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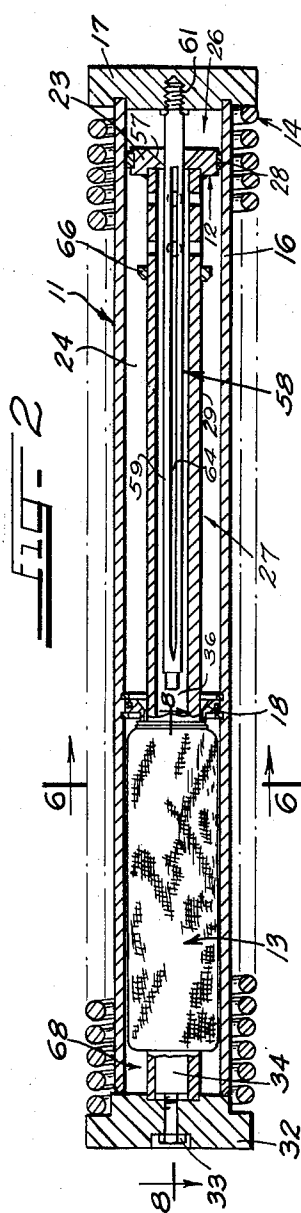
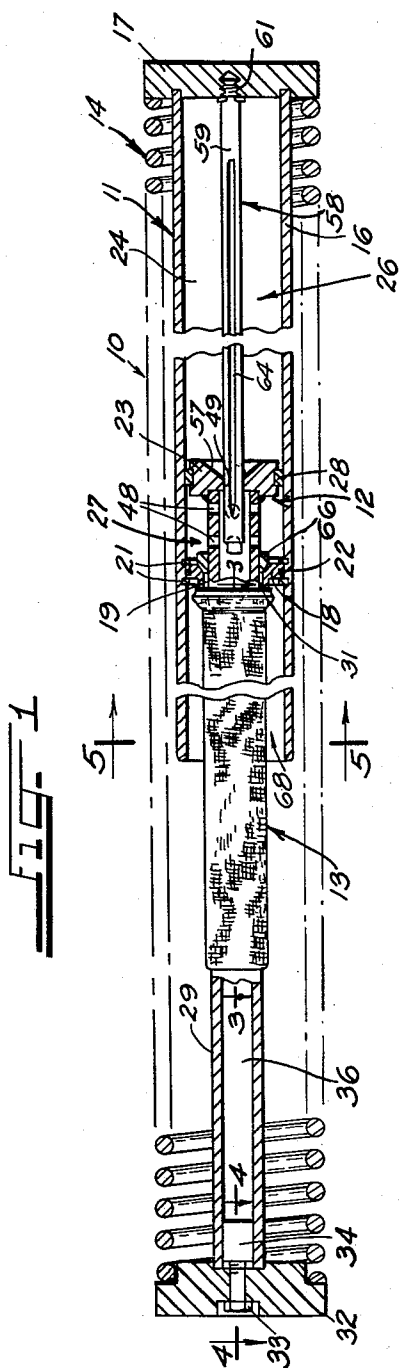
W. H. PETERSON

