April 5, 1938. E. E. ELLIES 2,113,372

RUBBER SPRING

Filed Sept. 21, 1935

Fig. 1

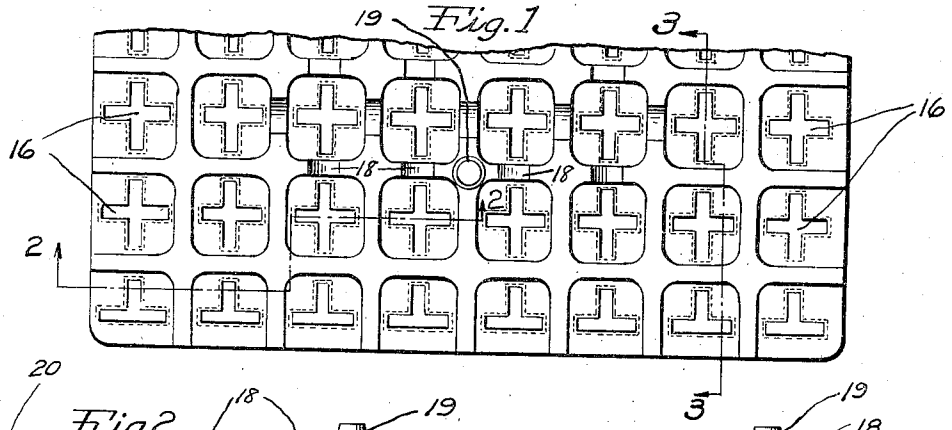


Fig. 2

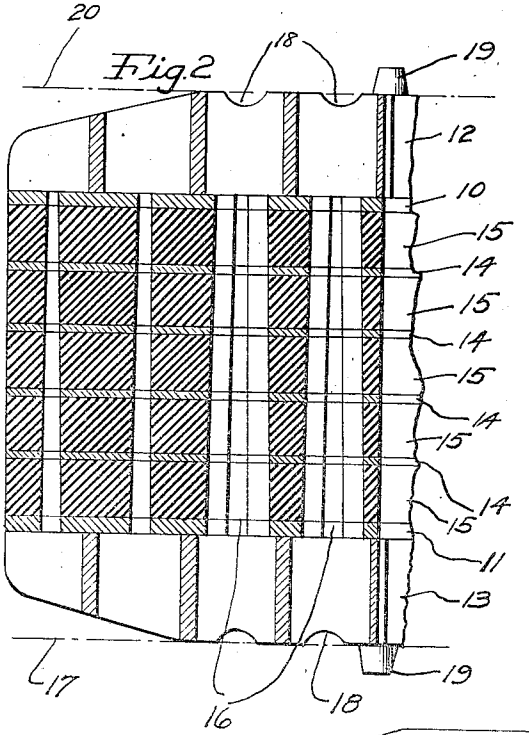
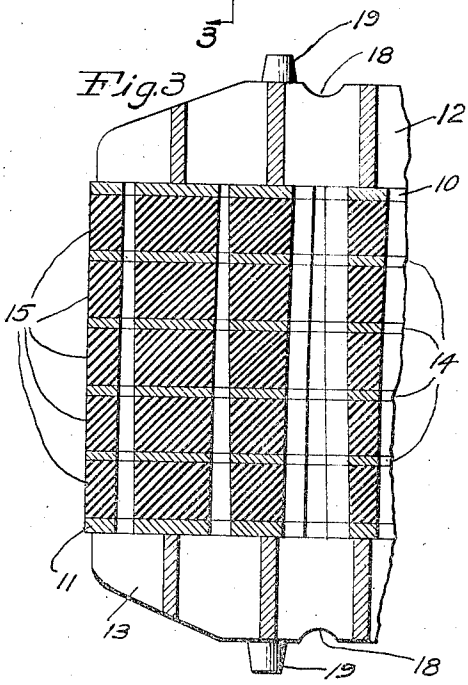


