June 24, 1969 J. G. STEPHENSON ET AL 3,451,561

DRAFT GEAR TRAIN ACTION CONTROL SYSTEM

Filed Jan. 20, 1967 Sheet 1 of 4

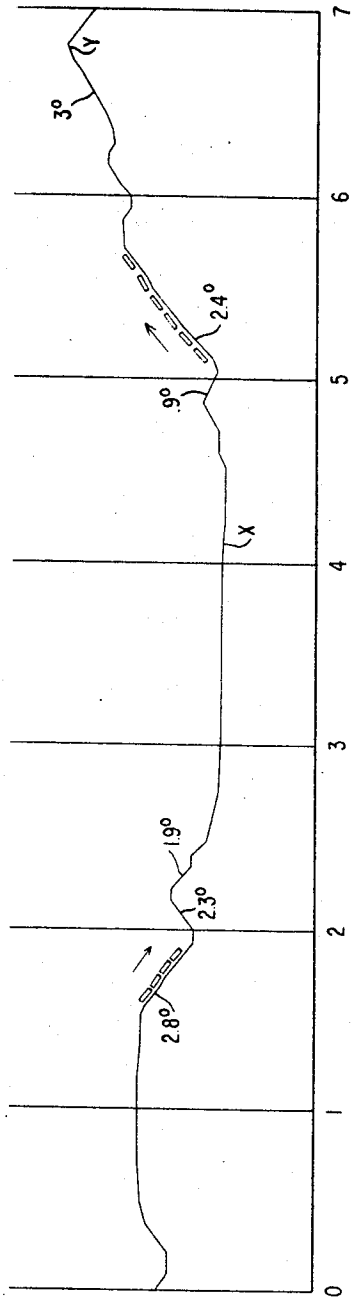
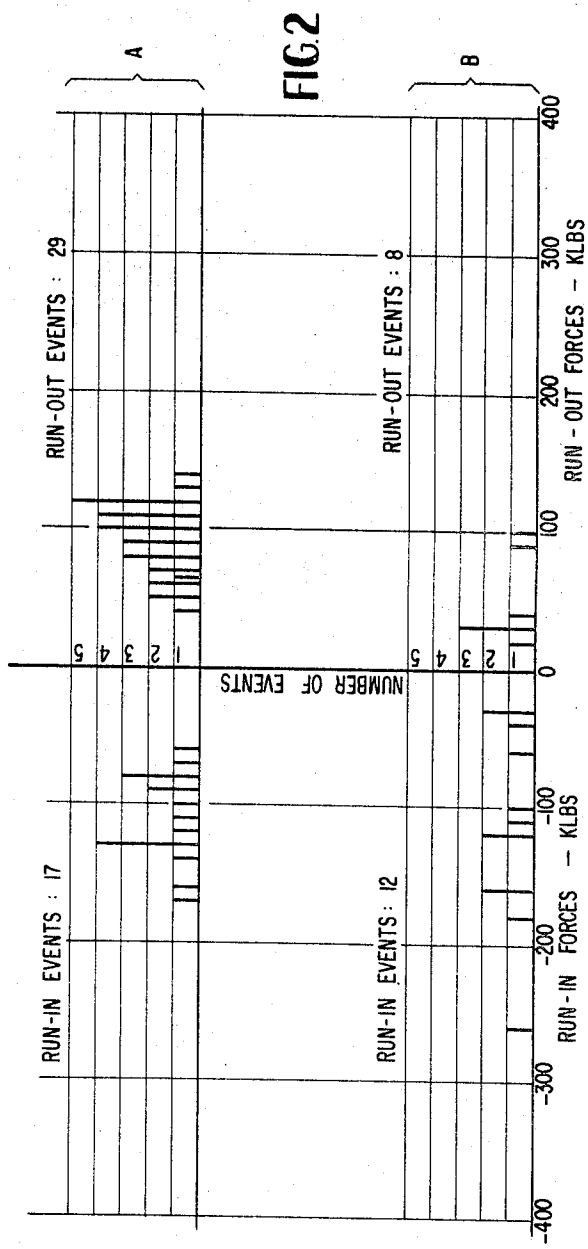


FIG. 1

FIG. 2



INVENTORS

JACK G. STEPHENSON
ROBERT E. ABBOTT

BY Burns, Doane, Benedict, Swecker & Mathis

ATTORNEYS

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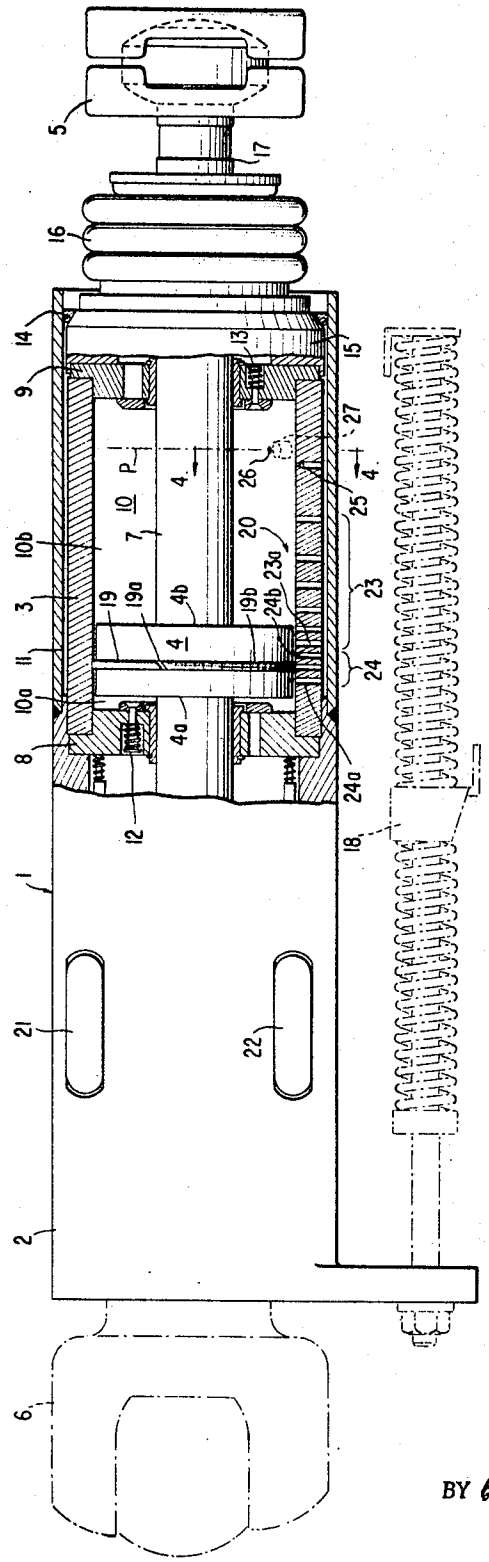


FIG 3

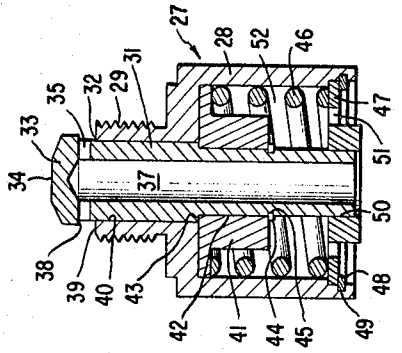


FIG 5

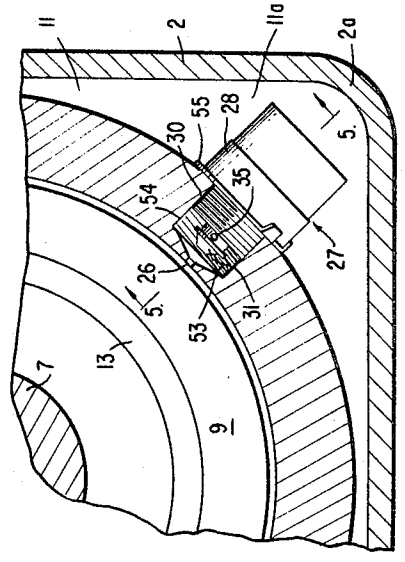


FIG 4

INVENTORS
JACK G. STEPHENSON
ROBERT E. ABBOTT

BY Burns, Doane, Benedict, Swecker & Mathis

ATTORNEYS

FIG. 6

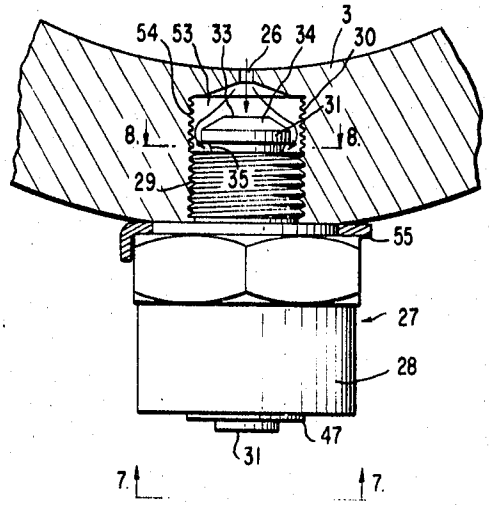
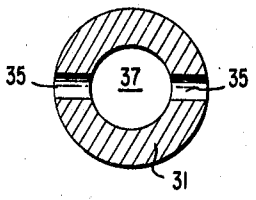


FIG. 8



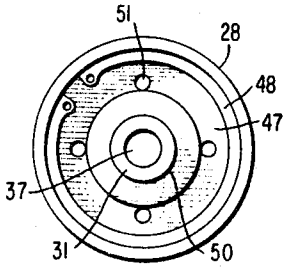


FIG. 7

INVENTORS
JACK G. STEPHENSON
ROBERT E. ABBOTT
BY Burns, Doane, Benedict, Swecker & Mathis
ATTORNEYS