3,148,869

HYDRAULIC CUSHION DEVICE

Filed Jan. 29, 1963

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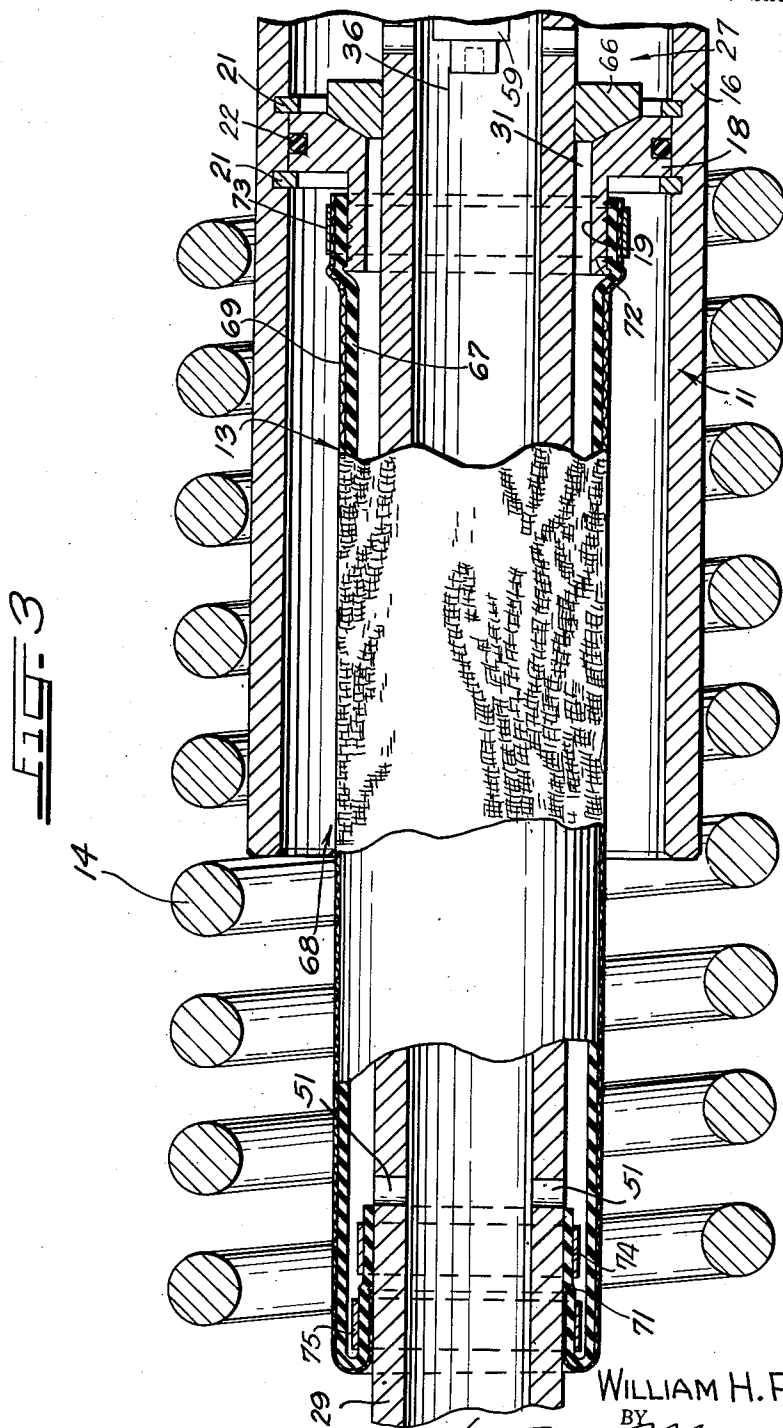
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HYDRAULIC CUSHION DEVICE

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5 Sheets-Sheet 2



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3,148,869

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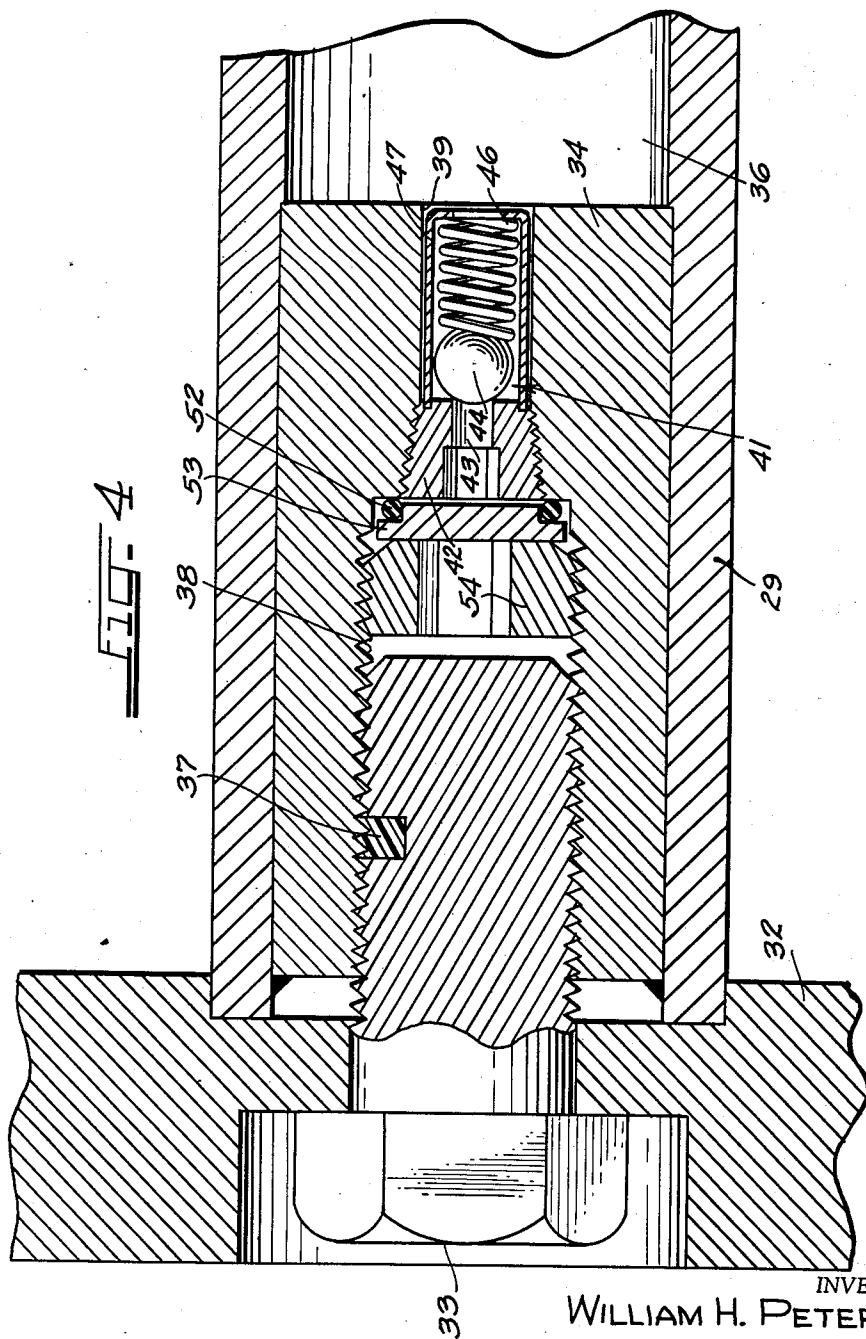


