Nov. 16, 1965 W. H. PETERSON 3,218,052

HYDRAULIC CUSHION METERING PIN ARRANGEMENT

Filed Oct. 23, 1963 4 Sheets-Sheet 1

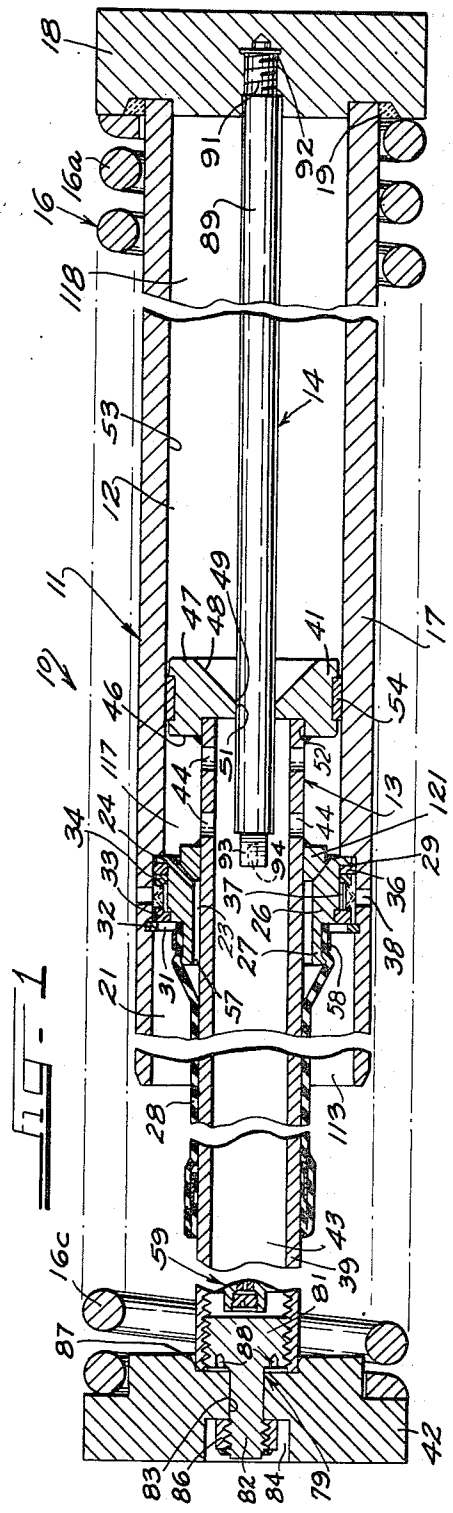

FIG - 1

