July 12, 1960 W. T. BLAKE 2,944,639

SHOCK ABSORBER WITH VACUUM COMPENSATOR

Filed July 30, 1956 3 Sheets-Sheet 1

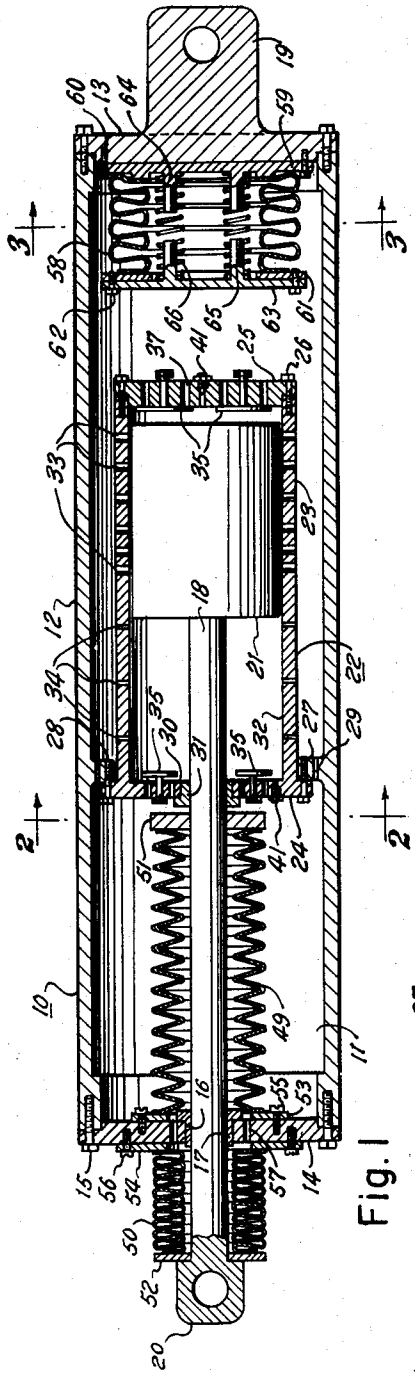


Fig. 1

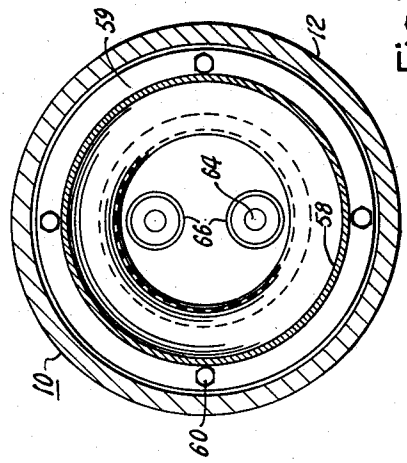


Fig. 3

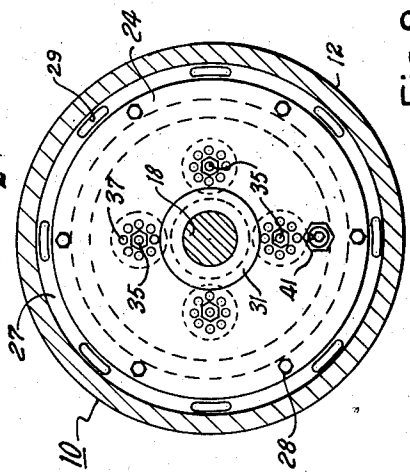


Fig. 2

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SHOCK ABSORBER WITH VACUUM COMPENSATOR

Filed July 30, 1956 3 Sheets-Sheet 2

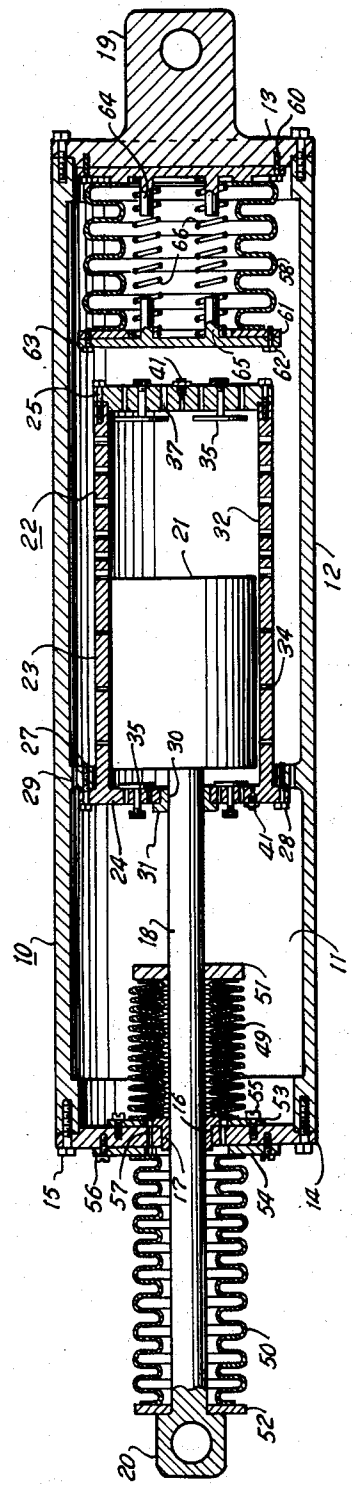


Fig.4

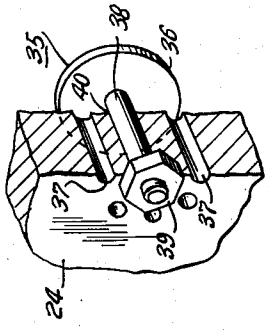


Fig.6

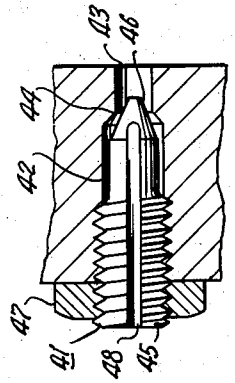


Fig.5

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July 12, 1960 W. T. BLAKE 2,944,639

