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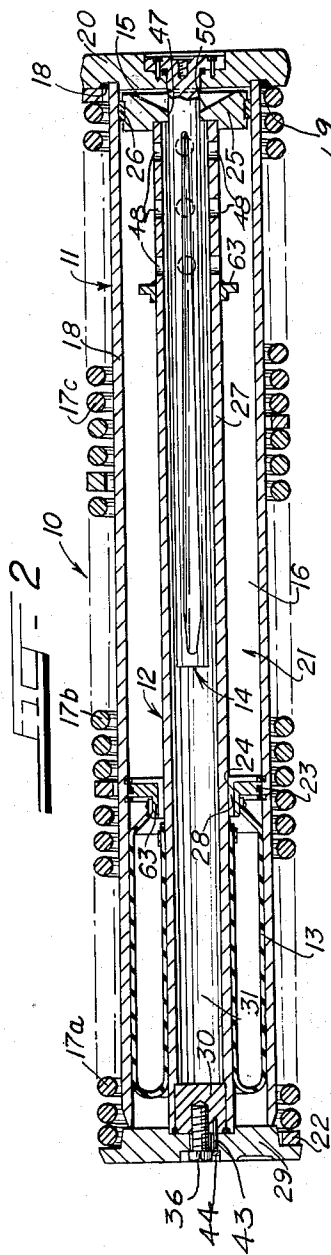
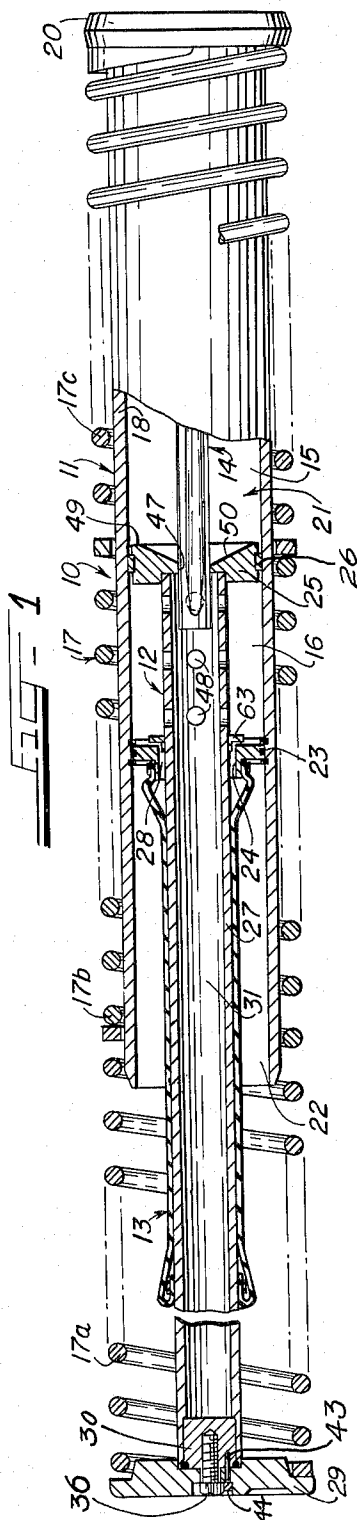
A. L. STRETCH

3,217,898

RAILWAY HYDRAULIC CUSHION ASSEMBLY

Filed Feb. 21, 1964

3 Sheets-Sheet 1



INVENTOR.

ARNOLD L. STRETCH

BY

Wayne Morris Russell.