DRAFT GEAR TRAIN ACTION CONTROL SYSTEM

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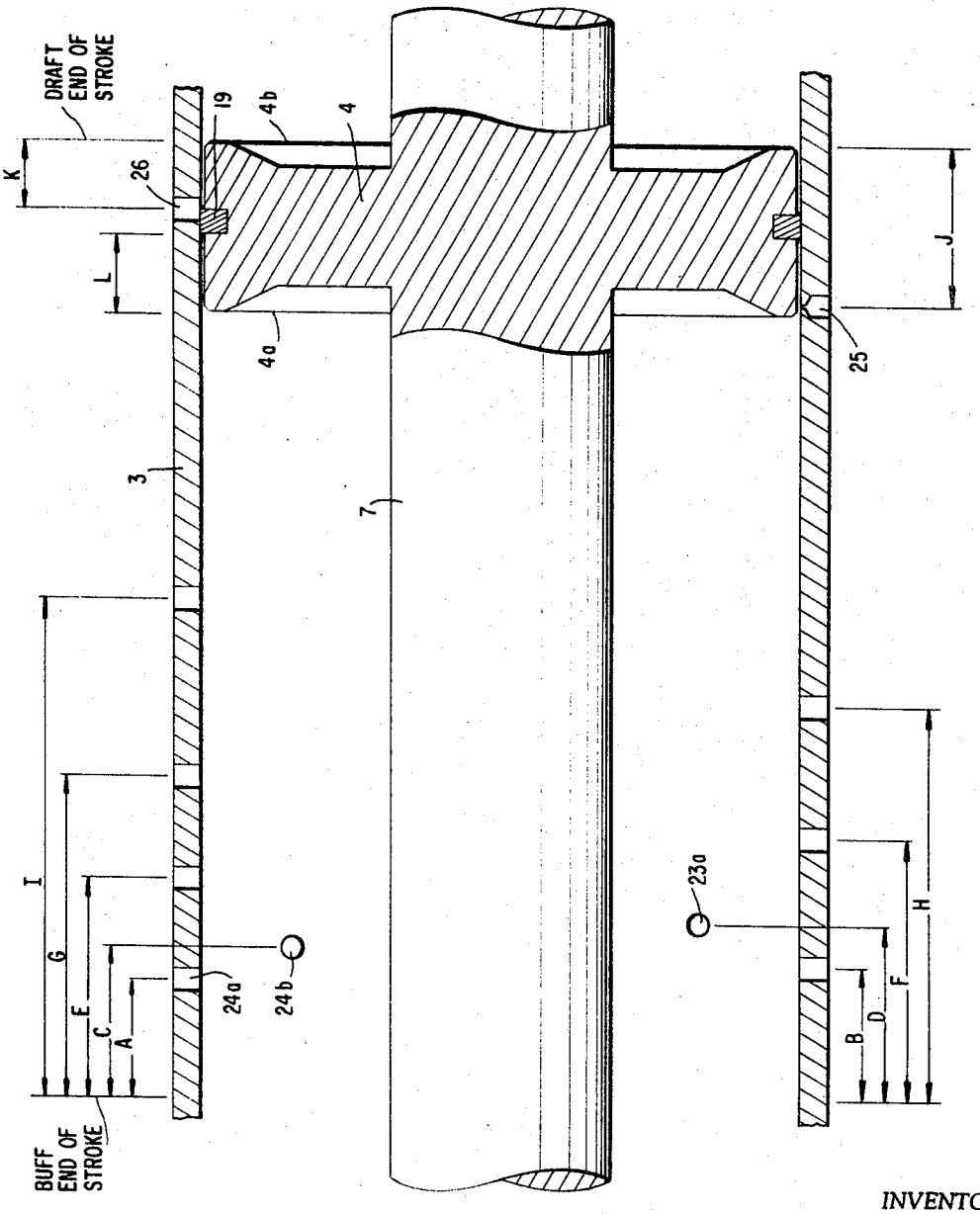


FIG 9

INVENTORS
JACK G. STEPHENSON
ROBERT E. ABBOTT
BY Burns, Doane, Benedict, Swecker & Mathis
ATTORNEYS

United States Patent Office 3,451,561 Patented June 24, 1969

3,451,561

DRAFT GEAR TRAIN ACTION CONTROL SYSTEM

Jack G. Stephenson, Duncan, Okla., and Robert E. Abbott, Forth Worth, Tex., assignors to Halliburton Company, Duncan, Okla., a corporation of Delaware

Filed Jan. 20, 1967, Ser. No. 610,553
Int. Cl. B61g 9/12
U.S. Cl. 213—8 20 Claims

ABSTRACT OF THE DISCLOSURE

Railway shock absorbing, i.e. cushioning, apparatus characterized by valve controlled fluid passage means for regulating fluid outflow from a body of shock absorbing fluid. This valve controlled fluid passage means provides an open passage to facilitate relatively rapid restoration of a coupling from a full buff condition to the position it normally occupies when not connected with the coupling of another railway car. This passage means is automatically closed in response to train action forces imposed on the coupling by other railway cars while a train is in motion so as to impede coupling movement by channeling flow of shock absorbing fluid through restricted passage means.

Shock absorbing apparatus for railway car couplings characterized by passage means adapted to control the flow of shock absorbing fluid and characterized by an exponentially varying passage arrangement augmented by an additional passage arrangement which is open during the initial imposition of buff force and progressively blanked off or covered at the end of the buff stroke of the coupling. The additional passage arrangement remains blanked off or covered for the initiation of the restoring draft stroke of the coupling.

A method of controlling the operation of a railway car shock absorbing mechanism wherein relatively open venting of a piston biasing, coupling movement resisting, fluid zone is permitted, while a coupling is disconnected or not subjected to train forces. Relatively restricted venting of this zone is achieved while the coupling is connected with another car in a train in motion and while the coupling is tending to extend.

A method of controlling the movement impeding and force absorbing characteristics of a railway car shock absorbing mechanism. This method is characterized by venting a shock absorbing fluid zone, in response to the imposition of buff force, through an exponentially varying passage arrangement and through a secondary passage arrangement. The secondary venting arrangement is blanked off or covered when draft force is imposed upon the coupling and the coupling is in its fully converged or full buff position.

RELATED APPLICATION

This applicaton discloses a train action control valve which is the subject matter of a pending United States Blake application Ser. No. 611,931, filed Jan. 26, 1967.

BACKGROUND OF INVENTION

In recent years, considerable attention has been paid to the development of hydraulic shock absorbing mechanisms to cushion forces imposed on railway car couplings.

A primary function of these shock absorbing mechanisms is to absorb the exceedingly high buff forces which are often imposed on couplings during its intercoupling of railway cars in railway yards.

Particularly effective railway shock absorbing mechanisms are described in Blake Patent 2,944,639 and Seay Patent 3,301,410.

In certain railway systems, such as some in Canada, extremely adverse track conditions are encountered which tend to induce an extraordinarily high degree of train action. Train action is a term applied to phenomena which occur as a consequence of slack in the couplings between railway cars, which slack enables cars to undergo relative movement while a train is in motion. Specifically, "train action" denotes the equalizing of speed of adjacent cars which have undergone relative movement. Where this relative movement is characterized by the adjacent cars moving apart, this action is termed "run-out." Where adjacent cars are tending to converge, this train action is referred to as a "run-in."

Such run-out and run-in phenomena produce a variety of undesirable effects. For example, during the period while couplings are extending or contracting, train crewmen have reported that they experience a "floating" sensation. Once couplings have ceased their extension or contraction, train action shocks of a high magnitude are imposed on cars which are noticeably severe and occasionally severe enough to jolt and injure crewmen. Such train action shocks also obviously are injurious to train components and may produce derailment tendencies.

The magnitude of the train action problem is discussed in connection with experimental and evaluation efforts pertaining to Canadian railway systems in a paper authored by F. E. King and R. W. Radford, entitled "The Effect of Freight Car Cushioning Characteristics on Train Action," and presented at the winter annual meeting of the American Society of Mechanical Engineers held in New York in November and December of 1966. Some appreciation of the track profile conditions which produce excessive train action may be gathered by reference to this article.

At this point, it should be recognized that coping with the train action phenomenon presents requirements which are diametrically opposed to coping with the absorption of impact loads in railway yards during car coupling operations. In order to effectively absorb the exceedingly high buff forces often imposed on couplings during car coupling operations, hydraulic shock absorbing mechanisms are necessarily characterized by relatively high capacity restricted passage means for venting fluid from shock absorbing fluid bodies. However, in order to effectively limit coupling movement while trains are in motion where coupling forces of a considerable lower magnitude are generally involved, it is necessary to provide a more restricted venting of fluid from a shock absorbing fluid body.

These diametrically opposite criteria obviously present a design dilemma, with there being no obvious reconciliation of the requirements for accommodating both coupling action and train action phenomena.

SUMMARY OF INVENTION

It is a principal object of the invention to provide methods and apparatus which enable railway car shock

absorbing mechanisms to effectively minimize both the magnitude and number of train action events while a train is in motion.

It is a related object of the invention to provide methods and apparatus for enabling railway car shock absorbing devices to minimize train action without significantly adversely affecting the ability of shock absorbing mechanisms to absorb the high level impact forces imposed on couplings in railway yards during coupling operations or restore at a satisfactory rate to a neutral position when not subjected to train action forces.

A further principal object of the invention is to provide methods and apparatus for effectively controlling both coupling and train action phenomena without requiring drastic alternation of existing shock absorbing mechanisms such as those described in the aforesaid Blake patent and Seay application.

In accomplishing the foregoing objects, there is presented through this invention an overall apparatus comprising fixed means adapted to be connected with the body of a railway car and movable means adapted to be connected with the coupling means of a railway car. A piston and cylinder assembly provides piston means connected with one of the fixed means and cylinder means connected with the other of the fixed means and movable means. First fluid passage means in the assembly control an outflow of fluid from a zero within the assembly acting on the piston means. The first fluid passage means varies exponentially in flow capacity along the longitudinal axis of the assembly. Second fluid passage means in the assembly control fluid outflow from a zone within the assembly acting on the piston means, with this second fluid passage means being longitudinally displaced from the first fluid passage means. The piston means and cylinder means of the assembly, upon having undergone maximum relative movement in response to the imposition of buff force on the movable means are operable to cover the second fluid passage means. Additional fluid passage means in the assembly are adapted to transmit liquid from a zone within the assembly acting on the piston means. Valve means control flow through the additional fluid passage means in response to force enabled on the movable means. This valve means is operable to close the fluid passage means when at least a predetermined force is exerted on the movable means and open the fluid passage means in response to exertion of less than this predetermined force on the movable means. Still further fluid passage means may be included in the assembly, with the first fluid passage means being interposed between this further passage means and the second fluid passage means. This further fluid passage means is characterized by a relatively restricted flow capacity in relation to the additional passage means.

An individually significant facet of this overall combination resides in the additional fluid passage means in combination with its valving mechanism as above described. Yet another individually significant facet of this combination resides in the arrangement of the first and second fluid passage means as above noted, as well as in the combination of the first and second fluid passage means and the additional valve-controlled passage means.

