Nov. 19, 1968 R. G. POWELL 3,411,635

RAILWAY CAR CUSHIONING DEVICE

Filed April 1, 1966 3 Sheets-Sheet 1

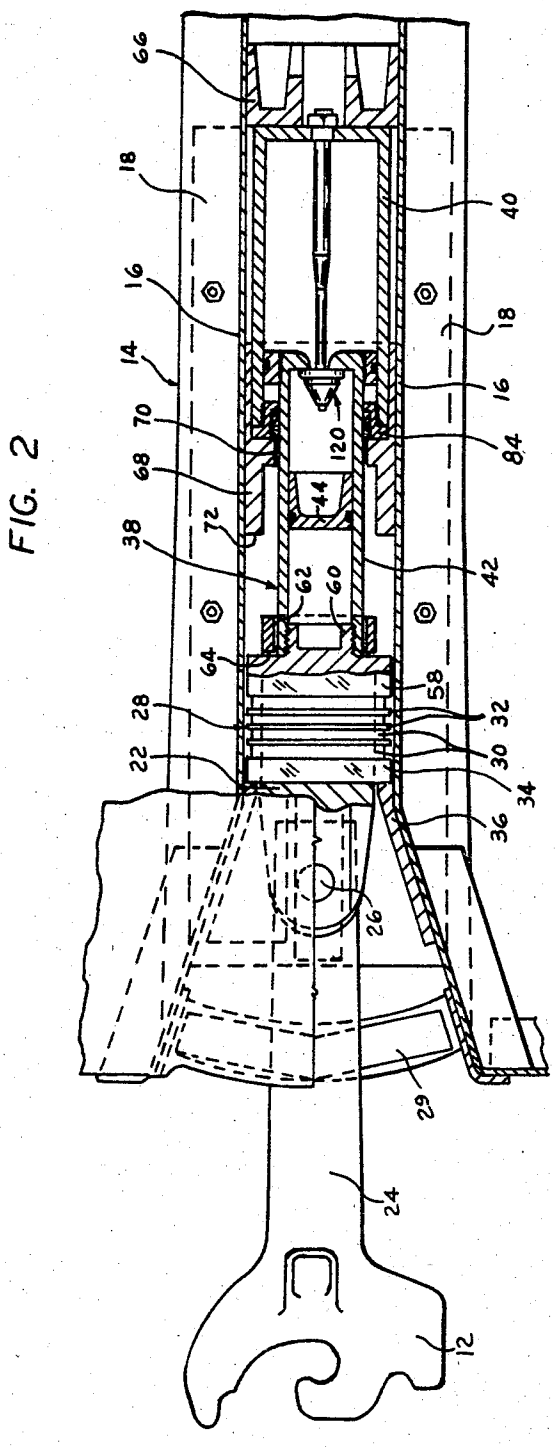


FIG. 2

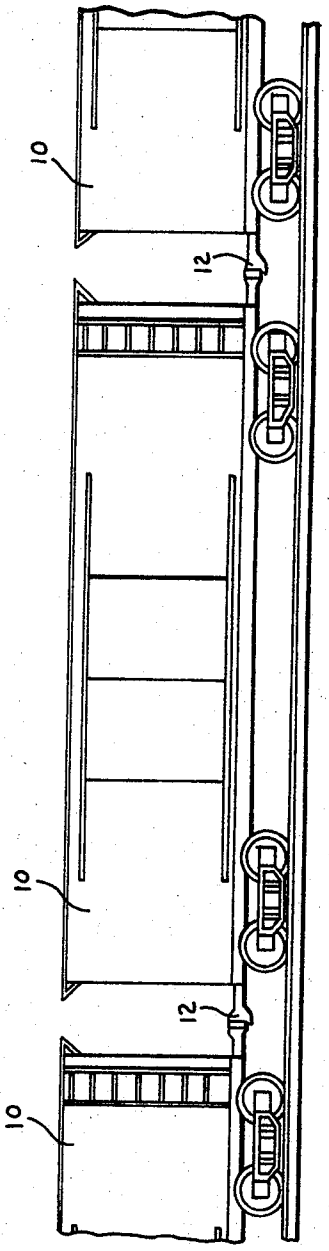


FIG. 1

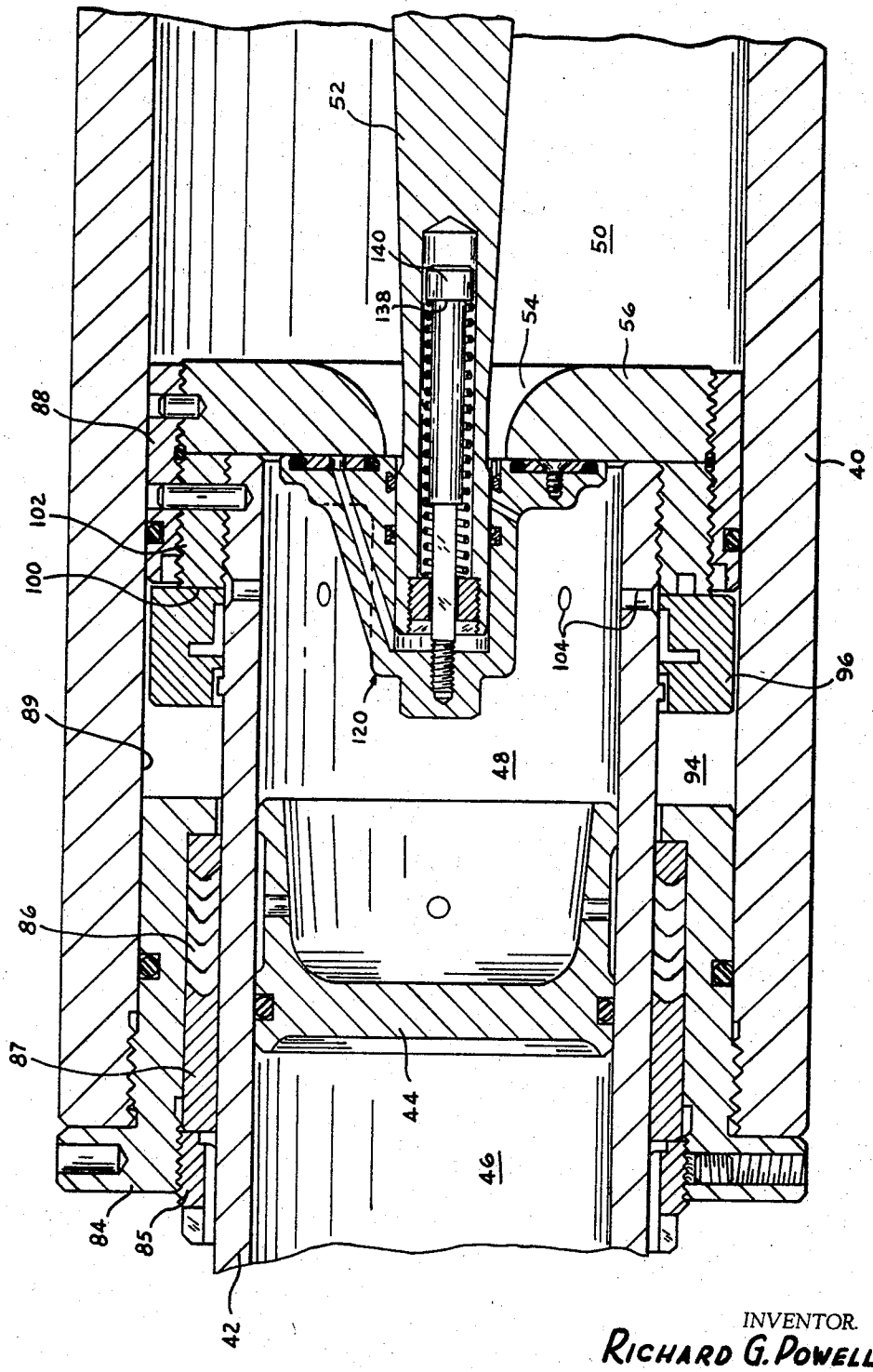
INVENTOR.
RICHARD G. POWELL
BY James E. Jackson
AGENT