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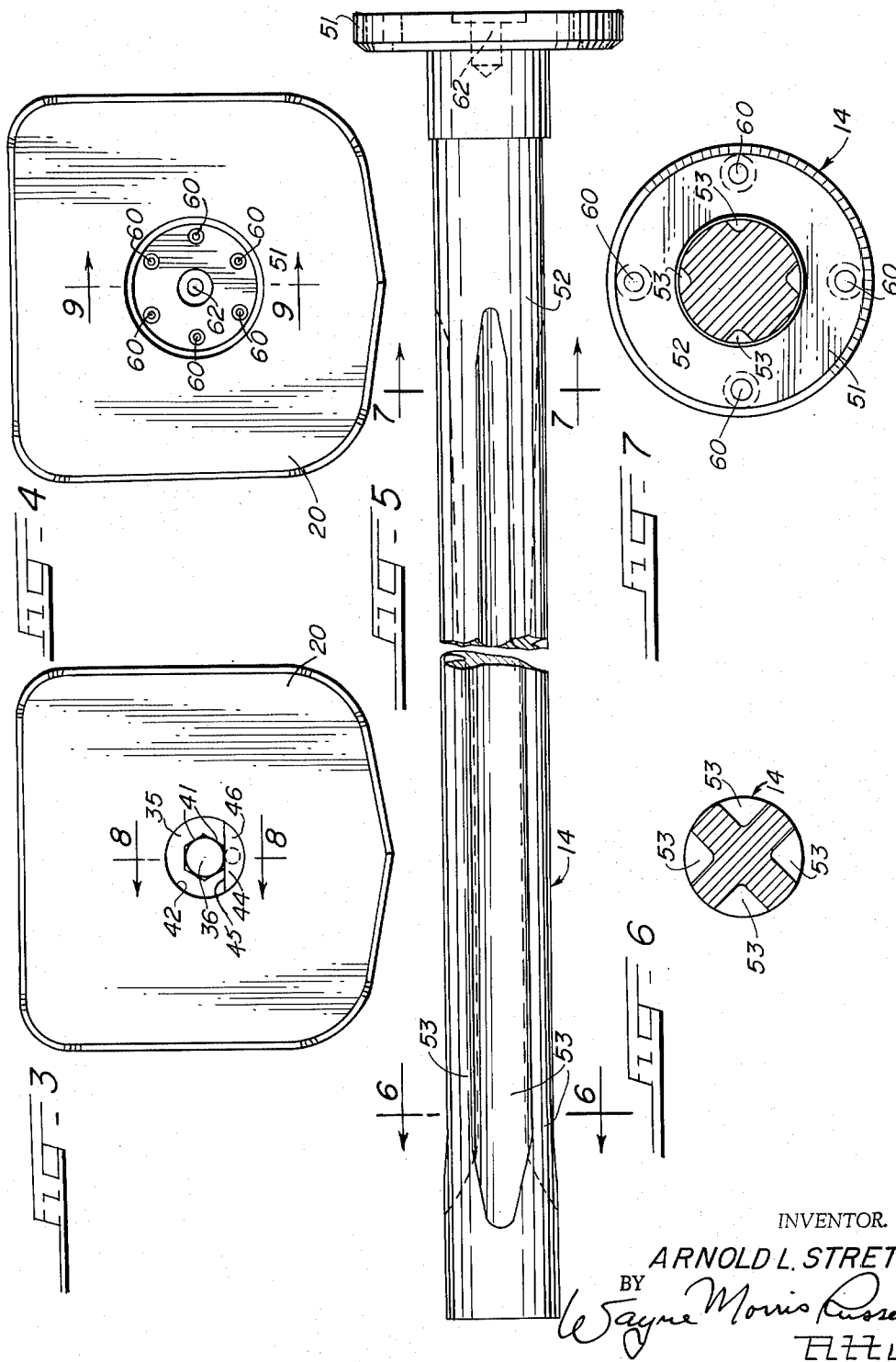
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RAILWAY HYDRAULIC CUSHION ASSEMBLY

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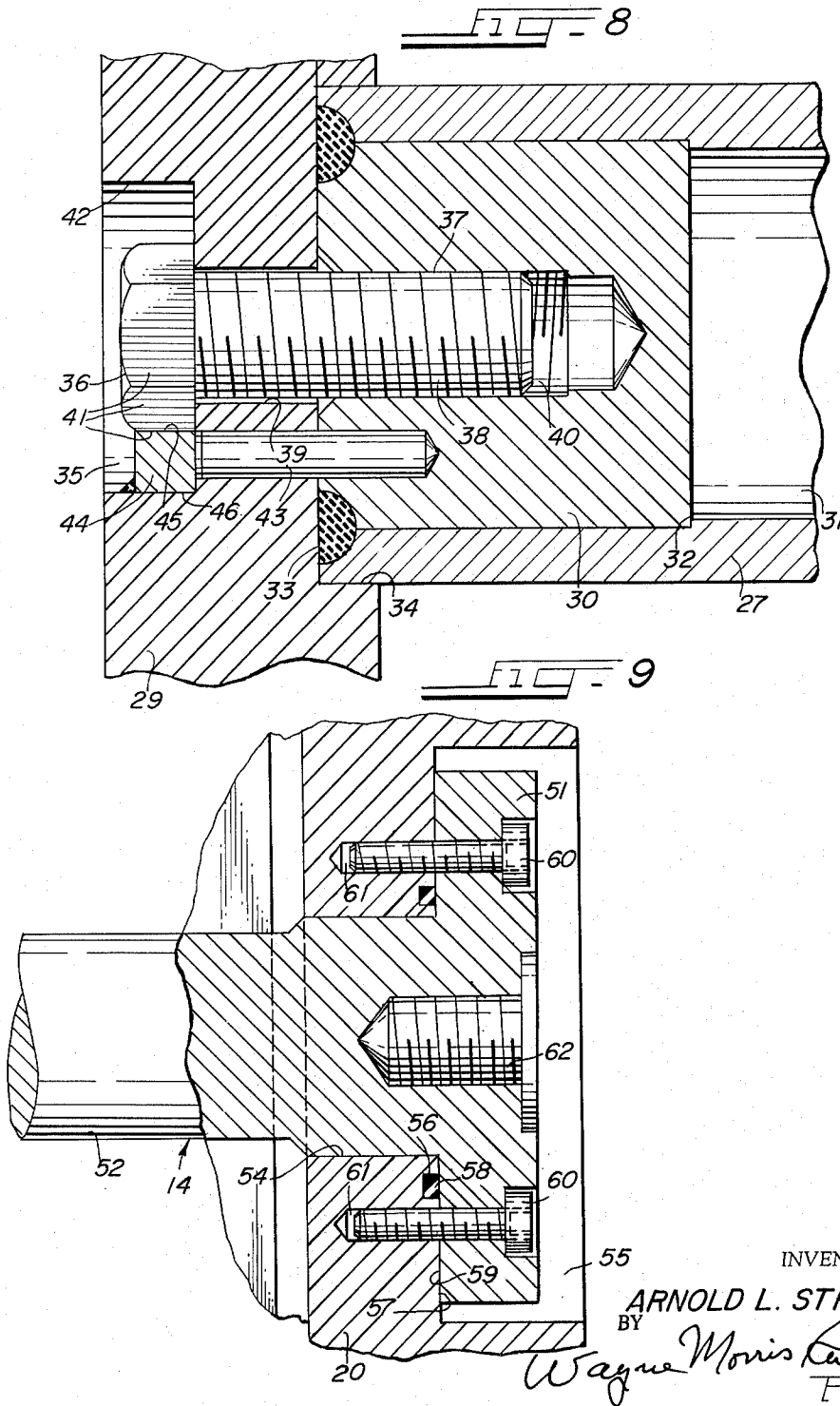
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3 Sheets-Sheet 3



INVENTOR.

ARNOLD L. STRETCH

BY

Wayne Morris Russell.

ATTY.

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RAILWAY HYDRAULIC CUSHION ASSEMBLY
Arnold L. Stretch, Highland, Ind., assignor to Pullman
Incorporated, Chicago, Ill., a corporation of Delaware
Filed Feb. 21, 1964, Ser. No. 346,425
1 Claim. (Cl. 213-43)

The present invention relates to hydraulic cushion devices and more particularly to an improved hydraulic cushion device of the type which may be used in cushion underframe railway cars for providing car body and lading protection.