Fig. 3



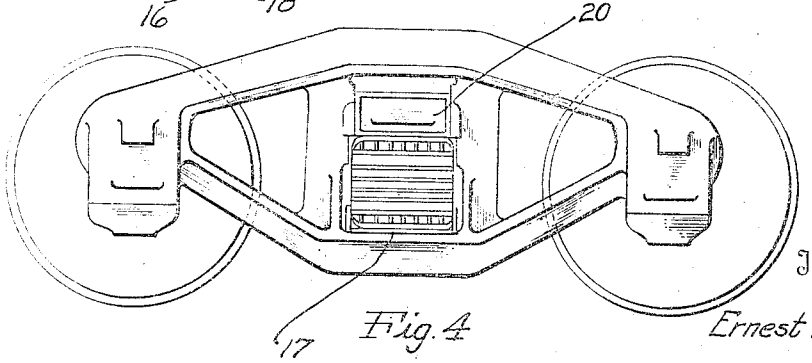


Fig. 4

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2,113,372

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2,113,372

RUBBER SPRING

Ernest E. Ellies, Akron, Ohio, assignor to Wingfoot Corporation, Wilmington, Del., a corporation of Delaware

Application September 21, 1935, Serial No. 41,592

16 Claims. (Cl. 267—63)

The present invention relates to resilient rubber cushions adapted for use in railroad trucks and the like and is an improvement on the invention disclosed in application Serial No. 1,291 of H. W. Protzeller et al., now Patent No. 2,058,623 granted October 27, 1936.

A great amount of experimenting has been done with reference to springs and like cushion means for trucks to be used on railroad cars and the like. In order to secure a cushion-type spring or resilient mounting, which will insure easy riding of railroad cars and eliminate certain periodic vibrations which tend to increase the vertical movement of the railroad cars and produce a sort of harmonic motion thereof, it is apt to injure goods being transported or, if used in a railroad passenger car, set up an unpleasant motion, thereby detracting from the comfort of those riding in the car.

It has been found that these coil springs have a certain period or resonance of vibration which means that if the car passes at a certain fairly uniform speed over the rail joints and is subjected to a slight jar at each rail joint, a gradual vertical reciprocating movement of the car body will be built up which has been found to be so severe as to cause much damage to the car and contents.

Some attempts have been made in the past to break up the natural resonance of the coil spring by bearing a part of the weight of the car upon elliptical springs or other steel friction elements which have a different period of vibration. This improvement has somewhat bettered the cushioning capacities of the metallic spring assemblies but has not proven entirely satisfactory due to considerable breakage as well as other maintenance expense.

It has been determined that the chief difficulty with coiled or other metallic springs is that the hysteresis of the metal is ordinarily about 5%, which means that the actual energy absorbed by the spring due to internal heating or deformation is only the said 5% of the amount of energy put into the spring. Thus 95% of the force impact in the ordinary metal spring will be given up by the spring, which in a case of a railroad car means a prolonged vibrating movement of a car body. A single vibrating movement imparted to the spring has been found to result in as many as 100 subsequent vibrations of gradually diminishing magnitude. In actual use the vibrations are somewhat reduced due to car friction and other losses, however, ordinarily the vibrations are continued at least 10 times. The shaking which these vibrations will naturally impart to the associated car body is accordingly apparent, particularly where the initial vibration-producing force is periodically repeated, possibly in synchronism.

It has been proposed to dampen the vibrating movement of the metallic spring members by providing artificial hysteresis which may be in the form of friction straps or the like. These have not, however, proven satisfactory due to the high initial cost and the expensive maintenance features involved.

It will be apparent from the foregoing that for cushioning devices for rail cars or like use, some material having a higher hysteretic factor would be more satisfactory. Vulcanized rubber of the proper character has been found to have an energy absorption or hysteresis of from 5 to 6 times that of spring steel and to possess other characteristics, such as quietness of operation and absence of necessity for lubrication, which render it particularly advantageous for railroad car suspension. It has been proposed heretofore to use rubber in the designated capacity, however various factors have arisen to render prior-known rubber structures unsatisfactory. In the first place, the rubber must be subjected to varying and heavy loads for continuous operation during all kinds of weather conditions. Prior-known structures have not been properly designed to produce the desired commercial results due to failure of the rubber body or to impart proper cushioning action. Thus, in prior-known devices, the resistance of the rubber to stress has not been properly proportioned, which has been found undesirable, resulting often in too active a cushioning movement under ordinary conditions.

Again in former types of rubber car supports, the rubber bodies have become overheated and failed in use. A rubber block subjected to compression and release will absorb energy and convert it to heat. It does this by means of internal friction. This heat that is generated in the rubber block must be conducted to the surface of the rubber before it can be radiated. The rate of the heat flow is inversely proportional to the length of paths that the heat must be conducted through. The amount of heat that can be radiated from a surface is directly proportional to the area of that surface. Therefore, there is a definite relation between the size of the rubber block that a given amount of heat can be conducted to the surface of and the area of the surface required to radiate that heat.