FIG. 4

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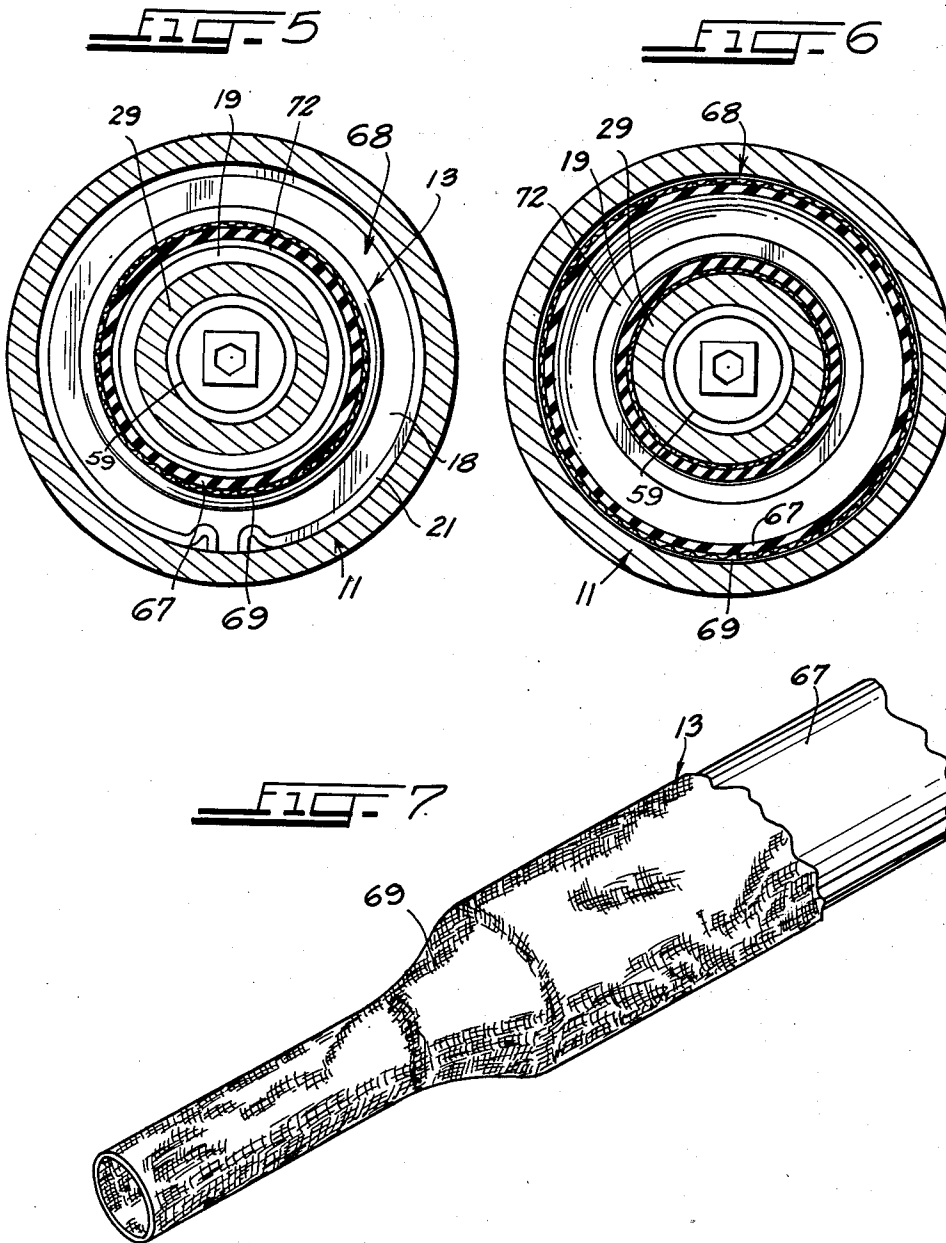
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HYDRAULIC CUSHION DEVICE