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FIG. 3



INVENTOR.
RICHARD G. POWELL
BY James L. Jackson
AGENT

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FIG. 4

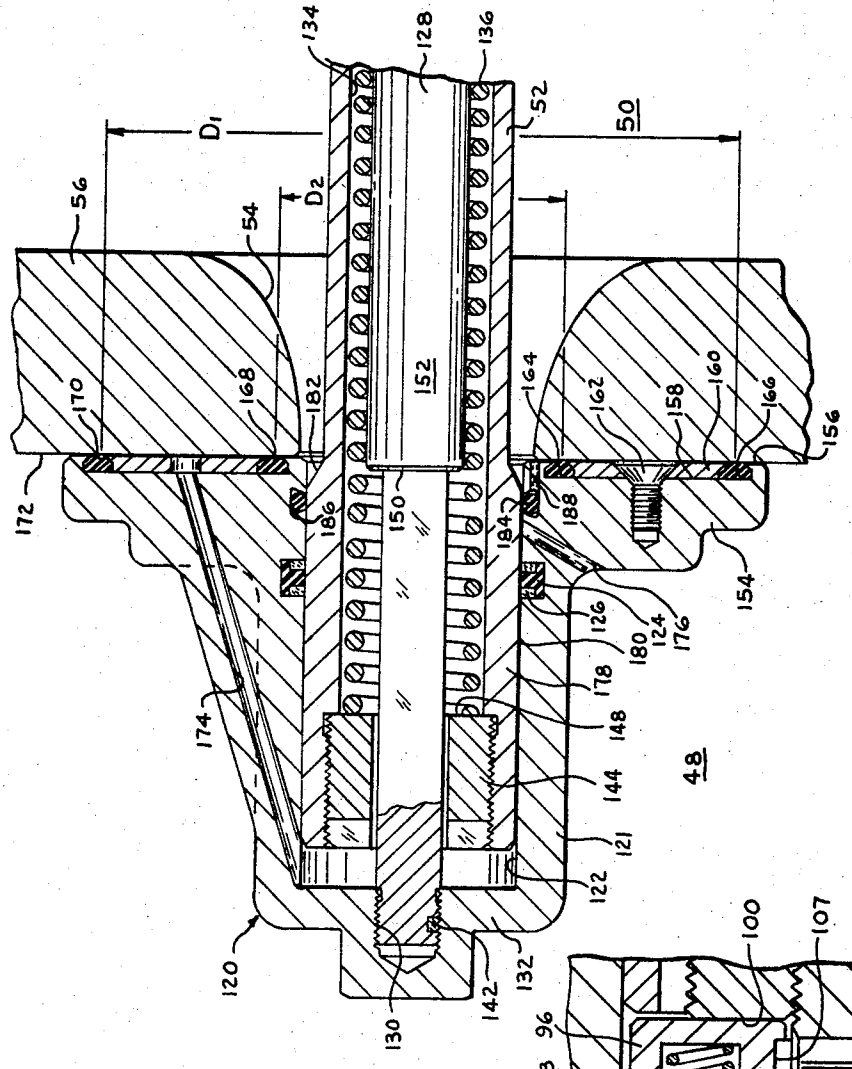


FIG. 5

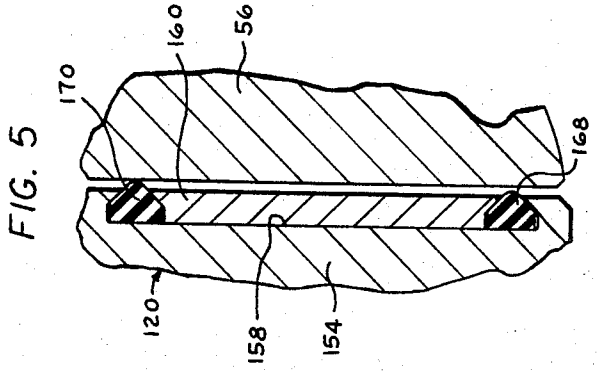
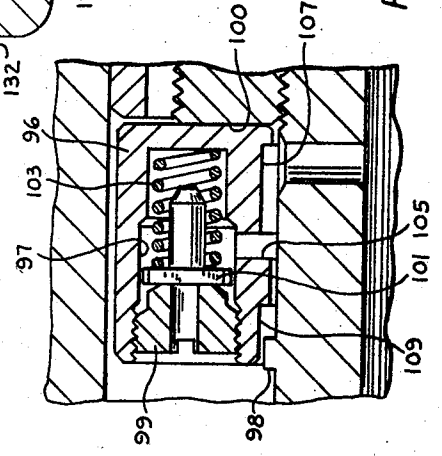


FIG. 6



INVENTOR.
RICHARD G. POWELL
BY
James L. Jackson
AGENT

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3,411,635

RAILWAY CAR CUSHIONING DEVICE

Richard G. Powell, Houston, Tex., assignor to ACF Industries, Incorporated, New York, N.Y., a corporation of New Jersey

Filed Apr. 1, 1966, Ser. No. 539,384
16 Claims. (Cl. 213—8)

ABSTRACT OF THE DISCLOSURE

An oleo-pneumatic cushioning device for railway cars which collapses and achieves internal metered transfer of hydraulic fluid between a pair of hydraulic chambers in addition to achieving compression of a compressible fluid within the unit to dissipate energy applied thereto. The unit includes a lockup device which is operative to prevent the interchange of hydraulic fluid between the hydraulic chambers upon the application to the unit of forces of low magnitude, but which is responsive to a predetermined increase in fluid pressure within one of the hydraulic chambers developed by the application of forces in excess of a predetermined magnitude to unlock and allow the interchange of hydraulic fluid between the hydraulic chambers thereby allowing the unit to collapse and dissipate energy.

This invention relates to cushioning devices for railway cars and more particularly to cushioning devices adapted to be operatively connected to a coupler adjacent the end of a railway car for absorbing impact forces exerted against the coupler.

The present invention is especially directed to a cushioning system or shock absorbing system in which the metering of a fluid is employed as an energy dissipative device. The majority of cushioning systems used for end-of-car cushioning employ the principal of hydraulic fluid metering to dissipate the energy. This method of energy dissipation is velocity sensitive in that the amount of energy dissipation is directly proportional to the velocity of fluid flowing through the metering orifice of the cushioning device. On downgrade run-ins of the cushioning devices, the velocity of fluid flowing through the metering orifice will be low and the energy dissipated will also be low allowing low loads to contract the cushioning device.