In order to determine just what the area and cubical contents of the block shall be, there must be known the rate at which heat will be radiated from the rubber surface and also the rate of conduction of heat. These can all be carefully determined and plotted out, which has been done on the design of rubber springs herein disclosed.

It is readily apparent that the maximum amount of service, or rather the maximum efficiency from the rubber as an energy absorption medium can only be obtained when there is a certain balance between the area from which the heat can be radiated and the cubical size of the block itself. This definite balance has been carefully predetermined in this design.

It has furthermore been found that by tapering the openings at least in part, the periodic vibrations are cut down to a marked degree over cushions employing straight openings, such as disclosed in the aforesaid application No. 1,291. By providing tapered openings the cross-sections of the openings in each successive rubber plate interposed between metal plates will be increasingly larger from one end to the other of the tapered opening, whereby upon compression of the cushion the hole in the rubber plate which is the smallest will be first to close completely as the rubber is compressed and squeezed so as to fill the opening, and upon further compression of the cushion the next larger opening of the plate will be closed etc. The various openings are therefore closed progressively and thus introduce a series of impedances which tend to break up the normal harmonic motion set up by the wheels striking the rail joints when the car is traveling at certain speeds. Furthermore, this construction eliminates the sudden bottoming of the spring which would normally occur when the openings in all of the rubber plates are the same. In other words, the smallest of the openings in the plates close first and make a substantially continuous plate of rubber, which from that point on during further compression of the cushion acts similarly to a solid plate of rubber and tends to break up the periodic vibration of the spring. Then the next-largest opening will be closed, etc. By this arrangement, as the spring is compressed, the compression is slowed down gradually so that at the end of the compression there is no sudden bottoming, which will cause a jar. The result is that a more even cushioning effect is produced and there is a better breaking up of the periodic vibrations to insure a smoother riding of the car.

It has been found that by vulcanizing the rubber plates and metal plates to each other a longer wearing plate is produced and this also insures that the openings in the plates and rubber will always be aligned as there cannot be any lateral shifting movement of the plates relative to each other.

It is an object of the present invention to avoid and overcome the foregoing difficulties of prior devices by the provision of a new and improved rubber cushioning member adapted for long and satisfactory commercial use.

Another object of the present invention is to provide a rubber-type resilient mounting for railroad cars in which the rubber portion is scientifically cooled during use. In the design herein disclosed it is the object of the invention to provide a simplified, unitary rubber-cushioned member, subdivided into blocks, with the blocks proportioned between radiating surface and heat that must be conducted through the rubber so as to obtain the most efficient use of the rubber.

Another object of the invention is to provide an improved elastic cushioning body of the character described wherein the resistance to deflection of the unit is designed to materially decrease once a certain load has been reached with the unit still being capable of considerable deflection.

Another object of the invention is the provision of a simplified unitary rubber cushioning member to directly support a rail car on the truck in which the parts are integrally vulcanized together and treated to render the same substantially unaffected by corrosion.

Another object of this invention is to provide in a rubber cushion of the type disclosed herein, one or more openings which at least are partially tapered from one end thereof to the other so as to eliminate periodic vibrations imparted normally to a railroad car by the striking of the rail joints by the wheels on the truck at certain speeds and to prevent sudden bottoming of the rubber cushions by having the openings in the various rubber plates closed successively, instead of simultaneously.

Other objects of the invention will appear hereinafter as the description hereof proceeds. Novel features, arrangements and combinations are clearly set forth in the specification and the claims hereunto appended.

In the drawing,

Fig. 1 represents a fragmentary plan view of a device embodying my invention;

Fig. 2 is a cross-section taken substantially along the line II—II of Fig. 1;

Fig. 3 is a cross-section taken substantially along the line III—III of Fig. 1; and

Fig. 4 is a side elevation of a railroad truck embodying my invention.

Referring now particularly to Figs. 1, 2, and 3, it will be noted that the rubber cushion comprises upper and lower metal end plates **10** and **11**, respectively, to which the lattice-like bracing plates **12** and **13** are secured, as by welding. Or, if desired, parts **10** and **11** can be formed integrally with plates **12** and **13**, respectively, as by casting.

There also are a series of metal plates **14** arranged in spaced relation to each other and to the end plates **10** and **11**, and all of these plates are held in spaced relation to each other by means of rubber plates **15** vulcanized or otherwise permanently secured to the metal plates so as to prevent lateral shifting movement relative thereto. Thus, there is formed a unitary structure composed of alternate layers of rubber and metal.