A hydraulic cushion unit of the type to which the present invention relates is disclosed in U.S. Patent 3,003,436. The hydraulic cushion unit comprises generally a hydraulic fluid-filled cylinder in which there is reciprocably disposed a fluid displacement means which may be in the form of a piston head having fixed to one face thereof an end of a tubular piston rod. The tubular piston rod extends through an intermediate cylinder head fixed inwardly of an open end of the cylinder. Fixed to the outwardly extending end of the cylinder is a base plate against which there abuts one end of a return spring means, the other end of which abuts against another base plate which closes off the other end of the cylinder.

The cylinder and the fluid displacement means are movable between a neutral extended and a contracted position. During the extension and contraction of the cushion unit, hydraulic fluid flows between a high pressure chamber defined between the forward face of the piston head and the closed end of the cylinder and a low pressure chamber defined between the rear face of the piston head and the intermediate cylinder head.

A flexible reservoir is attached between the intermediate cylinder head and the outwardly extending end of the piston rod. The reservoir communicates with the low pressure chamber via fluid passages through the cylinder head and serves to receive hydraulic fluid displaced during the contraction of the cushion unit.

The hydraulic cushion device is preferably of the type having an approximately constant resisting force travel characteristic. To this end, the piston head is provided with an orifice which is aligned with the piston rod bore having ports providing fluid communication with the low pressure chamber. Extending through the orifice is a pin which is constructed so as to vary the fluid flow through the orifice in a manner achieving the approximate substantially constant resisting or cushioning force. The metering pin is fastened at one end to the base or follower plate so as to form a fluid-tight seal.

The above generally described hydraulic cushion is primarily characterized by a structure utilizing only static seals which results in a substantially trouble-free and leak-proof unit.

In accordance with the present invention it is proposed to provide a new and novel fastening arrangement for fixing the closure plate to the end of the piston rod in a manner which forms a fluid-tight seal and prevents loosening or detachment of the closure plate.

This is accomplished generally by the provision of a fastening block fixed in the bore of the tubular piston rod and having a threaded hole which receives the threaded shank of a fastening bolt extending through an axial opening in the closure plate. The head of the fastening bolt is received within an enlarged recess formed on the outer face of the closure plate and being of a diameter greater than the maximum chord of the head. Extending through the recessed portion of the closure plate and into the fastening member to one side of the fastening bolt is a dowel pin. Overlying the dowel pin and having one face engaging a side of the fastening head and another

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face engaging the side wall of the recess is a wedge block fixedly secured to the closure head for preventing turning of the fastening bolt.

In the drawings:

5 FIG. 1 is a fragmentary view, partially in section, of a hydraulic cushion unit embodying the present invention and showing the unit in the neutral extended position thereof;

10 FIG. 2 is a longitudinal cross-sectional view of the hydraulic cushion unit of FIG. 1 showing the unit in the contracted position;

FIG. 3 is an end view of the left end of the hydraulic cushion unit of FIGS. 1 and 2;

15 FIG. 4 is an end view of the right end of the hydraulic cushion unit of FIGS. 1 and 2;

FIG. 5 is a fragmentary view of a metering pin embodying the present invention;

FIG. 6 is a cross-sectional view taken generally along the lines 6-6 of FIG. 5;

20 FIG. 7 is a cross-sectional view taken generally along the lines 7-7 of FIG. 5;

FIG. 8 is an enlarged cross-section view taken generally along the lines 8-8 of FIG. 3 and showing in particular the arrangement for fastening the base plate to the piston rod; and

25 FIG. 9 is an enlarged cross-sectional view taken generally along the lines 9-9 of FIG. 4 and showing in particular the metering pin fastening arrangement at the right base plate.

30 Referring now to the drawings there is shown a hydraulic cushion unit or device 10 embodying the present invention and comprising generally a hydraulic fluid-filled cylinder 11, a fluid displacement means 12 reciprocable within the cylinder 11, a flexible reservoir in the form of a boot 13 which is statically connected at one end to the cylinder 11 and at the other end to the fluid displacement means 12, a metering pin 14 for controlling the fluid flow from a high pressure chamber 15 and a low pressure chamber 16 and return spring means 17 disposed between the cylinder 11 and the fluid displacement means 12.

35 The cylinder 11 includes a tube 18 formed of steel or the like and of which one end is received within a groove 19 formed on the inner face of a follower or base plate 20 and fixed thereto as by welding to form a fluid-tight juncture. Disposed within the cylinder bore 21 inwardly of the open end 22 of the tube 18 is an intermediate cylinder head 23 having an axial opening 24. The intermediate cylinder head 23 may be suitably fixed within the bore 21 by means of snap rings. A sealing ring may be disposed between the contacting surfaces of the cylinder head 23 and the inner wall of the cylinder 11 to form a fluid-tight seal.

40 The fluid displacement means 12 includes a piston head 25 reciprocable within the cylinder bore 21 and defines on the closure plate side thereof the high pressure chamber 15 and on the cylinder head side the low pressure chamber 16.

45 Seated within a groove formed in the periphery of the piston head 25 is a guide and sealing ring 26 which is preferably formed of a laminated phenolic resin. The guide and sealing ring 26 is constructed so that the outer guiding surface thereof extends above the outer periphery of the piston head 25 and thereby precludes metal-to-metal contact of the piston head 25 with the cylinder wall.

50 Fixed to the piston head 25 as by welding is one end of a tubular piston rod 27 which extends through the axial opening 24 of the intermediate cylinder head 23. As shown, the outer periphery of the piston rod 27 and the inner periphery of opening 24 are radially spaced and define therebetween an annular opening 28 which pro-

vides communication between the low pressure chamber 16 and the flexible reservoir 13.

As shown in particular in FIGS. 3 and 8, a follower or base plate 29 is connected to the other end of the tubular piston rod 27. The base plate 29, similarly to the base plate 20, may be of substantially rectilinear contour as shown in FIGS. 3 and 4. In order to fixedly secure the base plate 29 to the tubular piston rod, a fastening plug 30 is inserted into the end of the piston rod bore 31. The end of the piston rod bore 31 may be slightly enlarged so that the fastening plug 30 seats against a shoulder 32. At the terminal end, the fastening plug is fixed within the bore as by a J-weld 33.

The base plate 29 is formed on its inner face with a recess 34 which snugly receives the terminal end portion of the tubular piston rod 27. On its outer face the base plate 29 is formed with a circular recess 35 which accommodates the head 36 of a fastening bolt 37 of which the threaded shank 38 extends through an opening 39 in the base plate 29 and is threadably received within an internally threaded hole 40 in the fastening plug 30. It is to be noted that the circular recess 35 is of a diameter greater than the distance across opposite corners of the hexagonal head (major diameter). Thus the flats 41 of the head 36 are spaced from the recess circumferential wall 42.

To prevent relative turning of the base plate 29 and the tubular piston rod 27 a dowel pin 43 or the like is inserted through the recessed portion thereof and into the fastening plug 30. As shown, the dowel pin 43 is located between the recess circumferential wall 42 and one of the flats 41 of the head 36. Inserted within the circular recess 35 in overlying relationship with the dowel pin 43 is a segment plate 44. The segment plate 44 is arranged so that the chordal face 45 thereof lies in flush abutting relationship with one of the flats 41 and the circumferential face 46 in snug engagement with the recess circumferential face 42. The segment plate 44 is fixed within the recess by way of a weld applied along the upper edge of the mating circumferential face 46 and circumferential wall 42.

The above described dowel pin arrangement results in maintaining the base plate 29 fixed against turning on the end of the tubular piston rod 27. At the same time the segment plate 44 prevents the dowel pin 43 from being displaced and prevents the fastening bolt 37 from turning so that the latter holds the base plate 29 securely fixed to the tubular piston rod 27 against detachment therefrom.

The piston head 25 is reciprocable within the cylinder bore 21, as heretofore described, and includes an axial orifice 47 through which the hydraulic fluid flows between the high pressure chamber 15 and the low pressure chamber 16 via the piston rod bore 31 and an array of ports 48 provided in the piston rod 27 inwardly of the piston head 25. The forward or high pressure face 49 of the piston head 25 is formed with a conical feed surface 50 which merges with the orifice 47.

