Oct. 5, 1954 C. E. ADAMS 2,690,762

HYDRAULIC SHOCK ELIMINATOR

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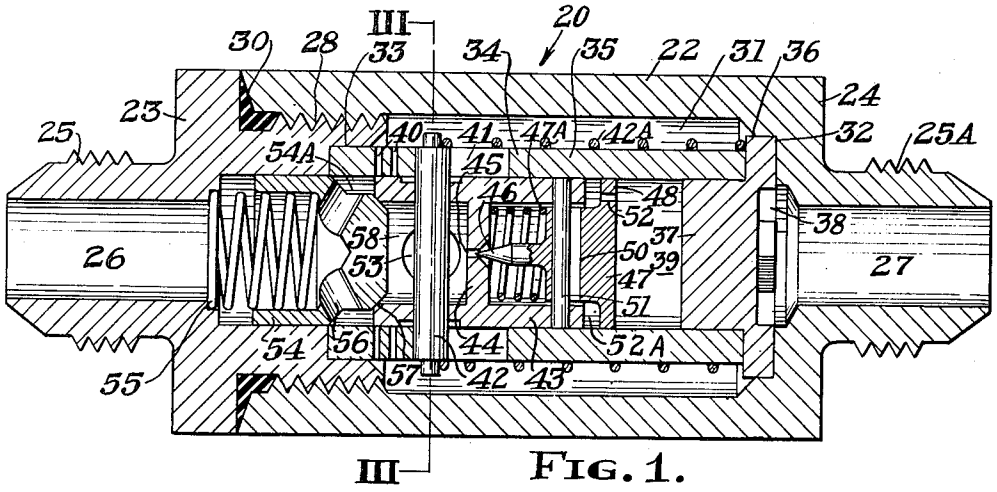


FIG. 1.

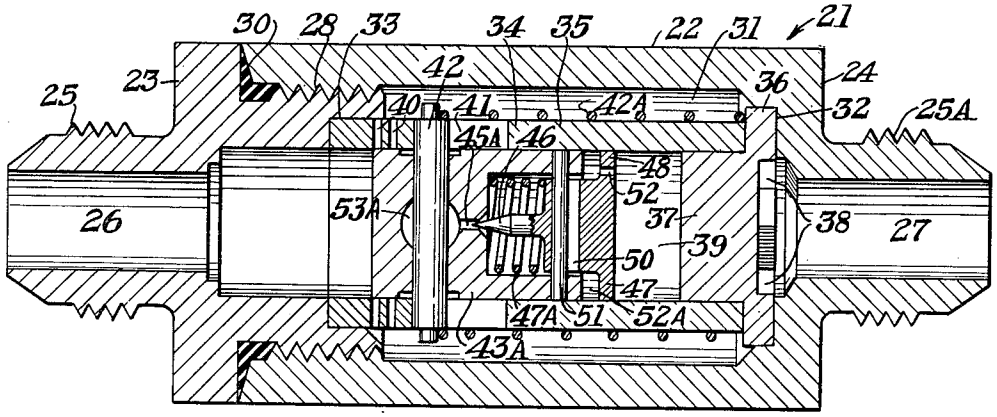


FIG. 2.

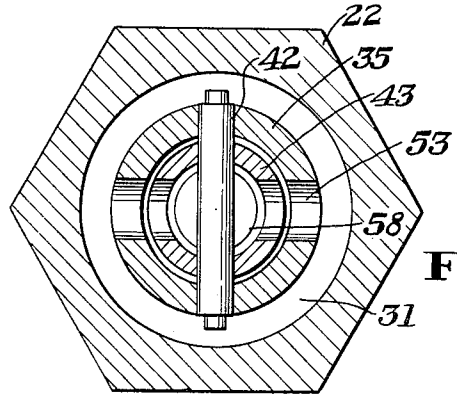


FIG. 3.

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FIG. 4.

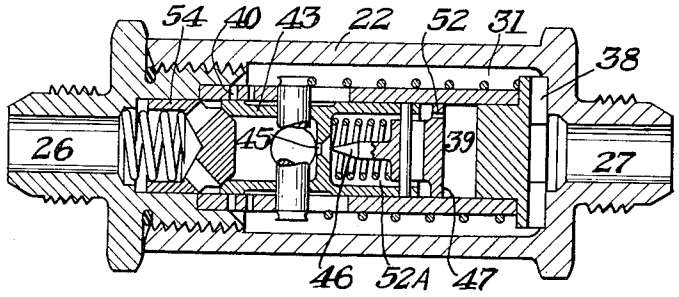


FIG. 5.