Extending through the metal and rubber plates from one end plate to another are a series of vertical openings **16** which, in cross-section, are shaped in the form of a Maltese cross and the side walls of these openings are tapered from the top to the bottom, as is clearly illustrated in Figs. 2 and 3, thereby in effect producing a series of openings in successive rubber plates from top to bottom of gradually increasing size. These are aligned with the openings provided in the lattice work at the top and bottom of the spring so as to permit the air to circulate through the spring as the spring is compressed and expanded.

The spring is normally arranged between the bolster **20** and a seat **17** on the truck frame and takes the place of the ordinary coil springs found in railroad trucks. In Fig. 2, I have illustrated by dot-dash lines, seats on the bolster **20** and

truck frame 17, respectively, and have given these the same reference character as these latter two elements. It will be noted that the bolster and truck frame contact the flat central upper and lower sides of the lattice-like plates 12 and 13 and, ordinarily, this would interfere with the circulation of the air through the vertical openings. In order to overcome this, I provide in the upper and lower edges, respectively, of the lattice-like plates 12 and 13, notches 18 which provide cross-circulation so that air can enter and leave the central vertical openings, as well as those around the edges of the spring. Thus, a more effective cooling of the spring results.

It will be apparent from an inspection of the drawing that the adjacent corners of the adjacent vertical openings, define in effect squares which are connected by the webs of rubber. Square spaced blocks of rubber held in fixed relation to each other, but unconnected, could also be used. During compression of the spring the corners of the squares which form the Maltese cross openings, move or flow together to substantially close the Maltese cross openings from four sides and meet substantially simultaneously. When they do, the openings are closed and the rubber plate is made into substantially a solid rubber plate, which then acts as an ordinary rubber plate and gives less resiliency to the spring than previously. Due to the taper on the openings through the metal plates and rubber plates, the closing of the openings is progressive from the top of the uppermost rubber plate to the bottom of the lowermost rubber plate, with similar action for each rubber plate. This is not strictly accurate in that the rubber plates and metal plates are vulcanized together as will be pointed out hereinafter, but is substantially so. At least the opening in the upper rubber plate is closed at least at one point before the openings in the lower rubber plates are closed, and there is a progressive closing from the top to the bottom. This introduces a series of impedances which tend to bring the spring to rest with less of a jar than in a construction such as shown in the aforesaid application of Protzeller et al., where the vertical openings are of uniform size throughout their lengths. This also, in addition to preventing a sudden bottoming of the spring, tends to more effectively break up the natural harmonic motion imparted thereto by the railroad car as the trucks thereof move over the rails at certain speeds. Consequently, there is less periodic vibration of the car under both light and heavy loads.

All of the metal parts in the rubber cushion are preferably made of steel for the purpose of strength and the rubber is vulcanized, or otherwise secured to the steel plates, but is preferably vulcanized thereto in the manner described in the aforesaid application to Protzeller et al. By positively vulcanizing the rubber to the plates, I provide a spring that maintains or possesses a constantly increasing resistance to load in all directions. It is apparent that as a load is placed upon the rubber block, tending to compress it vertically, the resistance to this compression is a curved line, or that the resistance increases as the deflection but not in direct proportion. I might state this in other words by saying that the rate of resistance constantly increases as the deflection, for vertical compression. This is true also of motion in a lateral or longitudinal direction. It is apparent, if the rubber spring described herein were set between two members, and the bottom member was rigidly held in position and the top one free to float, that it would not only compress the rubber in a vertical direction but that it might move laterally in either one of two directions or combinations thereof. It is also apparent that, due to the laminated rubber and steel, a constantly increasing resistance tending to prevent such motion is presented by the rubber spring. This is of great value, due to the fact that in freight cars it is absolutely essential that the load be free to float on the truck. Many devices have been introduced between the springs and the car body which would allow of this free motion, either by means of steel rollers or things of that nature but none have been entirely satisfactory.

I have thus developed a rubber spring that gives me the desired characteristics in a vertical direction, so as to reduce shock, and have at the same time produced a spring that will provide resistance to the lateral motion but still allow a degree of this motion which has been found necessary.

Pins 19, located on the lattice-like plates 12 and 13, are adapted to be located in similarly shaped recesses in the bolster and truck frame so as to cause these plates to take up the motion of the respective parts. This gives a better resilient action to the spring, in view of the fact that the spring can have horizontal flexing and thus permit relative horizontal movement between the truck frame and bolster. Since the pins 19 are tapered and the corresponding recesses which receive them are also tapered, the spring can be easily put in position and removed by merely separating the bolster and truck frame a sufficient amount to permit lateral movement of the spring as a whole from between the same.

