

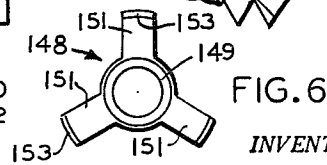
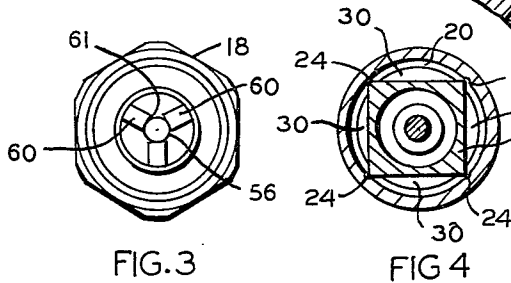
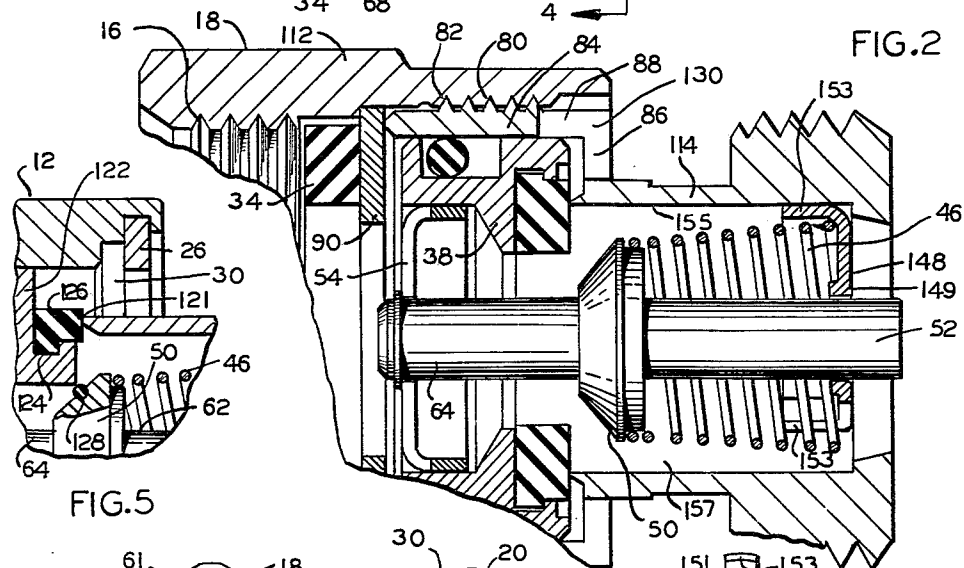
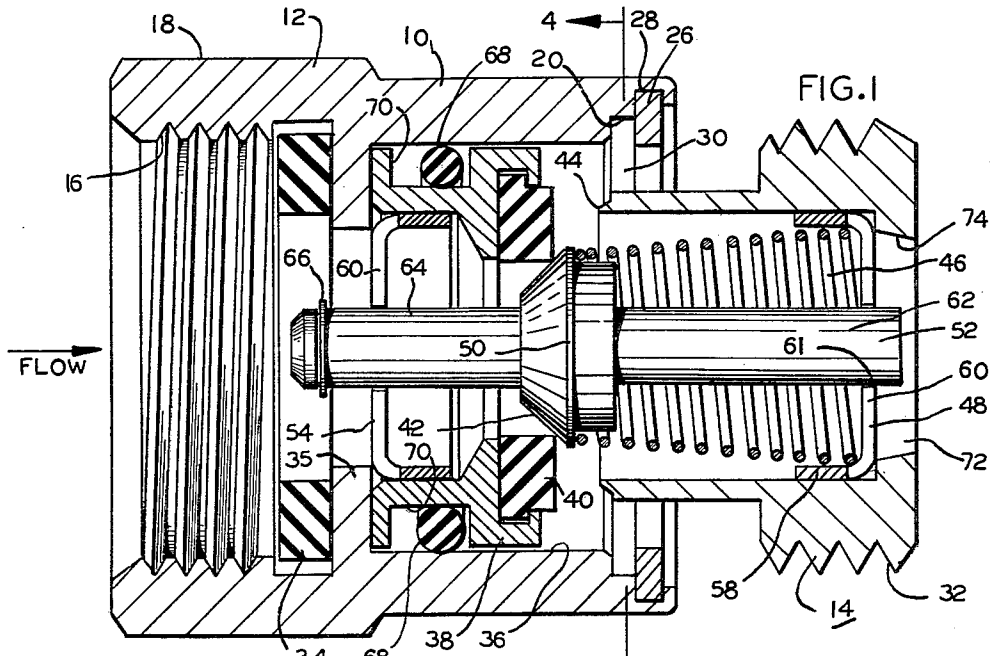
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VACUUM BREAKER

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VACUUM BREAKER

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This invention relates to a vacuum breaker, and particularly to a relatively low cost vacuum breaker capable of satisfactorily passing the plumbing codes of the major cities throughout the country.

Most plumbing codes require the provision of vacuum breakers in the water lines of commercial and residential buildings, the purpose of such vacuum breakers being to guard the drinking water supply against contamination in the event of a break in one of the water mains, or other malfunction in the system which would cause a siphoning or vacuum condition to exist in the water lines.

The principle of most present day vacuum breakers is to provide a check valve construction and air vent arrangement for closing the supply line and admitting air into the downstream portion of the vacuum breaker in the event of a vacuum force taking place upstream from the breaker; in this manner the vacuum breaker check valve is automatically closed without undue resistance from the liquid within the breaker. With conventional vacuum breakers, there is an undesirable period during normal operation of the system when the air vent openings are in communication with the upstream portion of the breaker so that the supply liquid is enabled to exhaust through the vent openings to splash against external structures. Also, on the occurrence of vacuum or siphoning conditions the vacuum forces can momentarily work around the valve element and thus cause possible contamination of the source, and/or undesired exhaustion of supply water through the vent openings.

It is an object of the present invention to provide a construction wherein the air vent openings are never permitted to communicate with upstream portions of the breaker, so that undesired fluid flow around the breaker valve element is precluded.

An additional object of this invention is to provide a vacuum breaker having a novel arrangement of parts such that obstructions downstream from the breaker are ineffective to have a deleterious effect on the breaker operation or to permit spray from the air vents.

A further object of the invention is to provide a vacuum breaker which operates successfully in the presence of water hammer or relatively high pressure downstream conditions.

A further object is to provide a vacuum breaker having a relatively long service life, even in the presence of such adverse conditions as valve element clogging, low supply pressures and partial clogging of the air vent openings.

A still further object of the invention is to provide a vacuum breaker having a relatively large air vent opening area and large air passage area from the air vents to the sealing seat.

An additional object is to provide a vacuum breaker having novel means for slidably guiding the operating parts to provide a jam-free operation and long service life.

A further object of the invention is to provide a vacuum breaker having improved features of sealing under low pressure conditions, so as to adapt the mechanism for quick response to changing pressure conditions without an indeterminate fluctuating action.

Another object of the invention is to provide a vacuum breaker which has no undesired effects on the flow characteristics of the liquid during normal operation of the liquid supply system.

Another object is to provide a vacuum breaker having

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a relatively small pressure drop therethrough during normal operation of the system, thereby adapting the breaker to use in systems having low water pressures.

A further object of the invention is to provide a vacuum breaker wherein the outlet flow issues as an even pattern without side splash, thereby adapting the breaker to use on the conventional household water taps.

A further object of the invention is to provide a vacuum breaker incorporating a compression spring, together with mechanism for insuring that the spring will not be overly compressed in a manner to shorten the service life of the breaker.

A still further object of the invention is to provide a vacuum breaker made up of two major housing components connected together with low cost attachment means to provide an economically formed structure.

A further object of the invention is to provide a breaker having a relatively small diameter and length so as to utilize a minimum amount of costly brass or other similar anti-corrosive materials.

Other objects of this invention will appear in the following description and appended claims, reference being had to the accompanying drawings forming a part of this specification wherein like reference characters designate corresponding parts in the several views.

In the drawings:

FIG. 1 is a sectional view through one embodiment of the invention.

FIG. 2 is a sectional view through a second embodiment of the invention.

FIG. 3 is a right end elevational view of the FIG. 1 embodiment taken on a reduced scale.

FIG. 4 is a reduced sectional view taken on line 4-4 in FIG. 1.

FIG. 5 is a sectional view through a portion of a third embodiment of the invention.

FIG. 6 is a left end elevational view of a spider-like guide structure employed in the FIG. 2 embodiment.

Before explaining the present invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also, it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation.

Referring to the drawings, and particularly to FIG. 1 there is disclosed a vacuum breaker including a two-piece brass housing 10 defined by the upstream flow tube or housing element 12 and the downstream flow tube or housing element 14. Housing element 12 comprises an annular housing body having internal threads 16 at its upstream end for connection with a threaded supply conduit or fitting (not shown). The external surface of the housing element is preferably hexagonal at 18 to facilitate attachment of the breaker to the supply conduit. The downstream end portion of housing element 12 is provided with a circular counterbore 20 for reception of the flange portion 22 of the housing body 14. Four small half circular holes or notches 24 are machined or milled into body 12 at peripherally spaced points around the recess 20 as shown in FIG. 4, the arrangement being such that the corner portions of the square shaped flange 22 are received in the small openings 24 to prevent relative rotation between the two housing bodies. Flange 22 is retained within the recess 20 by means of a snap ring 26 seated in an annular recess 28 in member 12.

It will be noted from FIG. 4 that the square shape of flange 22 cooperates with the internal surface configuration of housing element 12 to form four circular segment shaped air vent openings 30 of relatively large area. The

snap ring 26 and the notched construction at 24 serves as a fairly low cost method of securing the housing sections together, without providing a weak connection and with the attainment of a relatively large air vent area. The housing section 14 is provided with external threads at 32 for connection with the outlet receiver, which may be a water line, another valve, a water appliance, or a conventional garden hose.

Preferably the inlet housing element 12 is provided with a rubber gasket element 34 seated against internal wall 35 and adapted to sealingly engage the end of the supply conduit (not shown) for preventing leakage around the threads 16. The central portion of housing body 10 (to the right of wall 35) provides a cylindrical chamber 36 which slidably receives the hollow piston 38. Piston 38 carries a relatively soft neoprene sealing element 40 arranged to cooperate with the conical valve surface 42 of check valve 52 to prevent flow of liquid into the housing body 14. Sealing element 40 also cooperates with the annular seat 44 formed at the upstream end of tubular housing element 14 to seal the air vent openings 30 from the interior of the breaker.

In the illustrated "no flow" position of the breaker, the sealing element 40 is spaced away from the annular valve seat 44 by the compression spring 46, this spring being seated between a spider element 48 and the enlarged head portion 50 of the check valve element 52. Spring 46 acts in a leftward direction on the head portion 50, and the head portion in turn pressures against the sealing element 40 to urge the piston 38 to its FIG. 1 position.

When the FIG. 1 unit is connected to a water supply line the liquid pressure is effective on the piston 38 and check valve element 52 to initially move the piston-check valve assembly to the right until sealing element 40 abuts against the annular valve seat 44 for closing the air vent openings 30. Thereafter the fluid pressure is effective to move the check valve element 52 to the right to open the breaker to fluid flow.

Guiding of the check valve element is achieved with two identical low cost mounting structures 48 and 54. Each comprises an outer annular portion 58, and three spider forming arms 60 having flat end surfaces 61 slidably engaged with the surfaces of shaft portions 62 and 64, the arrangement being such as to provide an extensive path for flow of liquid adjacent and along the shaft portion. The outer annular portion 58 serves as a rigidifying element for the arms 60 and also as an axially extending mounting portion for accurately and easily mounting the guide structure as a tight fit in its supporting element. The spaces between the arms 60 form flow openings for passage of liquid through the breaker assembly. By utilizing similar structures for the guides 48 and 54, the cost of assembly is minimized, and production operations are facilitated.

It will be noted that mounting structure 54 is carried in the movable piston 38, whereas mounting structure 48 is carried in the fixed housing element 14. This however does not interfere with proper jam-free guiding of the shaft portions 62 and 64 of the check valve, since the mounting of structure 54 on the movable piston 38 provides an accurate alignment of the conical valve surface 42 with the cooperating edge of annular sealing element 40. The axially spaced character of the mounting structures 48 and 54 provides a very satisfactory guiding of the check valve 52, and in practice the illustrated check valve has performed over extended periods without malfunctioning of any kind.

The upstream end of shaft portion 64 is provided with an annular groove for reception of the snap ring 66, said snap ring forming a stop element for cooperation with the spider arms 60 of the mounting structure 54 to limit the downstream travel of the check valve. The arrangement is such that the check valve is prevented from dis-

lodgement from support structure 54 and the spring 46 is prevented from being unduly compressed in a manner to shorten its service life.

It has been previously pointed out that when the breaker receives its initial supply of fluid through the washer 34, piston 38 and check valve 52 are initially moved to the right as a unit, i.e., without any movement of the check valve relative to the piston 38. This "unitary movement" feature is made possible because the effective cross sectional area of the piston exposed to the upstream pressure is materially greater than the effective area of the check valve 52. Also, the compression spring 46 tends to maintain the piston and check valve together. As a result of the unitary movement the breaker is prevented from passing any liquid until after the sealing element 40 is engaged against the annular seat 44. Therefore, when the check valve 52 moves away from element 40 the air vent openings 30 are sealed from the liquid stream, and there is no possibility of liquid discharging through the vent openings. In many of the prior art devices the air vent openings are so located that liquid can work through the vent openings during portions of the operating cycle. By the present construction this objectionable characteristic is entirely avoided.

It will be noted that an O-ring is provided at 68 for preventing the inlet liquid from working around the piston 38. O-ring 68 is seated in an annular groove 70 formed in the outer surface of the piston 38, the axial dimension of groove 70 (parallel to shaft portions 62 and 64) being substantially greater than the corresponding dimension of the O-ring 68. Also the O-ring 68 is constructed of a relatively soft neoprene material having a durometer in the range of 30 to 40. The arrangement is such as to provide a rolling seal between the piston and the internal surface 36 of the housing section 12, the advantage residing in the fact that a minimum frictional resistance is imposed on the piston. This feature is particularly desirable in providing a quickly responsive non-sluggish valve operation during changing pressure conditions. It also adapts the device to operation in areas of extremely low water pressure, since the effect is to materially reduce pressure drop through the breaker. The "rolling seal" action is obtained by reason of the axial clearance between the side surfaces of groove 70 and the adjacent surface of O-ring 68, as well as the softness and extreme flexibility of the O-ring material. In operation the O-ring actually turns inside out by reason of its frictional engagement between the surface 36 and the groove surface 70.

It will be appreciated that during normal flow of liquid through the vacuum breaker the piston 38 will be displaced to the right with its sealing element 40 engaged with the annular seat 44; the check valve 52 will be displaced to the right with its conical surface valve 42 spaced from the edge of sealing element 40 to provide a flow passage to the outlet opening at 72. Opening 72 is defined by a surface 74 which tapers in a downstream direction so as to have a guiding effect on the liquid as it issues from the breaker. The guiding effect is such that the liquid issues as a relatively compact stream without side splash or undue divergency, particularly in those installations wherein the breaker is located at or closely adjacent to the discharge point from the supply line. A further feature which tends to promote a compact non-divergent stream is the guiding action achieved by the shaft portion 62; thus the liquid tends to flow evenly along the shaft portion 62 without the divergency which is noted when the shaft portion is not present.

At any time in the operation of a city water system there is the possibility of a break occurring in one or more of the mains. In fact in many large cities it is common for a main to break at one or more different points in the city every day. If the main supplying the FIG. 1 valve were to break, the flow through the break

would of course create a vacuum or siphoning condition in the area upstream from piston 38. Immediately on the occurrence of the low pressure condition upstream from piston 38 the spring 46 cooperates with the relatively high pressure liquid in the breaker outlet 72 to force the check valve to a position closing the annular element 40. As a result the water downstream from outlet 72 is prevented from travelling back through the vacuum breaker to possibly contaminate the lines between the vacuum breaker and the source of the break. During this operation the air vent openings 30 serve to exhaust any built-up pressures in the space immediately adjacent head 50; as a result, any high pressure liquid in the outlet of the breaker will flow to the atmosphere through the air vent openings 30 instead of having a tendency to act on the head 50 and piston 38 in a manner to possibly work back through the breaker into the low pressure area.

It should be noted that the FIG. 1 device has a successful operation even in the presence of water hammer or high outlet pressure such as would be obtained by a downstream obstruction in the line. In this connection, during normal operations of conventional water supply systems in many cases a water hammer or kick-back action occurs periodically, due to the operation of such devices as trip-actuated hand sprinklers or sudden opening and closing of faucets and the like; with the present invention such water hammer and kick-back actions are ineffective to cause improper operation of the device or splash through the air vents. This is due to the differential areas of the piston 38 and the enclosed contact surface of the sealing element 40 against the raised annular seat 44. In actual operation, water pressure and flow on the inlet side of the vacuum breaker serves to urge the piston 38 and the contained sealing element 40 against the seat 44 thus sealing the air ports 30 against flow of water, while the check valve 52 is unseated, allowing water flow through the vacuum breaker.

Should a sudden stoppage of flow downstream from the vacuum breaker occur, a ricocheting action occurs which may tend to lift the air port sealing element off the seat 44.

The unit pressures acting on the check valve 52 then either become equalized on both sides of the check valve seat or greater on the downstream side depending on how sudden the downstream flow is interrupted. This equalizing of forces allows the check valve spring 46 to decompress and to urge the check valve seat 42 against the sealing element 40 thus effecting a seal and preventing back flow of water through the valve to the inlet end.

However, the inlet pressure acting on the larger area of the piston exerts a relatively large force which cannot be overcome by the resultant force caused by a water hammer and the force of the spring 46 from the opposite direction, because of the smaller enclosed area of the sealing ring 40 which is exposed to the water hammer pressures.

The differential areas previously mentioned are of sufficient variation to allow for any water hammer or flow stoppage condition that may occur downstream from the vacuum breaker; therefore no leakage is possible thru the airports under the aforementioned conditions.

It will be noted that the FIG. 1 construction does not employ diaphragms, rubber-like bladders, disks or other diaphragm configurations which must deform and continually flex in order to accomplish sealing during the operating cycle. Such thin rubber-like structures are disadvantageous by reason of short service life, and in many cases requirement for a relatively large diameter casing construction. Such diaphragms also are limited in the extent of deformation or stretch and very often are a restriction to air passage from the air ports to the outlet due to necessary location very close to the air port sealing seat. The FIG. 1 construction using the slidable piston does not interfere with air passage since it

may be located at greater distances from the air port seat. The large diameter casing constructions are expensive by reason of the large amounts of brass materials required in their formation, and also by reason of installation problems. The FIG. 1 construction is susceptible of manufacture as a relatively small unit, as for example on the order of one and seven-eighths inches in length and a major diameter of one and eleven-thirty-seconds inches.

The construction shown in FIG. 2 is in many respects similar to that shown in FIG. 1, and similar reference numerals are employed wherever applicable. In the FIG. 2 construction the inlet housing section 112 is internally threaded at 80 to mesh with the external threads 82 formed on the annular extension 84 of the housing section 114. It will be noted that housing section 114 is connected with the annular extension 84 by means of a plurality of ribs 86 extending radially and then axially, as at 88, from the housing section to the annular extension. The spaces between the ribs 86 form air vent openings 130 which have a similar function to the previously discussed openings 30 in the FIG. 1 construction. It will be seen that housing section 114 is connected with housing section 112 by merely threading the two sections together until the extension 84 contacts the spacer ring 90. The spacer ring 90 serves the same function as wall 35, and could be formed integrally with the upstream housing section if desired.

In assembling the FIG. 2 components together the check valve 52 may be positioned within the housing section 114, the piston 38 and mounting structure 54 may be telescoped thereover as shown, and the snap ring 66 may then be snapped onto the shaft portion 64. Thereafter, the spacer 90 and gasket 34 may be positioned within housing 112, and the two housing sections threaded onto one another as shown in FIG. 2.

The right-most guide structure 148 as shown in FIG. 2 is of a somewhat different configuration than the corresponding guide structure in FIG. 1. Thus, guide structure 148 comprises an inner annular wall portion 149 and three outwardly radiating spokes 151 having the axially turned end portions 153, the arrangement being such that end portions 153 engage against the annular wall surface 155 to mount the guide structure in the outlet chamber 157 of the vacuum breaker device. If desired, any or all of the guide structures may be constructed as shown at 148 in FIG. 2.

The structure shown partially in FIG. 5 may be formed identical with that shown in FIG. 1, except for the construction of the annular valve seat, conical valve element, and the cooperating compressible sealing element. In the FIG. 5 construction piston 122 is formed with an annular outwardly facing groove 124 which receives a neoprene sealing element 126 for cooperation with the annular valve seat 121. In order to seal the joint between piston 122 and head 50 there is provided an annular sealing element 128 carried in an annular groove on the head. The arrangement of parts is such that on the initial occurrence of a high pressure condition upstream of the breaker, the assembly of members 122 and 50 is moved as a unit to the right until sealing element 126 seals against valve seat 121; thereafter the fluid pressure is effective to move head 50 to the right away from member 122 so as to open the breaker to fluid flow. During a vacuum condition or low pressure condition upstream of the vacuum breaker, the spring and fluid pressures are effective to move the assembly of members 122 and 50 to initially unseat element 126 from valve seat 121 without allowing member 122 to move away from member 50. In this manner the relatively high pressure condition downstream from member 50 is vented through the opening 30 without any fluctuation or back flow of liquid into the supply.

It will be seen that various novel features are employed in the illustrated construction, particularly the

arrangement of the sequentially closing valve elements, the improved guiding of the valve elements, the improved low resistance mounting of the valve element piston, the improved anti-jamming mounting of the check valve, the low cost mounting and assembly of the valve body components, the compactness of arrangement, the economization of materials, and the rugged, longlife character of the components. It will be appreciated that various modifications of the illustrated arrangements may be resorted to without departing from the spirit of the invention set forth in the appended claims.

I claim:

1. In a fluid line vacuum breaker, a housing having an inlet chamber and an outlet chamber with a cylindrical control passage therebetween, a valve port between said cylindrical control passage and said outlet chamber, atmospheric vent openings formed in the wall of said cylindrical control passage adjacent said valve port, an annular piston positioned within said cylindrical control passage and axially movable therein, said piston defining a flow passage therethrough, fluid seal means between said piston and said cylinder, a seal on the outlet chamber side of said piston engageable with said valve port on movement of said piston in a direction toward said outlet chamber, axially spaced and aligned guide means carried within said piston and said outlet chamber, a valve having a stem axially movably carried by said spaced and aligned guide means and extending through said valve port, said valve having a surface positioned on the outlet chamber side of said piston and engageable with said seal carried on the outlet chamber side of said piston to stop flow through said piston, and means biasing said valve toward said piston, thereby biasing said piston toward said inlet chamber when said valve contacts said piston.

2. In a fluid line vacuum breaker, a housing having an inlet chamber and an outlet chamber with a cylindrical control passage therebetween, a valve port between said cylindrical control passage and said outlet chamber, said cylindrical control passage having a larger area than said outlet chamber, atmospheric vent openings formed in the wall of said cylindrical control passage adjacent said valve port, an annular piston positioned within said cylindrical control passage and axially movable therein, said piston defining a flow passage therethrough, seal means between said piston and said cylinder, a seal on the downstream side of said piston engageable with said valve port on movement of said piston in a direction toward said outlet chamber, axially spaced and aligned guide means carried within said piston and said outlet chamber, a valve having a stem axially movably carried by said spaced and aligned guide means and extending through said valve port, said valve having a surface positioned on the outlet chamber side of said piston and engageable with said seal carried on the outlet chamber side of said piston to stop flow through said piston, said surface having an

area less than the area of said piston and means biasing said valve toward said piston and thereby biasing said piston toward said inlet chamber when said valve contacts said piston.

3. In a fluid line vacuum breaker, a housing having an inlet chamber and an outlet chamber with a cylindrical control passage therebetween, a valve port between said cylindrical control passage and said outlet chamber, atmospheric vent openings formed in the wall of said cylindrical control passage adjacent said valve port, an annular piston positioned within said cylindrical control passage and axially movable therein, said piston defining a flow passage therethrough, said annular piston having an endless peripherally extending groove, an O-ring positioned in said groove, said O-ring having a diameter less than the width of said groove whereby said O-ring can roll between the bottom of said groove and the wall of said cylindrical control passage and provide free axial movement of said piston, a seal on the downstream side of said piston engageable with said valve port on movement of said piston in the direction toward said outlet chamber, axially spaced and aligned guide means carried within said piston and said outlet chamber, a valve having a stem axially movably carried by said spaced and aligned guide means, said valve having a surface positioned on the outlet chamber side of said piston and engageable with said piston flow passage to stop flow through said piston, a spring interposed between said valve surface and said guide means carried within said outlet chamber, effective to bias said valve surface into engagement with said piston and thereby move said piston away from sealing engagement with said valve port toward said inlet chamber.

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