An overall method presented through the invention for accomplishing the foregoing objects entails the provision of hydraulic shock absorbing means between a coupling portion and a body portion of a railway car. The hydraulic shock absorbing means includes piston means connected to one of the coupling and body portions and cylinder means connected to the other of the coupling and body portions, as well as restoring means resiliently biasing the coupling portion to a predetermined position. The vent means through which piston means biasing fluid may flow out of a zone within the assembly is maintained open while the coupling of a railway car is disengaged from another car and while the coupling portion is moving longitudinally away from the body portion of the railway car under the influence of the restoring means. The vent means is closed in response to the imposition of at least a predetermined shaft force on the coupling portion. While buff forces are imposed on the shock absorbing means, fluid is discharged from a piston biasing first zone within the assembly through first fluid passage means which progressively and exponentially decrease in a flow capacity in response to the continued application of buff force to the coupling portion. Subsequent to the venting of fluid from the first zone through the exponentially varying fluid passage means, further fluid is vented from a second zone. This second zone is disposed adjacent the first zone, with venting from the second zone resulting from further continued application of buff froce to the coupling portion. This further venting permits a substantially lower outflow of fluid than is permitted by the exponential venting. The further venting is terminated when the coupling portion has moved to is terminal buff position whereby, upon restoring draft movement of the coupling portion, piston biasing fluid is displaced initially through the exponentially varying first passage means. At each end of the buff and draft movement extremities of the coupling portion, a substantially unported zone is provided within the shock absorbing means. Each such zone contains fluid acting on the piston means to resist relative movement between the piston means and cylinder means. Additionally, continuous, but highly limited, by-pass flow between the cylinder means and piston means is provided.

An individually significant method aspect of this overall method entails the above-described mode of maintaining vent means closed in response to the imposition of force on a coupling portion, with the vent means being maintained open while the coupling portion is disengaged from another railway car.

A further individually significant facet of the overall method combination resides in the above-described mode of venting through first and second zones while preventing venting through the second zone when the coupling portion is being restored from a full buff condition.

DESCRIPTION OF DRAWINGS

In describing the invention, reference will be made to the preferred embodiment of the apparatus illustrated in the appended drawings.

In the drawings:

FIGURE 1 provides an elevational profile of a portion of a test track over which trains were run in order to evaluate the improved ability of the cushioning or shock absorbing mechanism of the present invention to minimize train action events and reduce their severity;

FIGURE 2 provides a graphical comparison of the performance of railway cushioning gear constructed in general accordance with the present invention as opposed to the performance of conventional, friction-type, draft gear;

FIGURE 3 provides a partially sectioned, elevational view of a shock absorbing mechanism of the present invention in the format of an improvement in the mechanism disclosed in the aforesaid Seay Patent No. 3,301,410;

FIGURE 4 provides an enlarged transverse sectional view of a portion of the FIGURE 3 mechanism illustrating structural details of a valve controlled vent, as viewed along the section line **4—4** of FIGURE 3;

FIGURE 5 provides a still further enlarged transverse sectional view of the valve mechanism shown in FIGURE 4 as viewed along the section line **5—5** of FIGURE 4;

FIGURE 6 provides an enlarged elevational view of the valve shown in FIGURE 5;

FIGURE 7 provides an end view of the FIGURE 6 valve as viewed along the view direction **7—7**;

FIGURE 8 provides a transverse sectional view of the flow restricting ports included in a valve member of the FIGURE 6 valve assembly; and

FIGURE 9 provides a schematic view of a modified porting arrangement which may be used in the FIGURE 3 assembly, illustrating the general disposition of venting ports of the assembly in relation to a piston of the assembly.

Overall apparatus

FIGURES 3 through 8 illustrate structural details of a railway cushioning device fabricated in accordance with the present invention.

FIGURE 3 illustrates an improved form of the cushioning device illustrated and described in detail in the aforesaid Seay Patent No. 3,301,410. Briefly reviewing the structural characteristics of this cushioning device **1**, without unnecessarily redescribing structure which is known in the art, it will be appreciated that the basic components of this device **1** comprise a housing **2** having a generally rectangular cross section, a high pressure cylinder **3** contained within housing **2** and having a cylindrical cross section, a piston **4** mounted for telescoping movement within the cylinder **3**, and an anchor assembly **5**. A conventional coupling bar **6**, shown in phantom lines in FIGURE 3, is adapted to be connected by conventional mounting keys or a pivot pin to housing **2**.

Housing **2** is adapted to be movably mounted, i.e., slidably mounted in a sill beneath a railway car body, with anchor assembly **5** being fixedly anchored to a sill portion. In this manner, anchor assembly **5**, which is connected to a piston rod **7** extending from and connected with piston **4**, serves to fixedly position the piston **4** within a railway car sill.

Cylinder end walls **8** and **9** are secured to opposite ends of cylinder wall **3** so as to define a high pressure cavity **10** within cylinder **3** and a relatively low pressure zone **11** encircling cylinder **3** and disposed between the housing **2** and the cylinder **3**. This zone **11** communicates through openings in end walls **8** and **9**, not shown, with check valve means **12** and **13** contained in walls **8** and **9** respectively. This general check valve and passage arrangement is fully described in the aforesaid Blake Patent 2,944,681 and Seay Patent No. 3,301,410 and for that reason need not be reillustrated.

As described in this Blake patent, and Seay application, the low pressure zone surrounding the cylinder wall **3** and end walls **8** and **9** is sealed at opposite ends of the housing **2**. Thus, as shown in FIGURE 3, the left end of this low pressure zone is sealed by annular seal means **14** interposed between housing **2** and a housing end plate **15**.

Piston rod **7** telescopingly passes through the end plate **15** and is in sealed but slidable engagement with this plate. An axially extendable and contractable seal **16**, connected to the end plate **15** and a piston rod portion **17**, serves to protect the portion of the piston rod **7** which passes slidably through the housing end plate **15**.

A coil spring restoring mechanism **18**, preferably of the types disclosed in the U.S. Blake Patent 3,047,162 or in U.S. Abbott et al. Patent 3,233,747, filed Jan. 22, 1964, assigned to the assignee of this application is incorporated in device **1**. This restoring mechanism **18** tends to resiliently and yieldably maintain the housing **2** within a railway car sill in a predetermined neutral position so as to obtain a desired position of the piston **4** within the cylinder **3** when the coupling bar **6** is separated from the coupling of an adjacent railway car. In this connection, it will be understood that in FIGURE 3, the piston **4** is illustrated in a position where it has been displaced from its usual neutral position in response to the application of buff force to the coupling bar **6**. In the FIGURE 3 arrangement, it is contemplated that the restoring mechanism **18** would ordinarily tend to position the piston **4** so that a split piston ring **19** having a ring split or gap **19***a* is carried by the piston **4** will have its draft or right edge **19***b* substantially aligned with the plane P. This use of this ring provides an improved seal between the piston **4** and cylinder **3** and thus represents an improvement over the devices of the aforesaid Seay application and Blake patents.

Port means **20**, comprising a plurality of radial ports spaced longitudinally of the cylinder wall **3** and extending through the cylinder wall **3**, provide fluid communication between the zones **10** and **11**.

Key slots **21** and **22** may be provided in housing **2** to receive conventional cushioning device mounting keys of the type described, for example, in Blake Patent 3,207,324 and Blake Patent 3,047,162. These mounting keys extend fairly snugly through the slots **21** and **22** and into relatively long, longitudinally extending sill slots. The length of the sill slots may serve to determine the stroke of the cylinder **3** relative to the fixed piston **4** and thus limit the stroke in both buff and draft directions. That is, when the mounting keys engage either end of a sill slot, further movement of the cylinder **3**, housing **2**, and coupling bar **6** is prevented. In some instances, a housing flange carried by the housing **6**, as shown for example at element **65** in the Blake Patent 3,207,324, may abuttingly engage the sill end in response to imposition of buff force so as to delineate the termination of buff movement of the housing **2**, cylinder **3**, and coupling bar **6**.

The basic mode of operation of the previously described components of the FIGURE 3 assembly is described in considerable detail in the aforesaid Blake patents, Abbott et al. patent and Seay patent.

In brief review, when buff forces are imposed on the coupling bar **6** with the piston **4** disposed at its neutral position, fluid will be displaced from an annular zone **10***a* to the left of the piston buff end **4***a* through the port means **20** into the zone **11**. This displaced fluid will travel from the zone **11** through the previously described openings in the plate **9** to pass through the check valve means **13** into the zone **10***b* to the right of the piston **4**. The port means **20**, in restricting flow from the zone **10***a*, will cause the fluid within the zone **10***a* to absorb buff forces and thus cushion the imposition of buff shock on a railway car.

Conversely, when draft force is applied to the coupling bar **6** with the piston **4** disposed as shown in FIGURE 3, fluid will be displaced by the piston draft end **4***b* from the annular zone **10***b* through the port means **20**. This displaced fluid will flow through the previously described openings in the end plate **8** and return to the annular zone **10***a* through the check valve means **12**. As will be appreciated, check valve means **12** and **13** are biased to a closed position by conventional coil spring mounting arrangements and open inwardly into the zones **10***a* and **10***b* in response to a pressure differential across them characterized by a low pressure zone adjacent the check valves within the cylinder cavity **10**.

Improved porting and piston arrangement

The FIGURE 3 assembly is characterized by an improved arrangement of venting ports and piston components which provide effective control over train action events without impairing the ability of the FIGURE 3 assembly to absorb heavy buff impact under coupling conditions.

This improved porting arrangement is characterized by a first plurality of longitudinally spaced, cylinder wall ports **23**. Ports **23** are exponentially spaced and progressively and exponentially decrease in spacing in a longitudinal direction extending toward the coupling bar **6**. In order to obtain the desired orifice coefficient characterics of these flow-restricting ports, the dimensional relationships in the aforesaid Seay application should be followed. That is, the port diameters should fall within a range of about .28 inch to about .38 inch. In practice a diameter of $\frac{5}{16}$ of an inch for each port **23** has been found to produce satisfactory results, consistent with the teaching of this Seay application.

A second plurality of venting ports **24**, longitudinally displaced from the first plurality of ports **23**, is disposed between the ports **23** and the coupling bar **6**. Ports **24**

are preferably also dimensioned in accordance with the teachings of the aforesaid Seay application and in practice, have been found to perform satisfactorily when having a diameter of about 5/16 of an inch. However, the ports **24**, rather than being exponentially spaced, are equally spaced.

In a tested embodiment where the piston **4** had a diameter of about 9 inches and where the relative travel of piston **4** within cylinder **3** is about 10 inches, i.e. when housing **2** and cylinder **3** have a full stroke of 10 inches, satisfactory results have been obtained with six ports in the port means **23** and three port means in the port means **24**, with all of these ports being 5/16 inch in diameter.

As will be appreciated, the ports **23** and **24** are disposed to the left of the piston **4** when it has assumed its neutral position, as determined by the spring mechanism **18**. Thus, exponentially spaced ports **23** and uniformly spaced ports **24** serve to control fluid flow from the cylinder cavity **10** during the imposition of buff force when the cylinder is moved from its neutral position.

As shown in FIGURE 3, the cylinder **3** has been moved so as to position the piston **4** at the end of its buff stroke. In this position, the leftmost port **24***a* is displaced from the leftmost end **4***a* of the piston **4** by a distance of .75 inch. With these dimensional relationship, the longitudinal width of the piston **4** has been gauged at about 2½ inches with the ring **19** having a width of about .375 inch and being spaced from the left or buff end **4***a* of the piston **4** a distance of 1.22 inches.

Although the split piston ring **19** provides slidable and sealing engagement radially between the piston **4** and cylinder **3**, some limited and throttled fluid flow between the cylinder and piston may take place through the ring split zone **19***a*. Thus, when the piston **4** has been positioned so as to cover the leftmost port **24***a*, continued, but highly resisted, piston movement relative to cylinder **3** may continue, with fluid venting from zone **10***a* through ring split **19***a* into zone **10***b*. As will be further noted, when coupling **6** has moved to its full buff position so as to position piston **4** as shown in FIGURE 3, the port means **24** will have been covered.

It will also be appreciated that after the left edge **4***a* of the piston **4** has covered the port **24***a*, some limited and throttled leakage may take place between the piston **4** and cylinder **3** to the left of ring **19** as shown in FIGURE 3, thereby enabling fluid to flow from the zone **10***a* into one or more of the ports **24**. However, it is believed that the combined flow capacity of this leakage, as well as the leakage through ring split zone **19***a*, is not as great as the flow capacity of individual port **24**. Thus, when the cylinder **3** has moved sufficiently to cause the piston **4** to cover the ports **24**, further buff movement of the cylinder **23** will take place with intensified or increased resistance.

With the buff controlling port means **23** and **24** having been described, it now becomes appropriate to described the draft controlling port means of the FIGURE 3 apparatus.

It should be here observed, that in the FIGURE 3 embodiment, the cylinder **3** may travel nine inches from its neutral position in response to the imposition of buff force and one inch from its neutral position in response to the imposition of draft force.

This draft controlling port means comprises, in the right or draft end of the cylinder wall **3**, a relatively restricted single port **25** and a valved port **26**. As illustrated, restricted port **25** is longitudinally interposed between valve port **26** and first port means **23**. Thus, restricted port **25** may be viewed as third vent means with valve port **26** being viewed as fourth vent means.

At this point, it should be observed that in indicating that various ports of the port or vent means are longitudinally displaced, what is meant is that the ports are aligned with planes perpendicular to the longitudinal axis of the assembly **1**, with these planes being longitudinally displaced.

Longitudinal spacing, as previously used in this discussion, and as used subsequently, is intended to encompass not only longitudinal spacing with the maintenance of axial port alignment, but also longitudinal displacement where ports are circumferentially displaced from each other. Indeed, in practice, it has been found that it is undesirable to longitudinally align all of the venting ports of the apparatus. Because of the extreme fluid pressures encountered within the cavity **10**, metal deformation in the vicinity of the venting ports may tend to result. Where all of the ports are aligned, this axial alignment of deformed areas may tend to produce an undesired interference action between the piston and cylinder.

As shown in FIGURE 3, valved port **26** is preferably aligned with plane P, i.e., the location of the draft or right edge **19***b* of the piston ring **19** when the piston **4** is in its full draft position. Thus, with the valved port **26** open, even though a portion of the piston **4** covers the port **26**, fluid may flow from the zone **10***b*, to the left as shown in FIGURE 3 and between the piston **4** and cylinder wall **3**, and then through the port **26** into the low pressure zone **11**. This outflow, coupled with the by-pass outflows from the zone **10***b* through the ring split **19***b* to the zone **10***a*, will enable a desired rapidity of cylinder movement near the end of a draft stroke under conditions where the valve port **26** remains open. This restoration rapidity is desirable under "free air" conditions—i.e. when coupling bar **6** is disconnected from an adjacent car.

In practice, it has been found desirable for the longitudinal distance between the center line of the port **26** and the right or draft end **4***b* of the piston **4** at its full draft position to be on the order of 1.77 inches. Similarly, it has been found acceptable for the distance from this draft edge **4***b* of the piston **4** in its full draft position to the center line of the port **25** to be on the order of about 2.37 inches, with port **25** having a diameter of about 1/10 of an inch.

A valve mechanism **27** is mounted on the exterior of cylinder wall **3** and cooperates with cylinder wall **3** and port **26** to define a valved, radial flow path extending from cylinder cavity **10**. This flow path is unique in that the valve mechanism **27** is resiliently biased to an open position and tends to remain open until a predetermined pressure is created within cylinder draft zone **10***b* in response to the imposition of a predetermined draft force on coupling bar **6**. This predetermined force is of such a level as to be higher than the force imposed on housing **2** by restoring mechanism **18** but at least equal to the normal level of forces imposed on the coupling **6** as a consequence of run-out train action. As a consequence, port **26** will remain open while the coupling **6** is restoring from a full buff condition as shown in FIGURE 3, with the coupling **6** being disconnected from an adjacent railway car. However, the port **26** will be valved closed in response to the imposition of run-out forces on the coupling **6** while it is connected to the adjacent car of a train in motion.

Structural details of valve mechanism **27** are illustrated in FIGURES 4 through 8.

Mechanism **27** includes a generally cylindrical body portion **28** and a reduced threaded coupling portion **29** which is threadably secured in a threaded socket portion **30** of cylinder wall **3**. With body **28** thus threadably secured to threaded socket **30**, the longitudinal axis of the valve **27** projects generally radially into a corner portion **11***a* of cavity **11**. In other words, valve **27** projects generally radially toward rectangular housing corner **2***a* so as to project into a portion of the reservoir **11***a* large enough to accommodate the valve body without requiring enlargement of the housing **2**.

Valve **27** includes a tubular and movable valve member **31** which is telescopingly received within a valve body opening **32**. Movable valve member **31** is provided at the end facing port **26** with a head **33** providing a fluid reaction surface **34**. This surface **34** extends generally transversely of the radial axis of port **26** and faces this port.

A pair of diametrically opposed, restricted, radial ports **35** intersect the tubular wall of valve member **31** adjacent the valve member head **33**.

In practice, it has been found that the diameter of the head **33** should be on the order of .65 inch with the two ports **35** each having a diameter of about 1/10 of an inch. Each of the ports **35** communicate with a longitudinal passage **37** of tubular member **31** which has been found to have a satisfactory diameter of 5/16 inch, i.e., the same diameter as port **26**. Thus, passage **37** provides fluid communication, through ports **35**, between port **26** and reservoir **11**.

An annular under lip or abutment **38** on the head **33** of valve member **31** is adapted to abuttingly engage an annular, abutment defining upper end **39** of valve body portion **29** so as to limit radial outward movement of the valve member **31**. With the valve member **31** being telescoped radially outwardly of the valve body **28** so as to bring the abutments **38** and **39** into engagement, the ports **35** will have been brought into port closing engagement with tubular valve seat **40** defined by the cylindrical wall encircling opening **32**.

An annular piston **41** is slidably and telescopingly positioned within valve body portion **28**. Annular piston **40** includes a central aperture **42** through which valve member **31** projects. Annular piston **41** engages an annular shoulder or abutment **43** on valve member **31** and is secured against this abutment by a conventional snap ring **44** which is secured within an annular recess **45** of member **31**.

A coil spring **46** abuttingly engages annular piston **41** and is secured within the housing portion **28** by an annular plate **47**. Annular plate **47**, itself, is secured within the valve body **28** by a snap ring **48** which is anchored within a valve body recess **49**. With annular plate **47** locked in position by snap ring **48**, the spring **46** is maintained so as to exert a desired force transmitted through the piston **41** and acting on the valve member **31** to resist valve closing or port closing movement of this member **31**. Generally, the spring **46** will be preloaded or precompressed by the installed plate **47**. In this manner, the member **31** is yieldably biased to an open position under a load which will be offset by the predetermined loading on the coupling bar **6** necessary to generate sufficient pressure within the zone **10***b* to effect valve opening.

As illustrated in FIGURES 5 and 7, annular plate **47** includes a central aperture **50** through which the open lower end of the member **31** slidably and telescopingly projects. A plurality of ports **51** in the plate **47** provide limited fluid communication between the reservoir **11** and an annular zone **52** within the body **28** communicating with the piston **41**. In this connection, it will be appreciated that the entire valve member **27** is immersed in the hydraulic fluid occupying the reservoir **11** and cylinder cavity **10** and thus will also occupy the space **52**. Thus piston **41**, in cooperation with ports **51**, will provide a dashpot or movement impedance effect on member **31**, tending to prevent valve "chattering."

As fluid is discharged through the port **26** in response to draft movement of the cylinder **3**, this fluid will be first radially impinged on the fluid reaction surface **34**. This fluid will then be deflected laterally to flow into an annular space **53** defined by wall means **54** of socket **30**. This relatively enlarged annular zone **53** provides communication between the port **26** and the ports **35** of the valve member **31**, when the valve member **31** is in an open port position as shown in FIGURE 4 and FIGURE 5.

Fluid, after having been deflected by the reaction surface **34** into the annular zone **53** defined by wall **54**, will flow through the flow restricting ports **35** into the valve member passage **37**. These flow restricting orifices or ports **35** will produce a pressure drop between fluid in the space **53** and fluid in the passage **37** so as to tend to produce a valve closing pressure differential force acting on the valve head **33**.

As a result of this pressure differential, probably augmented by the force generated by the impingement of fluid on the reaction surface **34**, a valve closing force will be exerted on the valve member **31**, which of course is normally held open by the biasing spring **46**. When train action draft force is imposed on the coupling bar **6** to produce a pressurized flow through vent **26**, impinging on the surface **34** and passing through the ports **35**, this flow will create sufficient force acting on the valve **31** so as to overcome the biasing effect of the spring **46**. The valve member **31** will then move radially outwardly of the cylinder **3** and close the port **26**. However, when relatively low force is imposed on the cylinder **3** or the coupling bar **6**, such as the force imposed by restoring mechanism **18**, a flow of velocity and pressure insufficient to effect the closing of the valve **27** will take place through the port **26**. In practice, it has been found that the spring **46** should be adjusted to enable the valve **27** to close in response to a total imposition of draft force on housing **2** on the order of about 21,000 pounds, with about 7,600 pounds of this force being supplied by restoring mechanism **18**. In other words, valve **27** will close in response to a train action draft force of about 13,000 pounds.

As will be appreciated, the valve member **27** is coupled to the cylinder **3** so as to be sealingly engaged with the socket **30**. A conventional lock washer **55** may be interposed between the valve body **28** and the cylinder wall **3** to securely anchor the valve member **27** on the outer periphery of the cylinder **3**.

Alternate porting and piston arrangement

FIGURE 9 illustrates a modified porting and piston arrangement wherein the resorting mechanism **18** tends to restore the cylinder **3** to a full draft position as opposed to the intermediate neutral position of the cylinder contemplated in connection with the FIGURE 3 arrangement which allows a one inch draft stroke from a neutral condition.

In practice, it has been found that while a train is in motion, the movable cylinder **3** is generally positioned in either full draft or full buff positions except while train action events are occurring. It has also been found that in most instances, a cushioning device need not provide for fluid resisted cushioning movement under coupling loads imposed in railway yards. Thus, it is advantageous for the mechanism **18** to restore the cylinder to a full draft position so as to maintain the full travel stroke of the cylinder for absorbing buff loads.

In the FIGURE 9 arrangement, the port means **23** and **24** have been shifted, in relation to the FIGURE 3 device, further toward the draft end of the cylinder **3** so as to provide an unported annular zone in the left or buff end of the cylinder **3** of increased length. In thus increasing the length of this unported zone, there is provided at the end of the buff stroke a longer stroke portion of maximum resistance so as to more effectively impede coupling movements during extreme train action, run-in conditions.

In FIGURE 9, the distances A, B and C represent distances from the buff edge **4***b* of the piston **4**, in its full buff position, to the three equally spaced ports of second port means **24**. The distances D, E, F, G, H and I represent distances from the buff edge **4***b* of the piston **4**, when the piston is in its full buff position to the six exponentially spaced ports of the first port means **23**. The distance J represents the distance from the draft edge **4***b* of the piston **4**, in its full draft position, to the third vent means **25**, while the distance K represents the distance from the draft edge **4***b* of the piston **4** in it full draft position to the valve controlled fourth vent means **26**.

The distance L represents the distance between the buff edge of the piston **4** and the piston ring **19**.

To provide a fuller understanding of the invention, these dimensions in inches are tabulated below with reference to both the FIGURE 3 and FIGURE 9 embodiments when in each instance the travel distance of the

cylinder is ten inches and the distance between piston faces 4*a* and 4*b* is about 2½ inches.

Dimension	FIGURE 3 embodiment	FIGURE 9 embodiment
A	.75	1.75
B	1.00	2.00
C	1.25	2.25
D	1.62	2.62
E	2.25	3.25
F	2.90	3.90
G	3.75	4.75
H	4.85	5.85
I	6.37	7.37
J	2.37	2.37
K	1.77	.99
L	1.22	1.14

Criteria for determining port patterns

In developing a pattern for the ports of the first, second, third and forth vent means **23**, **24**, **25** and **26** respectively, the following approach may be advantageously utilized.

The distance A to leftmost port **24***a* is determined by providing the desired and empirically determined axial distance of relative movement between the piston **4** and cylinder **3**, with an unported fluid occupied zone resisting this movement at the buff end of the stroke. (The term "unported," as here used excludes port means **23**, **24**, **25** and **26** but not ring gap **19***a*.)

Once the axial length of the unported buff end of the stroke has been determined, the location of the leftmost exponential port **24***a* is fixed. The spacing between ports **24** is largely empirically determined so as to produce a desired rate of pressure intensification within zone **10***a* after port **23***a* has been cleared.

The spacing between the ports **24** may be somewhat less than the distance between the rightmost port **24***b* and the exponential port **23***a*, as reflected by the prior tabulation.

The distance D to the leftmost exponential port **23***a* is determined empirically so as to provide the desired resistance to cylinder movement near the end of the buff stroke after the empirical ports **23** have been traversed.

The number of ports in vent means **23** is determined to a large extent empirically, keeping in mind that the total number of ports in vent means **23** and **24** must effectively accommodate impact coupling loads.

The distance between the leftmost or buff face **4***a* of the piston **4** in the neutral piston position and the position of this face in the full buff position is based on the empirically determined extent of the full buff stroke of the cylinder from its neutral position. This distance, less the distance D, determines the length of the buff stroke through which the cylinder moves from its neutral position wherein empirical vent means **23** remains effective.

The positioning of the ports of vent means **23** is determined as though there were a number of ports in vent means **23** equal to the empirically determined number of exponential ports plus one, with this number of ports being exponentially spaced. The port **23***a* at the converging end of the port series is fixed in position as previously noted. The added port, at the enlarging end of the port series, is positioned so as to be aligned with the buff edge **4***a* of the piston **4** when the piston **4** is disposed in its neutral position. Thus, in determining the layout of ports where six exponential ports **23** are involved, the position of the ports in vent means **23** is determined as though there were 7 ports, with the first port located in alignment with the buff edge of the piston in its neutral position and the 7th port located at distance D from the buff end of the piston stroke. It will be understood, of course, that no actual exponential port is actually located at the buff edge of the piston when it is in its neutral position.

The distances J and K are also empirically determined. Distance J is determined so as to yield an acceptable axial travel at the end of a draft stroke where maximum resistance to this terminal draft movement will be afforded by an unported fluid zone. In this connection it will be appreciated that this distance D is relevant to the operating or moving train conditions when the valved port **26** will be closed.

The distance K is determined so as to position the port **26** in general alignment with draft edge **19***a* of the ring **19** when the piston **4** is in its neutral position. This ensures that under free air, coupling restoring conditions, fluid from the zone **10***b* can throttle between the piston **4** and the cylinder **3** and pass through the open port **26**, thus providing a desired rapidity of coupling restoration to a neutral position.

Summary of method of operation

In summarizing the method of operation of the cushioning device **1** of the present invention, reference will be made to the FIGURE 3 embodiment. In this connection, it will be understood that the observations concerning the FIGURE 3 embodiment are also generally applicable to the FIGURE 9 embodiment.

FIGURE 3 illustrates the cushioning device **1** in a full buff condition. When the device **1** restores from this full buff condition, in response to the imposition of draft force imposed by an adjacent railway car of a train in motion, three progressively intensifying stages of shock absorbing and coupling movement resistance will result.

In the first stage, with the piston **4** initially covering the second vent means **24**, movement control and shock absorbing will be governed by the exponential vent means **23**, the open port **25**, and the vent **26**. In this connection it should be noted that in the FIGURE 3 embodiment, the two leftmost ports of vent means **23** are also covered. During this first phase, the vent **26** will close either at the initiation of imposition of draft force or at some point of the relative movement of the piston **4** through the exponential port series **23**.

In the second stage, the piston **4** will have cleared the exponential port series **23**, with control now being effected by the restricted third port means **25** and with vent **26** being closed.

In the third stage, where resistance to movement is further intensified, the piston will have covered or moved past the port means **25** so that a higher degree of resistance to movement is imposed by a terminal body of fluid which can escape from the zone **10***b* through the highly restrictive ring gap **19***a*. The flow capacity of this gap is substantially less than that of any of the 5/16 inch ports of the system.

Under free air conditions, i.e., when the coupling bar **6** is not connected with the coupling of an adjacent railway car or not in significant force transmitting with another car, a different form of restoration from a full buff condition will result. The restoring force will here be provided by the spring mechanism **18** alone. Each of the three phases above described will be augmented by an outflow capacity from the zone **10***b* as permitted by the now open vent **26**. Thus, under free air conditions, an acceptably rapid restoration of the cylinder **3** to its neutral position is permitted. Were it not for the open port **26**, restoration would be at an undesirably slow rate, particularly once the piston **4** had cleared the port means **23** in moving toward the draft end of the cylinder **3**.

Conversely, were it not for the closed condition of the port **26** during train action run-out events, excessive coupling movement would occur which would produce both an inordinate number of train action events under adverse rail bed conditions and inordinately high coupling forces.

The mode of operation of the FIGURE 3 device will now be described with reference to restoration from a full draft condition of the cylinder **3**, where the piston **4** is disposed at the right extremity of its relative travel within the cylinder **3**.

In restoring from a full draft condition, whether in free air or under run-in train conditions, three progressively intensified stages of resistance to coupling movement will result.

In the first stage, control over movement of the cylinder **3** is provided by venting simultaneously through the first

and second port means **23** and **24**. Thus, during this phase, exponential venting as provided by port means **23** will be supplemented by the full venting capacity of the vent means **24**.

In the second control stage, when the piston **4** has cleared the port means **23**, primary control will be provided by the venting capacity of the equally spaced ports in the supplemental port means **24**. It should be noted that during this phase, as the piston progressively covers the ports in the vent means **24**, an in-phase, progressive intensification of resistance to coupler movement will result.

In the third stage of resistance to coupler movement, the piston **4** will have cleared the vent means **24**, with resistance to coupler movement now being governed by the venting capacity of the ring slot **19***a*.

At this point, it may be noted that at the extremity of either the buff or draft stroke, where control is being effected by the ring split **19***a*, some additional flow capacity may be provided by system leakage.

Significantly, when the piston has moved to a full buff position, the port means **24** are covered by the piston **4**. With this port covering, subsequent draft movement of the cylinder **3** will be initiated with resistance to coupler movement being intensified by the substantial blanking-off of the vent means **24**.

Summary of major advantages and scope of invention

Probably the principal advantage of the invention resides in the ability of the cushioning mechanism **1** to minimize both the number and severity of train action events.

The magnitude of this contribution may be appreciated by reference to the severity of train action problems as discussed in the previously noted article by King and Radford.

FIGURE 1 provides some indication of the adverse rail bed conditions which tend to produce excessive train events. FIGURE 1 illustrates the profile of a portion of a rail bed on a Canadian track extending between Garneau and Riviere a Pierre, Quebec. The maximum grade on this track is about 3.6° which is unusually steep. In addition to the grade problem, the track undulates severely in profile so as to tend to produce conditions uniquely conducive to train action events.

FIGURE 1 illustrates a track profile with vertical guide markers being provided at one mile increments. Track slope in degrees has been noted at varying points along this profile. The lowest point on this profile, i.e. point X, has an elevation above sea level of about 520 feet. The highest point Y on this profile has an elevation of about 632 feet above sea level. In the vicinity of the two-mile marker in the FIGURE 1 profile, a train moving from left to right moves down an incline at about 2.8° and then abruptly up an incline of 2.3° and then subsequently abruptly down another incline of about 1.9°. As will be apparent, by reference to FIGURE 1, these changes in inclination are closely spaced and fairly well typify the grade profile. Thus in moving down the 2.8° slope and approaching the two-mile marker, the cars of the train will tend to converge so as to produce run-in train action. Then abruptly, after clearing the two mile marker, and while moving up the 2.3° slope, the cars will tend to separate so as to produce train action run-out events.

Where conventional, frictional type, draft gear has been employed, this 40 mile length of track between Garneau and Riviere a Pierre, has produced extraordinary severe train action. The upper Section A of FIGURE 2 provides a graphical indication of a representative number of run-in and run-out train events, and the severity of these train events, which were encountered with standard friction type draft gear traversing this track.