The inherent dampening action of the rubber cushion, which is approximately 5 to 6 times as great as that of steel, causes all bounds and vibrations in the car and in the rubber cushion to be quickly dampened and absorbed by the generation of heat in the rubber body, with the heat being carried away by the flow of air through the vertical and lateral openings. The comparatively high hysteretic value of rubber in the type of cushion forming the present invention and its inherent advantages should be fully appreciated.

It will be recognized from the foregoing that an improved resilient mounting has been provided for railroad car use in which rubber and steel have been combined to produce a long-wearing self-dampening rubber cushion particularly adapted to resist corrosion and to dissipate internal heat formed therein.

It is obvious that any number of plates may be used and that the thickness of the rubber slabs may be varied. Also it is not essential that a certain prescribed number of openings be used in the spring. I have found that by making the spring in such a manner that the rubber blocks formed by the openings are substantially from ¾ to 1½ inches square and varying in cross-section from the uppermost layer of rubber to the lowermost layer the best results occur.

Obviously, those skilled in the art to which this invention pertains may make various changes in the construction and arrangement of the part shown in the accompanying drawing without departing from the spirit of this invention or the scope of the appended claims, and, therefore, I do not wish to be limited in my invention except as is set forth in the appended claims.

Having thus fully described my invention, what I claim and desire to secure by Letters Patent of the United States is:

1. In combination with a railroad truck bolster and a truck spring plank, of resilient rubber cushions secured between the ends of the truck bolster and the truck spring plank, said cushions comprising top and bottom metal members in the form of edge lattice castings with substantially square openings therethrough in a vertical direction, means on the members for releasably securing the same to the truck and bolster respectively, substantially flat top and bottom metal plates fastened to the top and bottom members and having square Maltese cross openings therethrough in alignment with the square apertures in the members, and a plurality of alternate rubber slabs and metal plates positioned between the top and bottom plates and having square Maltese cross openings extending vertically therethrough in substantial alignment with the openings in the end plates, said slabs, plates and end plates all being vulcanized securely together, said Maltese cross openings dividing the rubber slabs into a plurality of rubber blocks connected by relatively narrow fins with the blocks functioning under heavy compression load to flow and close the Maltese cross openings and thereby increase the resistance offered by the cushion in a greater-than-normal degree, said cross openings in the different rubber slabs being of different cross-sectional areas longitudinally thereof whereby when the cushion is compressed the openings in each individual rubber slab are closed by the surrounding material at different times than the openings in the other rubber slabs.

2. In combination with a railroad truck bolster and a truck spring plank of resilient rubber cushions secured between the ends of the truck bolster and the truck spring plank, said cushions comprising top and bottom metal members in the form of edge lattice castings with substantially square openings therethrough in a vertical direction, means on the members for releasably securing the same to the truck and bolster respectively, substantially flat top and bottom metal plates fastened to the top and bottom members and having square Maltese cross openings therethrough in alignment with the square openings in the members, and a plurality of alternate rubber slabs and metal plates positioned between the top and bottom plates and having square Maltese cross openings extending vertically therethrough in substantial alignment with the openings in the end plates, said slabs, plates and end plates all being vulcanized securely together, said Maltese cross openings dividing the rubber slabs into a plurality of rubber blocks connected by relatively narrow fins with the blocks functioning under heavy compression load to flow and close the Maltese cross openings and thereby increase the resistance offered by the cushion in a greater-than-normal degree, said Maltese cross openings being tapered at least throughout a portion of their length whereby the openings are not closed throughout their lengths simultaneously but are closed successively at different points along their lengths.

3. In combination with a railroad truck bolster and a truck spring plank of resilient rubber cushions secured between the ends of the bolster and the spring plank, each of said cushions comprising top and bottom metal members having square Maltese cross apertures therethrough and a plurality of alternate rubber slabs and metal plates positioned between the top and bottom members and having square Maltese cross apertures extending vertically therethrough in substantial alignment with the apertures in the members, at least some of said apertures being tapered throughout at least a portion of their lengths.

4. A resilient rubber cushion comprising top and bottom metal members in the form of edge lattice castings with openings therethrough in a vertical direction, substantially flat top and bottom metal plates fastened to the top and bottom members and having apertures therethrough in alignment with the openings in the members and a plurality of alternate rubber slabs and metal plates positioned between the top and bottom plates and having apertures extending vertically therethrough in substantial alignment with the apertures in the end plates, the aligned apertures in the individual rubber slabs being progressively larger from one point longitudinally of the aligned apertures to another point longitudinally thereof.

