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LIQUID FLOW CONTROL VALVE

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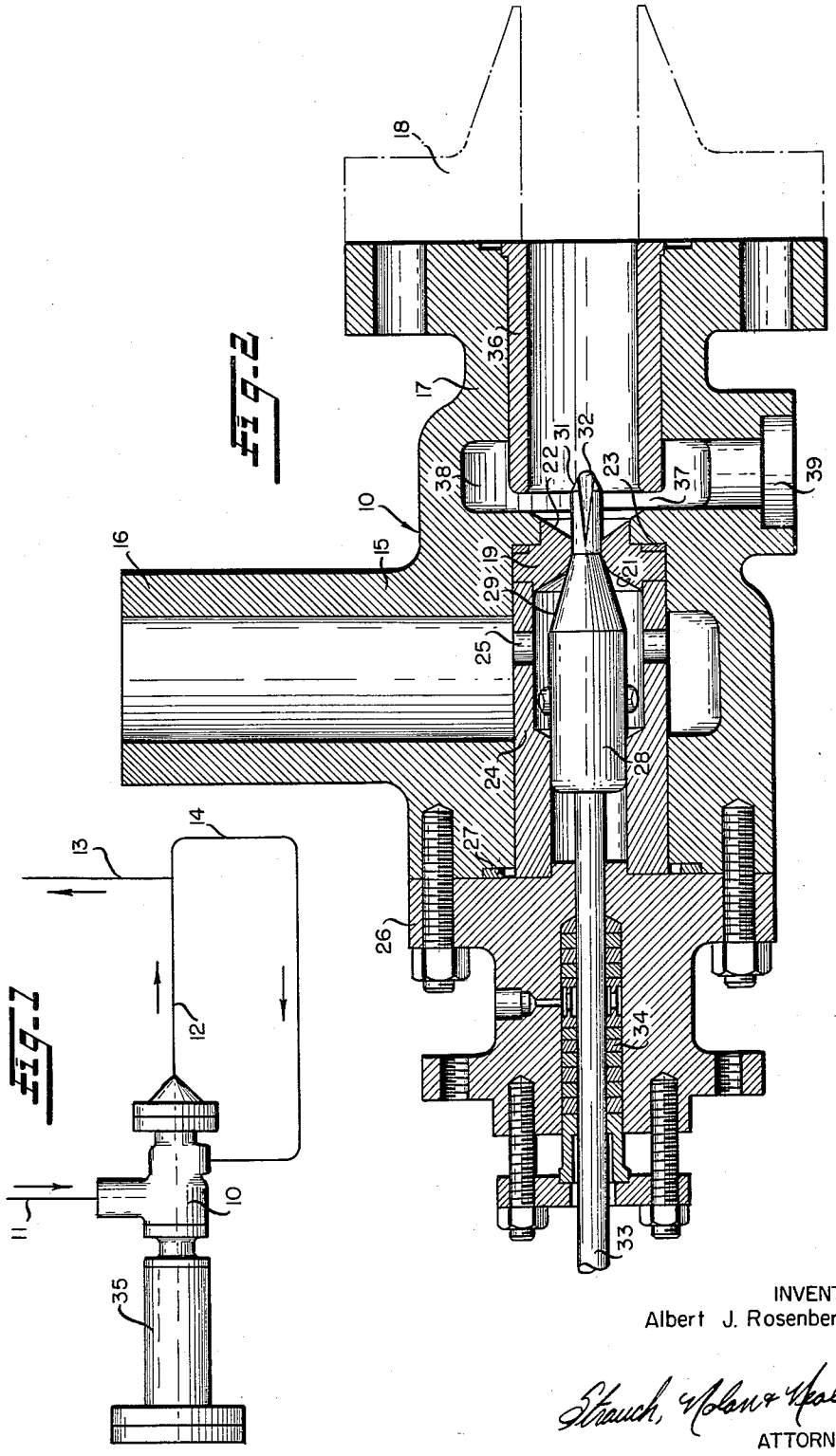


Fig. 2

Fig. 1

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LIQUID FLOW CONTROL VALVE

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This invention relates to a liquid flow control valve, and more particularly to a reducing valve construction for heated liquids, such as boiler feed water.

When water, and particularly heated water, is passed through a reducing valve to reduce the pressure thereon, it frequently occurs that some of the water will flash into steam after it passes through the valve seat. The high velocity of the issuing jet from the valve seat has serious deleterious effect on the adjacent and surrounding metal surfaces of the valve and due to cavitation and the erosive action of the fluid, in many cases, the metal beyond the valve seat will deteriorate seriously in a relatively short period of time. It has been the usual practice to employ an angle type construction so that the issuing jet discharges in the direction of the outlet connection of the valve without direct impingement upon the valve body. While this reduces the erosive action of the fluid jet, cavitation is not reduced thereby.