FIGURE 2 dramatically illustrates the extent to which the present invention reduces over all severity and number of train action events. Section B of the chart shown in FIGURE 2 illustrates run-in and run-out events, both by number and magnitude, for the same track with a similar train, but where train action was governed by cushioning devices generally constructed in accordance with the present invention. The essential similarities in the trains involved in compiling sections A and B of FIGURE 2 and the inclusion in the draft gear used in compiling Section B of the chart of the exponential port means **23**, the supplemental port means **24**, a valved port **26**, and a restricted port **25**, are believed to provide a valid basis for evaluating the improved train action control afforded by this invention. In this connection, it should be noted that the tests which produced the data for Section B of FIGURE 2 were performed where the vent **25** was less advantageously disposed as an axial orifice in the valve head **34**.

In comparing Section B with Section A of FIGURE 2, it will be noted that run-outs were reduced from 29 to 8 while run-in events were reduced from 17 to 12. The magnitude of run-out forces were substantially reduced, with the number of run-in events at higher run-in force being reduced. In this connection, it should be noted that the single run-in event which occurred with a run-in force between 200,000 and 300,000 pounds is believed to have resulted from train braking and thus probably does not provide valid data for comparison purposes.

The especially significant improvement in run-out control is directly attributable to the concept of covering or substantially blanking off the supplemental vent means **24** and automatically closing the valve port **26**. Undoubtedly, the exceedingly high resistance to coupler movement at the end of the draft stroke further contributes to minimizing run-out events.

The improved control over run-in events is believed to be primarily attributable to the progressive blanking off of the supplemental port means **24** followed by the intensification of the resistance to movement of the train coupler after the port means **24**, themselves, have been covered. This, of course, results from the unported zone at the end of the buff stroke.

Another significant advantage resides in the improved ability of the cushioning device of the present invention to pick up large numbers of loaded cars in a train before expending the full stroke capacity of the device. This ensures that while car pick up action is progressing through a train, the shock absorbing characteristics of the cushioning device remain effective. Tests thus far indicated that an excess of fifty loaded cars may be picked up before expending full stroke capacity.

It has also been observed that the reduced restoring rates of the cushioning device of the present invention, in relation to prior known hydraulic cushioning devices in and of itself, tends to reduce the magnitude of train action problems. In restoring slower to a neutral position from a full buff condition, for example, there is maintained within a cushioning device a greater ability to absorb draft forces imposed on a coupling subsequent to a run-in event.

A highly unexpected facet of the invention is the ability to supplement the exponential drainage afforded by the port means **23** with the supplemental drainage afforded by the port means **24** without adversely affecting the shock absorbing characteristics of the cushioning device **1**. Data thus far gathered, indicates that the high level impact forces generated during coupling operations may still be effectively handled by the cushioning device **1** even though at the end of the buff stroke, the supplemental ports **24** are blanked off. Some appreciation of the unobviousness of this facet of the invention may be derived by recognizing that in previously utilized shock absorbing devices, a continuously effective, but unappreciated, venting capacity approximating that afforded by the port means **24** was probably afforded by by-pass flow between the piston **4** and cylinder **3**, which by-pass flow is now highly reduced by the seal ring **19**.

It is also significant to note that these improvements in train action control may be easily incorporated in effective shock absorbing mechanisms such as those disclosed

in the aforementioned Blake patents and Seay application without requiring any signficant structural alterations of the basic components of these devices.

Those familiar with the disclosure of this invention will at once recognize that its scope is not limited to the port type venting system described, or to the particular piston and cylinder arrangements illustrated. As was noted in the aforesaid Seay application, limited deviations with respect to optimum port positioning is tolerable within the spirit of the invention.

Thus, those skilled in the art may recognize additions, deletions, substitutions, modifications, or other changes which would fall within the scope of the invention.

We claim:

1. In a railway car including
a railway car body; and
railway draft gear having railway coupling means operable to couple said railway car body to other railway car means;
the improvement in said draft gear comprising:
fixed means connected with said railway car body;
movable means connected in train action force transmitting relation with said railway coupling means;
a piston and cylinder assembly having piston means connected with one of said fixed means and movable means and cylinder means connected with the other of said fixed means and movable means, with said movable means being connected in train action force transmitting relation with one of said piston means and cylinder means;
vent means in said assembly operable to transmit liquid out of an interior zone within said cylinder means, which interior zone is disposed in pressurizable communication with said piston means; and
train action control means operable, in the absence of train action force acting on said railway coupling means, to maintain said vent means in a relatively open condition and operable in response to train action force acting on said railway coupling means to impede flow of said liquid from said interior zone through said vent means;
said train action control means including valve means operable to control flow of said liquid from said interior zone through said vent means in response to train action force imposed on said railway coupling means, said valve means being operable in response to pressure of said liquid within said interior zone, generated in response to train action induced force acting on said railway coupling means, to at least impede flow of said liquid from said interior zone through said vent means when train action induced force is exerted on said railway coupling means.

2. In a railway car including
a railway car body; and
railway draft gear having railway coupling means operable to couple said railway car body to other railway car means;
the improvement in said draft gear comprising:
fixed means connected with said railway car body;
movable means connected in train action force transmitting relation with said railway coupling means;
a piston and cylinder assembly having piston means connected with one of said fixed means and movable means and cylinder means connected with the other of said fixed means and movable means, with said movable means being connected in train action force transmitting relation with one of said piston means and cylinder means;
vent means in said assembly operable to transmit liquid out of an interior zone within said cylinder means, which interior zone is disposed in pressurizable communication with said piston means to a zone exterior of said assembly, said vent means comprising a port in a side wall portion of said cylinder means;
train action control means operable, in the absence of train action force acting on said railway coupling means, to maintain said vent means in a relatively open condition and operable in response to train action force acting on said railway coupling means to impede a flow of said liquid from said interior zone through said vent means;
said train action control means including valve means operable to control flow of said liquid from said interior zone through said vent means in response to train action force imposed on said railway coupling means, said valve means being operable in response to pressure of said liquid within said interior zone, generated in response to train action induced force acting on said railway coupling means, to move from an open position toward a closed position to at least impede flow of said liquid from said interior zone through said vent means when train action induced force is exerted on said railway coupling means;
said valve means being connected with said port to define a valved flow path through a side wall portion of said cylinder means;
said valve means being resiliently biased to a normally open position and being closable in response to a flow of fluid outward of the interior zone of said cylinder means through said flow path; and
auxiliary vent means having a substantially smaller flow capacity than said port and providing an auxiliary flow path for allowing a limited outflow of fluid from said interior zone while said valve means is impeding flow through said vent means.

3. In a railway car including
a railway car body; and
railway draft gear having railway coupling means operable to couple said railway car body to other railway car means;
the improvements in said draft gear comprising:
fixed means connected with said railway car body;
movable means connected in train action force transmitting relation with said railway coupling means;
a piston and cylinder assembly having piston means connected with one of said fixed means and movable means and cylinder means connected with the other of said fixed means and movable means, with said movable means being connected in train action force transmitting relation with one of said piston means and cylinder means;
vent means in aid assembly operable to transmit liquid out of an interior zone within said cylinder means, which interior zone is disposed in pressurizable communication with said piston means, to a zone exterior of said cylinder means;
train action control means operable, in the absence of train action force acting on said railway coupling means, to maintain said vent means in a relatively open condition and operable in response to train action force acting on said railway coupling means to impede a flow of said liquid from said interior zone through said vent means;
said train action control means including valve means operable to control flow of said liquid from said interior zone through said vent means in response to train action force imposed on said railway coupling means, said valve means being operable in response to pressure of said liquid within said interior zone, generated in response to train action induced force acting on said railway coupling means, to move from an open position toward a closed position to at least impede flow of said liquid from said interior zone through said vent means when train action induced force is exerted on said railway coupling means; and
auxiliary vent means for allowing an outflow of said liquid from said interior zone while said valve means

is impeding flow through said vent means, said auxiliary vent means having a substantially smaller flow capacity than said valved vent means;

said auxiliary vent means being adapted to be closed during a terminal portion of relative movement between said piston means and cylinder means induced by said train action induced force.

4. In a railway car including

a railway car body including a sill; and

railway draft gear having railway coupling means operable to couple said railway car body to other railway car means;

the improvement in said draft gear comprising:

fixed means connected with the sill of said railway car;

movable means connected with said railway coupling means of said railway car;

a piston and cylinder assembly having piston means connected with said fixed means and cylinder means connected in train action force transmitting relation with said movable means;

wall means defining a fluid reservoir encircling said assembly;

vent means comprising a port in a side wall portion of the cylinder means of said assembly adapted to transmit liquid from an interior zone within said cylinder means disposed in pressurizable communication with said piston mans to said reservoir;

train action control means operable, in the absence of train action force acting on said railway coupling means, to maintain said vent means in a relatively open condition and operable in response to train action force acting on said railway coupling means to impede flow of said liquid from said interior zone through said vent means;

said train action control means including valve means operable to control flow of said liquid from said interior zone through said vent means in response to train draft force imposed on said railway coupling means, said valve means being operable in response to pressure of said liquid within said interior zone, generated in response to train action induced draft force acting on said railway coupling means, to move from an open position toward a closed position to at least impede flow of said liquid from said interior zone through said vent means when train action induced draft force is exerted on said railway coupling means; and

auxiliary vent means for allowing an outflow of fluid from said interior zone while said valve means is impeding flow through said vent means, said auxiliary vent means having a substantially smaller flow capacity than said valved vent means;

said auxiliary vent means being adapted to be closed during a terminal portion of relative movement between said piston means and cylinder means induced by said train action induced draft force.

5. In railway draft gear, the improvement comprising:

fixed means adapted to be connected with the sill of a railway car;

movable means connected with coupling means of said railway car;

a piston and cylinder assembly having piston means connected with said fixed means and cylindrical cylinder means connected with said movable means;

wall means defining a rectangular fluid reservoir encircling said assembly;

vent means comprising a port in a side wall portion of the cylinder of said assembly adapted to transmit liquid from a zone within said cylinder acting on said piston means to said reservoir;

valve means mounted on the exterior of said side wall portion of said cylinder means and projecting radially thereof toward a corner of said fluid reservoir, said valve means controlling flow through said vent means in response to draft force imposed on said coupling means, said valve means being operable to close said vent means when at least a predetermined draft force is exerted on said movable means and open said vent means in response to the exertion of less than said predetermined force on said movable means;

said valve means including a movable valve member having fluid reaction surface means;

said valve means comprising wall means of said port defining a flow path for directing fluid flow out of said assembly axially against fluid reaction surface means of said valve means with said axial flow exerting a valve closing force on said valve means;

said movable valve member including restricted port means through which fluid passing outwardly of said assembly passes thereby creating a pressure differential across said movable valve member tending to induce closing of said valve means;

said valve means additionally including dashpot means connected with said movable valve member, in fluid communication with fluid passing through said port, and operable to retard valve closing movement of said movable valve member; and

auxiliary vent means for allowing an outflow of fluid from said assembly while said valve means is closed, said auxiliary vent means having a substantially smaller flow capacity than said valved vent means;

said auxiliary vent means being adapted to be closed during a terminal portion of relative movement between said piston and cylinder assembly induced by said imposed force which is effective to close said valve means.