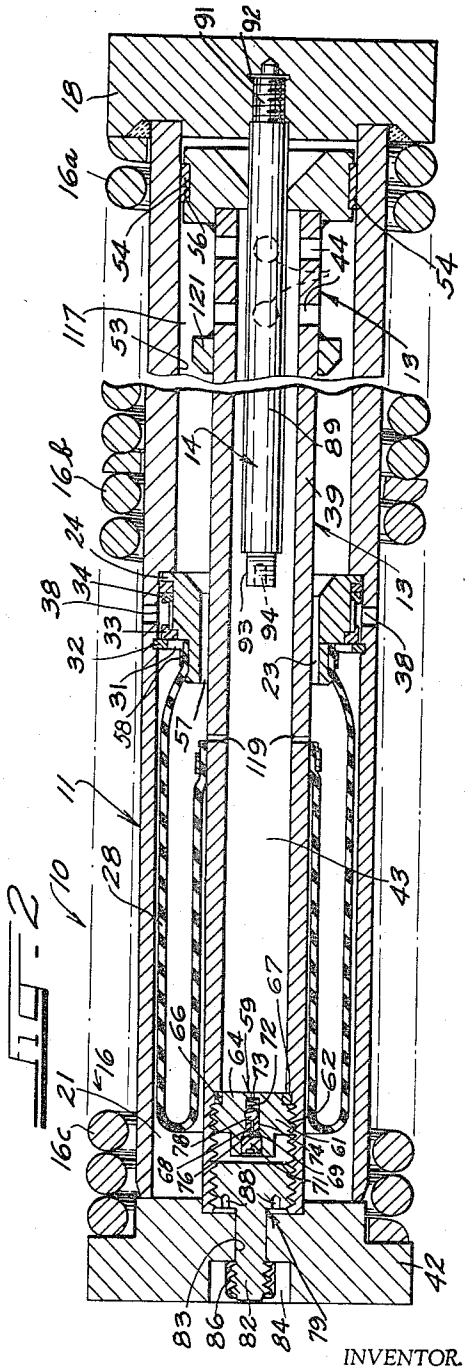

FIG - 2

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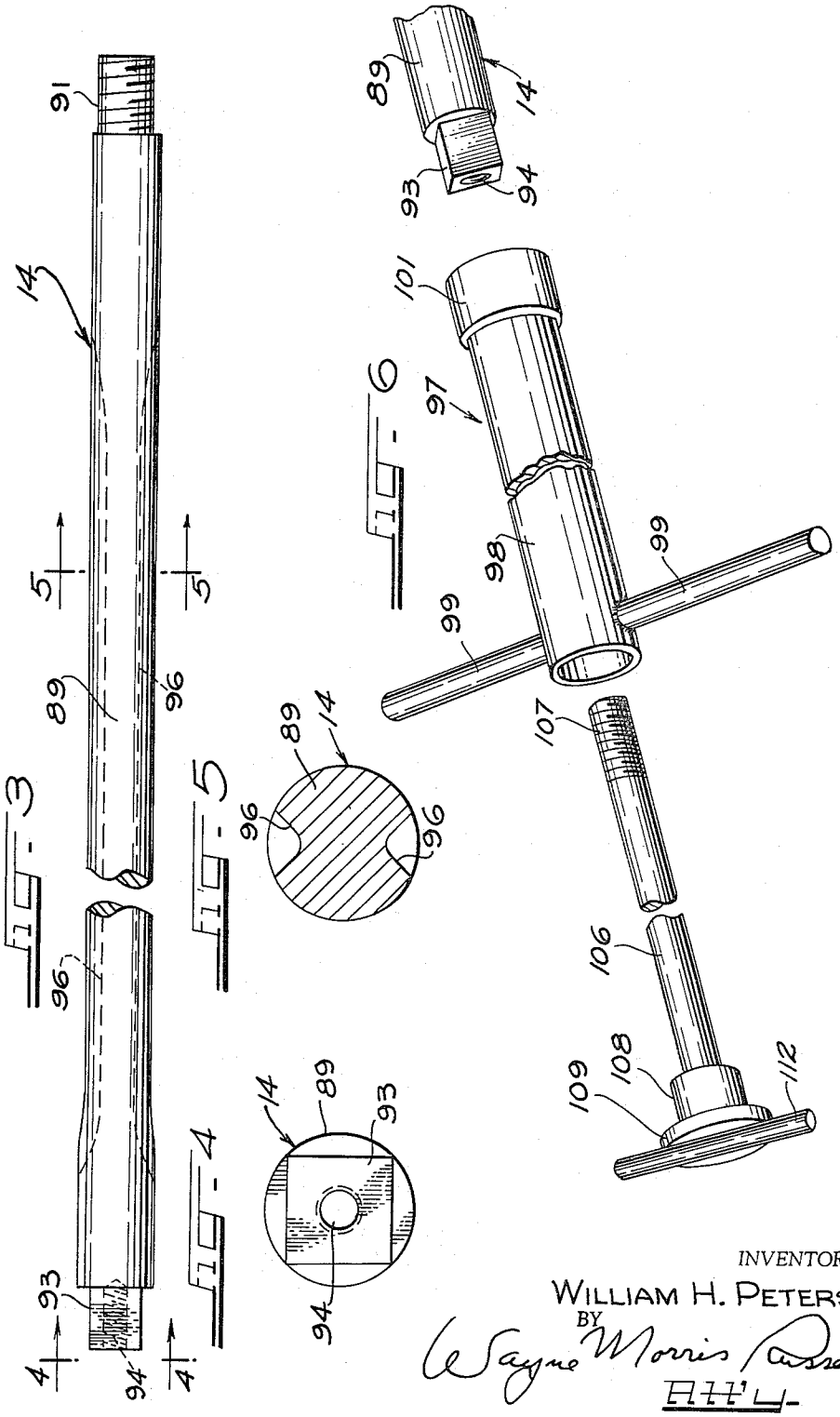
HYDRAULIC CUSHION METERING PIN ARRANGEMENT

