July 13, 1965 R. A. RASMUSSEN 3,194,415

LONG TRAVEL HYDRAULIC CUSHION DEVICE

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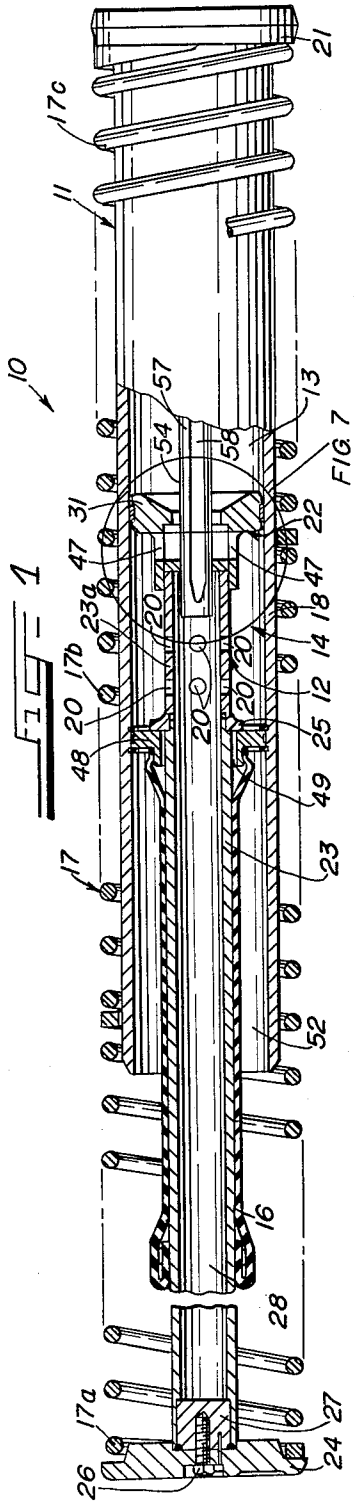


FIG. 1

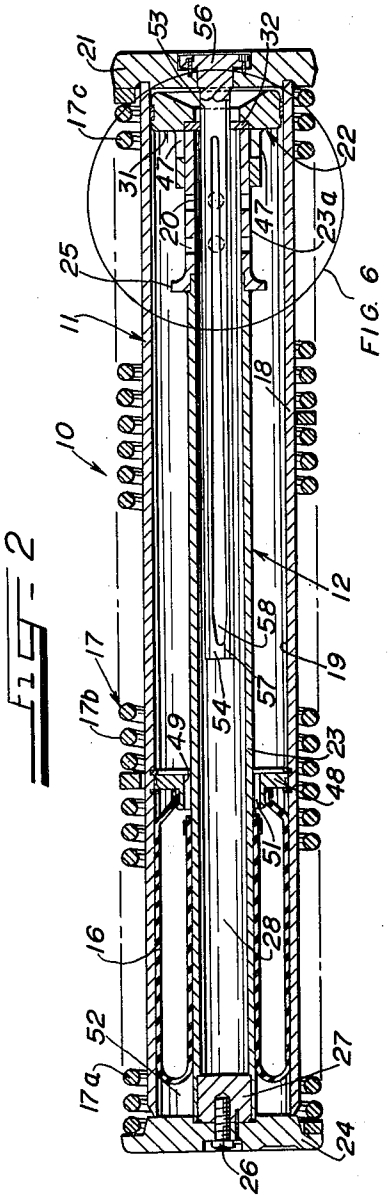


FIG. 2

FIG. 6

FIG. 7

INVENTOR.
ROBERT A. RASMUSSEN
BY
Wayne Morris Russell
ATTY.