When liquid pressure is suddenly subjected to a decrease in pressure, as in the case of a liquid jet issuing from the orifice of a valve, it may develop pockets or bubbles of vapor in this low pressure region. This is particularly true in the case of heated liquids. When a region of higher pressure is reached, the bubbles suddenly collapse, producing a shock or impact on the surrounding metal parts. These repeated shocks or impacts dislodge particles of metal, the cumulative effect of which is to cause deterioration of the metal parts in the high pressure region. Thus, in prior art valves, it has been found that in the region immediately downstream of the valve orifice where the region of expansion takes place, there is no cavitation effect but that further downstream, at the point where the pressure is recovered, deterioration of the metal parts due to cavitation takes place.

In the present invention, the applicant injects a stream of liquid at the point where cavitation would normally take place. This injected liquid then forms an axially moving layer around the inside of the metal valve parts which serves as a buffer to absorb and dissipate the impact of the collapsing bubbles. Conveniently, the applicant provides this layer by recirculating a portion of the downstream liquid and returning it to a point where cavitation would normally take place.

It is one of the objects of the present invention to provide a liquid flow control valve in which cavitation and erosion of the valve passages downstream from the seat are eliminated or reduced under all operation conditions.

Another object is to provide a liquid flow control valve in which a portion of the liquid discharged from the valve is returned to the flow passage through the valve adjacent to the discharge end of the seat. In this way, a buffer layer of water is maintained between the cavities or bubbles and the metal surfaces of the flow passage downstream of the throttling zone to eliminate cavitation damage to the valve body.

According to a feature of the invention, the seat flares abruptly at its discharge end, and a discharge tube extends into the body and terminates in spaced relation to the seat to leave an annular opening through which return liquid may enter the discharge tube.

A further object is to provide a liquid flow control valve in which the return connection to the valve opens into the discharge conduit from the valve facing the flow therethrough so that the velocity of the liquid in the discharge conduit tends to force it through the return connection.

The above and other objects and features of the invention will be more readily apparent from the following description when read in connection with the accompanying drawings, in which:

FIGURE 1 is a flow diagram of a valve embodying the invention, and

FIGURE 2 is an enlarged sectional view of the valve itself.

The valve of the present invention is adapted to be employed in locations wherein the pressure on hot water or the like is to be reduced as, for example, in a feed water pump by-pass. As shown in FIGURE 1, heated water under high pressure enters the valve indicated generally at 10, through an inlet connection 11, and is discharged through a discharge condunit 12 to the point of use. Water at reduced pressure is drawn off from the discharge conduit 12 through a conduit 13 which, as shown, extends from the conduit 12 at a right angle and may be connected thereto through a convention T coupling. A return conduit 14 is connected to the discharge conduit 12, preferably forming a continuation of the conduit 12 and being looped back and connected to the valve to return liquid thereto.

The valve 10, as best seen in FIGURE 2, comprises a valve body 15, which is preferably made of steel, and is formed with a nipple 16, for connection to the inlet conduit 11. The water from the valve is discharged through the discharge nipple 17 at right angles to the nipple 16, and which is connected through a flanged connection, or any other suitable type of coupling 18, to the discharge conduit 12.

The valve body is bored to receive a valve seat 19 which is joined by a reduced passage to an abruptly flared outlet side 22. As shown, the seat fits into bored recesses in a web in the valve body and is sealed to the body by an annular seal 23. To hold the seat in place, a tube 24 is inserted through an opening in the body to engage at one end thereof the seat, the tube being provided with openings 25 through which liquid can flow from the inlet connection to the seat. The tube 24 is held in place by a flange 26 secured to the end of the body and engaging the other end of the tube with a seal 27 being provided between the flange and the end of the body.

The tube 24 may serve as a guide for a valve plug 28, having cylindrical portions fitting slidably into the tube 24, a tapered seating portion 29 which may seat against the valve seat 19 to close the passage therethrough, and generally cylindrical control portion 31, the end of which is tapered, extending through the valve seat. As shown, the control portion 31 is adapted to slide through and be guided by the seat, and is formed at one or more points in its circumference with fluted portions 32 lying in planes at an acute angle to the axis of the plug. With this construction, as the plug is moved further into or out of the seat, the effective flow passage through the seat will be varied to regulate the flow of liquid.

The plug is connected to an operating stem 33, which may extend through a packing 34 carried by the flange 26, and which may be connected to any suitable type of operator to move the plug. As indicated in FIGURE 1, the stem may extend directly into the valve actuator 35 powered by fluid under pressure to control the position of the valve.