Filed Oct. 23, 1963 4 Sheets-Sheet 2



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HYDRAULIC CUSHION METERING PIN ARRANGEMENT

Filed Oct. 23, 1963 4 Sheets-Sheet 3

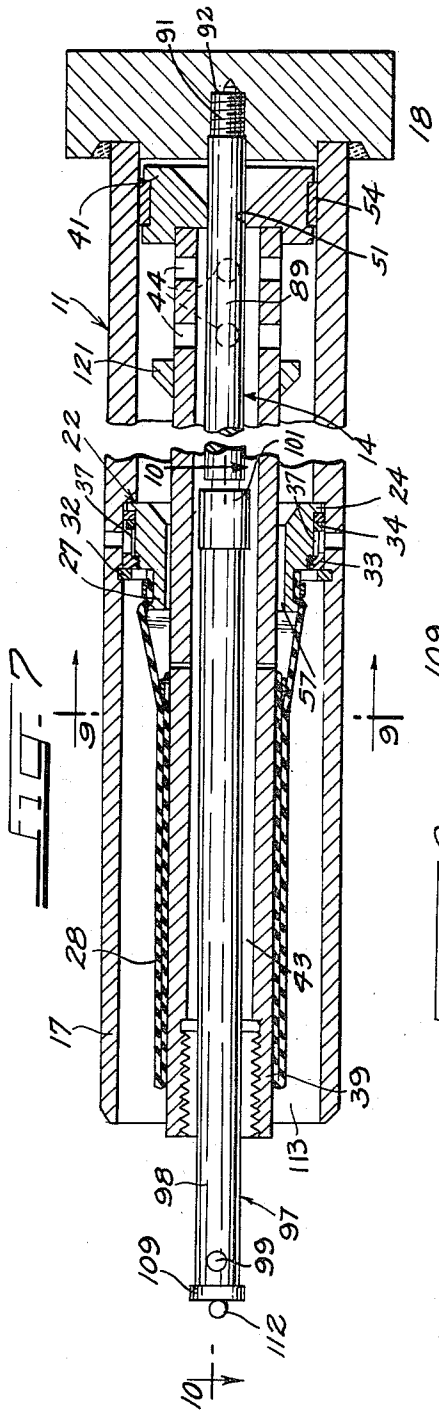

FIG. 7

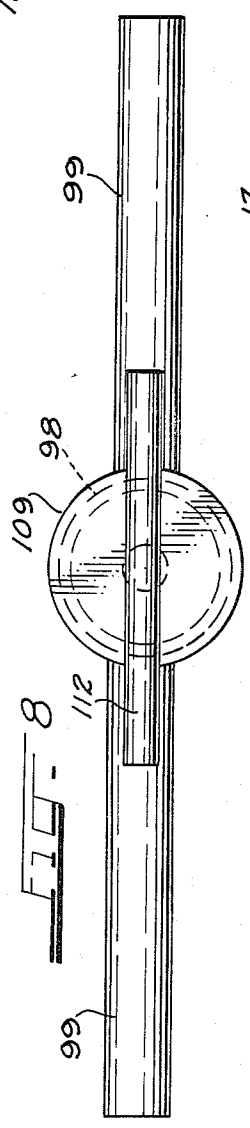

FIG. 8

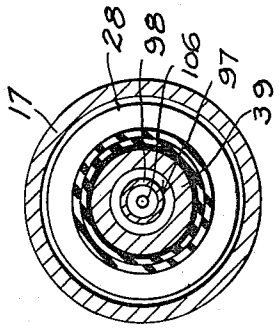

FIG. 9

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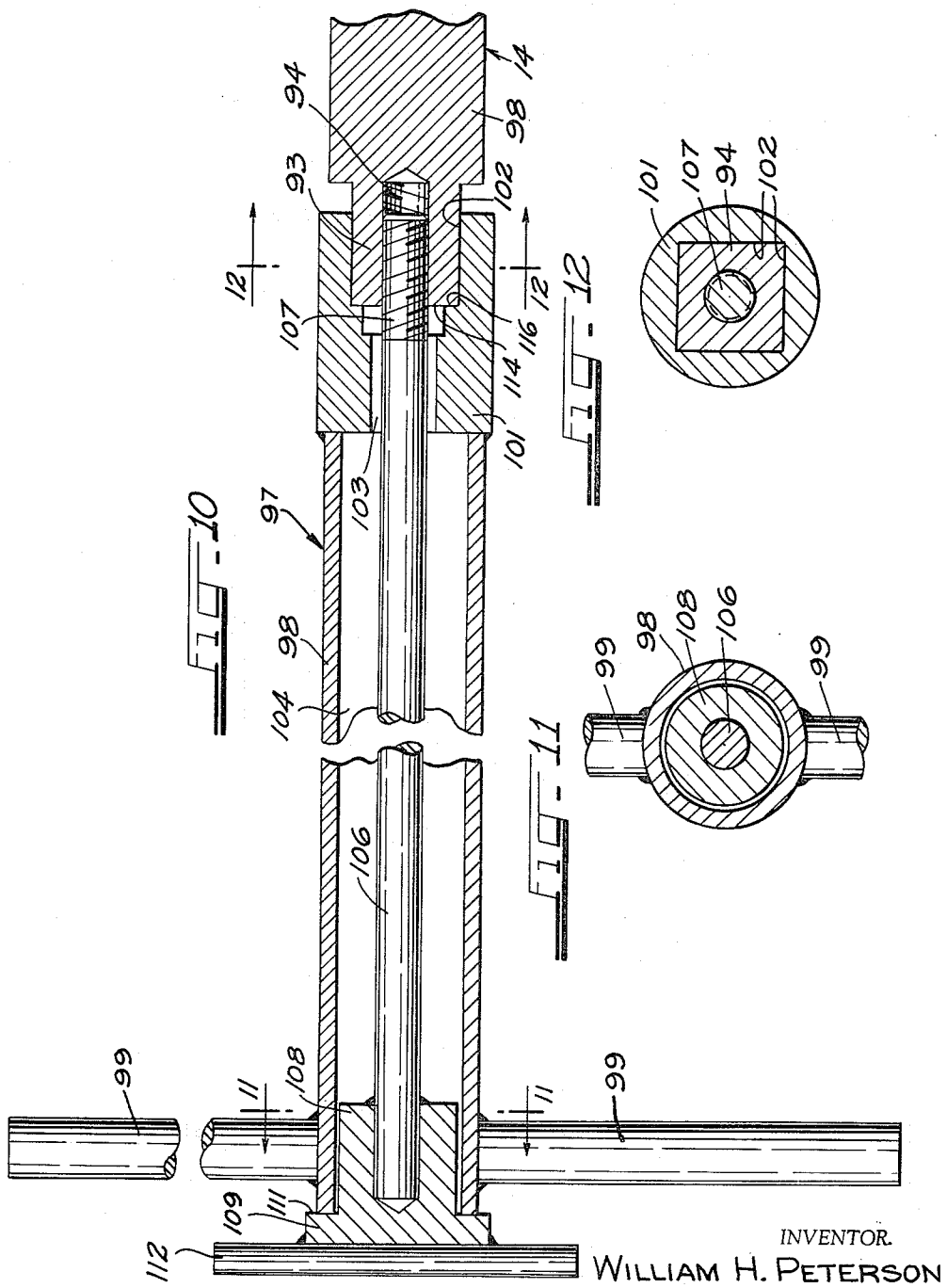
HYDRAULIC CUSHION METERING PIN ARRANGEMENT