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FIG. 3

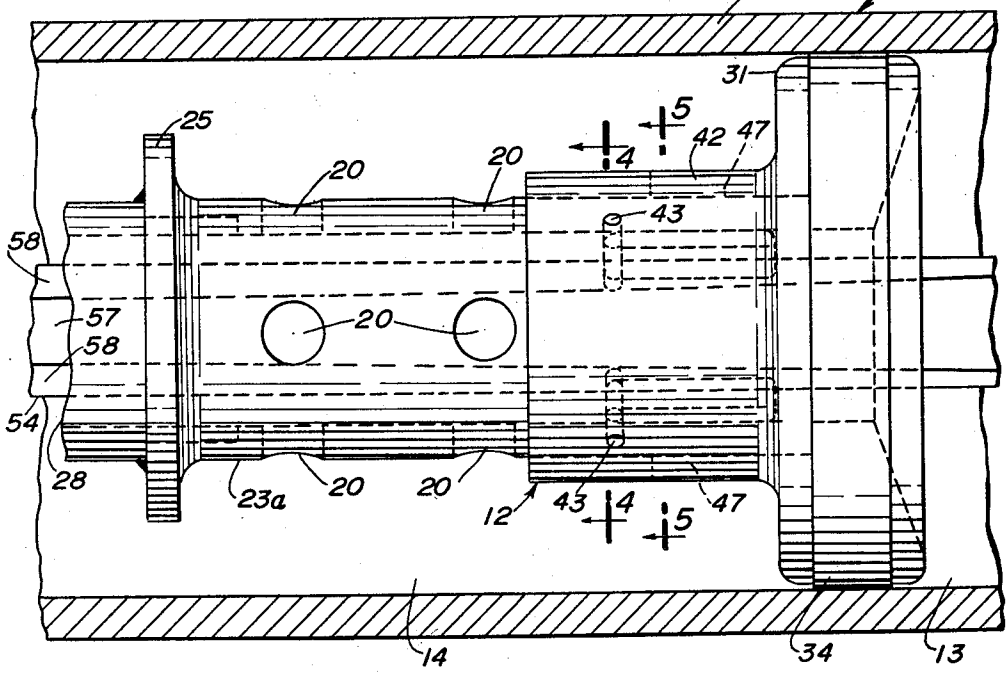


FIG. 5

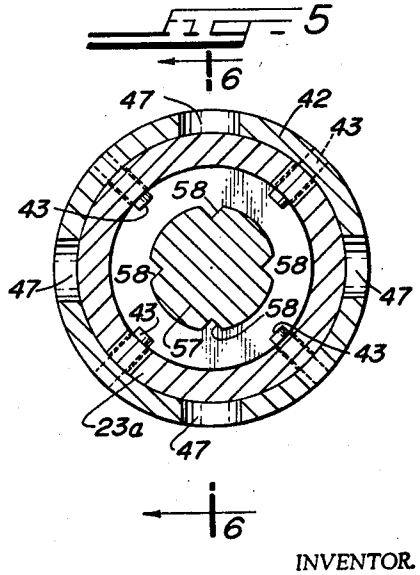
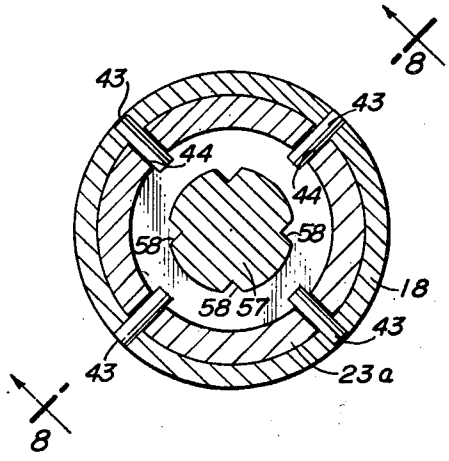


FIG. 4



INVENTOR.

ROBERT A. RASMUSSEN

BY Wayne Morris Rasell.

Atty.