Because of the velocity sensitive nature of this method of energy dissipation, the cushioning device will be permitted to go solid or completely contract under the application of extremely low velocity impacts such as slack run-in during a downgrade locomotive braking condition. When a sizable number of railway cars are included in a single train, the length of the train may shorten considerably by the sum of the travel of the cushioning units on all of the railway cars equipped with such units. Additionally slack run-outs of the coupled railway cars without a sufficient energy dissipation in each of the cushioning units create an acceleration which increases with each successive car. Other objections which result from present end-of-car hydraulic fluid metering systems include the gradual lengthening of a train when the brakes are released after a stop, the creeping of cars at loading docks and the inability of some cushioning units to return to neutral or centered position sufficiently rapid after an impact to be ready for a second impact.

Another problem in present end-of-car cushioning units employing fluid metering systems results from the wear of the piston seals caused by the continuous back and forth movement or hunting of the piston which is induced by normal train operation. With the present systems, the train action induces continuous reciprocation or hunting

of the piston with many reversals of the piston seals. As a buff load is gradually applied, the train action caused by the velocity sensitive nature of the cushioning device produces a relatively large drift of the hydraulic cushioning device causing increased wear on the piston seals and the cylinder seals of the cushioning device.

Thus, the two main undesirable features in present end-of-car cushioning units are: (1) The uncontrolled hunting or longitudinal reciprocation induced by train action on the piston or the movable portions of the device, and (2) the slack run-in of the cushioning device upon the application of continuous low velocity impact load with the cushioning device going solid and thereby having insufficient energy dissipating capability when the cushioning unit is subjected to a draft force when in the full buff position.

It is therefore a primary object of the present invention to provide a novel cushioning device of the fluid metering type for an end-of-car cushioning system which eliminates the uncontrolled hunting or longitudinal back and forth movement of the piston which is induced by normal train action.

A further object of this invention is the provision of a novel fluid metering type of cushioning device which retains its full energy dissipating capability under train operating conditions involving draft and buff forces which are below a predetermined minimum.

A further object of this invention includes the provision of a resilient draft gear in combination with such a fluid metering type of hydraulic cushioning device to supplement and complement the cushioning action of the hydraulic cushioning device.

The present invention comprises a hydraulic-pneumatic cushioning device of the fluid metering type for dissipating energy applied to the couplers of the railway cars. In operation of the invention is effective to maintain a positive resistance to impact forces until a predetermined fluid pressure is reached within specific areas of the cushioning device. Basically the cushioning device comprises inner and outer cylinders which cooperate in telescoping relationship to define an inner variable volume hydraulic fluid chamber and an outer variable volume hydraulic chamber separated by an orifice plate. An elongated metering member is fixed to one of the cylinders and is received within a metering orifice formed in the orifice plate. The metering member cooperates with the orifice to vary the effective size thereof in response to the relative positioning of the inner and outer cylinders. A free floating piston disposed within the inner cylinder in sealed relation with the inner cylindrical wall thereof and forms a movable partition separating the inner hydraulic chamber from a variable volume pneumatic chamber. The pneumatic chamber is filled with a compressible fluid such as compressed air or nitrogen and is maintained under a predetermined pressure. The fluid pressure within the pneumatic chamber is operative under conditions of no load to maintain the cushioning device in its extended or neutral position. This is accomplished by causing the floating piston to force a majority of the hydraulic fluid from the inner hydraulic chamber to the outer hydraulic chamber. Upon receiving a buff force or impact load, the cushioning device will contract causing the hydraulic fluid within the high pressure outer hydraulic chamber to be forced through the metering orifice into the low pressure inner hydraulic chamber causing movement of the free floating piston and increasing the pressure within the pneumatic chamber. As this occurs, a large amount of the energy applied to the cushioning device is dissipated.

The cushioning device includes means which prevent contracting thereof under low impact loads until such time as a predetermined fluid pressure is reached within

the high pressure outer hydraulic fluid chamber, thereby allowing the low force impacts to be absorbed by a resilient cushioning mechanism which is provided for simultaneous cooperation with the hydraulic pneumatic cushioning device both in draft and buff.

As the predetermined unlocking pressure is reached within the outer or high pressure hydraulic chamber, the hydraulic cushioning device will unlock and contract absorbing a substantial amount of the energy applied thereto. As the hydraulic-pneumatic cushioning device is contracted, it cooperates with the resilient cushioning mechanism to achieve a relatively smooth transition of forces, thereby precluding any transmission of jarring from the coupler of the railway car to the underframe thereof.

The cushioning device is provided with a variable volume auxiliary draft cushioning chamber defined between the inner and outer cylinders which is in fluid communication with the inner hydraulic chamber. Means is provided for control of the ingress and egress of hydraulic fluid between the inner hydraulic chamber and the auxiliary draft cushioning chamber to provide cushioning in draft as well as in buff.

Other and further objects of this invention will be obvious upon understanding of the illustrated embodiment about to be described or will be indicated in the appended claims, and various advantages not referred to herein will occur to one skilled in the art upon employment of the invention in practice. A preferred embodiment of the invention has been chosen for the purpose of illustration and description and is shown in the accompanying drawings forming a part of the specification wherein:

FIGURE 1 is a side elevational view of a plurality of railway cars coupled to each other;

FIGURE 2 is a plane view having portions thereof broken away showing the hydraulic cushioning device comprising this invention mounted within a thick sill adjacent the rear end of a draft gear and coupler structure, the cushioning device being illustrated in a neutral position;

FIGURE 3 is a fragmentary sectional view of the cushioning device of FIGURE 2, illustrating the neutral condition thereof;

FIGURE 4 is a fragmentary sectional view of the cushioning device of FIGURE 3 illustrating the lockup mechanism in detail;

FIGURE 5 is a fragmentary sectional view of the cushioning device of FIGURE 4, illustrating initial contact between the seals of the lockup member and the orifice plate;

FIGURE 6 is a fragmentary sectional view of the cushioning unit of FIGURE 3, illustrating the auxiliary draft cushioning mechanism in detail.

Referring now to the drawings for a better understanding of this invention, railway cars **10** illustrated in FIGURE 1 are interconnected by means of couplers **12**. With reference to FIGURE 2, assuming that the railway cars are of the cushioned underframe type, an end-of-car cushioning system will be arranged inwardly of each of the coupler **12**. A fixed center sill generally designated **14**, within which the cushioning system is arranged, is a hat-shaped sill having side webs **16** with bottom legs **18**. The center sill construction is provided with an open outer end which is flared to receive coupler member **12** and to allow swinging of the coupler member relative to the center sill construction. Connection between the coupler member **12** and the center sill **14** is achieved by means of a yoke member **22** disposed within the center sill and transmitting forces from the coupler to draft gear and hydraulic cushioning device structure as described in detail hereinbelow. A shank portion **24** of the coupler **12** is connected to the yoke **22** by means of a pivot pin **26**. A coupler carrier member **29** is located at the flared portion of the center sill and supports the shank portion **24** of the coupler **12**. While the coupler **12** has been shown as a type F coupler (Association of American Railroads' designation) mounted about a vertical pin, it is to be understood that the present invention may, if desired, be employed with a type E coupler connected to a horizontal key.

Mounted within the yoke **22** is a resilient draft gear generally indicated **28** and comprising a plurality of resilient pads **30** separated by metal plates **32**. A front follower stop **34** in engagement with the draft gear **28** is adapted to engage front stops **36** secured to the inner surface of the fixed center sill structure **14**.