Filed Oct. 23, 1963 4 Sheets-Sheet 4



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United States Patent Office

3,218,052

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3,218,052

HYDRAULIC CUSHION METERING PIN ARRANGEMENT

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1 Claim. (Cl. 267—1)

The present invention relates to hydraulic cushion devices and more particularly to an improved cushion device and to a means and method for assembling the cushion device.

The hydraulic cushion device of the present invention is of the general type comprising basically two relatively telescoping members having arranged therebetween the hydraulic fluid which is operative upon the application of an impact force on the members to dissipate a portion of the kinetic energy of the impact force. A cushion device embodying the general principles to which the improvements present invention relate is shown and described in U.S. patent, No. 3,003,436.

It is a principal object of the present invention to provide a hydraulic cushion device constructed and arranged to prevent fluid leakage during use.

It is a further object to provide an improved hydraulic cushion device having a new and novel metering pin attachment structure which is constructed and arranged to prevent fluid leakage from the device during use.

It is another object to provide an improved hydraulic cushion device wherein the metering pin employed to control the cushioning force of the device is formed with a threaded end which is threadably fastened within a blind opening in the cylinder head of the device and is formed at its other end with an attachment section adapted to receive an assembly tool for threading the metering pin in the blind opening.

It is still another object of the present invention taken in conjunction with the foregoing objects to provide an assembly tool for facilitating the attachment of the metering pin in the device.

It is a further object of the present invention to provide a new and novel method for assembling the cushion device.

In the drawings:

FIG. 1 is a fragmentary cross sectional view of a cushion device embodying the present invention with the components shown in the normal extended or neutral position.

FIG. 2 is a fragmentary cross sectional view of the cushion device, but showing the components in the contracted position.

FIG. 3 is a fragmentary view of the metering pin employed in the cushion device.

FIG. 4 is an end view of the metering pin taken generally along the lines 4—4 of FIG. 3.

FIG. 5 is a cross sectional view of the metering pin taken generally along the lines 5—5 of FIG. 3.

FIG. 6 is a fragmentary exploded view of the assembly tool employed to fasten the metering pin within the cushion cylinder and showing the attachment projection on the metering pin which is seatable within the socket of the tool.

FIG. 7 is a fragmentary cross sectional view of a partially assembled cushion device and showing in particular the disposition of the assembly tool therein for securing the metering pin on the cylinder head.

FIG. 8 is an end view of the assembly tool.

FIG. 9 is a cross sectional view taken generally along the lines 9—9 of FIG. 7.

FIG. 10 is an enlarged fragmentary cross sectional view of the assembly tool and the attachment projection of the metering pin taken generally along the lines 10—10 of FIG. 7.

FIG. 11 is a cross sectional view taken generally along the lines 11—11 of FIG. 10.

FIG. 12 is a cross sectional view taken generally along the lines 12—12 of FIG. 10.

Referring now in particular to FIGS. 1 and 2, there is shown a cushioning device **10** embodying the present invention and including generally a cylinder **11** having a bore **12** charged with a suitable hydraulic fluid; a fluid displacement means **13** telescopingly arranged relative to the cylinder **11** for movement from a normal fully extended or neutral position (FIG. 1) to a contracted position (FIG. 2) upon the application of a shock force to the device **10** and being operative during such movement to displace the hydraulic fluid within the bore **12** to dissipate a portion of the kinetic energy of the impact force; a metering pin **14** for controlling the displacement of the fluid within the bore **12** to impart an approximate constant force travel closure characteristic to the device; and a resilient means **16** disposed between the fluid displacement means **13** and the cylinder **12** for returning the components to their fully extended position upon dissipation of the shock force.