3,148,869

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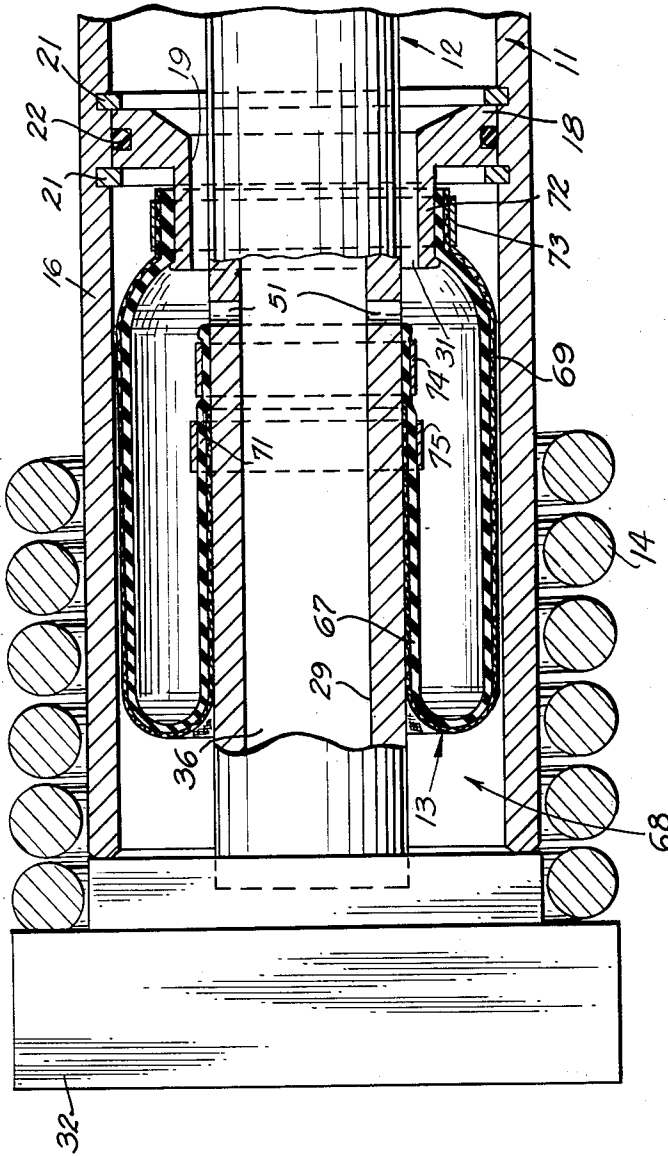
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HYDRAULIC CUSHION DEVICE

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FIG-8



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FIG-8

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3,148,869

HYDRAULIC CUSHION DEVICE

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Filed Jan. 29, 1963, Ser. No. 254,741

5 Claims. (Cl. 267—1)

The present invention relates to long travel cushion devices and more particularly to an improved long travel cushion device having a fluid filled cylinder and a fluid displacement means telescopingly arranged therewith and being operative upon impact to absorb a portion of the kinetic energy of impact.

The hydraulic cushion device of the type to which the improvements of the present invention relate is generally disclosed in U.S. Patent No. 3,035,827, dated May 22, 1962, assigned to the assignee of the present invention. As disclosed in this patent, the cushion unit is characterized by a construction which utilizes solely static seals so as to obviate the necessity of dynamic seals and thereby result in a more trouble-free and leakproof device.

The unit comprises generally a fluid-filled cylinder and a fluid displacement means reciprocable therein, the displacement means including a piston head and a hollow piston rod, which upon impact to the unit contract relatively to each other to displace fluid from one side of the piston head to the other at a controlled rate of flow. The rate of flow is controlled by a metering means constructed and arranged to achieve a substantially constant resisting force during each increment of travel of the unit.

For receiving the fluid displaced during the contraction of the unit, there is provided a radially expansible reservoir formed by a flexible boot which is statically fixed between the cylinder and the hollow piston rod and in communication with the latter. A resilient return spring means is disposed between the cylinder and fluid displacement means and is operative to return the device to its original extended or normal position after the shock impact has been dissipated.

The above-described cushion device is primarily adapted for use in railway cars wherein the lading supporting structure and coupler supporting structure are detached and slidable lengthwise to each other. The cushion device is associated with these relatively slidable structural components in accordance with my Patent No. 3,003,436 to provide a controlled acceleration or deceleration of the lading supporting structure when impacts are received by the coupler carrying structure, so that the lading supported thereon is accelerated primarily by its frictional contact thus maintaining the force between the lading and its supporting structure at values below that at which damage would result.