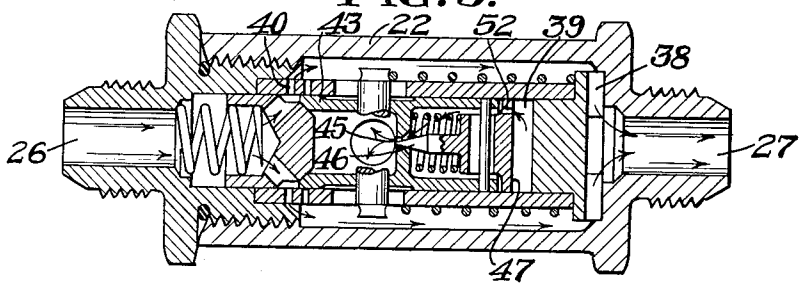
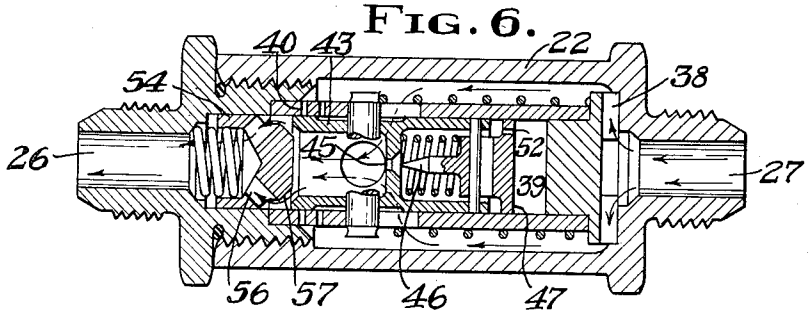


FIG. 6.



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HYDRAULIC SHOCK ELIMINATOR

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Application June 23, 1949, Serial No. 100,790

15 Claims. (Cl. 137—497)

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This invention relates generally to hydraulic apparatus and is particularly directed to a mechanism which may be positioned in a hydraulic system to decrease or eliminate surge due to the introduction of high pressure fluid into a line or other part of a hydraulic system containing static fluid. The device will hereinafter be termed either a surge eliminator or a surge dampening valve.

One of the objects of the present invention is to provide a surge eliminator which may be connected in a hydraulic line and which will be operative to decrease or eliminate the surge usually occurring when fluid under high pressure is introduced into the fluid conductor, the device being designed to permit substantially unrestricted fluid flow through the line after the danger of the surge has been eliminated.

Another object of the invention is to provide a surge eliminator or dampening device which will operate in inverse proportion to the necessity for such a device, in other words, if the pressure on fluid being introduced into a fluid conductor is high and one which would create a great surge in the fluid conductor, the device will be operative to prevent such surge, opening slowly until the danger of the creation of a surge is eliminated and then gradually accelerating in its opening movement until unrestricted communication between the line leading to the device and the line leading therefrom is established, conversely, if the pressure introduced to the conductor is low and consequently will cause a very slight surge, the valve will readily open to permit substantially unrestricted communication between the lines leading to and from the device.

A still further object of the invention is to provide a surge eliminating device having a body with inlet and outlet ports and means within the body to control communication between the inlet and outlet ports, such means being controlled in itself by fluid pressure dependent upon a contrast in pressure between the inlet and outlet of the device.

A further object of the invention is to provide a surge dampening valve having a body adapted for connection in a hydraulic line, the body containing a port-controlling spool which is normally disposed in communication-obstructing position and providing a hydraulic cushion for resisting the movement of the spool, means being provided to control the dissipation of the hydraulic cushion in response to the force applied to the spool by the fluid pressure introduced to the valve.

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Another object of the invention is to provide a surge dampening valve having a body with inlet and outlet ports and a spool for controlling communication between such ports, the spool being biased toward a closed position and movable, in response to the introduction of fluid pressure to the inlet of the device toward an open position, the movement being resisted by fluid to be displaced by the spool, the displacement of the fluid being controlled by valve means disposed in the device, the valve means being operated by a pressure drop caused by movement of the spool in response to the application of fluid to the inlet of the device. If the fluid pressure is high, the valve will tend to close and restrict the escape of fluid being displaced by the movement of the valve spool, causing the spool to move more slowly. As the spool moves, it will gradually or progressively expose ports through which the fluid may pass from the inlet to the outlet and the spool will continue to move until substantially unrestricted communication is established. As the ports are exposed, however, and the flow of fluid in the line leading from the device accelerates, the pressures at the inlet and outlet of the device gradually become equalized reducing the danger of the creation of a surge and permitting the spool to move more rapidly.