The cylinder **11** includes a tubular shell **17** formed preferably from a rigid metallic preformed tube capable of withstanding the internal pressures to which the cylinder is subject during use. The shell **17** may be formed of cold drawn steel tubing of which the inner wall is formed with a smooth finish to permit efficient operation of the fluid displacement means **13** therein.

The shell **17** is closed at one end by a cylinder head **18** having a groove **19** formed therein for receiving the end of the shell **17** and the latter is fixed therein as by welding to form a leak proof joint. The cylinder head **18** which may be of any suitable contour such as for example, circular or rectilinear, is sized to project outwardly of the outer diameter of the shell to form a retaining ledge against which one end of the resilient means or spring means **16** abuts.

As shown, the other end of the shell **17** is formed with a boot chamber bore **21** of larger diameter than the bore **12**. Disposed within the boot chamber bore **21** is an intermediate cylinder head **22** having an axial opening **23**. The intermediate cylinder head **22** may be formed at the inner end with an inner section **24** of a diameter substantially equal to the diameter of the boot chamber bore **21**, an intermediate section **26** of lesser outer diameter outwardly of the inner section **24**, and a boss **27** on which one end of a flexible boot reservoir **28** is secured as more fully to be explained hereinafter.

Fixing the intermediate cylinder head **22** within the boot chamber bore **21** is a snap ring **31** which is disposed within a groove **32** formed in the inner wall. The snap ring **31** is engageable with a collar **33** threadably fastened on the outer end of the intermediate section **26** of the intermediate cylinder head **22** such that the inner section abuts and is held firmly engageable with the shoulder **29**.

Slidable on the intermediate section **26** and disposed between the snap ring **31** and the inner section **24** is a ring member **34** and a sealing gasket **36** such as an O ring. A plurality of radially spaced bendable clips **37** compress the O ring **36** between the ring member **34** and the inner section **24** so that a substantially fluid tight seal is formed at the inner wall of the boot chamber bore **21**. As shown in the phantom lines in FIG. 1, the bendable clips **37** are initially inserted in bent form between the collar **33** and the slidable ring member **34** and thereafter flatten.

Access to insert the clip members and to straighten the latter is achieved through radially spaced openings **38** formed in the shell **17**. Upon straightening of the clips

the slidable ring 34 is urged toward the inner section 24 such that the resilient gasket 36 is compressed therebetween and thus causes the latter to radially expand and sealingly engage the inner wall of the boot chamber bore 21. In this manner a fluid tight seal is formed at the intermediate cylinder head 22.

The fluid displacement means 13 includes a piston rod 39 to one end of which there is fixed a piston head 41, which is reciprocable within the cylinder bore 12 between the cylinder head 18 and the intermediate cylinder head 22. Fastened to the other end of the piston rod 39 is a second cylinder head 42.

The piston rod 39 is of tubular construction including a bore 43 and may be formed of a rigid material such as cold drawn steel. Radially spaced ports 44 are formed in the piston rod 39 adjacent to the piston head 41 for providing communication between the piston rod bore 43 and the cylinder bore 12 as more fully to be explained hereinafter.

The piston head 41 is preferably formed from a metal such as steel and comprises a disk like body having a planar forward face 46 and a planar rearward face 47. The planar rearward face 47 merges it into a conical feed surface 48 which terminates in a rim 49 defining the perimeter of an orifice 51 formed axially in the piston head 41. The piston head 41 is formed on its forward face 46 with a recess 52 which receives the terminal end of the tubular piston rod 39 and the latter is fixed thereto as by welding.

For guiding the fluid displacement means 13 for relative telescoping movement within the cylinder bore 12 and for forming a seal between the inner wall 53 of the cylinder 11 and the piston head 41, the latter is provided with an elevated seal forming and guiding member 54. In this connection it is mentioned that the cushioning device 10 is primarily intended for use in railway vehicle car structures for providing lading and car body protection. When thus employed, the cushioning device 10 is disposed between the coupler carrying structure and the lading supporting structure to absorb a sufficient portion of the energy of the impact to protect the lading and car body. The structural environment in which the cushion device 10 is employed is such that relative cocking may occur between the cylinder 11 and the fluid displacement means 13. This cocking condition may result in galling between the metallic surfaces of the piston head and the cylinder wall.

To preclude galling and at the same time form a seal, the member 54 is formed as a split ring made preferably from a laminated phenolic resin. The split ring 54 is seated within a peripheral groove 56 formed in the piston head 41 such that the outer circumference thereof contacts the inner wall 53 above periphery of the metallic piston head 41. The guiding and sealing ring 54, which is primarily characterized by its non-affinity for the metallic surface and its ability to conform to the contour of the inner wall 53, forms an efficient and effective sealing and guiding means.