As illustrated in FIGURES 2 and 3 and forming an important part of this invention, a hydraulic-pneumatic cushioning unit generally designated **38** is positioned rearwardly of the draft gear **28**. The hydraulic cushioning device **38** comprises an outer cylinder **40** and an inner cylinder **42** movably cooperating in telescoping relationship. Disposed within the inner cylinder **42** is a floating piston **44** dividing the inner cylinder into a pneumatic chamber **46** and an inner hydraulic chamber **48**. An outer hydraulic fluid chamber **50** formed within the outer cylinder **40** contains a relatively incompressible liquid such as hydraulic fluid. The pneumatic fluid chamber **46** formed within the inner cylinder **42** contains a compressible fluid such as air or dry nitrogen gas. A metering pin **52** secured to the outer cylinder **40** has a free end thereof received within a metering orifice **54** in an orifice plate **56** forming a closure for the inner end of the inner cylinder **42**. The inner hydraulic chamber **48** is in fluid communication with the outer hydraulic chamber **50** by means of the metering orifice **54**. The metering pin **52** is tapered as shown in FIGURE 3 and controls the effective size of the metering orifice **54** in relation to the relative position of the cylinders **40** and **42** thereby forming a velocity sensitive control for the cushioning unit.

The inner cylinder **42** has an end cap **58** thereon which serves the additional function of a rear follower block. The end cap **58** has an externally threaded inner extension **60** engaging internal threads within the inner cylinder **42** as shown in FIGURE 2. The inner cylinder **42** extends through an opening **62** in the yoke **22** and the end cap **58** engages a peripheral shoulder or rim **64** defined inwardly of the yoke **22**. Thus, upon forward movement of the yoke **22**, which would occur upon the application of a draft force, the shoulder **64** in engagement with the end cap **58** causes extending movement of the inner cylinder **42**. The outer cylinder **40** abuts a rear support **66** secured to the fixed sill structure **14**. A rear follower stop generally designated **68** has a lug **69** which engages a portion of the front face of the packing gland adapter **84** as illustrated in FIGURE 2 to maintain the outer cylinder in its proper position. The front abutment surfaces **72** on the rear follower stop **68** engage the end cap **58** to limit the rearward travel of the inner cylinder **42** upon exertion of impact forces against the coupler **12**, as shown in FIGURE 2.

With reference now to FIGURE 3 illustrating an important part of this invention, a packing gland adapter **84** is retained at one extremity of the outer cylinder **40** and carries a packing member **86** therein for the establishment of a fluid tight seal between the outer cylinder **40** and the inner cylinder **42**. A retainer **85** threadedly engaging the gland adapter **84** retains the packing **86** and an outer bearing **87** in assembly. The outer bearing maintains alignment between the inner and outer cylinders. An inner annular bearing member **88** is retained at one extremity of the inner cylinder **42** for the establishment of bearing engagement between the inner cylinder and the inner wall **89** of the outer cylinder **40**.

The packing assembly **86** and the bearing member **88** cooperate to define a variable volume annular draft cushioning chamber **94** between the inner and outer cylinders. An annular pressure responsive fluid flow control mechanism **96** is disposed about the outer circumference of the inner cylinder **42** and is axially movable relative

to the inner cylinder **42** within limits defined by an annular stop mmeber **98** formed on the inner cylinder **42** and a stop surface **100** formed on a spacer member **102.**

A plurality of ports **104** are formed in the inner cylinder and communicate the inner hydraulic chamber with the draft cushioning chamber **94.** Hydraulic fluid is interchanged between the inner hydraulic chamber and the draft cushioning chamber upon relative movement of the inner and outer cylinders.

With reference now particularly to FIGURE 6, the flow control mechanism **96** includes a generally ring-like body member having at least one and preferably a series of poppet valve constructions which include preventing the flow of hydraulic fluid in one direction and allowing the flow of hydraulic fluid in the opposite direction in response to pressure of the hydraulic fluid. Each of the pressure responsive flow control or poppet structures comprises a stepped valve housing bore **97** which is internally threaded at its outer extremity to receive a valve seat structure **99.** The valve seat **99** is provided with an axial bore and a frusto-conical seat surface. A poppet **101** is disposed within the bore and is maintained in engagement with the valve seat under a predetermined mechanical bias by a spring **103.**

The poppet **101** is a generally rectangular member and when disposed within the cylindrical valve housing bore defines a plurality of flow passages between the poppet edges and the bore. An annular groove **105** interconnects the inner periphery of the flow control mechanism with each of the bores **97** and a recess **107** formed at the inner periphery of the flow control mechanism provides a flow passage from the groove **105** to the ports **104** in the inner cylinder **42.** The annular recess **107** obviates the need for precise radial alignment of the flow control mechanism relative to the ports **104.** An annular recess **109** is formed at the inner periphery of the flow control mechanism **96** defining an annular shoulder for engagement with the stop **98** of the inner cylinder **42.** The flow control mechanism, being loosely received, by the internal cylinder **42** is movable axially of the inner cylinder within limits defined by the surface **100** and the stop **98.** As illustrated in FIGURE 3, a clearance exists between the outer circumference of the flow control mechanism **96** and the inner cylindrical wall **89** of the outer cylinder **40.** Hydraulic fluid flowing from the low pressure or inner hydraulic chamber **48** into the draft cushioning chamber **94** therefore passes through the ports **104** and around the flow control mechanism **96** by means of the clearance between the flow control mechanism **96** and the outer cylinder. During the flow of hydraulic fluid into the draft cushioning chamber **94,** the flow control mechanism **96** is maintained in engagement with the stop **98** by the hydraulic fluid allowing the flow of hydraulic fluid between the surface **100** and the flow control mechanism **96.** Upon reversal of the flow of hydraulic fluid from the draft cushioning chamber **94** to the low pressure inner hydraulic chamber **48,** which occurs during extension of the cushioning device to its normally extended or static position, the flow control mechanism **96** is forced by the flowing fluid to move into engagement with the annular stop surface **100** of the spacer member **102** to prevent the flow of hydraulic fluid around the outer periphery of the flow control mechanism **96** in the return direction. The flow control mechanism **96** in its relation to the inner cylinder **42** defines a calibrated fixed flow control orifice or fluid flow passage which severely restricts the flow of hydraulic fluid being exhausted from the draft cushioning chamber **94** thereby causing substantial energy dissipation as the cushioning device is extended by its internal pressure after being contracted by an impact or buff force. The draft cushioning mechanism will also dissipate energy applied to the inner cylinder in draft when the inner cylinder is in its contracted position or neutral position as will be explained in detail hereinbelow.