A still further object of the invention is to provide a surge dampening valve which will be responsive to the pressure at the inlet and outlet ends thereof in such a manner that no changes or adjustments, other than those occurring automatically in the device itself, are necessary to obtain the optimum rate of opening under all conditions.

Another object of the invention is to provide a surge eliminating valve adapted for incorporation in a conductor of a hydraulic system to eliminate the usual surge of pressure when fluid under pressure is supplied to one end of the conductor, the valve being so constructed that when fluid is supplied to the other end of the conductor or otherwise caused to flow in the opposite direction therethrough, it will offer substantially no resistance to the movement of the fluid.

An object also, of the invention, is to so construct the surge eliminator mentioned in the previous paragraphs that it will be small and compact, having oppositely disposed inlet and outlet connections making it suitable for incorporation in a fluid line without requiring extraneous support, the device operating to reduce or eliminate the surge when fluid pres-

sure is introduced thereinto and then permit substantially unrestricted flow when the pressures at the inlet and outlet ends of the device are equalized, the mechanism further operating to quickly reset itself automatically for the next succeeding operation when fluid flow through the conductor is interrupted.

An object also is to provide a surge eliminator of the type mentioned which will not require a tank or drain line to render its operation successful.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred form of embodiment of the invention is clearly shown.

In the drawings:

Fig. 1 is a vertical longitudinal sectional view taken through a surge dampening valve formed in accordance with the present invention, the valve shown being capable of permitting fluid flow in both directions therethrough, the flow in one direction only being regulated to dampen or prevent a surge.

Fig. 2 is a similar view of a modified form of valve in which flow in a single direction only is permitted, this flow being regulated for the same purpose.

Fig. 3 is a vertical traverse sectional view taken through the valve shown in Fig. 1, the plane of the section being indicated by the line III—III.

Fig. 4 is a longitudinal sectional view taken through a surge damping valve of the type shown in Fig. 1 showing the parts thereof in inactive positions;

Fig. 5 is a similar view showing the parts in the positions occupied immediately following the introduction of fluid under pressure into the surge damping valve;

Fig. 6 is also a similar view showing the parts in the positions occupied during reverse flow of liquid through the valve.

Referring more particularly to the drawings, numeral 20 designates the first form of surge dampening device shown in the drawings. This device, as well as the second form of device, shown in Fig. 2 and which is indicated generally by the numeral 21, includes a casing 22 formed of two pieces 23 and 24. The parts in valves 20 and 21 are substantially identical and the same reference numerals will be used throughout, except, on the parts that are different. Parts 23 and 24 are provided with threaded extremities 25 and 25–A to permit the connection of the device in a fluid conductor. Each extremity 25 and 25–A is formed with a central bore, the bore 26 in part 23 being the inlet and the bore 27 in part 24 being the outlet. Housing parts 23 and 24 are threadedly connected as at 28, a gasket 30 being disposed between these parts to provide a fluid-tight joint. Body part 24 has a chamber 31 formed therein, which is closed at one end by the body section 23. Both parts 23 and 24 are recessed as at 32 and 33 to receive and locate a sleeve unit 34 which includes a tubular member 35 and a plug 36, the latter being formed from square stock, in this instance, and having a projection 37 which is disposed in the tube 35 to close one end thereof.

Plug 36 has a flange which engages this end of the tube and is disposed in the recess 32 to locate the number 35. The flanged end of the plug is transversely slotted several times at right angles to provide openings 38, which establish communication between the space in the chamber 31 at the outside of the sleeve member 35 and the bore or outlet 27. The projection 37 seals the end of the tube 35 and cooperates therewith to provide a closed end socket 39 the purpose of which will be hereinafter set forth. Near the opposite end of tube 35, the side wall thereof is provided with longitudinally spaced sets of openings 40 which establish communication between the interior of the tube and the chamber 31 at the exterior thereof. The side wall of the tube is also provided with registering slots 41 for receiving the end portions of a pin 42 extending traversely through the sleeve; this pin also extends traversely through a spool 43, which is disposed for sliding movement in the sleeve. A coil spring 42–A is arranged on the outside of the sleeve between the flange on the plug 36 and the reduced ends of the pin 42, this coil spring tending to urge the pin and consequently the spool toward the inlet end of the device. When the spool occupies its normal position determined by the engagement of the pin with the ends of the slots 41, the skirt of the spool covers the openings 40 and prevents communication between the inlet and outlet of the device.

