the upper extremity of the center cylinder **17** in free height relationships. As stated, the clearance between the underface of the well and the floor is 1½ inches so that the initial deflection of the coil spring provides soft cushioning action under light load conditions. Full stroke deflection of spring S is slightly less than 1½ inches so that the underface of the spring seat **19** restricts deflection of the spring prior to full stroke deflection thereof preventing damage to the spring S when the load forces exceed its load capacity. After the underface of spring seat **19** abuts against the floor, the center cylinder **17** begins to deflect.

The normal condition of the snubber under static full load conditions in a 100 ton car is represented in FIG. **5** wherein the unit is shown to have been deflected a total amount of approximately 3 inches. Since the coil spring S provided substantially the first 1½ inches of deflection, the elastomeric main cushion U has been deflected 1½ inches. At this load condition, no clearance exists between the center cylinder cushion **17** and the wall of the well and between the center cylinder cushion **17** and the surrounding sleeve **17** B. It will be noted that when the loading is such to drive the elastomeric cushion U snubber into a fully compressed solid condition, the arrangement automatically undergoes an abrupt change in cushioning characteristics. Prior to full closure, the center cushion **17** expands into contact with the wall of the well and into contact with the surrounding sleeve **17B**. The portion of the center cylinder cushion **17** which is within the well is inactive upon further deflection so that the final deflection is determined by the combined effect of the sleeve **17B** and the portion of the center cylinder cushion **17** which is above the shoulder **19**A.

FIG. **6** is a graph of the load-deflection curve of the snubber of FIGS. **4** and **5.** In FIG. **6** the curve **20** represents the compressive strain of the elastomeric main cushion U in response to loads up to approximately 15,500 pounds. Portion A of curve **20** is representative of the cushioning effects of the snubber when onl the central cylinder cushion **17** is under load and subject to deflection. The remaining portion of curve **20** represents the cushioning characteristics of the snubber after the center cylinder cushion **17** expands into contact with the wall of the well and into contact with the surrounding sleeve **17B**. Curve **21** represents the return characteristics of the main cushion U of the snubber. The area enclosed by the two curves **20, 21,** therefore, defines the amount energy dissipation of the snubber per cycle.

It will be noted that the maximum available deflection stroke for the snubber is determined by the **D-5** springs which go solid after 3-11/16 inch deflection. In the illustrated arrangement, this deflection stroke includes 1½ inch of travel of the coil spring S which is substantially fully compressed before any significant compression of the urethane main cushioning element and a final 2-3/16 inch of travel which is accommodated by the urethane main cushioning body. It is important to note, however, that complete deflection of the D-5 springs and maximum available deflection of the snubber is prevented both because of the amount of energy dissipation provided by the snubber during a deflection cycle and because of the great load carrying capacity of the main cushioning body U. For example, the snubber of FIGS. 4 and 5 is capable of carrying a load of 21,550 lbs. at full available deflection of 2-3/16 inches.

A snubber constructed in accordance with FIGS. 4 and 5 is capable of handling a cycle rate of deflection and release of 40 per minute under typical full load conditions.

Certain generalities apply to the snubber arrangement of the present invention. The shape and hardness of the main cushioning element U determines to a large extent the snubber's load bearing and cushioning characteristics. The effect of shape and hardness can be seen with reference to FIG. 12, which depicts compression-deflection characteristics of urethanes of various hardness and shapes. The "shape factor" is computed according to the following formula:

Shape Factor = Area of Load/Area of Free Side Faces

Thus, in the case of cylinders the "shape factor" formula is given as:

$$\text{Shape Factor} = D/4H$$

where D is the cylinder diameter
and H is the cylinder height.

The general shape factor formula is generally applicable where the elastomeric structures have load faces which are parallel and restrained from lateral movement and where the structure thickness is not more than twice the smallest lateral dimension. From FIG. 12 it can be seen that the configuration of the main cushioning element U can be easily tailored to meet requirements posed by specific freight car applications.

There is one restriction to the configuration and that is that the deflection ratio that the main cushioning element U be subject be less than about 20 percent of its height in order to preserve the useful life of the urethane under the cyclic load conditions they usually obtain.

Turning now to FIGS. 7 to 11, a number of alternate snubber embodiments are shown, each of which will be described for use in a 100 ton freight car truck having D-5 main springs.

The snubber of FIG. 7 comprises a cylindrically shaped urethane body 22 which typically is 5 inches in diameter and 5⅛ inches in height. The spring seat 24 is ¾ inch thick and the coil spring S has a free height of 4½ inches and a 5½ inch OD. The urethane body 22 typically has a Shore A durometer hardness of 70 to 90. The spring seat 24 includes a depending annular wall portion 24A which under no load is spaced 2-11/16 inches above the floor upon whicn the coil spring seats so that the maximum deflection of the coil spring is slightly less than 2-11/16 inches.