Referring now to FIGURES 3 and 4, forming an important part of this invention, the hydraulic cushioning device **38** is particularly adapted to permit contraction of the outer and inner cylinders **40** and **42** thereof only when a predetermined fluid pressure is reached within the high pressure hydraulic chamber **50** of the outer cylinder **40.** As pointed out above, the outer hydraulic chamber **50** contains a relatively incompressible fluid such as hydraulic fluid which is metered through an orifice **54** in an orifice plate **56** fixed at the inner end of the inner cylinder **42** by a metering pin **52** secured to the closed end of the outer cylinder **40.** The inner hydraulic chamber is also filled with an incompressible fluid. The freely floating piston **44** is mounted for movement within the inner cylinder **42** and separates the compressible fluid such as air, nitrogen or the like from the hydraulic fluid within the inner hydraulic chamber **48.** In order for the cushioning device **38** to be contracted under buff forces, hydraulic fluid must flow from the high pressure hydraulic chamber **50** through the metering orifice **54** and into the inner hydraulic chamber **48.**

To prevent the flow of hydraulic fluid from the outer chamber **50** to the inner hydraulic chamber **48** under conditions of low impact force applied to the hydraulic cushioning device **38,** a lockup member generally designated **120** is disposed within the inner hydraulic chamber **48** and is adapted to establish a fluid tight seal with the orifice plate **56** about the metering orifice **54.** The lockup member **120** is in the form of a generally hat-shaped body **121** having a cylindrical bore **122** formed therein. The cylindrical bore **122** receives the outer or free extremity of the metering pin **52** in sealing engagement therein established by a seal member **124** which is retained within an annular groove **126.** A bolt member **128** is threadedly retained by a threaded bore **130** formed in the closed end **132** of the hat-shaped body **121,** and extends into an axial bore **134** formed within the metering pin **52.** A spring member **136** is disposed within the axial bore **134** and has one end thereof in engagement with the shoulder **138** defined by a head **140** on the bolt **128.** A plastic insert **142** retained by the bolt **128** locks the bolt within the threaded aperture **130** to prevent the possibility of inadvertent separation. The spring **136** is retained in compressed condition within the bore by a retainer member **144** which is threadedly received by internal threads **146** formed at the outer extremity of the bore **134.** The other extremity of the spring **136** bears against and is maintained under compression by a shoulder **148** defined by the retainer **144.**

It is therefore apparent that the lockup member **120** is positively prevented from becoming separated from the metering pin **52** by virtue of the bolt, spring and retainer construction. It is also apparent that the lockup member may move relative to the metering pin within latitude determined by the end wall **132** and engagement between the shoulder **148** of the retainer **144** and a shoulder **150** defined by an enlarged portion **152** of the bolt **128.** The lockup member is illustrated in FIGURES 1 and 4 in its neutral position.

A skirt member **154** is formed integrally with the lockup member **120** and is provided with a sealing face **156** defining a generally planar surface. An annular groove **158** is formed in the sealing face **156** and cooperates with a retainer member **160** which is retained within the groove **158** by a series of screws **162** to define a pair of generally concentric sealed grooves **164** and **166.** Inner and outer sealing members **168** and **170** are retained respectively within the grooves **164** and **166** by the retainer member **160.** A sealing portion of the sealing members **168** and **170** extend outwardly slightly beyond the annular sealing face **156** for engagement with a generally planar sealing face **172** formed on the orifice plate **56.** With reference particularly to FIGURE 5, as the lockup member **120** moves into contact with the surface **172** of the orifice plate initial contact is made by the outer concentric member

170 which extends slightly beyond the plane established by the inner concentric sealing member 168. For example, the outer sealing member may extend .015 inch beyond the inner sealing member. As the lockup member is slightly compressed against the sealing surface, the outer sealing member 170 will yield and the inner sealing member 168 will move into sealing engagement with the surface 172.

A vacuum passage 174 extends through the lockup member body 121 and interconnects the cylindrical bore 122 of the lockup member with the face seal of the lockup member at a position intermediate the inner and outer seals 168 and 170. The vacuum passage 174 opens at a position intermediate the inner and outer sealing members 168 and 170 so that a reduced pressure may be effected within the annular area defined between the sealing members when the same are disposed in sealing engagement with the planar sealing surface 172 of the orifice plate 56.

A fluid bleed passage 176 is formed in the body 121 of the lockup member 120 and provides fluid communication between the inner hydraulic chamber 48 and the cylindrical bore 122 of the lockup member. The purpose of the fluid bleed passage 176 is to allow the flow of hydraulic fluid between the inner and outer hydraulic chambers 48 and 50 to allow continued relative movement between the inner and outer cylinders after a seal has been established between the lockup member 120 and the orifice plate 56. The metering pin 52 is provided with an enlarged diameter portion 178 at its free extremity defining a cylindrical surface 180 which closely interfits with the cylindrical bore 122 in the lockup member body 121. The enlarged diameter portion also defines a tapered annular shoulder 182. A sealing ring 184 which may be of the O-ring type is disposed within a seal groove 186 formed within the cylindrical bore 122 of the body 121. The O-ring 184 extends slightly beyond the cylindrical surface defining the bore 122 and is adapted for sealing engagement with the cylindrical surface 180 of the metering pin 52. A relief passage 188 communicates the groove 186 with the outer hydraulic chamber 50 and prevents the possibility of a buildup of pressure behind the O-ring 184 which might force the O-ring from the groove.

With the cushioning unit 38 in its contracted or partially contracted condition the lockup member 120 will be separated from its sealing engagement with the orifice plate 56. Under this condition the compression spring 136 acting between the shoulder 148 of the retainer 144 and the shoulder 138 of the bolt head 140 will force the lockup member into maximum interengagement with the cylindrical enlargement of the metering pin 52. The closed end 132 of the lockup member under this condition will be in engagement with the free extremity of the metering pin and the shoulder 182 of the metering pin will be disposed inwardly of the annular seal groove 186. Under conditions of maximum interengagement between the lockup member and the metering pin the O-ring 184 will not engage the cylindrical surface 180 of the metering pin and fluid communication between the inner hydraulic chamber and the cylindrical bore 122 will be established by way of the bleed passage 176.

When the hydraulic cushioning unit 38 is contracted by buff forces, hydraulic fluid is forced from the outer hydraulic chamber 50 to the inner hydraulic chamber 48 through the metering orifice 54. This causes the piston 44 to be forced from its neutral position as illustrated in FIGURE 3 toward the outer extremity of the inner cylinder. This causes compression of the gas within the pneumatic chamber from an initially charged pressure which, for example, might be 260 p.s.i. at its neutral or FIGURE 3 position to a maximum of 1500 p.s.i. at the fully contracted or full buff position of the cushioning unit As the buff force is released the compressed gas will force the piston toward the orifice plate 56 causing hydraulic fluid within the inner hydraulic chamber 48 to be displaced into the outer hydraulic chamber 50 through the metering orifice 54. Prior to the establishment of a seal between the lockup member, the fluid will flow around the lockup member and into the outer hydraulic chamber. As the hydraulic cushioning unit nears its neutral position, for example within ¼" of its neutral position, the outer sealing member 170 will sealingly engage the orifice plate preventing further flow of fluid therearound. Since the shoulder 182 of the metering pin 52 will be positioned inwardly of the O-ring 184 the flow of hydraulic fluid will continue at a reduced rate from the inner hydraulic chamber 48 to the outer hydraulic chamber 50 by way of the bleed passage 176. The hydraulic cushioning unit will therefore continue to be extended toward its neutral position even though sealing engagement has been established between the lockup member 120 and the orifice plate 56. After the outer seal has been established only a slight relative movement of the cylinders 40 and 42, for example .015 inch, is necessary to compress the material forming the outer sealing member sufficiently for the establishment of a fluid tight seal between the orifice plate and the inner concentric sealing member 168. The inner and outer concentric sealing members, when in sealing engagement with the orifice plate, define an enclosed area therebetween which is in fluid communication via the vacuum passage 174 with the cylindrical bore 122 inwardly of the positive seal 124.