The spool 43 has a central web or wall 44 in which is formed an orifice 45; a needle valve 46 cooperates with the wall of this orifice to control fluid flow to and from the socket 39 through the orifice. The needle valve 46 is formed on a member 47 having a disk portion 48 which is slidable in the socket 39 provided in the sleeve 35 between the spool 43 and the plug 37. The member 47 has a body portion in which a slot 50 is provided, this slot receiving a transversely extending pin 51, the end portions of which are disposed in registering openings formed in the wall of spool 43. A coil spring 47–A disposed between the web 44 of the spool and the end of the body portion of the member 47, normally tends to separate the spool and the member 47 so that the needle valve 46 will be held spaced from the seat formed by the walls of the orifice 45 in the web 44. The spacing of the needle valve and seat is limited by the pin 51. The disk portion of the member 47 has an orifice 52 formed therein, which orifice provides the only communication between the socket 39, at one side of the disk 48 and the space 52A between the member 47 and the spool 43; the latter space 52A communicates with the chamber 31 through the orifice 45, the interior of the spool 43 and registering openings 53 formed in the spool 43 and sleeve 35.

In the form of the invention shown in Fig. 2, the spool 43–A has a solid forward end through which a transverse bore 53–A is formed; this bore 53–A registers with the openings 53 in the sleeve 35 and with them establishes communication between the orifice 45–A and chamber 31. The spool 43–A is the only part in the form of the invention shown in Fig. 2 which is different from the corresponding parts in the form shown in Fig. 1, although two other parts, about to be described, are contained in the latter form and are omitted from the form shown in Fig. 2. These parts are a poppet valve 54 and a coil spring 55, which is employed to urge the poppet valve into seated engagement with the spool 43. The poppet valve 54 is reduced in diameter as at 54–A and has a plurality of openings 56, extending angularly therethrough, these openings permitting fluid to flow through the poppet valve at the reduced portion thereof, in the operation of the device. Valve 54 is disposed for sliding movement in the body section 23 and is chamfered as at 57 for engagement with the end of the valve spool 43, this

member having a seat provided thereon. When the poppet valve 54 and spool 43 are in engagement, a chamber 58 is formed in the valve spool between the end of the poppet valve 54 and the web 44.

This chamber 58 connects orifice 45 with openings 53, and is in constant communication with the chamber section 31, the latter being, in turn, in communication with the outlet 27. With this arrangement, the pressure existing in the outlet 27 also exists in chamber section 31, ports 53, chamber 58, opening 45 and in the space 52A between the web 44 and the member 47, when the needle valve 46 is open. Under normal operating conditions, spring 55 maintains poppet valve 54 seated against the spool 43 and permits no flow from the inlet 26 to the chamber 58. This poppet 54 constitutes a check valve, however, to permit reverse flow through the device when pressure in the outlet end exceeds that in the inlet end. When flow in this direction takes place, as shown by arrows in Fig. 6, the fluid enters the device through the outlet port 27, flows through the grooves 38 in the plug 36 to the chamber section 31, then through the ports 53 to the chamber 58. The pressure of this fluid moves valve 54 to an open position in opposition to the spring 55 and the fluid flows between the poppet valve 54 and the end of the spool 43 to the ports 56, these ports communicating with the inlet 26 through which the fluid leaves the body during reverse flow therethrough.

In the modified form of the invention shown in Fig. 2, the poppet valve 54 and its spring 55 are omitted, the spool valve 43–A also having the chamber 58 omitted therefrom. This modification does not provide for or permit reverse flow through the device. Its use is, therefore, limited to a portion of a hydraulic system, in which fluid flows in one direction only but the surge dampening functions are the same in both forms of the invention.

When either of these devices is utilized it is placed in a conductor connected with a source of fluid pressure. This fluid pressure flows into the device through the inlet 26, its force being applied through the check valve 54 to the forward end of the spool valve 43 or 43–A. The force of this fluid tends to and does move the spool valve toward the outlet or to the right as viewed in Fig. 5 of the drawings, to expose or open the ports 40. Movement in this direction by the spool 43 or 43–A will start to displace fluid as indicated by the arrows in Fig. 5 from the socket 39 formed by the inner end portion of the tube or sleeve 35. The fluid being displaced must flow through the orifices 52 and 45 to the chamber 58 and out through openings 53. Since the orifice 52 is relatively small, it will resist the flow of fluid from the socket 39 causing the pressure in such socket 39 to increase. A pressure drop between the inner and outer ends of the orifice 52 will thus be created, the higher pressure being at the inner side of the disk 48. This higher pressure will tend to resist movement of the disk 47 and needle valve 46. Further movement of the spool 43 while movement of the disk 47 is resisted causes the seat formed by the sides of the orifice 45 to approach the needle valve thus tending to close the orifice. This closing tendency will reduce the flow of fluid from the socket 39 and since fluid will thus be confined therein, it will yieldably resist inward movement of the spool 43. Since the movement of spool 43 is resisted, the number of holes 40 immediately exposed will be limited and, therefore, the volume of fluid flowing through the device 20 is likewise limited. This flow-limiting characteristic is temporary, however, since the disk 47 is spring-pressed toward the inner end of socket 39 and the orifice 52 is continually open, some fluid will flow from socket 39 to space 52–A allowing the disk to move in response to the force of spring 47–A into the socket 39 which movement will permit needle valve 46 to move somewhat gradually away from the walls of the orifice 45. When this orifice is even slightly open, some fluid will flow therethrough permitting the spool 43 to move further into the socket. As the spool 43 moves into the socket, more of the ports 40 will be progressively exposed to establish additional communication and permit a greater volume of fluid flow between the inlet 26 and the outlet 27. The rates at which the spool and the disk are permitted to move will be controlled, however, by the difference in pressure between the inlet and outlet end, so that the degree of communication established between the inlet and outlet of the device will increase in inverse proportion to the pressure of the fluid entering the inlet 26. If this pressure is high and tends to move the spool valve 43 suddenly, the needle valve 46 will move further toward a completely closed position and movement of the spool will be retarded. As mentioned above, however, some fluid will flow through the orifice 52 allowing the needle valve to move away from the orifice 45 and the flow of fluid from behind the spool 43; the spool will be permitted to move inwardly in the socket 39 gradually. In the device, as constructed, the rate of movement of spool 43 depends upon four conditions three of which are fixed, one fixed condition, is the area of the disk 48, another is the area of orifice 52, another is the force of spring 47–A. The fourth and variable condition is the differential in pressure between the inlet and outlet ends of the device. As long as the pressure drop through the orifice 52 remains unchanged spring 47–A will balance the force tending to close needle valve 46 and the flow past the valve will be uniform causing uniform movement of spool 43. It is important to the operation of the device that the leakage from socket 39 be parallel to the flow through the orifice 45 so that it will not affect such operation. As long as the total of the leakage and the flow through orifice 45 is insufficient to affect the pressure differential through orifice 52, the leakage will be unimportant. It will be observed that as the ports 40 are exposed, fluid will flow directly from the inlet to the outlet permitting the pressures in these two regions to approach equalization. As the inlet port pressure and the outlet port pressure approach equalization, the spool will move further to the right exposing additional ports and providing for full flow through the device.

As shown in both forms of the invention, the spring 47–A is arranged between and supported by the spool 43 and part 47; the latter will offer resistance to the flow of fluid through the device only while the spool 43 is moving toward an open position or when there is a differential in pressure between the inlet and outlet end of the casing. As soon as the inlet and outlet pressures are equalized, spring 47–A has no effect on the flow and the only resistance thereto will be offered by the spool 43 under the influence of spring 42–A. The spring 42–A, however, is relatively weak and will, therefore, offer a minimum of resistance to the flow of fluid through the device. It will be

observed from the drawing that several sets of openings **40** are provided, these being spaced longitudinally of the device to be progressively exposed as the spool **43** moves into the socket formed by the sleeve-like partition **35**.

One feature of the invention is that the valve formed in accordance therewith provides for a gradually accelerated flow from the inlet to the outlet. This flow will be substantially unrestricted after the necessity for the dampening effect is reduced and will remain unrestricted as long as fluid continues to flow through the valve. As soon, however, as flow is interrupted, the valve will be quickly reset to its original position ready to prevent a surge when fluid flow through the conductor is again initiated. As the valve is constructed, it will be responsive to the pressures in the inlet and outlet ends in such a way that no changes or adjustments are necessary to obtain the optimum rate of opening under all conditions. It has been pointed out that the rate of opening of the valve will be slower if high pressure is applied to the inlet than if a low pressure is applied thereto. This feature of operation is due to the hydraulic unbalance of the needle valve and its supporting member. When pressure is applied to the inlet of the device, this pressure will be effective over the end of the valve spool **43**. The force of this pressure will tend to move the valve spool into the socket provided by the sleeve-like partition **35** and the pressure in this socket will build up to equal the pressure in the inlet. This pressure is effective over the entire inner area of the disk **48** and is substantially balanced on the opposite side of the disk, except for the portion of the needle valve which is exposed to the area of the orifice **45**; this area is exposed to the pressure existing in chamber **58**, which is substantially equal to the outlet port pressure. There will thus be a force applied to the disk which tends to close the needle valve **46**. If this force is less than the force exerted by the spring **47–A**, the needle valve will remain open permitting some fluid to flow through the orifice **45**; the spring **47–A** has been so calculated that it will exert a force greater than the force tending to close the valve under all normal operating conditions. Since there will, therefore, always be some flow possible through the orifice **45**, spool **43** will be capable of commencing to move toward an open position when fluid pressure is applied to the inlet. When the fluid pressure is high, however, the effective force of spring **47–A** will be less than when the inlet port pressure is lower and needle valve will move closer to a closed position to further restrict flow through orifice **45**. The volume of fluid flow through orifice **45** will, therefore, depend upon the difference between inlet and outlet port pressure; if this pressure difference is slight the volume of fluid flowing through the port will be greater permitting the spool **43** to move at a faster rate. It will thus be seen that the rate of opening of the valve will be in inverse order to that of the pressure differential existing between the inlet and outlet ports.

While the form of embodiment of the present invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is:

1. A surge dampening device comprising a body with an internal chamber and inlet and outlet ports communicating therewith; a valve element disposed for movement in said chamber to control communication between said inlet and outlet ports; means yieldably urging said valve element toward a position in which communication between said inlet and outlet ports is prevented, a higher pressure in said inlet port than in said outlet port tending to move said valve element in opposition to said urging means to a position providing for communication between said inlet and outlet ports; a second means for controlling the movement of said valve element toward open position, said second means having a second fluid-receiving chamber disposed to have fluid displaced therefrom by movement of said valve toward open position; means forming a normally open passage between said second fluid-receiving chamber and said outlet; a valve seat in said passage; and a valve normally spaced from said seat and disposed for movement toward the same to close said passage in response to a higher fluid pressure in said second chamber than in said outlet.

2. A surge dampening device comprising a body with an internal chamber and inlet and outlet ports communicating therewith; a spool valve disposed for movement in said chamber to control communication between said inlet and outlet ports; means yieldably urging said spool toward a position in which communication between said inlet and outlet ports is prevented, a higher pressure in said inlet port than in said outlet port serving to move said spool in opposition to said urging means to a position providing for communication between said inlet and outlet ports; means for regulating the rate of movement of said spool toward open position having a second chamber to which inlet port pressure is transmitted; a passage leading from said second chamber to said outlet; means in said passage forming a valve seat; a metering valve disposed for movement toward and away from said seat to control fluid flow from said second chamber; and a piston element in said second chamber for actuating said metering valve, said piston element forming an orifice in said passage to create a pressure differential on opposite sides of said piston and impart movement thereto.

3. A surge dampening device comprising a body with an internal chamber and inlet and outlet ports communicating therewith; a spool valve disposed for movement in said chamber to control communication between said inlet and outlet ports; means yieldably urging said spool toward a position in which communication between said inlet and outlet ports is prevented, a higher pressure in said inlet port than in said outlet port serving to move said spool in opposition to said urging means to a position providing for communication between said inlet and outlet ports; means for regulating the rate of movement of said spool toward open position having a second chamber to which inlet port pressure is transmitted by said spool; a passage leading from said second chamber to said outlet, said passage having a valve seat formed therein; valve means supported for movement toward and away from said valve seat independently of said spool to control fluid flow through said passage; spring means tending to urge said valve means toward an open position, and means responsive to a greater pressure in said second chamber than in said outlet to move said valve means toward said seat in opposition to said spring means.