Another snubber embodiment is shown in FIG. 8 wherein the same basic arrangement as that of FIG. 7 is employed with there being an auxiliary cushion 26 of urethane located within the well defined by the depending annular wall 24A. The auxiliary cushion 26 has a nominal clearance of 2-3/16 inches so that it comes under load during the last half inch of deflection of the coil spring. It preferably has a lower hardness than the urethane in the upper cushion though it may be of identical hardness if desired. In this form, the spring seat is shown with a central through hole 28 so that the upper and lower urethane cushions 22, 26 may be poured at the same time even where different durometer materials are used for each. The cushions being poured in place have the load faces thereof securely bonded to the spring seat 24 to maintain fixed diameter relationships under all load conditions.

A further snubber embodiment is shown in FIG. 9 which is based essentially upon the embodiment shown in FIG. 8 except that the main upper cushion U is divided into a central cushion 30 of slightly greater height and a surrounding sleeve 32. In this form, the auxiliary cushion 34 is poured simultaneously with the central cushion 30 in the fashion previously described and the auxiliary cushion 34 comes under load before the coil springs reaches final deflection so that the central cushion 30 also begins to come under load in proportion to the action of the auxiliary cushion 34. After the central cushion 30 is deflected to the plane of the sleeve 32, an annular clearance will remain until the sleeve 32 and central cushion 30 have both been further deflected. Before final solid closure condition is reached, the central cushion 30 and sleeve 32 will come into contact and automatically generate a new shape factor condition to offer substantial increased resistance during final deflection.

Another snubber embodiment is shown in FIG. 10 which is similar to the arrangement of FIGS. 4 and 5 in the use of an inverted hat-shaped spring seat 36 and an 8 inches high central urethane cushion 38 seated in and projecting above this spring seat. In this arrangement, a pair of surrounding sleeves 40, 42 are employed. The inner sleeve 40 is again of 3½ inches free height and has a ⅜ inches clearance space relative to the central cushion 38. The outer sleeve 42 is about 3⅛ inches in free height and is of substantially higher durometer than the center cushion 38 or the first sleeve 40 to effectively serve as a high resistance urethane stop for the final stages of deflection.

Still a further snubber embodiment is shown in FIG. 11 wherein the spring seat 44 is shown supporting a set of three urethane cushions including an outer sleeve 46 having a free height of 5 inches, an inner sleeve 48 having a free height of 4 inches, and a central core 50 having a free height of 3½ inches. The outer sleeve 46 is of 60 durometer, the inner sleeve 48 of 80 durometer, and the central core 50 of 90 durometer urethane; the annular gap between the sleeves 46, 48 is ¼ inches and the annular gap between the innter sleeve 48 and the central core 50 is ¼ inches. When upon loading of the unit, the coil spring will take the first 1½ inches deflection and the outer sleeve 46 will then take 1 inches of deflection with there remaining a clearance gap at this point relative to the inner sleeve 48. Subsequent deflection of the two sleeves 46, 48 simultaneously is governed by their individual shape factors until the end space of the central cushion 50 is reached and at approximately that point all of the cushions interengage laterally and define a common shape factor of substantially increased resistance characteristics.

Thus, while preferred constructional features of the invention are embodied in the structure illustrated herein, it is to be understood that changes and variations may be made by those skilled in the art without departing from the spirit and scope of the appended claims.

The embodiments of the invention in which an exclusive privilege or property is claimed are defined as follows:

1. In an energy dissipating cushioning mechanism that includes a tandem arrangement having first and second deflectable load bearing structures interacting in series for transmitting load forces therethrough, the improvement wherein one of said structures includes concentric inner and outer bodies each being of compressible urethane material having a hardness in the range from about 60 to about 90 Shore A, means mounting said inner and outer bodies in radially spaced relation to undergo deflection along a common axis, with said bodies, when free of load, presenting load receiving surfaces in an axially offset relation and said bodies having load bearing determining shapes wherein one of said bodies undergoes individual initial axial compression for substantially carrying the static load forces and wherein said bodies undergo joint axial compression in radially contacting relation to dissipate energy in reacting to additional travel due to load oscillation, the other of said structures comprises a coil spring having a spring rate that is a small fraction of the spring rates of either of said bodies whereby said coil spring is deflectable through substantially full stroke prior to substantial deflection of either of said bodies and said arrangement includes means to restrict deflection of said coil spring prior to full stroke deflection thereof thereby preventing damage to said coil spring when said load forces exceed the load capacity of said coil spring.

2. In an arrangement as defined in claim 1 and wherein said inner body is longer than said outer body.

3. In an arrangement as defined in claim 1 and wherein said outer body is longer than said inner body.

4. In an arrangement as defined in claim 1 and wherein the axial travel corresponding to said joint axial compression is substantially less than the axial travel corresponding to said individual axial compression.

5. In an arrangement as defined in claim 1 and wherein said bodies are in radial contact after the limit of said initial individual travel and wherein the axial travel corresponding to said joint axial compression is substantially less than the axial travel corresponding to said individual axial compression.

* * * * *