Further extension of the cushioning unit 38 toward its neutral position after the lockup member has established inner and outer concentric seals with the orifice plate 56 results in the metering pin 52 being partially withdrawn from the cylindrical bore 122. Because the positive seal 124 prevents fluid pressure from balancing the pressure within the bore 122, a partial vacuum or reduced pressure will be formed within the cylindrical bore 122 and acting through the vacuum passage 174 will cause a pressure depression in the enclosed area between the inner and outer sealing members 168 and 170. This pressure depression effectively establishes area differentials of the lockup member represented by the effective lockup diameters D1 and D2, through which hydraulic fluid pressure in the inner and outer hydraulic chambers acts to control unlocking pressure of the hydraulic unit. At the neutral position of the hydraulic cushioning unit, the hydraulic fluid within the inner hydraulic chamber will be maintained under pressure by the gas pressure in the compressible fluid chamber acting through the floating piston 44. The hydraulic pressure within the inner hydraulic chamber acts through the effective area defined by the diameter D1 of the lockup member established by the sealing element 170 producing a predetermined force maintaining the lockup member 120 in sealed relationship with the orifice plate 56. Because of the reduced pressure established between the inner and outer concentric sealing members 168 and 170 the hydraulic fluid within the outer hydraulic chamber 50 must act through the smaller effective annular area of the lockup member defined between the diameter D2 of the inner sealing member 168 and the diameter defined by the cylindrical surface 180 of the enlarged diameter portion 178 of the metering pin 52. In order to unlock the lockup member 120 from its sealing relation with the orifice plate 56, the pressure within the outer hydraulic chamber must be sufficiently high that acting through the smaller effective annular area, it overcomes force developed by the gas pressure through the area defined by diameter D1 maintaining the lockup member 120 in a locked condition. For example, employing an internal area established by the diameter D1 of 10.99 inches square, a pneumatic pressure of 260 p.s.i. and an external annular area established between the diameters D2 and the diameter circumscribed by the cylindrical surface 180 of 1.58 inches square, it has been determined that an internal fluid pressure within the outer hydraulic chamber

of 1810 p.s.i. must be reached for unlocking of the lockup member to occur. It has been found desirable to allow unlocking of the lockup member at an end force on the car coupler in the range of 100,000 lbs. The above example is intended merely for purposes of illustration and is not to be taken as limiting in regard to this invention.

With the hydraulic unit **38** in its neutral locked condition, the lockup member **120** will effectively prevent the flow of hydraulic fluid between the inner and outer hydraulic chambers when the unit is subjected to a low level buff force or a draft force. The cushioning unit **38** when subjected to a draft force in its neutral locked position will extend to its fully extended position without any transfer of hydraulic fluid between the inner and outer chambers. This extension will be small, for example, less than two inches in a unit having a 30-inch stroke, and will cause a vacuum to be formed within the outer hydraulic fluid chamber **50** developing a void or vapor bubble therein. Hydraulic fluid within the draft cushioning chamber **94** will be metered into the inner hydraulic chamber **48** by the flow control mechanism **96** in the manner described above. The additional volume of hydraulic fluid forced into the inner hydraulic chamber **48** will force the piston **44** toward the outer extremity of the inner cylinder thereby further compressing the compressible fluid within the chamber **46**.

Upon dissipation of the draft force the cushioning unit **38** will be forced to return to its neutral position by the compressed gas within the chamber **46** which acts on the piston and forces a volume of hydraulic fluid to flow from the inner hydraulic chamber **48** into the draft cushioning chamber **94**. At the same time the void or vapor bubble will dissipate and the cushioning unit **38** will have returned to its neutral position.

The resilient draft gear **28** will act simultaneously with the hydraulic cushioning unit **38** in draft between the neutral and fully extended positions to effect a smooth force transition in the same manner discussed above.

OPERATION

When the coupler structure **12** of the railway car is impacted with a force which is less than that required for unlocking the lockup member **120**, for example, below 100,000 lbs., the cushioning unit because of the lockup member will remain in its neutral position and will transmit the force directly from the resilient draft gear to the underframe of the railway car. The resilient draft gear, under low impact loads, will therefore be effective acting alone to dissipate sufficient energy to afford ample protection to the railway car lading. Assuming that the coupler structure **12** of the railway car has received a buff impact which is above the force magnitude required for unlocking of the lockup member, the pressure of the hydraulic fluid within the outer hydraulic chamber **50** will rise to a sufficient level that, acting through the smaller effective area inside the inner concentric seal member **168**, the force produced on the lockup member will be greater than the force developed by the hydraulic fluid pressure within the inner hydraulic chamber **48** acting through the area defined by the diameter **D1** of the outer concentric seal **170**. When this occurs the lockup member will move slightly away from the sealing surface **172** of the orifice plate **56** and will allow the flow of hydraulic fluid from the outer hydraulic chamber **50** to the inner hydraulic chamber **48**. The hydraulic cushioning unit **38** will therefore begin to contract forcing hydraulic fluid from the outer hydraulic chamber **50** through the metering orifice **54** under velocity sensitive control of the metering pin **52** into the inner hydraulic chamber **48** causing compression of the gasiform fluid within the compressible fluid chamber **46**.

As the cushioning unit **38** contracts, the draft cushioning chamber **94** will become enlarged and hydraulic fluid will flow through the ports **104** from the inner hydraulic chamber **48** to the draft cushioning chamber **94** in the manner described hereinabove.

After dissipation of the buff forces the compressible fluid pressure stored within the chamber **46** by collapsing of the hydraulic cushioning unit **38** will act through the piston **44** to force hydraulic fluid from the inner hydraulic chamber **48** to the outer hydraulic chamber **50** causing the cushioning unit to extend toward its neutral position. Extension of the cushioning unit **38** by the compressible fluid is controlled by the calibrated flow passage defined between the flow control mechanism **96** and the inner cylinder. Under normal internal extension of the cushioning unit, therefore, the flow control mechanism will cause a snubbing action merely tending to retard rapid extension of the cushioning unit and prevent slamming of the same to the fully extended position and to prevent rebouding as discussed hereinabove. Extension of the cushioning unit by draft forces of sufficient magnitude to actuate the poppets of the flow control mechanism will cause the flow control mechanism to define a pressure differential sensitive draft cushioning mechanism having the capability of dissipating expected draft forces in the manner described above.

As the hydraulic cushioning unit **38** moves near to its neutral position, the outer sealing member **170** will engage the sealing surface **172** of the orifice plate **56** defining the effective area defined by the diameter **D1** of the lockup member. As the unit **38** moves from this initial contact position, the inner seal defining the diameter **D2** will be formed by the establishment of sealing engagement between the inner sealing member **168** and the sealing surface **172** defining the enclosed area between the seals. The metering pin being partially withdrawn from the bore **122** effects a pressure depression in the enclosed area thereby allowing fluid pressure in the outer hydraulic chamber **50** to act only through the smaller effective surface area defined by the difference in diameter of the inner sealing member **168** and the cylindrical surface **180** of the metering pin **52**. In this condition the hydraulic cushioning unit **38** is in its neutral locked condition and will remain so until a buff force is applied to the coupler **12** of the railway car **10** of sufficient magnitude to raise the hydraulic pressure in the outer hydraulic chamber to the predetermined unlocking pressure.