4. A surge dampening device comprising a body with an internal chamber and inlet and outlet

ports communicating therewith; a spool valve disposed for movement in said chamber to control communication between said inlet and outlet ports; means yieldably urging said spool toward a position in which communication between said inlet and outlet ports is prevented, a higher pressure in said inlet port than in said outlet port serving to move said spool in opposition to said urging means to a position providing for communication between said inlet and outlet ports; means for regulating the rate of movement of said spool toward open position having a fluid-receiving socket at one end of said spool; an orifice in said spool communicating with said outlet, movement of said spool toward an open position serving to exhaust fluid from said socket through said orifice; a disk having a second orifice disposed for movement in said socket; a needle valve supported by said disk adjacent the orifice in said spool; and resilient means tending to move said disk to withdraw said needle valve from said orifice.

5. A surge dampening device comprising a body with an internal chamber and inlet and outlet ports communicating therewith; a ported sleeve dividing said chamber into inlet and outlet sections; a spool disposed for movement in said sleeve to control communication between said sections; means yieldably urging said spool toward a position preventing communication between said sections, said spool moving in opposition to said urging means in response to the introduction of fluid pressure to said inlet; and means for regulating the rate of movement of said spool having a fluid-containing chamber; a movable partition having an orifice dividing said chamber into inner and intermediate pressure zones, the latter being between said spool and said partition; a wall in said spool having a port to connect said intermediate pressure zone with said outlet chamber section; and a normally open needle valve carried by said partition to control fluid flow through the port in said wall.

6. A surge dampening valve comprising a body with an internal chamber and inlet and outlet ports; a sleeve-like partition dividing said chamber into inlet and outlet sections communicating with said inlet and outlet ports respectively, said partition having ports establishing communication between said sections, said sleeve-like partition providing a socket communicating with the outlet section of said chamber; a spool member disposed for movement in said socket to govern fluid flow through the ports in said sleeve; means tending to urge said spool outwardly of said socket, said spool being moved inwardly in said socket and displacing fluid therefrom in response to a differential between inlet and outlet port pressure; and means for controlling the displacement of fluid from said socket by the movement of the spool thereinto, said means having a needle valve and pressure differential creating means for actuating said needle valve.

7. A surge eliminator comprising a body with an internal chamber and inlet and outlet ports; a sleeve-like partition dividing said chamber into inlet and outlet sections communicating with said inlet and outlet ports respectively, said partition having ports establishing communication between said sections, said sleeve-like partition providing a socket communicating with the outlet section of said chamber; a spool member disposed for movement in said socket to govern fluid flow through the ports in said sleeve; spring means yieldably urging said spool outwardly of said socket, said spool being moved inwardly in said socket and displacing fluid therefrom in response to inlet port pressure; means for controlling the displacement of fluid from said socket by the movement of the spool thereinto, said means having a needle valve; means tending to urge said needle valve toward an open position; and a disk with an orifice between said spool and the inner end of said socket, said disk and said needle valve being connected for movement in unison.

8. A surge eliminator comprising a body having aligned inlet and outlet ports and an internal chamber; a sleeve-like partition dividing said chamber into inlet and outlet sections communicating with said inlet and outlet ports respectively, said inlet section being closed at one end and communicating with said outlet section through spaced ports provided in said partition; a spool member disposed for movement in said inlet section to control fluid flow through said spaced ports, said spool and partition providing a passage with an orifice establishing communication between the closed end of said section and said outlet section; means resiliently urging said spool toward a position to close the ports in said partition, said spool being exposed and responsive to inlet port pressure to move in opposition to said resilient urging means to open said ports; means responsive to the difference in inlet and outlet port pressures for controlling the flow of fluid through the passage provided by said spool and partition, said means having a needle valve for cooperation with said orifice; and a disk movably supporting said needle valve, said disk being disposed in the closed end of said inlet section between the spool and the inner end, the opposite sides of said disk having areas exposed to unequal pressures when differences between inlet and outlet port pressures exist, such unequal pressures serving to hydrostatically unbalance said disk.

9. A surge eliminator comprising a body having an internal chamber and inlet and outlet ports communicating therewith at opposite ends of the body; a tubular partition dividing said chamber into inlet and outlet sections communicating with said inlet and outlet ports respectively, said tubular partition being closed at the end remote from said inlet port; spaced ports in said partition adjacent the end proximate to said inlet port, said spaced ports establishing communication between said inlet and outlet chamber sections; a spool member disposed for sliding movement in said tubular partition; spring means normally urging said spool member into a position to block the spaced ports in said partition, one end of said spool member being exposed to inlet port pressure and the other end being spaced from the closed end of said tubular partition to provide a pressure chamber; a passage formed in said spool and partition to connect said pressure chamber and said outlet section; an orifice in said passage; a needle valve; a disk-like piston disposed for movement in said tubular partition between the closed end thereof and said spool member, said piston supporting said needle valve for movement toward and away from said orifice, said piston having a second orifice; and spring means between said spool member and piston, said last-named spring tending to move said needle valve away from said first-mentioned orifice.