Upon relative contracting movement of the cylinder and the fluid displacement means, the flexible reservoir expands and receives fluid displaced during the contracting movement. Conveniently, the flexible reservoir is formed from a flexible rubber boot of which the rubber is selected to exhibit substantially uniform strength characteristics throughout so as to assure uniform radial expansion of the reservoir in a manner permitting the latter to be accommodated within the limited space provided within the device, as well as an allowance for thermal expansion and contraction. To obtain a rubber boot having the desired uniform strength characteristics requires a rigid quality control involving a time consuming testing of the boots to determine whether the boots fulfill the required standard.

The hydraulic pressures created within the cushion unit can, of course, be quite substantial. Under such circumstances the problem of leakage of hydraulic fluid is great. Improved cushion units, basically of the type disclosed

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herein, eliminate the use of dynamic seals toward overcoming this problem, but it has remained difficult to devise a suitable fluid filling arrangement which meets the leak-proof requirements. In fact, with some designs maximum hydraulic pressures developed in the high pressure side of the cushion will be in the neighborhood of about 20,000 p.s.i., and it is difficult to provide seals that will not leak at these pressures. In accordance with the filling arrangement of the present invention, the need for such seals is eliminated.

It is a principal object of the present inventions to provide a hydraulic fluid cushion device with an improved flexible reservoir structure including a rubber boot and having a reinforcing and/or confining means constructed and arranged to assure a uniform radial expansion of the flexible reservoir whereby the latter may be readily controllably accommodated with the space provided therefor.

It is a further object to provide a hydraulic fluid cushion device with an improved reservoir structure including a rubber boot and having a reinforcing means which also serves as a protective shield.

It is another object to provide a hydraulic fluid cushion with an improved arrangement for charging the device with the hydraulic fluid by locating seals on the low pressure side of the cylinder.

In the drawings:

FIG. 1 is a view partially in section illustrating a hydraulic fluid cushion unit embodying the improved structure of the present invention and showing the components in the extended or neutral position.

FIG. 2 is similar to FIG. 1 but showing the components in the contracted position thereof.

FIG. 3 is an enlarged fragmentary view of the cushion device partially in section showing in particular the improved auxiliary reservoir structure of the present invention and showing the components thereof in the extended position of the cushion device.

FIG. 4 is an enlarged fragmentary view of the cushion device partially in section showing in particular the improved charging check valve arrangement, this view being taken generally along lines 4—4 of FIG. 1.

FIG. 5 is an enlarged cross-sectional view taken substantially along the lines 5—5 of FIG. 1.

FIG. 6 is an enlarged cross-sectional view taken substantially along the lines 6—6 of FIG. 2.

FIG. 7 is an isometric view showing the elastic reinforcing sleeve being applied on the rubber casing of the auxiliary reservoir.

FIG. 8 is similar to FIG. 3 but showing the components in the contracted position of the cushion device.

Referring now to the figures, there is illustrated a cushion device 10 embodying the present invention and including generally a fluid filled cylinder 11, a fluid displacement means 12 reciprocable within the cylinder 11, a flexible reservoir in the form of a boot 13 statically connected at one end to the cylinder 11 and at its other end to the fluid displacement means 12, and return spring means 14 disposed between the cylinder 11 and the fluid displacement means 12.

The cylinder 11 includes generally a tube 16 to one end of which there is fixed a follower or closure plate 17. Disposed inwardly of the other end of the tube 16 is an intermediate cylinder head 18 having an axially opening 19. The cylinder head 18 is suitably fixed within the tube 16 by snap rings 21. A sealing ring 22 is disposed between the contacting surfaces of the cylinder head 18 and the tube 16 to seal the interior of the cylinder from atmosphere.

The fluid displacement means 12 includes a piston head 23 reciprocable within the bore 24 of the tube 16 and defining on the closure plate side thereof a high pressure

chamber 26 and on the cylinder head side thereof a low pressure chamber 27.

Seated within a groove formed in the periphery of the piston head 23 is a guide and sealing ring 28 which is preferably formed of a laminated phenolic resin. The guide ring 28 is arranged so that its outer guiding surface extends above the outer periphery of the piston head 23 so as to preclude metal-to-metal contact between the inner wall of the cylinder bore 24 and the piston head 23.

Fixed to the piston head 23 as by welding is one end of a hollow tubular piston rod 29 which extends through the axial opening 19 of the intermediate cylinder head 18. As shown the outer periphery of the piston rod 29 and the inner periphery 19 of the cylinder head 18 are radially spaced from each other and define therebetween an annular space or passage 31 which provides communication between the low pressure chamber 27 and the flexible fluid reservoir 13.

Fixed to the other end of the piston rod 29 is a follower or closure plate 32. The closure plate 32 is fixed to the piston rod 29 by means of a bolt 33 threaded to a plug 34 fixed in the piston rod bore 36. The bolt 33 may be of the type having a plastic insert 37 to lock the bolt against reverse rotation when it has been installed.