To obtain an energy absorbing or resisting force which remains as close as practically possible substantially constant during each increment of travel of the unit from its fully extended neutral position in FIG. 1 to the fully contracted or compressed position, there is provided the metering pin 14. The metering pin 14 serves to meter the flow of the fluid through the orifice 47 by varying the effective flow area thereof.

In accordance with the present invention the metering pin 14 is formed from a forging having integrally formed on one end thereof an annular attaching flange 51 for fastening the pin on the base plate 20. As shown in particular in FIGS. 5-7 and 9, the forged metering pin 14 includes an elongate body portion 52 of substantially constant diameter along the length thereof and which is machined to be snugly slidable within the orifice 47.

Formed along the length of the metering pin body 52

is a plurality of angularly spaced flutes 53, each of which vary similarly in cross-section along the length thereof so that upon relative movement between the cylinder 11 and the piston head 25 moving along the metering pin flutes 53 there is provided a varying effective orifice area which imparts a substantially constant force-travel characteristic to the cushion device. To this end, the flutes 53 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 47 and the flutes 53 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 53 may be varied somewhat from the above relationship to achieve the desired constant-force travel characteristics for any given situation. For a more detailed description of the flutes 53 and the fluid metering achieved thereby, reference is made to the aforementioned patent.

As shown in particular in FIG. 9, the end portion of the length of the metering pin body 52 which extends through an opening 54 in the base plate 25 may be of slightly larger diameter than the fluted or metering length of the pin 14. The integral flanged end 51 is received within a circular recess 55 formed on the outer face of the base plate 20. Seated within an annular groove 56 formed in the bottom wall 57 of the recess 55 is a sealing gasket in the form of an O-ring 58 which is compressed between the bottom recess wall 57 and the inner surface 59 of the flange 51 when the angularly spaced fastening studs 60 extending through the flange 51 are tightened within the complementary located internally threaded openings 61.

From the foregoing description of the metering pin 14, it should be readily apparent that the fastening thereof to the base plate 20 results in a rigid fluid-tight connection. The rigidity is achieved primarily by way of the unitary metering body 52 and the fastening flange 51 of which the latter is held in firm engagement with the bottom wall 57 of the recess 55. Moreover, the O-ring 58 compressed between the inner surface 59 of the flange 51 and the recess bottom wall 57 serves to prevent fluid leakage. At the same time the unitary structure of metering pin facilitates the original fastening and replacement thereof, if necessary. In connection with the replacement or removal of the metering pin 14 it is to be noted that there is provided an axial internally threaded opening 62 which is adapted to receive the threaded end of a removal tool (not shown). Also, as more fully to be explained hereafter, the fastening arrangement provides a convenient means for filling the cushion unit with hydraulic fluid.

The flexible reservoir or boot 13 which serves as a reservoir for hydraulic fluid displaced during the contraction of the hydraulic cushion unit 10 may be formed from a fluid-impervious flexible material capable of resisting the corrosive effects that the hydraulic fluid may have. Advantageously, the material may be rubber of the type having special additives for low temperature flexibility. The thickness of the casing or rubber boot 14 is selected to provide the greatest strength and ruggedness commensurate with the flexibility required and may be, for example, $\frac{3}{16}$ inch.

The boot 13 is fixed by means of hose clamps at one end to a boss 63 formed on the intermediate cylinder head 23 and at the other end, which is reversely turned, to the tubular piston rod 27. As shown in FIGS. 1 and 2, the boot 13 is flexed between a deflated condition wherein the boot is devoid of any substantial quantity of fluid to an expanded condition wherein the boot accommodates hydraulic fluid displaced during contraction of the unit.

The return spring means 17 interposed between the base plates 20 and 29 and which serves to return the hydraulic cushion unit 10 to the neutral position of FIG. 1 may be a plurality of springs 17a, 17b and 17c arranged in tandem.

Assuming that the hydraulic cushion device 10 is assembled to the extent that the metering pin is not attached thereto so that the opening 54 in the base plate is unobstructed, hydraulic fluid is charged into the cushion device 10 via the opening 54. The fluid enters the high pressure chamber 15 and into piston rod bore 31 via the piston head orifice 47 and through the array of ports 48 into the low pressure chamber 16 from whence it is free to flow into the boot 13 via the annular opening 28. The hydraulic fluid is charged in a sufficient quantity such that the device is completely filled when the metering pin 14 is fastened thereto and exerts in the neutral position of the device 10 a minimum pressure of about 2 p.s.i.

Assuming further that the hydraulic cushion device is employed in a cushion underframe railway car and is interposed between the lading supporting and coupler mounting structures thereof, in the absence of shock impact at the couplers the components of the hydraulic cushion device assume the neutral position shown in FIG. 1. Upon shock impact in either buff or draft, the cylinder 11 and the piston head 25 move relatively to each other toward the compressed or contracted position illustrated in FIG. 2.

As the cushioning device 10 contracts under the impact or force being cushioned, the metering pin 14 displaces hydraulic fluid contained within the piston rod bore 31 through the ports 48 into the low pressure chamber 16 and through the annular opening 28 into the boot 13 causing the latter to expand.

At the same time, the hydraulic flow initiated by the relative movement of the piston head 25 and the cylinder 11 is directed from the high pressure chamber 15 to the low pressure chamber 16 via the orifice 47, the piston rod bore 31 and the ports 48. Thence the hydraulic fluid flows into the boot 13. The rate of flow through the orifice 47 is controlled by way of the metering pin 14 and the flutes 53 formed thereon by varying the effective orifice area in a manner that achieves a substantially constant resisting force for each increment of travel of the components. Contraction of the unit continues until the open end of the cylinder 11 contacts the closure plate 29. After the shock has been fully dissipated, the return springs 17a, 17b and 17c acting in tandem are operative to return the hydraulic cushion device components to the initial neutral position as limited by contact of the stop ring 63 fixed to the piston rod 27 with the intermediate cylinder head 23.

During this movement under the action of the return springs 17a, 17b and 17c, the hydraulic fluid flow previously described is reversed and the boot 13 deflates and

returns to the position shown in FIG. 1, thereby insuring that the hydraulic fluid displaced by the piston head is restored to its original location.

What is claimed is:

In a hydraulic cushion device comprising a cylinder having a bore, a first base plate fixed to one end of said cylinder, an intermediate cylinder head fixed within said cylinder bore inwardly of the open end of said cylinder, said intermediate cylinder head defining on one side thereof with said first base plate a hydraulic fluid-filled bore and on the opposite side thereof adjacent said open end a flexible boot reservoir chamber, an axial opening in said intermediate cylinder head, a piston head means reciprocable within said bore and having a hydraulic fluid orifice means formed therein, said piston head means defining within said bore a high pressure chamber with said first base plate means and a low pressure chamber with said intermediate cylinder head, a tubular piston rod extending outwardly through said intermediate cylinder head axial orifice, a flexible boot reservoir connected between said intermediate cylinder head and said outwardly extending end of said tubular piston rod, said flexible boot reservoir having fluid communication with said cylinder bore, a second base plate fixed to the other end of said tubular piston head, and return spring means disposed between said first and second base plates, the improvement comprising a fastening plug fixed in the other end of said tubular piston rod, a circular recess formed on the outer face of said second base plate, a bolt having a polygonal head with a threaded shank screwed into said fastening plug for securing said second base plate to said piston rod, said polygonal head being disposed in said circular recess, a dowel pin extending through said base into said fastening plug, parallel with the threaded shank of said bolt and terminating at one end substantially flush with the base of said circular recess, and a chordal plate fixed within said recess in overlying relationship of said dowel pin, said chordal plate having a diameter substantially equal to the diameter of said circular recess and a side forming the chord thereof abutting and lying flush with one of the flatted sides of said polygonal head.

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ARTHUR L. LA POINT, *Primary Examiner*.

MILTON BUCHLER, *Examiner*.