Fluid leaving the valve seat enters a cylindrical discharge tube 36, which fits into the discharge nipple 17, and is held therein by the mating pipe flange 18. The

tube 36 terminates short of the valve seat as shown, to leave an annular passage 37 between the end of the tube and the valve seat, and closely adjacent to the downstream or discharge side of the seat. The valve body is formed with an annular recess 38 around the end of the tube 36, and which communicates with a lateral opening 39 to which the return conduit 14 is connected.

In use, when the valve is fully or partially open, heated water under high pressure entering through the inlet connection 11 will flow through the opening 25 and through the seat around the control portion 31 of the valve. As the fluid leaves the valve seat, the velocity is maximum and therefore the pressure is at a minimum, as in an aspirator. This will tend to draw water from the discharge conduit 12 through the return passage 14, and through the annular passage 37 into the discharge tube.

The return conduit 14 is connected to the discharge conduit 12 in the manner shown, so that it opens into the discharge conduit facing the flow therethrough. In this manner, the velocity head of the liquid flowing through the discharge conduit is converted to static head which will tend to force the liquid through the return connection, thereby assisting the reduced pressure created by the jet to recirculate liquid.

As the fluid jet issues from the valve orifice, a low pressure region is created immediately downstream from the orifice in the region of the annular recess 38 and passage 37. As explained above, this low pressure area has two effects. One is to form vapor bubbles. The other effect is to tend to draw in liquid from return passage 14 which, when combined with the effect of converting the velocity head of the return liquid into static head at the point where return line is connected to discharge conduit 12, causes the recirculated liquid to be injected into the valve downstream of the orifice. This recirculated liquid forms a layer around the inner surface of the tube 36 at the point where the pressure on the fluid stream is increased and where, therefore, the vapor bubbles would collapse and normally cause cavitation effects. However, the layer of recirculated water acts as a buffer to absorb and dissipate the impact or shock waves caused by the collapsing of the bubbles. Thus, not only is the effect of cavitation absorbed by this layer of recirculated water but because of the presence of the layer, the vapor bubbles are prevented from being in close physical proximity to the metal parts, whereby the cavitation effect of the jet stream is eliminated or reduced.

While one embodiment of the invention has been shown and described in detail, it will be understood that this is illustrative only and is not to be taken as a definition of the scope of the invention, reference being had for this purpose to the appended claims.

What is claimed is:

1. In combination, a supply source of liquid having sufficient internal heat that at least a portion thereof vaporizes upon a predetermined slight reduction in pressure, and a liquid flow control valve assembly connected to said supply source to receive said liquid in the form of a stream and comprising a valve body, an annular valve seat disposed in said body in fluid communication with said source of supply, a valve member having a portion of varying cross section extending into the opening of said seat and being axially movable relative to said seat to vary the effective flow area through said seat, outlet fluid flow passage means including a discharge passage formed in said valve body posterior to and coaxially aligned with said seat and a discharge conduit connected to said body to conduct liquid away from said discharge passage and said valve body, said seat being effective in cooperation with said valve member to increase the velocity of the liquid stream issuing from said seat whereby the pressure of said issuing stream is reduced to create pockets of vapor in said issuing stream from a first region immediately adjacent the downstream side of said seat to a second predetermined region further downstream thereof where the pressure of said issuing stream has recovered to a magnitude sufficiently great to maintain the fluid in said issuing stream in its liquid phase, the liquid pressure at said second region being of such magnitude to collapse said vapor pockets thereby producing shock waves capable of causing deterioration of the walls of said outlet fluid flow passage means at said second region, recirculating conduit means for returning to said outlet passage means at said first region a portion of liquid from a downstream location where the pressure of said issuing stream has recovered said magnitude of pressure, and means providing an uninterrupted annular fluid inlet opening radially into said outlet fluid flow passage means at said first region and being in fluid communication with said recirculating conduit means for introducing and establishing in said outlet fluid passage means a continuous annular axially moving boundary of liquid returned through said recirculating conduit means extending from said first region to said second region in surrounding relationship to the fluid stream issuing from said seat for absorbing and dissipating said shock waves resulting from collapse of said vapor pockets.

2. The combination defined in claim 1 wherein said means providing said uninterrupted annular inlet comprises a fluid discharge tube received in said body in said outlet fluid passage means and having an inner end axially spaced downstream from said seat and an annular inwardly opening recess in fluid communication with said recirculating conduit means, said recess being so disposed in surrounding relationship to the inner end of said discharge tube as to cooperate with said tube to form and locate said annular uninterrupted inlet axially between the inner end of said tube and said seat.

3. The combination defined in claim 1 in which the recirculating conduit means opens into the discharge conduit facing the direction of flow through the conduit whereby velocity of the liquid tends to force it through the recirculating conduit means.

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