6. In railway draft gear, the improvement comprising:

fixed means adapted to be connected with the body of a railway car;

movable means adapted to be connected with coupling means of said railway car;

a piston and cylinder assembly having piston means connected with one of said fixed means and movable means and cylinder means connected with the other of said fixed means and movable means;

first vent means in said assembly for controlling an outflow of fluid therefrom and comprising a first plurality of ports spaced exponentially of the longitudinal axis of said assembly; and

second vent means in said assembly for controlling fluid outflow therefrom and comprising a second plurality of ports longitudinally displaced from said first vent means;

said piston means and cylinder means, upon having undergone maximum relative movement in response to the imposition of buff force on said movable means, being operable to cover said second vent means.

7. In railway draft gear, the improvement comprising:

fixed means adapted to be connected with the sill of a railway car;

movable means adapted to be connected with coupling means of said railway car;

a piston and cylinder assembly having piston means connected with one of said fixed means and movable means and cylinder means connected with the other of said fixed means and movable means.

first vent means in said assembly for controlling an outflow of fluid therefrom and comprising a first plurality of ports spaced exponentially of the longitudinal axis of said assembly;

second vent means in said assembly for controlling fluid outflow therefrom and comprising a second plurality of ports longitudinally displaced from said first vent means;

said piston means and cylinder means, upon having undergone maximum relative movement in response to the imposition of buff force on said movable means, being operable to cover said second vent means; and

seal means disposed radially between said piston means and said cylinder means.

8. In railway draft gear, the improvement comprising:

fixed means adapted to be connected with the sill of a railway car;

movable means adapted to be connected with coupling means of said railway car;

a piston and cylinder assembly having piston means connected with one of said fixed means and movable means and cylinder means connected with the other of said fixed means and movable means;

first vent means in said assembly for controlling an outflow of fluid therefrom and comprising a first plurality of ports spaced exponentially of the longitudinal axis of said assembly;

second vent means in said assembly for controlling fluid outflow therefrom and comprising a second plurality of ports longitudinally displaced from said first vent means;

said piston means and cylinder means, upon having undergone maximum relative movement in response to the imposition of buff force on said movable means, being operable to cover said second vent means; and

seal means disposed radially between said piston means and said cylinder means;

said assembly including a fluid-occupied unported zone within which said piston means and cylinder means undergo relative movement at the terminal end of the relative movement resulting from the imposition of buff force on said movable means, said zone being longitudinally displaced from said second port means, with said second port means being located longitudinally between said zone and said first port means;

said seal means comprising split piston-ring means carried by said piston means and providing limited flow therethrough between said piston means and cylinder means, with said limited flow being substantially less than that permitted by said second port means.

9. In railway draft gear, the improvement comprising:

fixed means adapted to be connected with the sill of a railway car;

movable means adapted to be connected with coupling means of said railway car;

a piston and cylinder assembly having piston means connected with said fixed means and cylinder means connected with said movable means;

first vent means in the side wall of said cylinder means for controlling an outflow of fluid therefrom and comprising a first plurality of ports spaced exponentially of the longitudinal axis of said assembly;

second vent means in the side wall of said cylinder means for controlling fluid outflow therefrom and comprising a second plurality of ports longitudinally displaced from said first vent means;

reservoir means encircling said assembly;

said piston means and cylinder means, upon having undergone maximum relative movement in response to the imposition of buff force on said movable means, being operable to cover said second vent means; and

seal means disposed radially between said piston means and said cylinder means;

said assembly including a fluid-occupied unported zone within which said piston means and cylinder means undergo relative movement at the terminal end of the relative movement resulting from the imposition of buff force on said movable means, said zone being longitudinally displaced from said second port means, with said second port means being located longitudinally between said zone and said first port means;

said seal means comprising split piston-ring means carried by said piston means and providing limited flow therethrough between said piston means and cylinder means, with said limited flow being substantially less than that permitted by said second port means.

10. In railway draft gear, the improvement comprising:

fixed means adapted to be connected with the sill of a railway car;

movable means adapted to be connected with coupling means of said railway car;

a piston and cylinder assembly having piston means connected with said fixed means and cylinder means connected with said movable means;

first vent means in the side wall of said cylinder means for controlling an outflow of fluid therefrom and comprising a first plurality of equally sized ports spaced exponentially of the longitudinal axis of said assembly, with the spacing of said ports decreasing exponentially toward said movable means;

said first port means comprising at least six ports each having a diameter of from about .28 inch to about .38 inch;

second vent means in the side wall of said cylinder means for controlling fluid outflow therefrom and comprising a second plurality of equally spaced and equally sized ports longitudinally displaced from said first vent means;

said second port means comprising at least three ports each having a diameter of from about .28 inch to about .38 inch, with the ports of said second port means being longitudinally displaced;

reservoir means encircling said assembly;

said piston means and cylinder means, upon having undergone maximum relative movement in response to the imposition of buff force on said movable means, being operable to cover said second vent means; and

seal means disposed radially between said piston means and said cylinder means;

said assembly including a fluid-occupied unported zone within which said piston means and cylinder means undergo relative movement at the termnal end of the relative movement resulting from the imposition of buff force on said movable means, said zone being longitudinally displaced from said second port means, with said second port means being located longitudinally between said zone and said first port means;

said seal means comprising split piston-ring means carried by said piston means and providing limited flow therethrough between said piston means and cylinder means, with said limited flow being substantially less than that permitted by said second port means.

11. In railway draft gear, the improvement comprising:

fixed means adapted to be connected with the body of a railway car;

movable means adapted to be connected with coupling means of said railway car;

a piston and cylinder assembly having piston means connected with one of said fixed means and movable means and cylinder means connected with the other of said fixed means and movable means;

first vent means in said assembly for controlling outflow of fluid therefrom and comprising a first plurality of ports spaced exponentially of the longitudinal axis of said assembly;

second vent means in said assembly for controlling fluid outflow therefrom and comprising a second plurality of ports longitudinally displaced from said first vent means;

third vent means longitudinally displaced from said first vent means, with said first vent means being longitudinally interposed between said second vent means and said third vent means, said third vent means comprising at least one port for controlling and outflow of fluid from said assembly and having

a cross-sectional area less than that of the ports of said first and second vent means;

fourth vent means longitudinally displaced from said first vent means with said first vent means being longitudinally interposed between said fourth vent means and said second vent means, and comprising at least one port to transmit an outflow of liquid from said assembly; and

valve means controlling flow through said fourth vent means in response to force imposed on said movable means, said valve means being operable to close said fourth vent means when at least a predetermined force is exerted on said movable means and open said vent means in response to the exertion of less than predetermined force on said movable means;

said first and second vent means being disposed such that relative movement between said piston means and cylinder means in response to the imposition of buff force on said movable means will cause said first vent means to be progressively closed prior to the progressive closing of said second vent means.

12. In reilway draft gear, the improvement comprising:

fixed means adapted to be connected with the body of a railway car;

movable means adapted to be connected with coupling means of said railway car;

a piston and cylinder assembly having piston means connected with one of said fixed means and movable means and cylinder means connected with the other of said fixed means and movable means;

first vent means in said assembly for controlling outflow of fluid therefrom and comprising a first plurality of ports spaced exponentially of the longitudinal axis of said assembly;

second vent means in said assembly for controlling fluid outflow therefrom and comprising a second plurality of ports longitudinally displaced from said first vent means;

third vent means longitudinally displaced from said first vent means, with said first vent means being longitudinally interposed between said second vent means and said third vent means, said third vent means comprising at least one port for controlling an outflow of fluid from said assembly and having a cross-sectional area less than that of the ports of said first and second vent means;

fourth vent means longitudinally displaced from said first vent means with said first vent means being longitudinally interposed between said fourth vent means and said second vent means, and comprising at least one port to transmit an outflow of liquid from said assembly;

valve means controlling flow through said fourth vent means in response to force imposed on said movable means, said valve means being operable to close said fourth vent means when at least a predetermined force is exerted on said movable means and open said vent means in response to the exertion of less than predetermined force on said movable means;

said first and second vent means being disposed such that relative movement between said piston means and cylinder means in response to the imposition of buff force on said movable means will cause said first vent means to be progressively closed prior to the progressive closing of said second vent means;

a substantially unvented first zone containing fluid acting on one side of said piston means and longitudinally displaced from said second vent means, with said second vent means being interposed between said first zone and said first vent means;

a substantially unvented second zone longitudinally displaced from said fourth vent means with said fourth vent means being interposed between said second zone and said first vent means and containing fluid acting on a side of said piston means opposite to said one side; and

seal means between said piston means and said cylinder means providing limited fluid flow between the outer periphery of said piston means and the inner periphery of said cylinder means.

13. In railway draft gear, the improvement comprising:

fixed means adapted to be connected with the body of a railway car;

movable means adapted to be connected with coupling means of said railway car;

a piston and cylinder assembly having piston means connected with one of said fixed means and movable means and cylinder means connected with the other of said fixed means and movable means;

first vent means in said assembly for controlling outflow of fluid therefrom and comprising a first plurality of ports spaced exponentially of the longitudinal axis of said assembly;

second vent means in said assembly for controlling fluid outflow therefrom and comprising a second plurality of ports longitudinally displaced from said first vent means, said second vent means being covered in response to terminal buff movement of said movable means;

third vent means longitudinally displaced from said first vent means, with said first vent means being longitudinally interposed between said second vent means and said third vent means, said third vent means comprising at least one port for controlling an outflow of fluid from said assembly and having a cross-sectional area less than that of the ports of said first and second vent means;

fourth vent means longitudinally displaced from said first vent means with said first vent means being longitudinally interposed between said fourth vent means and said second vent means, and comprising at least one port to transmit an outflow of liquid from said assembly;

said third vent means being disposed longitudinally between said first and said fourth vent means;

valve means controlling flow through said fourth vent means in response to force imposed on said movable means, said valve means being operable to close said fourth vent means when at least a predetermined force is exerted on said movable means and open said vent means in response to the exertion of less than predetermined force on said movable means;

said first and second vent means being disposed such that relative movement between said piston means and cylinder means in response to the imposition of buff force on said movable means will cause said first vent means to be progressively closed prior to the progressive closing of said second vent means;

a substantially unvented first zone containing fluid acting on one side of said piston means and longitudinally displaced from said second vent means, with said second vent means being interposed between said first zone and said first vent means;

a substantially unvented second zone longitudinally displaced from said fourth vent means with said fourth vent means being interposed between said second zone and said first vent means and containing fluid acting on a side of said piston means opposite to said one side; and

seal means between said piston means and said cylinder means providing limited fluid flow between the outer periphery of said piston means and the inner periphery of said cylinder means.