July 13, 1965 R. A. RASMUSSEN 3,194,415

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FIG. 6

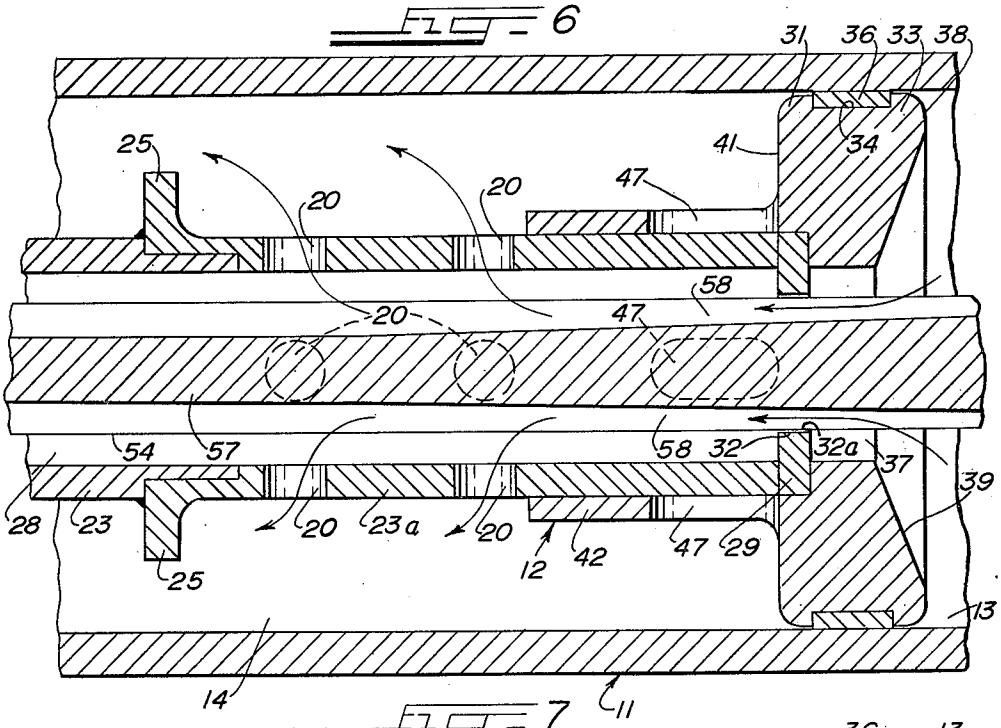
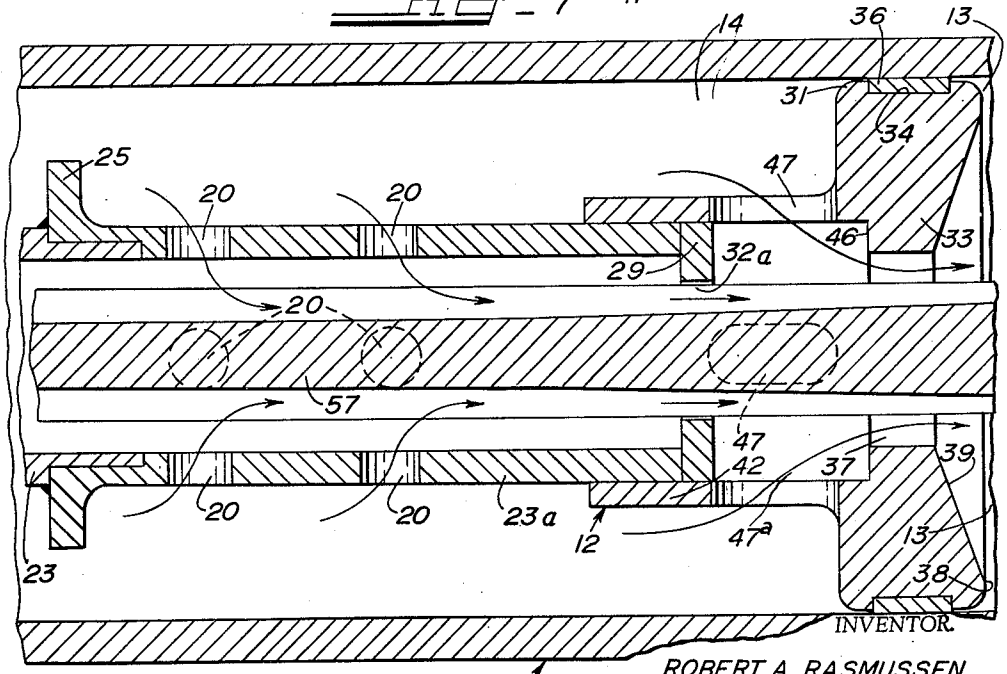