The tubular piston rod 39 is of a diameter which defines an annular passage 57 with the axial opening 23 in the intermediate cylinder head 24 and provides communication between the low pressure chamber 117 on one side of the piston head 41 and the flexible boot reservoir 28. The flexible boot reservoir or invaginating tube 28 is formed from a fluid impervious flexible material which is capable of resisting the corrosive or deteriorating effects which may be present in the hydraulic fluid employed in the device and advantageously may be a neoprene-buna type of rubber having special additives for low temperature flexibility. The invaginating tube 28 is fixed at one end to the boss 27 of the intermediate cylinder head 26 by means of a hose clamp 58. At its other end, the invaginating tube 28 is reversely bent and the reversely bent end is fixed to the tubular piston rod 39 also by means of a hose clamp 58. To firmly grip the ends of the invaginating tube 28 on the respective surfaces, these surfaces may be suitably roughened as by knurling, scoring, or the like.

Disposed within the tubular piston rod bore 43 adjacent to the free end thereof, may be a charging check valve assembly 59. The charging check valve assembly 59 includes a body member 61 having a threaded end portion 62 which is screwed into the internally threaded end of the piston rod bore 43 and a forwardly projecting reduced end portion 63. The threaded end portion is formed with a reduced end 64 about which there is disposed a sealing gasket such as an O ring which is compressed against a shoulder 67 and to form a leak proof seal.

Extending through the body 61 is a fluid charging passageway 68 including a closure cap chamber 69 into which a closure cap 71 is threaded when the device 10 has been charged with hydraulic fluid. Communicating at one end with the closure chamber 69 is a check valve chamber 72 which communicates at its other with an orifice 73 which opens into the tubular piston rod bore 43.

Threadably fastened within the check valve chamber 72 is a valve seat member 74 having an orifice 76 which provides communication between the closure cap chamber 69 and the check valve chamber 72. Normally urged in seating engagement over the orifice by means of a spring 77 is a ball check valve 78.

Securing the second cylinder head 42 on the tubular piston rod 39 is a fastening member 79 having an externally threaded portion 81 which is screwed into the internally threaded end of the tubular piston rod 39. Projecting outwardly from and integral with the threaded portion 81 is a shank 82 which extends through an axial opening 83. Threaded on the outer end of the shank 87 which projects into a recess 84 formed on the outer face of the second cylinder 42 is a nut 86 which is tightened so that the end of the tubular piston rod 39 is firmly clamped within a recess 87 formed on the opposite face of the second cylinder head 42. In order to facilitate the insertion of the cylinder fastening member 79 within the tubular piston rod 43, the forward face of the body may be provided with a pair of diametrically spaced openings 88 for receiving a spanning wrench, or the like.

The metering pin 14 comprises a rod which may be of constant circular cross section along the major portion of its length to provide a metering section 89 and is formed with a threaded end 91 which is threadably fastened within an axial blind opening 92 formed on the inner side of the first cylinder head 18. At the other end the metering pin 14 is formed with an attachment projection 93 of substantially rectilinear section. Coaxially formed in the attachment projection 93 is an internally threaded hole 94. The attachment projection 93 and the threaded hole 94 formed therein are provided to facilitate the attachment of the metering pin 14 to the cylinder head 18 as more fully to be described hereinafter.

The metering section 89 of the metering pin 14 is slidable and extends through the piston head orifice 51 and is formed along the length thereof with flutes 96 of gradually tapering depth as shown in FIG. 5. Upon relative movement between the cylinder 11 and the fluid displacement means 13 as occurs upon application of an impact force at either the cylinder head 18 or cylinder head 42 the piston head 41 and the metering section 89 are moved relatively to each other so that the flow through the orifice 51 as determined by the depth of flutes 96 at substantially any given distance of travel impacts a substantially constant force travel closure characteristic to the unit.

To achieve the substantially constant force travel characteristic the flutes 96 are designed to conform to the expression

$$A_x = A_o\sqrt{l - \frac{x}{d}}$$

wherein A_x is the orifice area of any given position x over the total nominal stroke or length of travel l of the

device between its extended and or contracted position (substantially corresponding to the length of the surface in which the flutes **96** are formed) and A_o is the initial orifice area defined by the orifice **51** and the flutes **96** at the beginning of the stroke under conditions where a completely rigid body is being cushioned from impact.

In accordance with the present invention a metering pin assembly tool **97** as shown in FIGS. 6–12 is provided to facilitate the assembly of the metering pin **14** within the cylinder **11**.

The assembly tool **97** includes a hollow cylindrical tube or housing **98** adjacent one end of which there is fixed as by welding a pair of diametrically opposed hand grip members **99**. Fixed to the other end of the housing **98** is a socket member **101** having a socket **102** which may be of rectilinear contour complementary to the metering pin attachment projection **93** as shown in FIGS. 10 and 12. A coaxial opening **103** providing communication between the housing bore **104** and socket **102** is formed in the inner end of the socket member **101**.