14. In railway draft gear, the improvement comprising:

fixed means adapted to be connected with the body of a railway car;

movable means adapted to be connected with coupling means of said railway car;

a piston and cylinder assembly having piston means connected wtih said fixed means and cylindrical cylinder means connected with said movable means;

rectangular reservoir means housing said assembly;
first vent means in a cylindrical wall portion of said cylinder means for controlling outflow of fluid therefrom and comprising a first plurality of equally sized ports spaced exponentially of the longitudinal axis of said assembly and progressively decreasing in spacing toward said movable means;
second vent means in a cylindrical wall portion of said cylinder means for controlling fluid outflow therefrom and comprising a second plurality of equally sized and equally longitudinally spaced ports longitudinally displaced from said first vent means, said second vent means being covered in response to terminal buff movement of said movable means;
third vent means in a cylindrical wall portion of said cylinder means longitudinally displaced from said first vent means, with said first vent means being longitudinally interposed between said second vent means and said third vent means, said third vent means comprising at least one port for controlling an outflow of fluid from said assembly and having a cross-sectional area less than that of the ports of said first and second vent means;
fourth vent means in a cylindrical wall portion of said cylinder means longitudinally displaced from said first vent means with said first vent means being longitudinally interposed between said fourth vent means and said second vent means, and comprising at least one port to transmit an outflow of liquid from said assembly, said fourth vent means being covered in response to terminal draft movement of said movable means;
said third vent means being disposed longitudinally between said first and said fourth vent means;
valve means connected with the exterior of said cylinder means and projecting radially toward a corner of said reservoir means controlling flow through said fourth vent means in response to force imposed on said movable means, said valve means being operable to close said fourth vent means when at least a predetermined force is exerted on said movable means and open said vent means in response to the exertion of less than predetermined force on said movable means;
said first and second vent means being disposed such that relative movement between said piston means and cylinder means in response to the imposition of buff force on said movable means will cause said first vent means to be progressively closed prior to the progressive closing of said second vent means;
a substantially unvented first zone containing fluid acting on one side of said piston means and longitudinally displaced from said second vent means, with said second vent means being interposed between said first zone and said first vent means;
a substantially unvented second zone longitudinally displaced from said fourth vent means with said fourth vent means being interposed between said second zone and said first vent means and containing fluid acting on a side of said piston means opposite to said one side; and
seal means between said piston means and said cylinder means providing limited fluid flow between the outer periphery of said piston means and the inner periphery of said cylinder means.

15. In a railway car including:
a railway car body; and
railway draft gear having railway coupling means operable to couple said railway car body to other railway car means;
the improvement in said draft gear comprising:
fixed means connected with said railway car body;
movable means connected in train action force transmitting relation with said railway coupling means;
a piston and cylinder assembly having piston means connected with one of said fixed means and movable means and cylinder means connected with the other of said fixed means and movable means, with said movable means being connected in train action force transmitting relation with one of said piston means and cylinder means;
fluid passage means in said assembly adapted to transmit liquid from a zone within said assembly acting on said piston means; and
train action control means operable, in the absence of train action force acting on said railway coupling means, to maintain said vent means in a relatively open condition and operable in response to train action force acting on said railway coupling means to impede flow of said liquid from said interior zone through said vent means;
said train action control means including valve means operable to control flow of said liquid from said interior zone through said fluid passage means in response to train action force imposed on said railway coupling means, said valve means being operable in response to pressure of said liquid within said interior zone, generated in response to train action induced force acting on said railway coupling means, to move from an open position toward a closed position to at least impede flow of said liquid from said interior zone through said fluid passage means when train action induced force is exerted on said railway coupling means.

16. In a railway draft gear, the improvement comprising:
fixed means adapted to be connected with the body of a railway car;
movable means adapted to be connected with coupling means of said railway car;
a piston and cylinder assembly having piston means connected with one of said fixed means and movable means and cylinder means connected with the other of said fixed means and movable means;
first fluid passage means in said assembly for controlling an outflow of fluid from a zone within said assembly acting on said piston means, said first fluid passage means varying exponentially in flow capacity along the longitudinal axis of said assembly; and
second fluid passage means in said assembly for controlling fluid outflow from a zone within said assembly acting on said piston means and displaced longitudinally from said first fluid passage means;
said piston means and cylinder means, upon having undergone maximum relative movement in response to the imposition of buff force on said movable means, being operable to cover said second fluid passage means.

17. In a railway draft gear, the improvement comprising:
fixed means adapted to be connected with the body of a railway car;
movable means adapted to be connected with coupling means of said railway car;
a piston and cylinder assembly having piston means connected with one of said fixed means and movable means and cylinder means connected with the other of said fixed means and movable means;
first fluid passage means in said assembly for controlling an outflow of fluid from a zone within said assembly acting on said piston means, said first fluid passage means varying exponentially in flow capacity along the longitudinal axis of said assembly;
second fluid passage means in said assembly for controlling fluid outflow from a zone within said assembly acting on said piston means and displaced longitudinally from said first fluid passage means;
said piston means and cylinder means, upon having undergone maximum relative movement in response

to the imposition of buff force on said movable means, being operable to cover said second fluid passage means;

additional fluid passage means in said assembly adapted to transmit liquid from a zone within said assembly acting on said piston means; and

valve means controlling flow through said additional fluid passage means in response to force imposed on said movable means, said valve means being operable to close said additional fluid passage means when at least a predetermined force is exerted on said movable means and open said additional fluid passage means in response to the exertion of less than said predetermined force on said movable means.

18. A method of controlling coupling forces between railway cars, said method comprising:

interconnecting two railway cars with hydraulic shock absorbing means, with said hydraulic shock absorbing means being connected between a body portion of one of said railway cars and a coupling portion of said one railway car, which coupling portion is connected in draft and buff force transmitting engagement with the other of said railway cars;

said hydraulic shock absorbing means including piston means connected to one of said coupling and body portions, cylinder means connected to the other of said coupling and body portions, and restoring means yieldably biasing said coupling portion to a predetermined position, with said coupling portion being connected in train action force transmitting relation with one of said piston means and cylinder means;

providing open, but valve controlled, vent means communicating with an interior zone of said cylinder means which interior zone is disposed in pressurizable communication with said piston means, said open vent means permitting fluid in said interior zone to flow out of said interior zone while said coupling portion of said one railway car is substantially free of train action force transmitted thereto from said other railway car and while said coupling portion is moving toward said predetermined position under the influence of said restoring means; and

valving said vent means at least partially closed, in response to the generation of fluid pressure in said interior zone, with said fluid pressure being generated by said piston means and cylinder means in response to the imposition of at least a predetermined train action force on said coupling portion by said other railway car.

19. A method of controlling coupling forces between railway cars, said method comprising:

interconnecting two railway cars with hydraulic shock absorbing means, with said hydraulic shock absorbing means being connected between a body portion of one of said railway cars and a coupling portion of said one railway car, which coupling portion is connected in draft and buff force transmitting engagement with the other of said railway cars;

said hydraulic shock absorbing means including piston means connected to one of said coupling and body portions, cylinder means connected to the other of said coupling body portions, and restoring means yieldably biasing said coupling portion to a predetermined position, with said coupling portion being connected in train action force transmitting relation with one of said piston means and cylinder means;

while buff forces are imposed on said shock absorbing means, discharging fluid from a piston biasing first zone within said assembly through first fluid passage means which progressively and exponentially decrease in flow capacity in response to the continued application of buff force to said coupling portion;

subsequent to the venting of fluid from said first zone through said exponentially varying fluid passage means, venting further fluid through second fluid passage means from a second zone adjacent but displaced from said first zone in response to the further continued application of buff force to said coupling portion, with said further venting permitting a substantially lower outflow of fluid than said exponential venting; and

substantially terminating said further venting when said coupling portion has moved to its terminal buff position whereby, on the restoring draft movement of said coupling portion, piston biasing fluid is displaced initially through said exponentially varying first fluid passage means.

20. A method of controlling coupling forces between railway cars, said method comprising:

interconnecting two railway cars with hydraulic shock absorbing means, with said hydraulic shock absorbing means being connected between a body portion of one of said railway cars and a coupling portion of said one railway car, which coupling portion is connecting in draft and buff force transmitting engagement with the other of said railway cars;

said hydraulic shock absorbing means including piston means connected to one of said coupling and body portions, cylinder means connected to the other of said coupling and body portions, and restoring means yieldably biasing said coupling portion to a predetermined position, with said coupling portion being connected in train action force transmitting relation with one of said piston means and cylinder means;

providing open, but valve controlled, vent means communicating with an interior zone of said cylinder means, which interior zone is disposed in pressurizable communication with said piston means, said open vent means permitting fluid in said interior zone to flow out of said interior zone while said coupling portion of said one railway car is substantially free of train action force transmitted thereto from said other railway car and while said coupling portion is moving toward said predetermined position under the influence of said restoring means; and

valving said vent means at least partially closed, in response to the generation of fluid pressure in said interior zone, with said fluid pressure being generated by said piston means and cylinder means in response to the imposition of at least a predetermined train action force on said coupling portion by said other railway car;

while buff forces are imposed on said shock absorbing means, discharging fluid from a piston biasing first zone within said assembly through first fluid passage means which progressively and exponentially decrease in flow capacity in response to the continued application of buff force to said coupling portion;

subsequent to the venting of fluid from said first zone through said exponentially varying fluid passage means, venting further fluid through second fluid passage means from a second zone adjacent said first zone in response to the further continued application of buff force to said coupling portion, with said further venting permitting a substantially lower outflow of fluid than said exponential venting:

substantially terminating said further venting when said coupling portion has moved to its terminal buff position whereby, on the restoring draft movement of said coupling portion, piston biasing fluid is displaced initially through said exponentially varying first fluid passage means;

at each of the buff and draft movement extremities of said coupling portion, providing within said shock absorbing means a substantially unported zone containing fluid acting on said piston means to resist

relative movement between said piston means and said cylinder means; and

providing continuously operative but limited bypass flow between said cylinder means and said piston means.

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DRAYTON E. HOFFMAN, *Primary Examiner.*

U.S. Cl. X.R.

188—88; 213—43