FIG. 7



INVENTOR.
ROBERT A. RASMUSSEN
BY
Wayne Morris Russell
Atty

July 13, 1965 R. A. RASMUSSEN 3,194,415

LONG TRAVEL HYDRAULIC CUSHION DEVICE

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Fig. 8

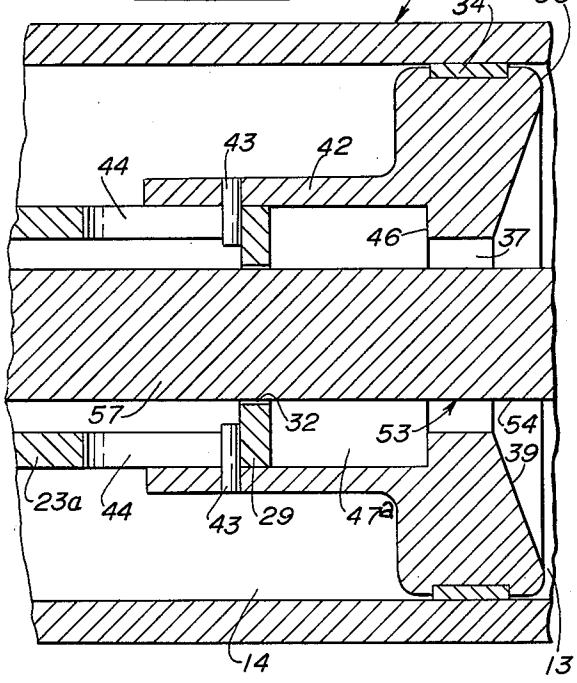
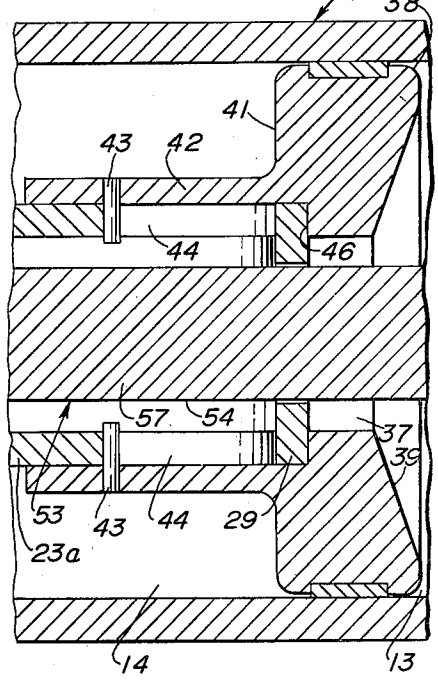


Fig. 9



INVENTOR.

ROBERT A. RASMUSSEN

BY

Wagner Morris Russell

ATTY.

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3,194,415

LONG TRAVEL HYDRAULIC CUSHION DEVICE

Robert A. Rasmussen, Portage, Ind., assignor to Pullman Incorporated, Chicago, Ill., a corporation of Delaware

Filed Dec. 18, 1963, Ser. No. 331,501
6 Claims. (Cl. 213—43)

The present invention relates to cushion devices and more particularly to a hydraulic cushion device of the type employed in cushion underframe railway vehicles for the purpose of providing car body and lading protection.

A hydraulic cushion of the general type to which the present invention relates is disclosed in U.S. Patents 3,003,436, 3,035,714 and 3,035,827. The first mentioned patent in particular discloses the operation of the hydraulic unit in a typical cushion underframe car.

The hydraulic cushion comprises generally a hydraulic fluid-filled cylinder and a fluid displacement means telescopingly disposed therein for displacing fluid from a high pressure chamber to a low pressure chamber upon impact causing relative contraction to either the cylinder or fluid displacement means. Associated with the low pressure chamber is an expandable reservoir which expands to receive a portion of the fluid from the high pressure chamber. Disposed between the cylinder and the fluid displacement means is a return spring means which is operative upon dissipation of the impact to return the relative telescoping cylinder and the fluid displacement means to the neutral position.

During the return, the direction of fluid flow is reversed under the influence of the force exerted by the returning fluid displacement means and the inflated tube such that the hydraulic fluid again returns to the high pressure chamber.

The present invention is primarily directed toward an arrangement for providing a rapid return flow of the hydraulic fluid from the low pressure chamber to the high pressure chamber. Rapid return flow of the hydraulic fluid is frequently required to render the cushion device fully effective upon a rapid sequence of oppositely directed impact forces applied thereto. In the absence of a rapid return flow of the hydraulic fluid, the flexible reservoir associated with the low pressure chamber may be excessively inflated and the high pressure chamber may be only partially filled and have a vacuum therein. Under these conditions, should an impact be applied it is obvious that the cushion unit would not provide a resisting force of the same magnitude as when the high pressure chamber is completely filled and that the flexible reservoir will be further inflated beyond its intended capacity.

By the present invention it is proposed to provide the fluid displacement means with a fluid flow arrangement which is operative during the return of the cushion unit from the compressed position to the neutral position to admit a greater flow to the high pressure chamber than occurs during the telescoping or compression of the fluid displacement means and cylinder. The fluid displacement means of the hydraulic cushion unit of the general type embodied in the present invention is in the form of a piston head having an axial orifice and is attached to one end of a tubular piston rod. To provide hydraulic fluid communication between the high pressure chamber on one side of the piston head to the low pressure chamber on the other side thereof via the orifice and the piston rod bore, a plurality of radial ports are formed in the piston rod. The flow through piston head orifice is gradually diminished by means of a metering pin to provide a resisting force which is approximately constant for each increment of travel of the cushion unit toward the compressed position.

When the hydraulic cushion unit is in the contracted or compressed position the flow through the metering pin is disposed so that substantially all of the flow of the hydraulic fluid is cut off therethrough. Hence, during the return movement the hydraulic fluid flow occurs through the orifice at a gradually increasing rate to the maximum rate at the neutral position.

To admit a greater flow to the high pressure chamber during the return stroke the piston head of the present invention is formed of two members of which one of the members is slidably fastened to the piston for lengthwise movement thereon and the other of the members is formed with the orifice and is fixedly secured to the piston rod.

The slide piston member is fastened to the rod such that during the contraction of the device fluid flow is possible only through the orifice. During the return stroke the slide piston member is positioned on the piston rod relative to the orifice by the pressure forces of the hydraulic fluid so that communication is established between the low pressure and high pressure chambers in a manner providing an additional flow passage which bypasses the orifice.

In the drawings:

FIG. 1 is a plan view, partially in cross-section, of a hydraulic cushion device embodying the present invention, the hydraulic cushion device being shown in the extended or neutral position thereof;

FIG. 2 is a cross-sectional view of the hydraulic cushion device of FIG. 1, but showing the device in its compressed or contracted position;

FIG. 3 is a fragmentary side elevational view of the piston head end of the fluid displacement means, and showing in particular the piston head construction;

FIG. 4 is a cross-sectional view of the piston head taken generally along the lines 4—4 of FIG. 3;

FIG. 5 is a cross-sectional view of the piston head taken generally along the lines 5—5 of FIG. 3;

FIG. 6 is an enlarged fragmentary cross-sectional view taken generally within the encircled portion of FIG. 2 and showing in particular the relative positions assumed by the piston head components during the contraction movement of the cushion device;

FIG. 7 is a fragmentary cross-sectional view of the piston taken generally within the encircled portion of FIG. 1 showing in particular the relative positions assumed by the piston head components during the return movement of the cushion device to the neutral position;

FIG. 8 is an enlarged cross-sectional view taken generally along the lines 8—8 of FIG. 4; and

FIG. 9 is an enlarged cross-sectional view similar to FIG. 8, but showing the position assumed by the components during the contraction of the cushion unit.

Referring now to the drawings, there is shown a hydraulic cushion device 10 comprising generally a hydraulic fluid-filled cylinder 11 and a fluid displacement means 12 telescopingly disposed therein for lengthwise movement between the neutral position shown in FIG. 1 and the contracted position shown in FIG. 2. During contraction caused by an impact force applied on the ends of the fluid displacement means 12 or the cylinder 11, the hydraulic fluid is caused to flow from a high pressure chamber 13 to a low pressure chamber 14. Associated with the low pressure chamber 14 is a flexible reservoir 16 which, in the form shown, comprises a flexible boot reservoir which is expanded upon being filled with the displaced hydraulic fluid. Disposed between the cylinder 11 and the fluid displacement means 12 is return spring means 17 which is operative upon dissipation of the impact energy to return the cushion device 10 from the contracted position shown in FIG. 2 to the neutral position shown in FIG. 1.

The cylinder 11 may be formed from a metal tube 18 made from steel or the like and having a cylinder bore 19. Suitably fixed as by welding to one end of the tube 18 is a base or follower plate 21.

Telescopingly disposed within the open end of the tube 18 for lengthwise movement therein is the fluid displacement means 12 which comprises generally a piston head assembly 22 fastened to one end of a tubular piston rod 23. Fixed to the other end of the rod 23 so as to form a fluid-tight seal is a second base or follower plate 24.

The tubular piston rod 23 may be made from a suitable rigid material such as steel. The rod end 23*a*, to which the piston head assembly 22 is fixed, may be a separate section having a stop shoulder 25. Formed in the section 23*a* is an array of ports 20 providing fluid communication between the piston rod bore 28 and the low pressure chamber 14. The follower plate 24 is fastened to the outer end of the rod 23 by means of a bolt 26 which is threaded into a block 27 suitably fixed within the piston rod bore 28 as by welding.

In accordance with the present invention, the piston head assembly 18 (FIGS. 3–9) is formed of two components comprising an orifice plate member 29 fixed to the inner end section 23*a* of the piston rod 23 and a slidable head member 31. As shown, the orifice plate member 29 is in the form of an annular ring having an orifice 32 coaxially disposed relative to the piston rod bore 28 and of lesser diameter than the latter. The annular ring or orifice plate member 29 also serves as stop ring for the slide head member 31 as more fully to be explained hereinafter.

The slide head member includes a head 33 formed of cast iron or the like and having a diameter slightly less than the inner diameter of the cylinder bore. Seated within a groove 34 formed on the periphery of the head 33 is a sealing and guiding ring 36 which sealingly engages the inner wall of the cylinder bore. Preferably the sealing ring 36 is made from a laminated phenolic resin.

The head 33 is formed with an axial opening 37 having a diameter which is greater than the diameter of the orifice 32. The forward face 38 is formed with a rearwardly tapering face so as to provide a feed surface 39. Extending from the rear face 41 is an integral seleeve 42 which is lengthwise slidable on the end section 23*a* of the piston rod 23. Angularly spaced about the sleeve 42 and fixed thereto are a plurality of slide pins 43 which are accommodated within complementary guide slots 44 formed on the inner end piston rod section 23*a*. Limiting the lengthwise sliding of the slide head is the annular orifice plate member 29 which overlies the inner ends of the guide slots 44 and thereby also serves as a stop plate to limit outward extension of the piston slide head 31 relative to the piston rod 23. As shown in FIG. 9, in the fully contracted position a shoulder 46 defined by the inner end of sleeve bore 47*a* abuts against the orifice plate member 29.

To provide fluid communication between the low pressure chamber 14 and the high pressure chamber 13 bypassing the orifice 32 there is formed in the sleeve 42 a plurality of hydraulic fluid passages 47. The passages 47, as shown in particular in FIGS. 5–7, are angularly spaced in staggered relationship to the guide pins 43 so that fluid communication is cut-off during the movement of the cushion device to the contracted position as shown in FIG. 6.

During the return travel of the cushion device 10 the slide head 31 assumes the position shown in FIG. 7 wherein the slide head is extended relative to the inner end of the piston rod 23. In this position the fluid passages 47 are located outwardly of the orifice plate member 29 so that hydraulic fluid flows therethrough into the sleeve bore 47*a* and through the opening 37.

Associated with the low pressure chamber 14 is the expansible flexible reservoir which, in form shown, is a flexible boot 16 connected at one end as by a hose clamp to an intermediate cylinder head 48 fixed within the cylinder bore. The other end of the flexible boot 16 is reversely bent and is fixed to the tubular piston rod 23 as by a hose clamp.

The intermediate cylinder head 48 includes an axial opening 49 through which the piston rod 23 extends and defines therewith an annular passageway 51 to provide fluid communication between the low pressure chamber 14 and the flexible boot 16. The intermediate cylinder head 48 is located inwardly of the open end of the cylinder to provide a boot chamber 52 which accommodates the expanded boot 16 as shown in FIG. 2.

Fixed to the base plate 21 is a metering means 53 for metering the flow of hydraulic fluid through the orifice 32 so as to impart to the cushion device a preferable substantial constant resisting-force characteristic. As shown, the metering means 53 is in the form of pin 54 having an integrally formed head 56 seated within a recessed opening formed in the outer face of the base plate 21 within which the head is fixed as by screws. Extending from the head 56 is an elongate metering body 57 of substantially uniform circular section along its length. The circular section body 57 is snugly slidable through the orifice 32 and extends into the piston rod bore 28.

To control the hydraulic fluid flow through the orifice 32, lengthwise extending flutes 58 of gradually varying depth are formed on the periphery of the metering body 57. As shown in particular in FIG. 2, the flutes are tapered to provide a gradually diminishing flow as the cushion device travels toward the contracted position until substantially no flow occurs at the fully contracted position. The effective orifice area at the orifice 32 as defined by the width and depth of the flutes and the rim of the orifice is thus varied so as to obtain a flow therethrough which achieves a resisting force which is approximately constant for each increment of travel to the contracted position.

Assuming that the hydraulic cushion device 10 is disposed for interaction between a sliding sill and a stationary sill of a cushion underframe railway vehicle (all not shown), upon impact at the couplers the force of impact causes the fluid displacement means 12 and the cylinder 11 to travel from the neutral position shown in FIG. 1 to the contracted position shown in FIG. 2. In the absence of impact and when the cushion device is in the neutral position, the slide head member 13 may be fully extended as shown in FIGS. 7 and 8. However, as soon as the travel is initiated, the force of the hydraulic fluid in the high pressure chamber 13 acting on the forward face 38 of the side head member 33 causes the latter to slide rearwardly on the piston rod section 23*a* to the position shown in FIGS. 6 and 9. In this position of the slide head 33, the hydraulic fluid flows only through the orifice area 32 defined by the rim 32*a* of the flutes 58 of the metering pin 54 and thence into the piston rod bore 28.

As the cushion device contracts, the metering pin body 54 displaces fluid outwardly into the low pressure chamber 14 via the ports 20 and thence via the annular opening 51 into the flexible boot reservoir 16. At the same time the fluid displaced from the high pressure chamber 13 and into the piston rod bore 28 also flows into the low pressure chamber 14 through the ports 20.

When the cushion device 10 has completed its travel to the fully contracted position, flexible boot reservoir 16 is inflated by the displaced hydraulic fluid received therein to the extent that it substantially occupies the full volume of the boot chamber 52 as shown in FIG. 2. Should an excessive volume of fluid be introduced into the boot reservoir it should be readily apparent that the latter would further expand outwardly both radially and longitudinally of the cylinder.

Upon dissipation of the kinetic energy of the impact, the spring means 17 which, as shown, comprises three springs 17*a*, 17*b* and 17*c* acting in tandem are operative to return the hydraulic cushion unit 10 to the neutral position. As the cushion unit returns, the fluid displacement means 12 moves outwardly relative to the open end

of the cylinder. As this outward movement occurs, the pressure forces of the hydraulic fluid in the low pressure chamber 14 acting on the rear face 41 of the slide head 33 are operative to slide the slide head 33 to the extended position shown in FIGS. 7 and 8.

In the extended position of the slide head 33 shown, the fluid passages 47 in the sleeve are clear of the annular orifice member 29 so that the fluid is free to flow therethrough into the high pressure chamber 13 via the sleeve bore 47*a* and the opening 37 as indicated by the arrows in FIG. 7. It should be readily apparent that the flow through fluid passages 47, at least during the initial portion of the return stroke, provides a greater flow area than occurs through the effective orifice area at the metering pin 54 which, as above described, is substantially closed-off to flow through the orifice 32 in the contracted position of the cushion device 10 and provides only a restricted flow area during the initial portion of the return travel. Hence, when the slide head 33 is extended, the additional flow area of the fluid passages 47 is available along with the effective area at the orifice member 32 so that adequate flow occurs from the low pressure chamber 14 to the high pressure chamber 13.

In this manner the accumulation of an excessive quantity of hydraulic fluid within the flexible boot is prevented such that the latter does not expand beyond the confines of the cylinder boot chamber 52 and become entangled with the return springs 17*a*, 17*b* and 17*c*. Moreover, the additional hydraulic fluid flow through the fluid passages 47 assures that the high pressure chamber is filled so that a vacuum is not formed therein.

What is claimed is:

1. A hydraulic cushion device comprising a hydraulic fluid-filled cylinder having a closed end and an open end, a piston head assembly reciprocable within said cylinder from a neutral position between said open end and said closed end of said cylinder and a contracted position adjacent said closed end, said piston head assembly defining a high pressure chamber adjacent the closed end of said cylinder and a low pressure chamber adjacent the open end of said cylinder, a tubular piston rod fastened at one end to said piston head assembly, said tubular piston rod having the other of said ends extending outwardly of said open end of said cylinder, an expandable hydraulic fluid receiving reservoir communicating with said low pressure chamber and connected between said cylinder and said piston rod for closing-off said open end of said cylinder, spring means for returning said piston head assembly from said contracted position to said neutral position, said piston head assembly including an orifice plate fixed to said one end of said tubular piston rod and having an orifice axially aligned with the bore of said tubular piston rod, a metering pin fixed to said closed end of said cylinder and projecting through said orifice to provide a gradually diminishing effective orifice area as said piston head assembly moves toward said contracted position, said piston head assembly further including a slide head longitudinally slidable mounted on said one end of said tubular piston rod for movement between a position abutting said orifice plate member when said piston head assembly moves toward said contracted position and a position extended from said orifice plate when said piston head moves to said neutral position, said slide head having fluid passage means by-passing said orifice in said orifice member when said slide head is in said extended position to provide direct hydraulic fluid communication between said low pressure and high pressure chambers.

2. The invention as defined in claim 1 wherein said slidable head includes a sleeve member slidably mounted on said one end of said bore.

3. The invention as defined in claim 2 wherein said head includes an axial bore extending through said sleeve member and wherein said sleeve member is formed with fluid passages communicating with said head axial bore.

4. The invention as defined in claim 3 wherein said fluid passages are located on said sleeve member such that hydraulic fluid flow is cut-off when said slide head is in said abutting position.

5. In a hydraulic cushion device including a hydraulic fluid-filled cylinder, and a fluid displacement means reciprocable within said cylinder from a neutral position intermediate the ends of said cylinder and a contracted position adjacent one end of said cylinder and being operative during reciprocation between said neutral and contracted positions to displace fluid between a high pressure chamber and a low pressure chamber, said fluid displacement means comprising a tubular piston rod, an annular orifice plate fixedly-secured to one end of said tubular piston rod and having an orifice coaxially disposed relative to the bore of said tubular piston rod, a slide head slidably mounted on said tubular piston rod for lengthwise movement relative thereto from a position abutting said annular orifice plate when said fluid displacement means moves from said neutral to said contracted position to an extended position relative thereto when said fluid displacement means returns from said contracted position to said extended position, said slide head having hydraulic fluid passage means located therein such that no hydraulic fluid flow occurs therethrough in said abutting position and hydraulic fluid flow occurs therethrough to provide hydraulic fluid communication between said low pressure chamber and said high pressure chamber and by-passing said orifice only when said slide head is in said extended position.

6. The invention as defined in claim 5 wherein said slide head includes a sleeve slidably mounting said slide head on said one end of said piston rod, an axial passage communicating with the bore of said sleeve, and hydraulic fluid passage means formed in said sleeve and located so that hydraulic fluid flows therethrough into said sleeve bore only when said slide head is in said extended position.

No references cited.

LEO QUACKENBUSH, *Primary Examiner.*