SHOCK ABSORBER WITH VACUUM COMPENSATOR

Filed July 30, 1956 3 Sheets-Sheet 3

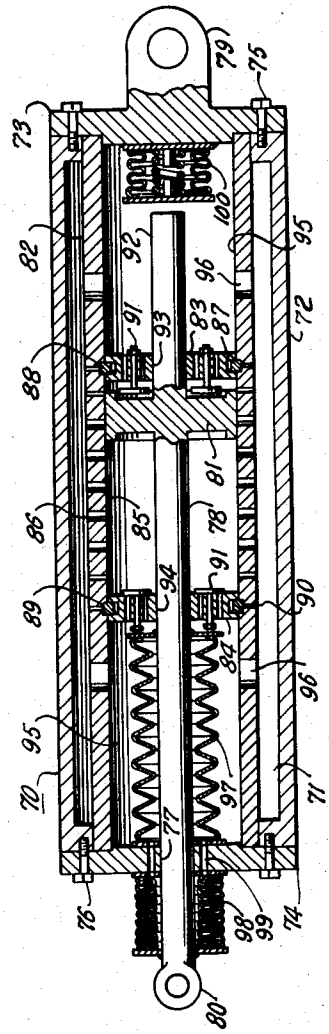


Fig. 7

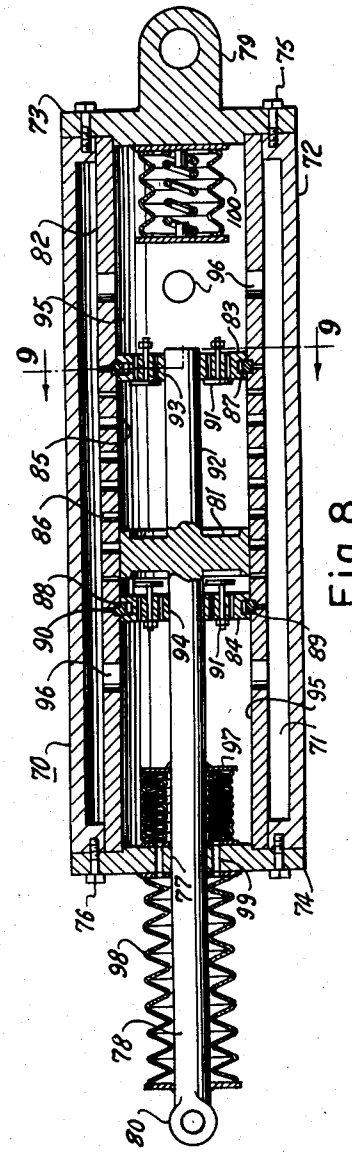


Fig. 8

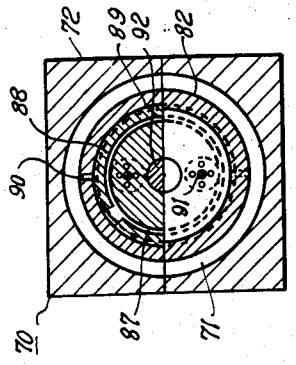


Fig. 9

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2,944,639

SHOCK ABSORBER WITH VACUUM COMPENSATOR

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Filed July 30, 1956, Ser. No. 600,977

17 Claims. (Cl. 188—97)

This invention relates to new and useful improvements in hydraulic mechanisms and more particularly to shock-resisting hydraulic mechanisms.

This application is a continuation-in-part of my co-pending application Serial No. 479,546, filed January 3, 1955, for "Hydraulic Mechanism," now abandoned.

It is well known that railway cars, particularly freight cars, are subjected to many impacts or shocks of relatively great magnitude and that such impacts or shocks are amplified or multiplied by the number of cars in a given train. This is due in part to the fact that there is a certain amount of slack between the couplers of the cars. The cars tend to "bunch" or crowd together on slowing or stopping of the prime mover or engine, on down grades and on entering curves, whereby each car bumps the car forwardly thereof and the combined impact of all of said cars is transmitted to the slower traveling foremost car. On initial movement or acceleration of the engine, on up grades and on leaving curves, the cars tend to "stretch" or move away from one another so as to be jerked by the faster traveling cars thereahead and the combined stress or relative movement of all of the cars is exerted upon the rearmost car. Manifestly, these impacts or shocks damage the cars and particularly their contents as well as wear the couplers to thereby produce greater impacts or shocks in the future. Also, other equipment and machinery are subjected to similar shocks due to sudden stops, impacts, or changes in the direction of movement.

Moreover, when freight trains are made up severe impact stresses are set up in the couplers and draft gear and great shocks are imparted to the contents of the cars when cars are moved into impact with each other in effecting coupling.

Accordingly, one object of the invention is to provide an improved hydraulic mechanism of such construction as to be particularly adapted for use in appreciably reducing the impacts or shocks exerted on machinery and equipment and particularly on railway cars and their contents through their couplings and draft gear upon relative movement of the cars.

Another object of the invention is to provide an improved shock-resisting hydraulic mechanism for machinery and equipment, such as a railway car draft gear, which is arranged to permit limited movement of the coupler relative to its car while controlling the speed of such movement so as to cushion any shock or impact caused by the initiation or cessation of said movement.

A particular object of the invention is to provide an improved hydraulic mechanism, of the character described, wherein movement in either direction is controlled and wherein movement in one direction may be at a different rate of travel than movement in the opposite direction.

An important object of the invention is to provide an improved hydraulic mechanism, of the character described, which includes a hermetically-sealed unit having compensating means to accommodate variations in the volume of its interior whereby the unit may be completely filled with a non-compressible fluid.

A further object of the invention is to provide an improved hydraulic mechanism, of the character described, which includes a hermetically-sealed housing having a cylinder mounted in and communicating with the interior of the housing and pressure-responsive, substantially temperature insensitive, vacuum-filled means in the housing for permitting variation of the volume of its interior and the filling thereof with a non-compressible fluid.

Still another object of the invention is to provide an improved hydraulic mechanism, of the character described, having a piston reciprocally mounted in its cylinder and of substantially the same length as its stroke, whereby the rate of travel of the instroke and outstroke of the piston may be independently varied.

Another object of the invention is to provide an improved hydraulic mechanism, of the character described, wherein the cylinder has inwardly opening check valves so that the rate of travel of the piston or force required to move the piston on its instroke and outstroke is primarily controlled by openings in the side wall of the cylinder.

Yet another object is to provide an improved hydraulic mechanism, of the character described, having one or more adjustable valves for compensating piston movement due to unavoidable tolerance variations in the fit of the piston in the cylinder occurring in manufacture or as a result of wear.

Still another object is to provide an improved hydraulic mechanism of the character described, having means for hermetically sealing the reciprocating piston rod in the mechanism housing eliminating the necessity for a packed seal at the point where the piston rod passes through the housing and insuring a completely protected sliding joint.

A still further object of the invention is to provide an improved hydraulic mechanism of the character described, wherein the compensating means includes a bellows containing a vacuum with a spring mounted in the bellows or biasing the bellows to balance the bellows in expanded positions against the collapsing force of varying fluid pressure.

A further object of the invention is to provide a substantially temperature insensitive device for compensating changes in volume of a confined body of non-compressible or hydraulic fluid.

In summary, the foregoing and other aims, objects and advantages of the invention are achieved in a shock-resisting hydraulic mechanism having a housing and a working cylinder having end and side walls mounted in the housing providing a chamber between the cylinder and the housing. In one form, the walls of the cylinder are spaced from the walls of the housing to provide a chamber, in effect, completely surrounding the cylinder. A wall of the cylinder has an opening or openings establishing communication between the cylinder and the chamber and a piston is mounted in the cylinder for reciprocation between its end walls. The piston has a piston rod extending to the exterior of the mechanism through one of the end walls of the cylinder and sealingly through a wall of the housing. The chamber and cylinder are completely filled with a non-compressible fluid such as oil. A substantially temperature insensitive compensating device is exposed to the fluid in the chamber for the purpose of compensating for fluid pressure changes in the chamber due to temperature changes and volume changes occasioned by negative or positive displacement of fluid due to reciprocation of the piston rod and associated parts. This compensating device includes a collapsible and expansible container member, such as a bellows having end plates or heads, providing an inclosed space which contains a vacuum or is substantially evac-

uated to tend to collapse the container member under pressure of the fluid in the chamber. Spring means is provided for urging the container to an expanded position and for balancing the container member in expanded positions against the collapsing force of the fluid in the chamber as such force varies in response to temperature changes and displacement of fluid. Preferably the compensating device is mounted within the aforesaid chamber.

There is also provided in the hydraulic mechanism of the invention a construction and arrangement for sealing the piston rod where it passes through the housing wall to provide a hermetic seal that retains the fluid in the housing with certainty and protects the sliding joint through which the piston rod reciprocates. The sealing arrangement includes expansible and contractible means, such as bellows, surrounding the piston rod internally and externally of the housing and being connected to the piston rod and the housing to provide a positive hermetic seal therebetween. The internal and external bellows may be of generally cylindrical configuration and may have the same mean diameter. They are preferably spaced from the piston rod to provide gas filled spaces that are interconnected by passages providing for flow of gas therebetween and for equalization of pressures within the bellows on each side of the housing wall.

Moreover, in the double-acting, shock-resisting hydraulic mechanism of the invention, the piston is of substantially the same length as its stroke and the openings of the side wall of the cylinder are disposed in a pair of groups at the end portions of the side wall, one group of openings being closed by the piston at each end of its stroke whereby each group of openings controls reciprocation of the piston towards its end of the cylinder. To assist in this control, the end walls of the cylinder are provided with check valves that open inwardly of the cylinder to relieve vacuum as the piston moves away from the end wall and close as the piston moves towards the end wall to allow the side openings to control rate of travel of the piston. The groups of openings may have different combined areas so that the forces required to move the piston on its instroke and outstroke differ and, thus, the rate of travel of the piston may be controlled. Adjustable tolerance compensating valves may be provided in the cylinder end walls for establishing a regulable restricted communication between the cylinder and the chamber to regulate the final rate of movement of the piston as it approaches an end wall, irrespective of reasonable variations in the fit of the piston in the cylinder.

Constructions designed to carry out the invention will be hereinafter described, together with other features of the invention.

The invention will be more fully understood from a reading of the following detailed description and by reference to the accompanying drawings, wherein examples of the invention are shown, and wherein:

Fig. 1 is a longitudinal, sectional view of the hydraulic mechanism, constructed in accordance with the invention, showing its piston at the end of its instroke,

Fig. 2 is a transverse, sectional view, taken on the line 2—2 of Fig. 1,

Fig. 3 is a transverse, sectional view, taken on the line 3—3 of Fig. 1,

Fig. 4 is a view, similar to Fig. 1, showing the piston at the end of its outstroke,

Fig. 5 is an enlarged, fragmentary, cross-sectional view of one of the adjustable valve elements mounted in each end wall of the cylinder,

Fig. 6 is a fragmentary perspective view, partly in section, showing the mounting of one of the check valves,

Fig. 7 is a view, similar to Fig. 1, of a modified hydraulic mechanism, showing the piston immediately after commencement of the outstroke,

Fig. 8 is a view, similar to Fig. 4, of the modification, showing the piston immediately after commencement of the instroke, and

Fig. 9 is a transverse, sectional view, taken on the line 9—9 of Fig. 8.

In Figs. 1 through 4 of the drawings, the numeral **10** designates the housing of a hydraulic mechanism or unit embodying the principles of the invention and of the double-acting, shock-resisting type which is particularly adapted for use in mounting railway car couplers in a draft gear as well as connecting parts of other equipment and machinery subjected to shocks. Although the housing **10** may be of any desired shape, preferably, it has a cylindrical bore or chamber **11** and an elongated side or peripheral wall **12**. As will be explained, the chamber **11** is adapted to be completely filled with a non-compressible fluid. A transverse wall **13** removably closes one end of the chamber, while its opposite end is closed by a removable cap or end plate **14** which is fastened to the outer end of the side wall **12** by suitable bolts **15**. The cap **14** has an axial opening **16** in which a bushing **17** is mounted for slidably supporting the outer end portion of a piston rod or shaft **18**. Mounting means, such as apertured lugs **19** and **20**, are carried by the end wall **13** and the outer projecting end of the rod **18** for connecting the mechanism such as between a railway car or its center sill and one of its drawbars (not shown). Movement of the piston rod **18** with respect to the housing **10** may be confined within extreme limits by means of stops (not shown) in the mounting means, so that the piston **21**, to be described, will stop short of engagement of the end walls of the cylinder on the in and out strokes.

The inner end of the piston rod is secured to a piston or plunger **21**, as by a threaded joint (not shown), and the piston is reciprocable in a cylinder or working barrel **22** which is mounted coaxially in the chamber **11** in spaced relation to the housing walls **12**, **13** and **14**. In addition to a side or peripheral wall **23**, the cylinder **22** includes an enlarged outer end wall **24**, forming a cylinder head and a cap or end plate **25**, forming an opposite head attached to the inner end of the side wall by suitable bolts **26**. An internal, radial flange **27** is provided in the chamber for receiving suitable bolts **28** to support the cylinder by its enlarged outer end wall **24**. The flange **27** has a plurality of arcuate, elongated openings or slots **29**, externally of the end wall **24**, to permit free communication between the portions of the chamber **11** on opposite sides of said flange (Fig. 2). It is pointed out that the working barrel or cylinder is completely surrounded by the fluid in the chamber since its side and end walls **23**, **24** and **25** are spaced respectively from the side and end walls **12**, **14** and **13** of the housing. An axial opening **30**, having a bushing **31**, is formed in the outer end wall **25** to slidably support the inner end portion of the piston rod **18**.

The cylinder **22** has a bore **32** in which the piston **21** has a snug sliding fit and which communicates with the chamber **11** through inner and outer groups or sets of apertures, openings or ports **33** and **34** in the side wall **23**. If desired, one group of ports, such as the ports **33** at the inner portion of the cylinder, may be larger and/or more numerous than the other group of ports **34** at the outer portion of said clinder. The piston **21** is of a length substantially equal to the length of its stroke and covers one group of ports at each end of said stroke (Figs. 1 and 4) whereby the inner ports **33** control the rate of travel of the instroke and the outer ports **34** control the rate of travel of the outstroke of the piston. When the inner group of ports is larger and/or more numerous than the outer group of ports, as shown, the instroke is faster and resisted less than the outstroke of the piston.

A plurality of check valves **35** are mounted in the end walls **24** and **25** of the cylinder to instantly relieve the vacuum which is created behind the piston on initial movement thereof away from said walls and prior to un-

covering of the ports. As shown most clearly in Fig. 6, each check valve **35** includes a circular valve head or plate **36** disposed within the cylinder **22** so as to overlie the inner ends of a plurality of apertures **37** arranged in a circle in the end wall. An axial valve stem **38**, having a nut **39** screw-threaded on its outer end, is secured to each valve head **36** and extends through an opening **40** in the cylinder end wall centrally of the apertures **37** for slidably supporting the valve **35**. Since the length of the stems **38** is greater than the thickness of the end walls, the valve heads **36** move inwardly to uncover the apertures and outwardly to close the apertures upon movement of the piston away from and toward their respective end walls. As a result, the vacuum is insufficient or is relieved instantly so as not to interfere with the initial movement of the piston away from the cylinder heads. Also, the combined area of the side wall openings **33** and the check valve apertures **37** at the instroke end of the cylinder is sufficiently larger than the combined area of the side wall openings **34** so that the piston movement, on the outstroke, is controlled largely by the openings **34**. Conversely, the combined area of the apertures **37** in the outstroke end of the cylinder and the sidewall openings **34** is sufficiently large that control of the piston movement on the instroke is largely under command of the sidewall apertures **33**. Naturally, all of the openings and apertures exert some degree of control on piston movement and the disposition and relative sizes of the openings and apertures are so arranged and constructed as to provide the desired rate of movement of piston in either direction and at any point therein.

In order to compensate for any variations in the fit of the piston in the cylinder and permit greater manufacturing variations than conventional, an adjustable valve **41** is mounted in each of the end walls **24** and **25**. As most clearly shown in Fig. 5, an opening **42** is formed in each cylinder end wall and has a counterbore **43** at its inner end with an outwardly-facing valve seat **44** therebetween. A metering pin or valve element **45** is screw-threaded in the outer end of the opening **42** and has a bevelled or tapered seating surface **46** at its inner end for coacting with the seat **44**. The metering pin **45** is held in adjusted positions by a lock nut **47** and a groove **48** extends longitudinally thereof to establish maximum constant communication between opposite sides of the end wall through the opening. Manifestly, the adjustable valves **41** can be set permanently to provide preselected, uniform resistance to the reciprocation of the piston **21** into either of its extreme inner or outer positions irrespective of piston fit. The adjustable valve **41** at the outstroke end of the cylinder can be closed off entirely if the leakage between the bushing **31** and the piston rod **18** is sufficient to allow the piston to move slowly into the final position of Fig. 4.

In order to eliminate the necessity of packing off between the piston rod **18** and the bushing **17** of the housing end wall **14**, and to provide a hermetically sealed unit, expansible and contractible sealing means or bellows **49** and **50** surround the rod internally and externally of the wall. The movable ends of the bellows **49** and **50** are secured to the rod by annular plates or collars **51** and **52**, respectively, while enlarged annular plates **53** and **54** are carried by the fixed ends of the bellows for connection to opposite sides of the end wall by suitable screws **55** and **56**. For establishing communication between the interiors of the bellows, a plurality of openings **57** are formed in the end wall inwardly of the central peripheries of the plates **53** and **54**. As shown in Fig. 1, the external bellows **50** collapses or contracts and the internal bellows **49** elongates or expands upon inward reciprocation of the piston rod. When the rod moves outwardly as shown in Fig. 4, the internal bellows **49** contracts and the external bellows **50** expands. All of the joints between the housing end wall **14**, the bellows and the piston rod are positively sealed. Due to this arrangement, a positive hermetic seal is provided between the piston rod and the end wall of the housing through which said rod extends. The bushing **17** as well as the rod portion within the bellows are protected against internal as well as external contamination and leakage of fluid from the chamber **11** is prevented. As a result, the rod may have a relatively loose fit in the bushing and may be permanently lubricated or allowed run dry. The fluid with the mechanism need not necessarily be a good lubricant since it does not have to lubricate the bushing **17**.

The outer sealing bellows **50** and inner sealing bellows **49** are preferably of substantially the same effective diameter and may conveniently be of about the same length so that, on the instroke for example, as the outer bellows contracts in volume the inner bellows expands in volume in about the same amount. Both bellows are preferably filled with air or inert gas at about atmospheric pressure and the pressure within both the bellows is equalized through the intercommunicating openings **57**. Moreover, when both sealing bellows have equal effective diameters and the rod diameter within the bellows is uniform, the presure of gas within the bellows remains the same for any stroke position of the piston rod **18**. In action, the pressure in either bellows does not change significantly provided the intercommunicating openings **57** have a sufficiently large combined area to take care of the required interchange of gas from one bellows to the other.

Since the chamber **11** and cylinder **22** are adapted to be completely filled with a non-compressible fluid, it is very desirable to provide compensating means to accommodate variations of the volume of the fluid brought about by inward and outward reciprocation of the piston **21**, its rod **18** and the internal sealing bellows **49**. In accordance with the invention, the compensating means may be in the form of a pressure-responsive container member or bellows **58** mounted in the chamber. A circular plate **59** is attached to one end of the bellows and is fastened to the housing end wall **13** by suitable bolts **60**. The other end of the bellows carries an annular plate or collar **61** for connection by bolts **62** to a circular closure plate **63**. Pairs of opposed pins **64** and **65** are carried by the plates **59** and **63**, respectively, and have the ends of helical compression springs **66** confined thereupon for expanding the bellows **58**. The container or bellows construction provides an enclosed internal space that contains a vacuum; that is to say the space is evacuated to a high degree from the industrial or practical point of view to provide therein a low absolute pressure. The pressure should be as low as possible, preferably less than one inch of mercury absolute, and the lower the pressure that can be achieved the greater the advantage. The container may be provided with a sealing composition at all joints to insure maintenance of the vacuum therein or it may be sealed as by welding or the like.

Whereas, the compression springs **66** in the compensating means may be constant displacement springs having the characteristic of compressing in direct proportion to the applied force, it is desirable to employ springs of the non-linear displacement type exhibiting greater reduction in length under initial increments of load than under subsequent increments of load. With the latter type of spring, the compensating unit will accommodate a given decrease in effective volume of the internal chamber of the hydraulic mechanism with a lesser increase in internal pressure of the hydraulic fluid than where springs of the constant displacement type are used.

In general, the volume of the compensating unit will be considerably greater than the volume change it is designed to accommodate so that the pressure within confined fluid will not change greatly from maximum to minimum volume.

Owing to the fact that the compensating unit contains a vacuum it is little affected by changes in temperature,

and fluid pressures in the hydraulic unit in which it is used are substantially independent of temperature changes in ranges ordinarily encountered under field conditions, the compensating unit acting to accommodate volume changes in the hydraulic fluid chamber without imposing pressure variations engendered by change in its own temperature.

In the hydraulic mechanism of the invention, the pressure of the fluid in the cylinder and chamber will ordinarily be approximately atmospheric pressure and this pressure will be maintained substantially constant by the compensating unit regardless of the temperature or the position of the piston 21 and its rod 18. Pressures above or below atmospheric pressure may similarly be applied to and maintained in the hydraulic fluid.

Since the hydraulic mechanism of the invention remains completely full of non-compressible fluid under all conditions of operation it may be operated in any position such as horizontal, vertical or at an angle to the vertical.

As shown in Fig. 1, the bellows 58 collapses or contracts upon inward reciprocation of the piston 21 and its rod 18 and expands or elongates upon outward reciprocation of said piston and rod (Fig. 4). The effective volume of the chamber 11 is reduced by the elongation of the internal sealing bellows 49 upon the instroke of the piston and rod. In view of the fact that the volume of the fluid remains substantially constant, the compensating means or bellows 58 is highly advantageous to the operation of the hydraulic mechanism if the sealing bellows is not to be distorted too much and the pressure of the hydraulic fluid is not to increase unduly. Due to the compensating means, which eliminates the need for breathing by the mechanism, positive hermetic sealing of the mechanism is made possible. In addition, the compensating means accommodates variations in the volume of the fluid due to thermal expansion and contraction of the fluid and metallic parts of the mechanism. The compensating means may be located in a separate chamber apart from the housing but communicating with the interior of the housing.

Due to its unique construction, the hydraulic mechanism is capable of use where shock resistance is desired or required. For example, the mechanism may be employed to absorb or minimize the shock or impact of a falling weighted body, the stress applied in lifting heavy loads, the recoil of artillery and other sudden cessation of movement or change of direction encountered in various types of machinery and equipment. The mechanism is adapted to gradually absorb or ease the impact imposed on a railway car or other equipment by applied force in either direction, such as when a sudden blow or collision occurs or when a sudden pull or stress is exerted.

With reference to piston instroke, a sufficient number of openings 33 are provided in the side wall 23 of the cylinder 22 to permit initial relatively rapid movement of the piston 21 at a speed dependent upon the applied force. As the openings are closed by the instroke of the piston, the combined flow area is gradually restricted so as to gradually increase the resistance to the inward reciprocation of the piston. As a result, the piston travels more slowly and its force is transmitted to the cylinder and the housing 10 so as to tend to move said housing and the railway car or other object to which it is attached in the same direction, whereby the force applied to said piston through its rod 18 is cushioned so as to minimize or reduce the shock which would otherwise occur.

As explained, the decreased volume of the chamber 11 and cylinder is accommodated or offset by the collapsing of the compensating means or bellows 58 so that the fluid remains at substantially the same pressure. Due to the plurality of check valves 35 and their multiplicity of apertures 37 in the outer end wall 24 of the cylinder, the vacuum behind the piston is instantly relieved to prevent any substantial interference with the instroke of the piston. The combined areas of the valve apertures 37 at the piston rod end of the cylinder is sufficient to permit the free flow of fluid from the chamber into the cylinder through the end wall. Therefore, the flow areas of the outer openings 34 have no great effect upon the rate of travel of the piston.

Upon the outstroke of the piston, the outer ports 34 control its rate of travel which may be the same as or slower than the instroke. Again, the check valves 35 of the inner cylinder wall 25 open immediately to relieve the vacuum behind the piston. Of course, the check valves at the opposite end of the cylinder are closed due to the piston moving toward the same. When the openings 34 are restricted, as shown, the outstroke of the piston is much slower than its instroke and its final outward movement is very slow since the outermost ports are closed whereby the only flow is around the piston and through the groove 48 of the adjustable valve 41. The compensating means or bellows 58 is expanded by its springs 66 to compensate for the increased volume of the chamber and cylinder upon the oustroke of the piston.

The arrangement of ports 33 and 34 to cause a relatively rapid instroke and a slower outstroke of the piston is particularly suitable for railway draft gear because the mechanism as so constructed quickly absorbs and dissipates upon instroke of the piston the sudden shocks encountered in coupling cars. Also, when a train is suddenly braked, the mechanism will readily absorb the forward impact of cars by instroke of the piston. The slower outstroke of the piston absorbs the more slowly applied stresses encountered in starting and accelerating a train. It will be apparent that the size and disposition of the ports 33 and 34 may be varied to provide whatever piston action is desired for the absorption of particular kinds and types of impact energies.

The construction of the compensating unit shown and described may be modified without departing from the invention. For example, the compensating unit 58 may be replaced by one or more "Bellofram" units, as manufactured by the Bellowfram Corporation of Boston, Massachusetts, and as modified in accordance with the present invention. The "Bellofram" unit includes a piston loosely fitted in a cylinder with a long stroke, flexible diaphragm extending across the cylinder and attached to the piston head. The piston is spring pressed in one direction. In accordance with the invention, the cylinder on the spring side of the piston is sealed and evacuated. The diaphragm at the other side is exposed to the hydraulic fluid in the fluid mechanism of the invention.

Another form of the invention is shown in Figs. 7, 8 and 9, and includes a housing 70 similar to the housing 10 and having a cylindrical bore or chamber 71 and an elongated side wall 72. The housing may be square or angular in cross-section (Fig. 9). End walls 73 and 74 are fastened to the ends of the side wall 72 by suitable bolts 75 and 76, respectively, for closing the ends of the chamber 71. The end wall 74 has an axial opening 77 through which a piston rod or shaft 78 slidably extends. Suitable mounting means, such as apertured lugs 79 and 80, are carried by the end wall 73 and the outer projecting end of the rod 78 for connecting the mechanism, for example, between the center sill of a railway car and one of its drawbars. The piston rod has a piston 81 mounted thereon for reciprocation within a coextensive tubular sleeve 82 which is supported by the coaction of the side and end walls 72, 73 and 74 of the housing 70 in concentric, spaced relation to said wall.

A pair of transverse bulkheads or partitions 83 and 84 extend transversely within the sleeve in spaced relation to each other and to the housing end walls 73 and 74, to provide a working barrel or cylinder 85 therebetween for the piston 81, with the partitions forming the end walls of the cylinder. The portion of the sleeve 82 between the partitions 83 and 84 functions as the side wall of the cylinder 85 and has a plurality of open-

ings or ports 86 therein for establishing communication between said cylinder and the chamber 71. Each partition preferably has a circumferential groove for receiving an annular expansion member or split ring 88 which has its outer periphery confined in a complementary groove or recess 89 formed internally within the bore of the sleeve 82 (Fig. 9). A pair of diametrically-opposed openings 90 are formed in the sleeve in registration with each groove 89 to permit access to the expansion rings 88 for contraction thereof and removal of the partitions 83 and 84 when desired. Each partition includes two or more check valves 91, similar to the check valve 35, for relieving the vacuum created behind the piston 81 upon reciprocation of said piston toward the other partition.

An axial guide pin or rod 92 extends inwardly from the piston 81 and axial openings 93 and 94 are formed in the partitions to accommodate and slidably support the guide pin and the piston rod 78. Due to the provision of the partitions, chambers 95 are formed in each end of the sleeve 82 between said partitions and the housing end walls 73 and 74 and these chambers communicate freely with the chamber 71 of the housing through relatively large openings or ports 96, whereby said chambers are in effect one chamber.

Expansible and contractible sealing means or bellows 97 and 98, similar to the bellows 49 and 50, surround the piston rod internally and externally of the housing end wall 73 so that it is unnecessary to pack off between said rod and the opening 77. It is believed unnecessary to described the bellows 97 and 98, but it is noted that the interiors of the same communicate through a plurality of openings 99 formed in the housing end wall.

Compensating means in the form of a pressure-responsive member or bellows 100, similar to the pressure-responsive member or bellows 58, is mounted on the end wall 74 so as to be exposed to the non-compressible fluid with which the chambers 71 and 95 as well as the cylinder 85 are completely filled. Although differing slightly in construction and mounting, the bellows 100 contains a vacuum and is spring-pressed and functions identically to the bellows 58, so as to compensate for variations in the volume of the interior of the housing due to reciprocation of the piston 81, its rod 78, and its guide pin 92 and the internal sealing bellows 97.

Since the hydraulic mechanism of Figs. 7 to 9 operates similarly to the mechanism of Figs. 1 to 6 hereinbefore described, its method of operation will be apparent.

It will be seen that, in accordance with the invention, fluid pressures within the working cylinder may build up to considerable magnitudes during moments when the piston is reciprocating and the mechanism is absorbing energy. However, even during these moments, pressures within the communicating chamber outside of the cylinder do not increase very much due to the throttling effect of the openings in the side wall of the cylinder and the pressure offsetting effect of the compensating unit.

The foregoing description of the invention is explanatory thereof and various changes in the size, shape and materials, as well as in the details of the illustrated construction may be made, within the scope of the appended claims, without departing from the spirit of the invention.

I claim:

1. A shock-resisting hydraulic mechanism comprising a housing, a cylinder having end and side walls mounted in said housing and providing a chamber between said cylinder and said housing, a wall of said cylinder having openings establishing communication between said cylinder and said chamber, a piston reciprocable in said cylinder between its end walls, a piston rod connected to the piston and reciprocably extending to the exterior through one of the end walls of said cylinder and sealingly through said housing, said chamber and cylinder being completely filled with a non-compressible fluid, and a substantially temperature insensitive compensating device exposed to the fluid in said chamber having a hermetically-sealed collapsible and expansible container member providing an enclosed space, said space being substantially evacuated to tend to collapse said container member under pressure of the fluid in said chamber, and spring means balancing said chamber member in expanded positions against the collapsing force of the fluid in said chamber as said force varies in response to temperature changes and displacement of said fluid due to reciprocation of said piston rod.

2. A hydraulic mechanism as defined in claim 1 wherein said compensating device is mounted within said chamber and said spring means is mounted within said container member.

3. A hydraulic mechanism as defined in claim 1 wherein said compensating device is mounted within said chamber and said spring means comprises a compression spring mounted within said container member of non-linear reaction exhibiting greater reduction in length under initial increments of load than under subsequent increments of load.

4. A shock-resisting hydraulic mechanism including a hermetically-sealed housing, a cylinder having end and side walls mounted in said housing and providing a chamber between said cylinder and said housing, at least one of the end walls of said cylinder being spaced from the walls of said housing, a wall of said cylinder having openings establishing communication between said cylinder and said chamber, a piston reciprocable in said cylinder between its end walls, a piston rod connected to the piston and reciprocably extending to the exterior through said one end wall of said cylinder and through a wall of said housing, expansible and contractible sealing sleeves surrounding the piston rod internally and externally of said housing and connecting said piston rod to the wall of said housing to provide a positive hermetic seal therebetween, and passage means providing communication between the spaces within said internal and external sealing sleeves for equalizing pressures within said sleeves, said internal sealing sleeve being disposed in said chamber between said cylinder and said housing.

5. A hydraulic mechanism as defined in claim 4 wherein said sealing sleeves comprise internal and external bellows elements connected between said piston rod and the inner and outer surfaces of the wall of said housing.

6. A hydraulic mechanism as defined in claim 4 wherein said sealing sleeves comprise internal and external bellows elements of generally cylindrical configuration and having the same mean diameter connected between said piston rod and the inner and outer surfaces of the wall of said housing.

7. A hydraulic mechanism as defined in claim 4 wherein said sealing sleeves comprise internal and external bellows elements connected between said piston rod and the inner and outer surfaces of the wall of said housing, the undulating walls of said bellows elements being spaced from said piston rod to provide gas filled spaces between said bellows elements and the portion of said piston rod surrounded thereby.

8. A double-acting, shock-resisting hydraulic mechanism comprising a hermetically-sealed housing, a cylinder mounted in the housing and having end and side walls spaced from the walls of said housing to provide with said housing a continuous chamber surrounding the end and side walls of the cylinder, the side wall of said cylinder having openings establishing communication between the chamber and cylinder, a piston reciprocable in said cylinder between its end walls, a piston rod connected to the piston and reciprocably extending to the exterior through one of the end walls of said cylinder and sealingly through said housing, said piston being of substantially the same length as its maximum stroke, and the openings of said side wall of said cylinder being disposed in a pair of groups at the end portions of said side wall, one group of openings being closed by said piston

at each end of its stroke, and large, inwardly-opening, check valve means, one in each end wall of said cylinder, each said check valve means, when open establishing communication between said chamber and said cylinder, whereby each group of openings controls reciprocation of said piston towards its end of the cylinder.

9. A double-acting, shock-resisting hydraulic mechanism comprising a hermetically sealed housing, a cylinder mounted in the housing and having end and side walls spaced from the walls of said housing to provide a chamber surrounding the cylinder, the side walls of said cylinder having openings establishing communication between the chamber and the cylinder, a piston reciprocable in said cylinder between its end walls, a piston rod connected to the piston and reciprocably extending to the exterior through one of the end walls of said cylinder and through said housing, said piston being of substantially the same length as its stroke, the openings of the side walls of said cylinder being disposed in a pair of groups at the end portions of said side walls, one group of openings being closed by said piston at each end of its stroke, said chamber and said cylinder being completely filled with a non-compressible fluid, expansible and contractible sealing bellows surrounding the piston rod internally and externally of said casing and connecting said piston rod to the wall of said housing to provide a positive hermetic seal therebetween, passage means providing communication between the spaces within said bellows for equalizing pressures within said bellows, inwardly opening check valves in the end walls of said cylinder, and a substantially temperature insensitive compensating device mounted in said chamber and having a hermetically-sealed collapsible and expansible container member exposed to the fluid in said chamber, said container providing an enclosed space substantially evacuated to tend to collapse said container under pressure of the fluid in said chamber, and spring means balancing said container member in expanded positions against the collapsing force of the fluid in said chamber as said force varies in response to temperature changes and displacement of said fluid due to expansion and contraction of the inner of said sealing bellows as said piston rod is reciprocated.

10. A hydraulic mechanism comprising: a housing; an operating rod extending through a wall of said housing and being reciprocable through said wall; means reciprocably sealing said rod in said wall; said housing providing a chamber enclosing a portion of said rod, said rod upon reciprocation varying the volume of said chamber; a body of non-compressible fluid in and completely filling said chamber; and a substantially temperature insensitive compensating device exposed to the fluid in said chamber, said compensating device including a hermetically-sealed, collapsible and expansible container member providing an enclosed space, said space being substantially evacuated to tend to collapse said container member under pressure of said fluid, and resilient means balancing said container member in expanded positions against the collapsing force of said fluid as said force varies in response to temperature changes and displacement of said fluid due to reciprocation of said rod, whereby in operation of said mechanism the pressure of said fluid remains within narrow limits and said sealing means is subject to no undue pressure variations.

11. A hydraulic mechanism comprising: a housing; an operating rod extending through a wall of said housing and being reciprocable through said wall; means reciprocably sealing said rod in said wall; said housing providing a chamber enclosing a portion of said rod, said rod upon reciprocation varying the volume of said chamber; a body of non-compressible fluid in and completely filling said chamber; and a substantially temperature insensitive compensatiang device immersed in the fluid in said chamber, said compensating device including a hermetically-sealed, collapsible and expansible container member providing an enclosed space, said space being substantially evacuated to tend to collapse said container member under pressure of said fluid, and resilient means balancing said container member in expanded positions against the collapsing force of said fluid as said force varies in response to temperature changes and displacement of said fluid due to reciprocation of said rod, whereby in operation of said mechanism the pressure of said fluid remains within narrow limits and said sealing means is subject to no undue pressure variations.

12. A hydraulic mechanism comprising: a housing; an operating rod extending through a wall of said housing and being reciprocable through said wall; means reciprocably sealing said rod in said wall including an expansible and contractible sealing sleeve surrounding the rod internally of said housing and connecting said rod to the wall of said housing to provide a positive hermetic seal therebetween; vent means communicating the interior of said sealing sleeve with the exterior of said housing; said housing providing a chamber enclosing said internal sealing sleeve, said internal sealing sleeve upon reciprocation varying the volume of said chamber; a body of non-compressible fluid in and completely filling said chamber; and a substantially temperature insensitive compensating device exposed to the fluid in said chamber, said compensating device including a hermetically-sealed, collapsible and expansible container member providing an enclosed space, said space being substantially evacuated to tend to collapse said container member under pressure of said fluid, and resilient means balancing said chamber member in expanded positions against the collapsing force of said fluid as said force varies in response to temperature changes and displacement of said fluid due to reciprocation of said internal sealing sleeve, whereby in operation of said mechanism the pressure of said fluid remains within narrow limits and said internal sealing sleeve is subject to no undue pressure variations.

13. A hydraulic mechanism comprising: a housing; an operating rod extending through a wall of said housing and being reciprocable through said wall; means reciprocably sealing said rod in said wall including expansible and contractible sealing sleeves surrounding the rod internally and externally of said housing and connecting said rod to the wall of said housing to provide a positive hermetic seal therebetween, and passage means providing communication between the spaces within said internal and external sealing sleeves for equalizing pressures within said sleeves; said housing providing a chamber enclosing said iternal sealing sleeve, said internal sealing sleeve upon reciprocation varying the volume of said chamber; a body of non-compressible fluid in and completely filling said chamber; and a substantially temperature insensitive compensating device immersed in the fluid in said chamber, said compensating device including a hermetically-sealed, collapsible and expansible container member providing an enclosed space, said space being substantially evacuated to tend to collapse said container member under pressure of said fluid, and resilient means balancing said chamber member in expanded positions against the collapsing force of said fluid as said force varies in response to temperature changes and displacement of said fluid due to reciprocation of said internal sealing sleeve, whereby in operation of said mechanism the pressure of said fluid remains within narrow limits and said internal sealing sleeve is subject to no undue pressure variations.

14. A double-acting, shock-resisting hydraulic mechanism for railway car couplings including a hermetically-sealed housing having end and side walls, a cylinder mounted in the housing and having end and side walls spaced from the walls of said housing to provide a chamber surrounding the cylinder, the side walls of said cylinder having openings establishing communication between the chamber and cylinder, a piston reciprocal in said cylinder between its end walls, a piston rod con-

nected to the piston and extending to the exterior through one of the end walls of said cylinder and housing, expansible and contractible sealing means surrounding the piston rod internally and externally of the chamber and connecting said rod to the end wall of the housing to provide a positive hermetic seal therebetween, said chamber and cylinder being completely filled with a non-compressible fluid, and spring-pressed compensating means containing a vacuum mounted in said chamber to accommodate thermal expansion and contraction of the non-compressible fluid and variations in the volume of said chamber due to the displacement of the piston rod.

15. A double-acting, shock-resisting hydraulic mechanism for railway car couplings including a hermetically-sealed housing having end and side walls, a cylinder mounted in the housing and having end and side walls spaced from the walls of said housing to provide a chamber surrounding the cylinder, the side walls of said cylinder having openings establishing communication between the chamber and cylinder, a piston reciprocal in said cylinder between its end walls, a piston rod connected to the piston and extending to the exterior through one of the end walls of said cylinder and housing, expansible and contractible sealing means surrounding the piston rod internally and externally of the chamber and connecting said rod to the end wall of the housing to provide a positive hermetic seal therebetween, said sealing means including internal and external bellows carried by the piston rod and connected to the inner and outer surfaces of the end wall of the housing, said chamber and cylinder being completely filled with a non-compressible fluid, and spring-pressed compensating means containing a vacuum mounted in said chamber to accommodate thermal expansion and contraction of the non-compressible fluid and variations in the volume of said chamber due to the displacement of the piston rod.

16. A double-acting, shock-resisting hydraulic mechanism for railway car couplings including a hermetically-sealed housing having end and side walls, a cylinder mounted in the housing and having end and side walls spaced from the walls of said housing to provide a chamber surrounding the cylinder, the side walls of said cylinder having openings establishing communication between the chamber and cylinder, a piston reciprocal in said cylinder between its end walls, a piston rod connected to the piston and extending to the exterior through one of the end walls of said cylinder and housing, and expansible and contractible sealing means surrounding the piston rod internally and externally of the chamber and connecting said rod to the end wall of the housing to provide a positive hermetic seal therebetween, said sealing means including internal and external bellows carried by the piston rod and connected to the inner and outer surfaces of the end wall of the housing.

17. A double-acting, shock resisting hydraulic mechanism comprising a hermetically-sealed housing, a cylinder mounted in said housing and spaced from the inner walls thereof to provide with said housing a continuous chamber surrounding the end and side walls of the cylinder, said cylinder having openings establishing communication between said chamber and said cylinder, a piston reciprocable in said cylinder, a piston rod connected to said piston and reciprocably extending to the exterior through one of the walls of said cylinder and sealingly through said housing, the openings of said cylinder being disposed in a pair of groups at opposite ends of said cylinder, and large, inwardly-opening, check valve means, one in each end of said cylinder, each said check valve means when open establishing communication between said chamber and said cylinder.

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