Axially extending through the housing bore **104** is a retainer rod **106** having a threaded end **107** which is extendable through the opening **103** into the socket **102**. At the other end, there is fixed to the retainer rod **106** as by a force fit and welding a journal member **108** which turnably seats within the housing bore **104**. The journal member **108** further includes an enlarged head **109** having a diameter at least as great as the outer diameter of the housing **98** to provide a shoulder **111** which is abuttable against the end of the housing **98** and thereby limits inward movement of the retainer rod **106** within the bore **104** as shown. Fixed across the top of the head **109** is a handle **112**.

In accordance with the present invention, the sequence of the assembly of the cushion device **10** is arranged so that the components thereof may be utilized to facilitate the assembly of the metering pin thereto. To this end, the cylinder head is fixed to one end of the shell **17**. The piston head **41** is fixed to the end of the piston rod **39** and a stop ring **121** is fixed to the piston rod **39** outward of the ports **44**; and the intermediate cylinder head **22** may be slipped over the rod **39** for lengthwise movement. Also, the reversed end of the invaginating boot **28** is clamped to the piston rod **39** and the other end clamped to the boss.

The sub-assembly of the piston rod **39**, piston head **41**, invaginating tube **28**, and intermediate cylinder head **22** is then inserted through the open end **113** of the cylinder **11** with the piston head **41** disposed adjacent the cylinder head **18**. The intermediate cylinder head **22** is then fixed within the cylinder by way of the snap ring **32**. Thereafter, the bendable clips **37** are inserted through the openings **38** and straightened so that the slidably mounted ring member **34** is urged to the left as viewed in FIGS. 1 and 2 to compress the O ring **36** against the shoulder **29**.

The device **10** thus partially assembled is then supported vertically on the cylinder head **18** with the open end **113** extending upwardly preparatory to the insertion of the metering pin **14**.

To fasten the metering pin within the cylinder the metering pin **14** is initially fastened to the assembly tool **97** prior to inserting the metering pin within the cylinder bore **12**. This is accomplished by fitting the socket **102** in the socket member **101** over the rectilinear end section of the metering pin so the metering pin **14** is turnable with the housing **98**. Thereafter, the retainer rod **106** is turned within the bore **104** of the housing so as to screw the threaded end **107** within the internally threaded opening **94** and thereby cause the attachment projection **93** to be drawn further into the socket **102** until the terminal face **114** thereof is firmly seated against a shoulder **116**. In this manner the housing **98** of the tool **97** forms an extension of the metering pin **14** such that the overall length of the assembly tool **97** and metering pin **14** is greater than the overall length of the partially assembled unit as shown in FIG. 7.

The assembly tool **97** with the metering pin **14** attached thereto are then introduced through the bore **43** of the tubular piston rod **39** and through the piston head orifice **51**. When thus inserted through the metering pin orifice **51** as shown in FIG. 7 the latter serves as a guide for the metering pin **14** and aligns the threaded end thereof with the blind threaded opening **92** in the cylinder head **18**. The assembly tool **97** is then turned by means of the handles **99—99** to screw the metering pin **14** into the opening **94** until firmly fastened therein.

Detachment of the assembly tool from the metering pin is accomplished by holding the housing **98** against turning the retainer rod **106** relative thereto to unscrew the threaded end **107** from the metering pin threaded opening **94** so that the socket member **101** is freely slidably out of seating engagement with the attachment projection **93** and the tool **97** withdrawn from the piston rod bore **43**.

To complete the assembly of the device **10** the check valve assembly **59** with the closure cap **71** removed is inserted into the threaded end of the piston rod **59**. Thereafter, the device **10** is charged with a suitable hydraulic fluid. The hydraulic fluid flows through the closure cap chamber **69** and the orifice **76** past the unseated ball check **78** and through the fluid charging passageways **15** into the tubular piston rod bore **43** and into the low pressure chamber **117** of the cylinder bore **12** via the ports **44**. At the same time the hydraulic fluid flows into the invaginating tube **28** via the annular opening **57** about the piston rod **39** and through openings **119** formed in the piston rod **39** inwardly of the reversed end of the tube **28**.

Fluid also flows through orifice **51** in the piston head **41** and the metering pin flutes **96** into the high pressure chamber **118** of the device. The device **10** is charged to the extent that the pressure exerted by hydraulic fluid in the extended position of the device is maintained at a minimum, for example about 2 p.s.i.

To complete the assembly, the resilient return spring **16** is positioned about the cylinder and the second cylinder head **42** is fastened to the end of the piston rod **39**. As heretofore described, the cylinder head **42** is fastened to the piston rod **39** by means of the fastener **75** which is threaded into threaded end of the rod **39** with the stud portion **82** to which the cylinder head **18** is fastened projecting outwardly. The resilient return spring **16** is generally formed from a plurality of helical springs **16***a*, **16***b*, and **16***c* arranged to operate in tandem as shown. To fasten the cylinder head **42** on the stud **82** it may be necessary to employ a fixture or the like for holding the springs **16***a*, **16***b* and **16***c* sufficiently compressed at or below the end of the rod **39** so that the second cylinder head **42** may be fastened to the rod **39** without interference therefrom. After the spring is compressed the second cylinder head **42** is positioned on the stud **82** and the nut **86** is tightened. Thereafter, the spring fixture (not shown) may be removed so that the return springs **16***a*, **16***b*, and **16***c* are operative to maintain the cylinder **11** and fluid displacement means **13** in the normal extended position shown in FIG. 1.