As shown in particular in FIG. 4 the threaded opening 38 of the plug 34 receiving the bolt 33 communicates with a coaxial passageway 39 of lesser diameter which extends through the other end of the plug 34. Disposed within the passageway 39 is a check valve assembly 41 including a housing 42 threaded in the inner end of the passageway 39 and providing communication between the threaded opening 38 and passageway 39 by way of an orifice 43. Seated over the orifice 43 is a ball check valve 44 biased into seating engagement by a spring 46 which is retained within the passageway 39 by a retainer housing 47 fixed at its inner end to the valve housing 42.

The cylinder is charged with the hydraulic fluid before the closure plate 32 and bolt 33 are assembled on the piston rod 29 so that the fluid may be introduced through the threaded opening 38, the orifice 43 and past the check valve 44 which is unseated by the pressure of the entering fluid and into the piston rod bore 36 via the passageway 39. Fluid flows from the bore 36 into the low pressure chamber 27 via ports 48 and into the high pressure chamber 26 via an orifice 49 associated with the piston head 23 as more fully to be explained hereinafter. Fluid is also charged into the boot 13 by way of passages 51. Since cushion 10 could be filled standing vertically, passages 51 permit entrapped air to bleed out, and by squeezing the folded area of the boot, the air here is forced out insuring a complete fill.

When the unit 10 is completely charged, orifice 43 is sealed by an O-ring 52 and plate 53 which are firmly held by a lock screw 54 disposed in the threaded opening 38. Thereafter the closure plate 32 is fastened to the piston rod 29 by means of the bolt 33 having the plastic insert 37. The cylinder and the bore of the piston rod 29 are charged to the extent that in the normal or neutral position of the device shown in FIG. 1, the pressure exerted by the fluid is at a minimum, say for example, about 2 p.s.i. With the above described arrangement of the check valve assembly 41 sealed by the O-ring 52 and sealing plate 53 firmly seated over the orifice 43 and the expandable insert 37 in the bolt 33, fluid leakage through the check valve assembly is prevented. The lock screw 54 is formed with a flattened bore to receive a suitable tool for threaded advancement of the lock screw into the threaded opening 38 and into clamping engagement with the sealing plate 53. Similarly, the outer end of the orifice 43 is formed with a flattened surface to receive a similar tool for ready assembly of the check valve assembly 41 in the plug 34. The arrangement described is of uncomplicated low cost design, adapted for ready fabrication and installation, and includes a multiple arrangement of simple sealing

means providing for leakproof operation of the cushion unit.

As heretofore described, communication between the high pressure chamber 26 and the low pressure chamber 27 is established by way of the piston head orifice 49. The orifice 49 extends axially through the piston head 22 and merges at one end with a conical feed surface 57 formed on the outer face of the piston head 23.

To obtain a substantially constant resisting force during each increment of travel of the unit 10 from its fully extended neutral position shown in FIG. 1 to its fully compressed position shown in FIG. 2, there is provided a metering means 58 which serves to meter the rate of flow of the fluid through the orifice 49 by varying the effective area thereof. The metering means 58 as shown is in the form of a rod or pin 59 slidably extending through the orifice 49 and of substantially constant diameter along its length. The rod or pin 59 is threaded at one end within a threaded opening 61 in the closure plate 17.

Formed along the length of the metering pin 59 are a plurality of angular spaced flutes 64 each of which vary similarly in cross-section so that upon relative movement between the cylinder 11 and the fluid displacement means 12 the piston head 23 moves along the flutes 64 and the flow through the orifice 49 at any given distance of travel imparts a substantially constant force-travel characteristic to the cushion device. To this end the flutes 64 are designed to conform substantially with the relationship

$$A_x = A_0 \sqrt{1 - \frac{x}{d}}$$

wherein A_x is the orifice area of any position x over the total nominal stroke d (length of the surface in which the flutes are formed), and A_0 is the initial orifice area defined by the orifice and the flutes at the beginning of the stroke under conditions where a completely rigid body is being cushioned. It is of course to be understood that the design of the flutes may be varied somewhat from the above relationship to achieve the desired constant force travel characteristics for any given situation. For a more complete description, reference is made to the aforementioned U.S. Patents 3,003,436 and 3,035,827.

Fixed on and located outwardly of the ports 48 of the piston rod 29 is a stop ring 66 which, as shown in FIG. 1, engages the cylinder head 18 to limit the travel of the fluid displacement means 12 to its fully extended position. This provides a minimum low pressure volume in the low pressure chamber 27 for receiving the fluid from the chamber 26 via the orifice 49 and bore 36 of the piston rod 29.