10. A surge dampening valve comprising a body with inlet and outlet ports; a normally closed

valve in said body for controlling communication between said ports, said valve being movable toward open position by the application of fluid pressure to said inlet port; a fluid containing chamber in said body, movement of said valve toward open position displacing fluid from said chamber; flow control means for governing the displacement of fluid from said chamber, said means having a flow restrictor to create a pressure drop on the fluid flowing from said chamber; and a second valve movable relative to the first mentioned valve and responsive to such pressure drop to restrict fluid flow from said chamber.

11. A surge dampening valve comprising a body with inlet and outlet ports; a normally closed valve in said body for controlling communication between said ports, said valve being movable toward open position by the application of fluid pressure to said inlet port; a fluid containing chamber in said body, movement of said valve toward open position displacing fluid from said chamber; a passage between said chamber and one of said ports; flow control means in said passage, said flow control means having flow restricting means to cause a pressure differential on fluid flowing from said chamber through said passage; and a second valve movable relative to said normally closed valve and responsive to such pressure differential to restrict the flow of fluid through said passage.

12. A surge dampening device comprising a body with inlet and outlet ports; a normally closed valve in said body for controlling communication between said ports, said valve being movable toward open position by the application of fluid pressure to said inlet port; means for controlling the rate of opening movement of said valve, said means having a fluid-receiving chamber; a single restricted outlet leading from said chamber, movement of said valve toward an open position tending to increase the pressure on the fluid contained in said chamber; and a valve element disposed for movement in said chamber independently of said first-mentioned valve and responsive to the pressure of the fluid in said chamber to reduce the size of said restricted outlet.

13. Surge dampening means comprising a body with an internal chamber and inlet and outlet ports communicating therewith; a spool valve disposed for movement in said chamber to control communication between said inlet and outlet ports; means yieldably urging said spool toward a position in which communication between said inlet and outlet ports is prevented, a higher pressure in said inlet port than in said outlet port serving to move said spool in opposition to said urging means to a position providing for communication between said inlet and outlet ports; means for regulating the rate of movement of said spool having a passage within said body through which fluid is forced by the movement of said spool valve toward open position; a valve seat in said passage; a second valve movable relative to said spool valve and cooperating with said seat to control fluid flow through said passage; means for actuating said second valve having a piston and a restricted orifice forming part of said passage and establishing communication between opposite sides of said piston, the latter being responsive to an excess in pressure on the side thereof remote from said seat caused by fluid flow through said orifice to move said valve toward a closed position; and yieldable means for urging said valve actuating means toward a valve opening position, the approach toward an equalization of pressure in said inlet and outlet serving to permit opening movement of said second valve.

14. A surge dampening valve comprising a body with inlet and outlet ports; a normally closed valve in said body for controlling communication between said ports, said valve being movable toward open position by the application of fluid pressure to said inlet port; flow control means for governing the rate of movement of said valve toward open position, said flow control means having a chamber and a single restricted passage leading therefrom, movement of said normally closed valve toward open position causing fluid flow from said chamber through said restricted passage to create a pressure differential in said passage; and a second valve in said passage movable relative to said normally closed valve, said second valve being responsive to such pressure differential to restrict the flow of fluid from said chamber concurring with and dependent upon movement of said normally closed valve toward open position.

15. A surge dampening valve comprising a body with inlet and outlet ports; a normally closed valve in said body for controlling communication between said ports, said valve being movable toward open position by the application of fluid pressure to said inlet port; means for controlling the rate of opening movement of said valve, said means having a fluid containing chamber; a wall member disposed for sliding movement in said chamber, movement of said normally closed valve toward open position tending to move said wall member and increase the fluid pressure in a part of said chamber; a single outlet leading from said chamber, said outlet being restricted; and a second valve movable independently of said normally closed valve and cooperating with said restricted outlet to control fluid flow from said chamber, said second valve being actuated by said wall member in response to fluid pressure in said part of said chamber to reduce the effective size of said restricted outlet.

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