Assuming that the hydraulic cushion device is employed in a railway car for the purpose for which it is primarily intended and is disposed between and operatively associated with the coupler carrying structure and the lading supporting surface for cushioning the force of impact applied on the coupler, the cushion device is normally in the fully extended position as shown in FIG. 1. Upon the application of a shock impact in either buff or draft at the couplers, the cushion device **10** is associated with the coupler carrying structure and the lading structure such that either the cylinder **11** will start movement in the direction of piston head **41**, or piston head **41** will

start movement toward cylinder head 18, or possibly both movements will occur.

As the cushioning device 10 thus contracts under the force being cushioned, the metering pin 14 displaces hydraulic fluid contained within the bore 43 of the piston rod 39 outwardly through the ports 44 into the low pressure chambers from where it flows via the annular opening 57 into the invaginating tube 28. At the same time the piston head 41 displaces fluid in the high pressure chamber 18 through the orifice 51 into the piston rod bore 43. The hydraulic flow through the orifice 51 is determined by its position relative to the flutes 96 which as heretofore described are formed so as to impact a substantially constant resisting force closure characteristic to the hydraulic cushion device 10. In other words, the flutes 96 of the metering pin are cooperative with the orifice 51 so that the flow of hydraulic fluid during substantially each increment of travel of the piston head 41 relative to the cylinder 11 results in a substantially constant cushioning effect resisting the force of impact.

The hydraulic flow caused by the relative movement of the piston head 41 and the cylinder 11 as above described flows from the high pressure chamber 118 through the orifice 51 and into the bore 43 of the tubular piston rod 39. Hence, the hydraulic fluid flows radially outward through the ports 41 into the low pressure chamber 117 of the cylinder bore 12. The hydraulic flow through the ports 41 occurs at a relatively high velocity so that turbulence is created as the displaced fluid enters the low pressure chamber 117. The turbulence is caused at least in the part by the radially directed flow of the fluid impinging directly against the inner wall of the cylinder 11 so that a major portion of the kinetic energy of the hydraulic fluid is dissipated in the form of heat. In this connection, it is to be noted that the stop ring 121 contacting the intermediate cylinder head 41 is effective to limit the volume of the low pressure chamber 117 and in this manner provides a chamber into which the hydraulic fluid displaced by the piston may freely enter as described above and thereby dissipate the kinetic energy in the form of the heat under minimum shock or load conditions.

During contraction of the cushioning device 10 the high pressure chamber 118 continues to reduce in volume because of the advancement of the piston head 41 toward the cylinder head 18. The hydraulic fluid passing through the orifice 51 fills the low pressure chamber 117, while at the same time a volume of hydraulic fluid equivalent to that displaced by the total entry into the chamber 117 of the cylinder 11 passes through the annular opening and into the reservoir defined by the invaginating tube 28 which inflates or expands and assumes substantially the position shown in FIG. 2.

After the shock has been fully dissipated the compression springs 16*a*, 16*b*, and 16*c*, acting in tandem between the cylinder heads 18 and 42 are operative to return the hydraulic cushion components to the initial position. During this movement, under the action of the compression springs, the hydraulic fluid flow previously described is reversed and the invaginating tube deflates and returns to the position shown in FIG. 1, thereby assuring that the hydraulic fluid displaced by the piston head 41 is restored to its normal operative position.

What is claimed is:

In a hydraulic cushion device comprising a cylinder having a bore, a first cylinder head fixed to one end of said cylinder, an intermediate cylinder head fixed within said cylinder inwardly of the other end thereof, an axial opening in said intermediate cylinder head, a piston head disposed within said cylinder bore for movement between said intermediate cylinder head and said first cylinder head, an axial orifice formed in said piston head, a tubular piston rod fixed at one end to said piston head and extending through said axial opening in said intermediate cylinder head, a flexible reservoir connected between said intermediate cylinder head and said piston rod, means providing communication between said cylinder bore and said flexible reservoir, and a second cylinder head fastened to the other end of said piston rod; the improvement comprising an axially threaded hole formed on the inner side and extending only partially through said first cylinder head, and a metering pin coaxially disposed within said cylinder, said metering pin being of lesser length than said tubular piston rod and including an intermediate portion of substantially uniform cross section along the length thereof and extending through said piston head orifice into said tubular piston rod, a threaded end formed on one end of said metering pin which is fastened in said threaded opening, and a projection of substantially rectilinear section formed on the remaining end of said metering pin for receiving a complementary socket head of an assembly tool adapted to be inserted through said piston rod prior to the fastening of said second cylinder head on said other end of said piston rod, said projection of rectilinear section having a centrally located threaded opening adapted to receive the threaded end of a retainer rod of the assembly tool.

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