While the hydraulic cushioning unit of this invention has been generally disclosed in its application as an energy dissipating device for railway cars, it is obvious that it is equally well suited for applications in various other environments. For example, loading docks for ocean going vessels may employ the invention to allow collapsing or moving of a portion of the dock adjacent the vessel to prevent damage to both the vessel and dock in case of impacts therebetween. Aircraft landing gear might also be provided with the instant invention to protect the aircraft from damage in case of severe landing impacts.

It will be evident from the foregoing that I have provided a unique hydraulic cushioning unit which effectively prevents downgrade run-ins of the hydraulic cushioning unit due to train operation. Due to the unique construction of the instant invention, the cushioning device will not be permitted to go solid or completely contract under the application of extremely low velocity impact such as slack run-in during a downgrade locomotive braking condition, for example. The hydraulic cushioning unit incorporating the instant invention will be maintained in its neutral position until such time as buff forces developed by impact become sufficiently high to cause an increase in hydraulic pressure within the outer hydraulic chambers of the cushioning units of sufficient magnitude to cause unlocking of the lockup member of the cushioning unit. Since the hydraulic cushioning units incorporating this invention will normally be retained in their neutral positions, continuous back and forth movement of the free pistons due to train action is effectively prevented and piston seals therefore experience little wear thereby prolonging the life

of the cushioning unit. Subsequent to impact forces, unlocking of the lockup member **120** and dissipation of the impact forces, slack run-outs of the coupled railway cars will be effectively prevented by the draft cushioning mechanism set forth hereinabove. Excessively rapid extension of the cushioning unit as well as rebounding of the same is effectively prevented by the draft cushioning mechanism, thereby reducing any tendency of damage to the railway car lading by slamming or rebounding of the cushioning unit. The hydraulic cushioning unit of the invention cooperates with the resilient draft gear structure both in buff and draft, thereby producing a cushioning effect thereby producing smooth force transition protecting the railway car lading. Therefore it is seen that this invention is one well adapted to obtain all of the objects hereinabove set forth together with other advantages which become obvious and inherent from the description of the apparatus itself.

It will be understood that certain combinations and subcombinations are of utility and may be employed without reference to other features and subcombinations.

What is claimed is:

1. A railway car having an underframe structure, a coupler device movably carried by said underframe structure, an oleopneumatic cushioning unit interposed between said underframe structure and said coupler device and adapted to dissipate buff forces applied to the coupler device to protect the lading within the railway car from excessive shock, said cushioning unit comprising inner and outer tubular members disposed in telescoping relation and being movable one relative to the other between collapsed, neutral and fully extended positions, means closing the outer extremities of said tubular members, an orifice plate closing the inner extremity of the inner tubular member and defining an inner variable volume hydraulic chamber within said inner tubular member and an outer variable volume hydraulic chamber within said outer cylinder, a metering orifice formed in said orifice plate allowing the interchange of hydraulic fluid between said inner and outer hydraulic chambers, a metering pin cooperating with said metering orifice to define a velocity sensitive control for the interchange of hydraulic fluid between the inner and outer chambers, said orifice plate defining a substantially planar sealing surface, a lockup member disposed within said cushioning unit and adapted in the neutral to fully extended positions to form a seal with said sealing surface to prevent the interchange of hydraulic fluid between said hydraulic chambers, said lockup member when in sealing engagement with said sealing surface presenting a small surface area to the hydraulic fluid in said outer hydraulic chamber and presenting a large surface area to the hydraulic fluid within said inner hydraulic chamber, whereby hydraulic fluid pressure in said outer hydraulic chamber acting through said small surface area must rise substantially in excess of the hydraulic fluid pressure in said inner hydraulic chamber acting through said large surface area to break said sealing engagement, collapsing of said cushioning unit subsequent to unlocking of said lockup member being controlled solely by said velocity sensitive control upon movement of said cushioning unit back to its neutral position upon dissipation of said buff force said lockup member automatically establishing said sealing engagement with said sealing surface.

2. A railway car as set forth in claim **1**, said lockup member establishing inner and outer annular seals about said metering orifice defining an enclosed area therewith, means developing a pressure depression in said enclosed area whereby said fluid pressure in one of said fluid chambers acts through the area defined by said inner seal and the fluid pressure in the other of said chambers acts through the area of said lockup member defined by said outer seal.

3. A railway car as set forth in claim **2**, said lockup member being supported by said metering pin and cooperating with said metering pin during movement of said cushioning unit to its neutral position to effect said pressure depression in said enclosed area.

4. A railway car as set forth in claim **3**, said lockup member comprising a body portion provided with a bore, a portion of said metering pin being received in sealing relation within said bore, a skirt formed on said body and provided with inner and outer sealing members surrounding said bore, a vacuum passage communicating the area between the inner and outer sealing members with said bore, means biasing said lockup member bore into full interengagement with said metering pin, said lockup member being moved against said bias as said cushioning unit moves to its neutral position causing said metering pin to be partially withdrawn from said bore.

5. A cushioning unit comprising an outer tubular member and an inner tubular member disposed in telescoping relationship and movable one relative to the other, said tubular members having closed outer ends, an orifice plate closing the inner end of the inner tubular member and defining inner and outer variable volume hydraulic chambers, said orifice plate having a metering orifice formed therein defining fluid communication between said inner and outer chambers for the interchange of hydraulic fluid between said inner and outer chambers upon relative movement of said tubular members, a metering pin extending through said metering orifice and cooperating with said metering orifice to form a velocity sensitive control for said interchange of hydraulic fluid, a freely, movable piston disposed within said inner tubular member and defining a compressible fluid chamber, lockup means supported by said metering pin and cooperating with said orifice plate in the netural position of said cushioning unit to prevent the interchange of hydraulic fluid between the inner and outer hydraulic chambers until a predetermined hydraulic fluid pressure differential is developed between said inner and outer chambers, upon the development of said predetermined fluid pressure differential said means being automatically moved out of said cooperation with said orifice plate allowing the interchange of hydraulic fluid between said chambers and allowing said cushioning unit to be collapsed under sole control of said velocity sensitive control means, upon movement of said cushioning unit back to said netural position said means automatically establishing said cooperation with said orifice plate.

6. A cushioning unit as set forth in claim **5**, said lockup means comprising a body formed with a bore and having a sealing face, said bore receiving one extremity of said metering pin in sealing relation therewith, means normally biasing said lockup member into full interengagement with said metering pin, said sealing face during relative movement of said tubular members toward the neutral position contacting said orifice plate and establishing sealing engagement about said metering orifice.

7. A cushioning unit as set forth in claim **6**, said sealing face having inner and outer annular sealing members which cooperate with said orifice plate to define an enclosed annular area about said metering orifice, means to effect a pressure depression in said enclosed annular area, at the neutral position of said cushioning unit fluid pressure within the outer fluid chamber acts through the effective surface area of said lockup means established by the inner periphery of said annular area and fluid pressure within said inner fluid chamber acts through the surface area of said lockup means defined by the outer periphery of said lockup means, thereby requiring a greater fluid pressure within said outer fluid chamber than in said inner fluid chamber to break the sealing engagement between said lockup means and said orifice plate.