The flexible reservoir or boot chamber 13 further extends the low pressure chamber 27 and, as shown in FIGS. 3 and 5-8, includes a casing 67 formed from a fluid impervious, flexible material capable of resisting any corrosive effects that the hydraulic fluid may have. Advantageously, the material may be a type of rubber having special additives for low temperature flexibility.

The thickness of the rubber boot 67 is selected so as to provide the greatest strength and ruggedness commensurate with the flexibility required and may be, for example, $\frac{3}{16}$ inch. As shown in FIGS. 3 and 8, the boot 67 is flexed between the neutral or deflated position shown in FIG. 3 wherein the reservoir is devoid of any substantial quantity of fluid to an expanded position shown in FIG. 8 wherein it accommodates the fluid displaced during contraction of the unit. The rubber boot 67 may, when being filled by the displaced fluid, tend to bulge in localized areas in the nature of a bubble such that the boot cannot be accommodated wholly within the boot chamber 68 defined by the open end of the cylinder tube 16 outwardly of the cylinder head 18, and the normal smooth folding action interfered with. This may cause malfunctioning of the cushion device 10 or may even cause the boot 67 to be pinched between the cylinder end and the closure plate 32 so as to cause the latter to be ruptured. The tendency of the rubber boot 68 to bubble may be inherently caused

by such as variations in the boot wall thickness or variations in the curing properties and the like.

In accordance with the present invention there is provided a reinforcing means which controls and serves to prevent the non-uniform expansion of the rubber boot 67 and assures that the expanded boot is maintained within the confines of the boot chamber 68. This is accomplished by the use of pliable reinforcing means 69 overlying the exterior of the boot. The pliable reinforcing means 69 is constructed and arranged so as to control and maintain a substantially uniform radial expansion of the boot casing while precluding substantially any longitudinal expansion. To this end there is employed a pliable fabric in the form of a seamless sleeve capable of radial stretching or expansion, as distinguished from a universal stretch, in the nature of a two-way stretch, while being incapable of any substantial longitudinal elongation. The pliable fabric is preferably formed from threads produced from synthetic yarns and may include kinked yarn or elastomers arranged to provide the radial expansion. The pliable fabric having the desired elastic characteristics may be braided, woven, or knitted.

The elastic fabric sleeve 69 is sized such that it is stretched over the boot casing 67 as shown in FIG. 7 so as to be partially radially extended or expanded. However, upon radial expansion of the boot between the positions shown in FIGS. 3 and 8, the sleeve 69 further expands and applies a peripherally uniform resisting force against the underlying rubber boot casing 67. It is to be noted that as the boot casing 67 expands, the reversed end portion 71 fixed to the piston rod 29 curls outwardly along the piston rod and is wholly confined within the boot chamber 68. Such curling of the reversed end is permitted by the flexibility of the casing material and the pliability of the sleeve 69. However, because the sleeve is constructed to prevent any substantial longitudinal extension of the boot casing 67, any outward bulging of the boot is substantially precluded.

In the fully expanded position the elastic sleeve 69 is completely extended so that it applies a force resisting further radial expansion of the underlying boot 67. The sleeve 69 is constructed so as to maintain the maximum outer diameter of the expanded boot casing 67 somewhat less than the maximum diameter of the boot chamber 68. In this manner a clearance space is provided between the boot 13 and the cylinder tube 16 whereby any seizure of the boot within the cylinder is prevented.

It is further noted that the elastic sleeve or sheath 69 particularly when formed of synthetic yarns serves as a protecting shield for the soft underlying rubber boot 67 and protects the latter against abrasion, scoring, cutting and the like.

The boot assembly including the rubber boot casing 67 and the overlying elastic fabric sleeve 69 is fixed at one end to a hub 72 of the intermediate cylinder head 18 by way of a suitable hose clamp 73. The other end of the boot casing 67 preferably projects from the sleeve 69 and is separately fixed by a clamp 74 to the piston rod 29 to establish a fluid seal therewith. The other end of the sleeve 69 is fixed with an overlying portion of the boot casing 67 to the piston rod by another clamp 75. The sleeve 69 is fixed tautly between the clamped ends so as to be capable of providing the longitudinal reinforcement described above which at the same time permitting the boot casing 67 to expand.

Assuming that the cushion device 10 is assembled to the extent that the closure plate 32 and spring 14 are not mounted thereto, the hydraulic fluid is charged into the unit via the charging check valve assembly 41. The fluid fills the cylinder 11, piston rod bore 36 and the auxiliary reservoir of the boot 13 via the various communicating openings such as the ports 48, annular opening 31 and orifice 49, as heretofore described.

Assuming further that the cushion device 19 is employed in a railway car between the lading supporting and

coupler mounting structures to isolate the shock from the lading, the components of the device assume the position illustrated in FIG. 1 in the absence of shock impact at the couplers. Upon shock impact in either buff or draft, the cylinder 11 and the piston head 23 move relatively to each other toward the compressed or contracted position of the device illustrated in FIG. 2.

As the cushioning device contracts under the impact or force being cushioned, the metering pin 59 displaces hydraulic fluid contained within piston bore 36 through the ports 48 into the low pressure chamber 27 and through the annular opening 31 into the boot or reservoir 13, causing the latter to expand. In the event the rubber has localized weak areas, there may be a tendency for the latter to bulge or form a bubble-like projection during the filling thereof. As heretofore described, the elastic fabric sleeve 69 which is prestretched exerts a counteracting inner radial force which precludes such localized bulging, but yields readily under the pressures within the boot chamber to permit expansion thereof to the limit, but beyond this point, the fabric exerts a sharp increase in force, thus preventing further radial expansion, shown in FIG. 8. At the same time, the longitudinal confining force exerted by the fabric sleeve 69 substantially prevents any elongation of the boot casing 67.

The hydraulic flow initiated by the relative movement of the piston head 23 and the cylinder 11 is directed from the high pressure chamber 26 to the low pressure chamber 27 via the orifice 49, to the piston rod bore 36 and ports 48 and thence into the boot reservoir 13. The rate of flow through the orifice 49 is controlled by way of the metering pin 59 and the flutes 64 formed thereon so as to vary the effective orifice area such that the resisting force is maintained substantially constant for each increment of travel of the components. Contraction of the unit 10 continues until the open end of the cylinder contacts the closure plate 32. After the shock has been fully dissipated the return spring 14 is operative to return the hydraulic cushion components to the initial extended position as limited by contact of the stop ring 66 with the cylinder head 18. During this movement under the action of the spring 14, the oil flow previously described is reversed and the boot reservoir 13 deflates and returns to the position shown in FIGS. 1 and 3, thereby insuring that the hydraulic fluid displaced by the piston is restored to its normal position.

What is claimed is:

1. A hydraulic cushion device comprising a fluid-filled cylinder having a closed end and an open end, fluid displacement means reciprocally received by said cylinder for relative movement between a neutral extended position and a contracted position, an intermediate cylinder head fixed in said cylinder inwardly of said open end, an axial opening in said cylinder head, said fluid displacement means including a piston head reciprocal within said cylinder between said closed end and said intermediate cylinder head and defining adjacent the closed end side thereof a high-pressure chamber and adjacent the intermediate side thereof a low-pressure chamber, a piston rod fixed to said piston head and extending through said intermediate cylinder head opening, fluid passage means through said intermediate cylinder head, said fluid displacement means including means providing fluid communication between said high-pressure chamber and said low-pressure chamber during contraction and extension of said device, a flexible auxiliary reservoir fixed at one end to said piston rod and at the other end to said intermediate cylinder head and communicating with said low-pressure chamber by way of said fluid passage means, said flexible reservoir being expandable for receiving fluid displaced upon relative contraction of said fluid displacement means and said cylinder, said flexible reservoir including a rubber boot and an overlying sleeve means for controlling the expansion of said rubber boot, said sleeve means in the deflated condition being partially expanded and tensioned on said rubber boot and in the fully ex-

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panded condition exhibiting a diameter less than the diameter of said cylinder so as to maintain a clearance between said flexible reservoir and the inner surface of said cylinder.

2. The invention as defined in claim 1 wherein said sleeve means is substantially incapable of elongation so that said boot is substantially only radially expanded and is maintained within the confines of the open end of said cylinder and said intermediate cylinder head in the maximum expanded condition thereof.

3. In a hydraulic cushion device wherein fluid filled cylinder and piston means telescopically coact to absorb forces applied thereto, at least one of said cylinder and piston means being formed with a tubular portion closed off at one end thereof by a removable end plate, the provision of a fluid charging and end plate attachment unit forming a part of said one cylinder and piston means, said unit comprising plug means fixed in said tubular portion, a fluid delivery passage extending through said plug means, said passage including a threaded portion, check valve means in an innermost portion of said passage and operative to permit one-way flow of fluid during charging of said cushioning device, and end plate fastener means extending through said end plate and threadedly received in said threaded portion of said passage.

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4. The device of claim 3 wherein said check valve means includes a valve seat portion threadedly received in said passage, said valve seat portion being provided with a fluid flow orifice coaxial with said passage and formed with tool engaging surfaces for blind insertion and removal of said check valve means.

5. The device of claim 3 wherein sealing means are received in the threaded portion of said passage between said check valve means and said fastener means, said sealing means including an imperforate disc peripherally mounting an O-ring in a recessed seating area, and lock nut means threadedly received in said passage and engaging said disc and pressing said O-ring into sealing engagement with a radial surface portion of said passage, said lock nut means including tool engaging means for blind insertion and removal thereof.

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