5. A resilient rubber cushion comprising top and bottom metal members in the form of edge lattice castings with openings therethrough in a vertical direction, substantially flat top and bottom metal plates fastened to the top and bottom members and having apertures therethrough in alignment with the openings in the members and a plurality of alternate rubber slabs and metal plates positioned between the top and bottom plates and having apertures extending vertically therethrough in substantial alignment with the apertures in the end plates, at least some of said aligned apertures being tapered.

6. A resilient rubber cushion comprising top and bottom metal members in the form of edge lattice castings with openings therethrough in a vertical direction, substantially flat top and bottom metal plates fastened to the top and bottom members, and having apertures therethrough in alignment with the openings in the members, and a plurality of alternate rubber slabs and metal plates positioned between the top and bottom plates and having apertures extending vertically therethrough in substantial alignment with the apertures in the end plates, at least some of said apertures forming openings from one end of said cushion to the other and being shaped to form tapered walls for said opening at least throughout a portion of the length of said openings.

7. A resilient rubber cushion comprising metal plates having interposed layers of rubber, each layer of rubber being formed with unobstructed openings transversely thereof, at least some of the openings in adjacent rubber layers being aligned and of different cross-sectional areas, the openings being small enough that the sides thereof meet when the spring is under the maximum compression for which the spring is designed, whereby the openings are substantially filled with rubber and act to snub the action of the spring.

8. A resilient rubber cushion comprising alternating layers of rubber and metal formed with unobstructed aligned openings making continuous passages through said layers of rubber and metal, the passages being tapered at least throughout a portion of their lengths, the openings being small enough that the sides thereof meet when the spring is under the maximum compression for which the spring is designed, whereby the openings are substantially filled

with rubber and act to snub the action of the spring.

9. A resilient rubber cushion comprising alternating layers of rubber and metal formed with unobstructed aligned openings making continuous passages through said layers of rubber and metal, said passages being tapered from one end thereof to the other, the openings being small enough that the sides thereof meet when the spring is under the maximum compression for which the spring is designed, whereby the openings are substantially filled with rubber and act to snub the action of the spring.

10. A resilient rubber cushion comprising alternate plates of rubber and metal having unobstructed aligned openings extending transversely thereof to form passages from one end of said cushion to the other substantially at right angles to the planes of the layers, at least some of said passages being of varying widths at different points longitudinally thereof, the openings being small enough that the sides thereof meet when the spring is under the maximum compression for which the spring is designed, whereby the openings are substantially filled with rubber and act to snub the action of the spring.

11. A resilient rubber cushion comprising alternate plates of rubber and metal, having aligned openings extending transversely thereof to form passages from one end of said cushion to the other, substantially at right angles to the planes of the layers, at least some of said passages being of varying widths at different points longitudinally thereof, and said passageways having a cross-section substantially that of a Maltese cross.

12. A resilient rubber cushion comprising alternate plates of rubber and metal, having aligned openings extending transversely thereof to form passages from one end of said cushion to the other, substantially at right angles to the planes of the layers, at least some of said passages being of varying widths at different points longitudinally thereof, said passageways having longitudinal grooves in the inner peripheral wall thereof.

13. A resilient rubber cushion comprising alternate plates of rubber and metal, having aligned openings extending transversely thereof to form passages from one end of said cushion to the other, substantially at right angles to the planes of the layers, at least some of said passages being of varying widths at different points longitudinally thereof, said passageways having longitudinal ribs on the inner walls thereof.

14. A rubber cushion comprising alternate layers of rubber and metal, with at least one unobstructed transverse passage extending through all of said layers and tapered longitudinally throughout at least a portion of its length, said opening being small enough that the sides thereof meet when the spring is under the maximum compression for which the spring is designed, whereby the openings are substantially filled with rubber and act to snub the action of the spring.

15. A rubber cushion comprising alternate layers of rubber and metal, with at least one transverse passage extending through all of said layers and tapered longitudinally throughout at least a portion of its length and having a cross-section substantially that of a Maltese cross.

16. A rubber cushion comprising alternate layers of rubber and metal, with at least one transverse passage extending through all of said layers and tapered longitudinally throughout at least a portion of its length, and having longitudinal grooves in the walls thereof forming intermediate ridges adapted to close the passageway upon compression of said spring.

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