8. A cushioning unit as set forth in claim **6**, said sealing face having inner and outer annular sealing members defining an enclosed area about said orifice in the neutral position of said cushioning unit, said body having a vacuum passage interconnecting said bore with said enclosed area, during extension of said cushioning unit subsequent to collapsing thereof, said lockup means engaging said

orifice plate prior to said cushioning unit reaching its neutral position, said metering pin being partially withdrawn from said bore upon further movement of said cushioning unit toward said neutral position, whereby a pressure depression is established within said bore and is operative through said vacuum passage to establish a pressure depression in said enclosed area, fluid pressure within said inner fluid chamber acting through the surface area of said lockup means defined by said outer sealing member and fluid pressure developed within said outer hydraulic fluid chamber acting through the effective surface area of said lockup means established by said inner sealing member, whereby greater fluid pressure is required in said outer hydraulic chamber than within said inner hydraulic chamber to break the sealing engagement between the sealing face and said orifice plate.

9. A hydraulic cushioning unit for use in railway cars comprising inner and outer tubular members disposed in telescoping relation and being relatively movable between collapsed neutral and fully extended positions, means closing the outer ends of said tubular members, said inner member having an orifice plate fixed at its inner extremity defining a barrier separating the inner and outer variable volume hydraulic chambers and providing a metering orifice allowing the interchange of hydraulic fluid between the inner and outer hydraulic chambers, means defining a variable volume gas chamber within said inner tubular member, velocity sensitive metering means cooperating with said metering orifice to control the interchange of hydraulic fluid between said inner and outer hydraulic chambers upon relative movement of said tubular members, a lockup member disposed within said cushioning unit, said lockup member preventing the interchange of hydraulic fluid between said inner and outer hydraulic chambers whereby collapsing of the cushioning unit is prevented upon the application of buff forces of a magnitude below a predetermined minimum, said lockup member allowing the interchange of hydraulic fluid between said inner and outer hydraulic chambers upon the application to said cushioning unit of a buff force of a magnitude above said predetermined minimum.

10. A hydraulic cushioning unit as set forth in claim **9**, said orifice plate defining a substantially planar sealing surface, sealing means carried by said lockup member adapted to engage said sealing surface in the neutral position of said cushioning unit and to establish a seal about said metering orifice.

11. A hydraulic cushioning unit as set forth in claim **10**, said sealing means of said lockup member establishing inner and outer concentric seals with said sealing surface and defining an enclosed area between said inner and outer concentric seals, means establishing a pressure depression in said enclosed area whereby hydraulic fluid in said outer hydraulic chamber acts on said lockup member through an effective area established by said inner concentric seal and hydraulic fluid in said inner hydraulic chamber acts on said lockup member through an area defined by said outer concentric seal and a fluid pressure in said outer hydraulic chamber of greater magnitude than the fluid pressure within the inner hydraulic chamber to break said concentric seals and allow the interchange of hydraulic fluid between said inner and outer hydraulic chambers.

12. A hydraulic cushioning unit for use in railway cars comprising an outer fluid cylinder and an inner fluid cylinder movable relative to each other, an orifice plate on the inner end of said inner cylinder, a metering member on said outer cylinder cooperating with said orifice plate to meter the flow of fluid between the inner cylinder and the outer cylinder upon relative movement therebetween, and a freely movable piston mounted within said inner fluid cylinder forming a compressible fluid chamber within said inner cylinder, said orifice plate forming an enclosed inner variable volume hydraulic fluid chamber within said inner cylinder, said outer cylinder forming with the orifice plate an outer variable volume hydraulic fluid chamber, a lockup member within said cushioning unit and cooperating with said orifice plate in the neutral position of said unit to prevent the interchange of hydraulic fluid between the inner and outer hydraulic fluid chambers thereby preventing relative movement between the inner and outer tubular members, said lockup member cooperating with said orifice plate so that a minor area thereof is exposed to hydraulic fluid in the outer chamber and a major area thereof is exposed to hydraulic fluid in the inner chamber, said lockup member being movable from its neutral position when a predetermined pressure differential is reached between said outer hydraulic chamber and said inner hydraulic chamber, fluid communication between the high pressure chamber and the low pressure chamber will be effected and said cushioning unit will be allowed to collapse to dissipate energy applied to said cushioning unit, said piston returning under bias of said pressurized compressible fluid to its neutral position after absorption of energy by the cushioning device and causing said lockup member to return to its neutral position again establishing said cooperation with said orifice plate to prevent said interchange of hydraulic fluid.

13. A device for retarding motion of a moving body by dissipation of energy by hydraulic means, said device comprising a tubular member, means disposed in movable relation within said tubular member and defining with said tubular member first and second variable volume hydraulic fluid chambers, movable means forming a force transmitting wall in one of said variable volume hydraulic fluid chambers, means for transmitting force to said force transmitting wall, whereby force is transmitted by said force transmitting wall to said hydraulic fluid in said one hydraulic fluid chamber, means defining fluid communication between said first and second hydraulic fluid chambers, means defining a velocity sensitive hydraulic fluid flow control whereby hydraulic fluid is metered between said first and second chambers upon relative movement of said tubular members thereby dissipating energy causing said relative movement, said device having lockup means movable between a locked position blocking the interchange of hydraulic fluid between said first and second chambers and an unlocked position allowing the interchange of hydraulic fluid between said first and second chambers, said lockup means, when in its locked position, being responsive to a predetermined pressure differential between said first and second chambers to move to said unlocked position, whereby said interchange of hydraulic fluid may occur only after said predetermined pressure differential has been established.

14. A cushioning unit comprising an outer tubular member, an inner tubular member slidably disposed in radial spaced relation within said outer tubular member, base means closing the outer ends of said members, sealing means secured to one of said members and closing said radial space between the members to form a main variable volume chamber enclosed by said members, an orifice plate secured to the inner open end of said inner tubular member and dividing said main chamber into an inner and an outer chamber, a fixed area opening in said orifice plate, a metering pin carried by the base of said outer tubular member and movable through the opening in said orifice plate to vary the effective area thereof, hydraulic fluid in said inner and outer chambers, means mounted within said inner tubular member, said means including gas under pressure to thereby pressurize said hydraulic fluid, and valve means carried by said metering pin to seal said orifice plate opening thereby isolating said outer chamber from said gas pressure and limiting separating movement of said members.

15. The structure of claim **14** characterized in that said valve means is resiliently mounted on said metering pin to permit controlled separation movement of said member upon application of external force to said members.

16. In a railway car the combination of center sills,

front draft lugs secured to said center sills adjacent their ends, back stop lugs secured to said center sills in inwardly spaced relation to the ends, intermediate lugs secured to center sills between said front and rear lugs, a rear cylinder retained longitudinal movement between said rear and intermediate lugs, a front cylinder slidably received in said rear cylinder, hydraulic fluid in said cylinders, means in said front cylinder including gas under pressure to pressurize said hydraulic fluid and cause separating movement of said cylinders, a coupler receiving yoke mounted within said center sills for longitudinal sliding movement, front followers mounted within said yoke and normally engaging said front draft lugs and yoke, a rear follower mounted within said yoke for movement relative thereto and normally engaging the inner portions of said yoke, means connecting said rear follower and front cylinder for movement in unison, resilient gear precompressed between said front and rear followers and normally holding said followers in engagement with the yoke, and means mounted within said front cylinder and acting to isolate said rear and front cylinders to limit the separating movement thereof due to expansion of the gas thereby preventing additional compression on said resilient gear.

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DRAYTON E. HOFFMAN, *Primary Examiner.*

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,411,635

November 19, 1968

Richard G. Powell

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 36, cancel "of". Column 15, line 5, after "retained" insert - against --.

Signed and sealed this 10th day of March 1970.

EAL)
test:

vard M. Fletcher, Jr.
esting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents