

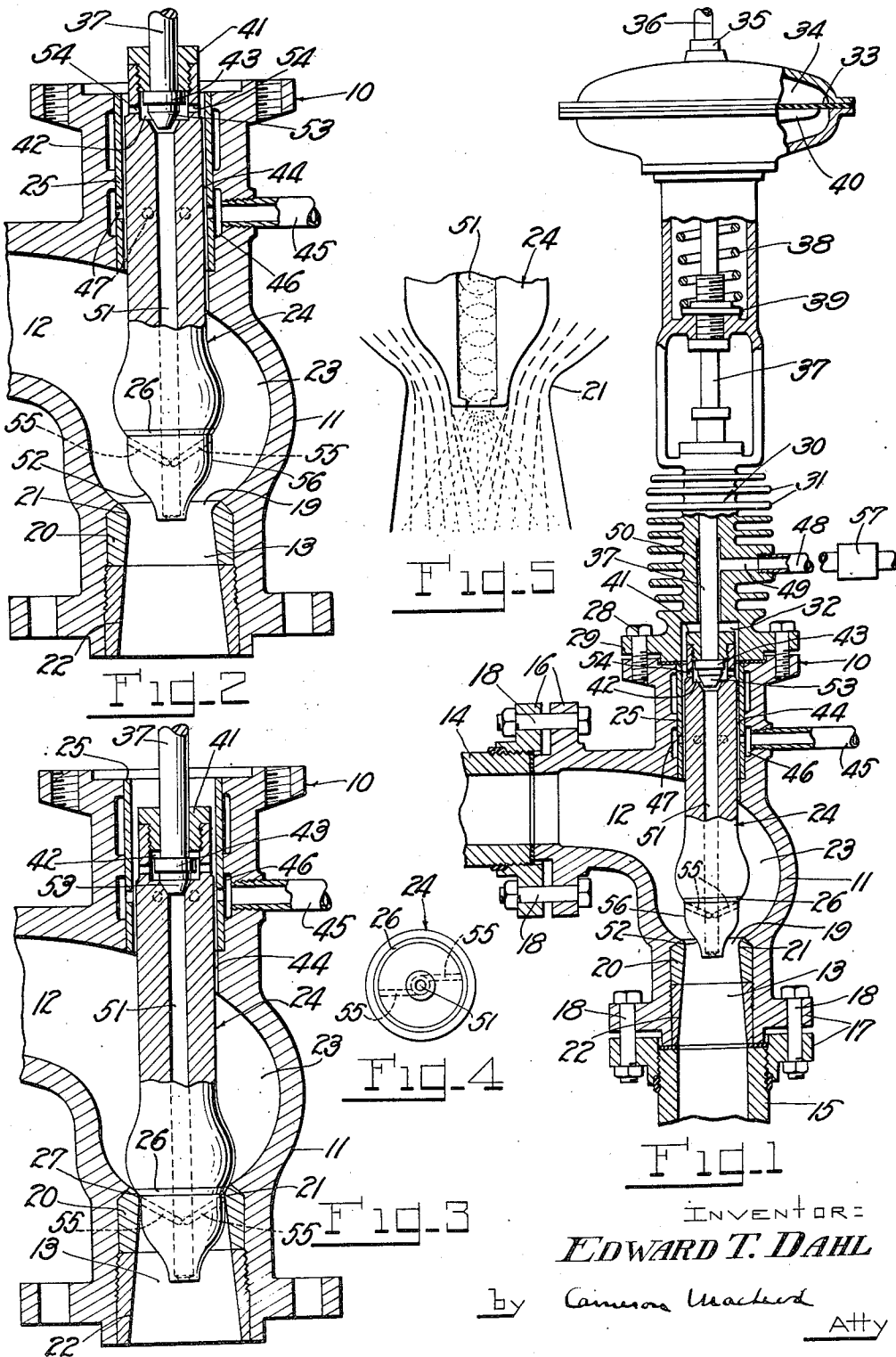
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COMBINATION CONTROL AND QUENCH VALVE

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COMBINATION CONTROL AND QUENCH VALVE

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This invention relates to fluid pressure reduction and has for an object an improved regulating valve having certain novel features including combined means, first, for providing a substantially balanced single seated valve plug, comparable in this respect to a double seated valve and, second, for introducing an independent fluid which may serve to cool the controlled medium, lubricate the valve parts, or prevent the formation of undesirable deposits.

It is a further object of this invention to provide means for assuring a more complete dispersion of quench liquid by introducing the quench liquid substantially at the center of the valve orifice, the orifice being preferably of the expanding type, and, as a further aid to atomization, to provide additional means for atomizing the quench liquid at the point of introduction.

In fluid control valves as heretofore constructed, so far as known to me, localized superheat occurs, and for that reason such valves are not adapted to control any type of fluid, such as hydrocarbons, or the like, in which the components tend to separate at temperatures in excess of the normal temperatures for the controlled pressure. In fluid having this characteristic a separation of some of the necessary components results both in an inferior product and in an accumulation of undesirable deposits.

It is accordingly an object of this invention to avoid localized superheat due to flow pockets created by excessive turbulence which are out of the direct path of flow and for that reason do not receive a sufficient quantity of quench liquid. This is accomplished by providing a valve orifice having a gradually contracting throat and an expanding outlet and combining this structure with a valve plug adapted to maintain the desired flow characteristics and having means for the introduction of quench liquid into the center of the controlled medium at a point of substantially maximum velocity and where the initial fluid expansion occurs.

It is a further object of this invention to effect a saving in quench liquid by so arranging and combining the valve orifice, control plug, and quench liquid discharging means, that a central core is formed in the controlled fluid and the quench liquid is discharged into the central core where it is enveloped in the controlled fluid and dispersed before coming in contact with the colder walls of the fluid conduit.

It is also an object of this invention to provide a non-chattering valve of the single seated balanced type and to so combine it with the quench liquid atomizing means that liquid atomization takes place only when the flow of controlled fluid occurs.

While I have referred to the use of the valve in connection with the control of fluids having

a tendency to break down into various components at excessive temperature for the pressure and also having a tendency to form deposits, it will be understood that the valve is applicable for the control of any type of fluid such as steam or the like.

Having reference to the drawing:

Fig. 1 is a vertical section of a fluid pressure reducing valve embodying my invention.

Fig. 2 is an enlarged vertical section of the lower portion of the valve shown in Fig. 1.

Fig. 3 is a similar view with the parts in a different position.

Fig. 4 is a bottom plan view of the valve plug.

Fig. 5 is a diagram illustrating the flow of controlled fluid and the dispersion of quench liquid therein.

Having reference to the drawing, a reducing valve 10 is shown which is preferably of the general type illustrated and described in my co-pending application, Serial No. 189,950 filed Feb. 11, 1938, comprising a body 11 having an angular inlet passage 12 and an expanding discharge passage 13, said passages being connected to inlet and discharge pipes 14 and 15 by means of suitable flanges 16 and 17, as by bolts 18. Communication from the inlet passage to the outlet passage is effected through an orifice 19 included in a nozzle member 20 having a restricted throat 21 and an expanded outlet 22, same being arranged to gradually increase the velocity of fluid flow to the orifice and thereafter to gradually diminish the velocity as the fluid discharges to the valve outlet.

The inlet passage 12 is preferably enlarged at 23 to accommodate for the displacement of a cylindrical valve plug 24 one end of which is guided in a liner 25 secured in the valve body 11 and the other end of which has a seating portion 26 adapted to cooperate with a corresponding seating portion 27 around the orifice in the nozzle member. Secured to the valve body 11 by bolts 28 is a recessed flange 29, herein shown as integral with an intermediate 30 having cooling fins 31. The liner 25, upper end of the plug 24, and the recessed flange 29 together form a chamber 32 which, as will be hereinafter described, may be conveniently termed a combined pressure balancing and quench liquid supply chamber.

Suitable means for operating the valve plug 24 may include a diaphragm 33 mounted in a diaphragm chamber 34 subjected to operating fluid pressure through a connection 35 and pipe 36 from a suitable source of supply and governed by a condition responsive device such as an air operated instrument or the like, not shown. The diaphragm 33 may be connected to the plug 24 by a stem 37 which extends through a guide opening in the intermediate 30 and is surrounded by a compression spring 38 mounted between

an adjustable member 30 on the intermediate and a suitable button 40 connected to one end of the stem and adapted to engage the diaphragm 33. The other end of the stem 37 extends through a guide bushing 41 threaded into a recess 42 formed in the upper end of the plug, and secured to the stem is a collar 43 adapted to engage the lower surface of the guide bushing and to lift the plug 24 off its seat when the stem is raised by the spring, as occurs on a decrease in fluid pressure in the diaphragm chamber. When the diaphragm fluid pressure increases and the main plug 24 comes to its seat the end of the stem 37 engages the plug and affords a positive means for closing the valve. While I have illustrated and described a diaphragm motor for operating the valve stem 37 it will be understood that any other suitable power device or hand operating means may be employed.

The combined pressure balancing and supply chamber 32 is in fluid communication with the inlet passage 12 by means of the restricted passage 44 between the valve plug 24 and the liner 25, and for this purpose I preferably allow a clearance of between .005 inch and .020 inch. The passage 44 also affords means for introducing liquid for lubricating the plug and liner when the valve is open, and for preventing the formation of deposits around the plug and seat and in the valve body when the valve is closed. Suitable liquid for this purpose may be supplied to the passage from a fluid flush line 45 which connects with an annular space 46 around the lower end of the liner, said space being in communication with the passage by a plurality of ports 47.

A combination cooling and quenching liquid may be supplied to the chamber by means of a pipe 48 connected to a lateral port 49 in the intermediate 30 through which it communicates with a passage 50 formed in the intermediate around the valve stem 37 which passage extends from the port 49 to the chamber 32. The supply passage 50 is designed to pass a sufficient quantity of liquid for cooling the stem 37 under conditions of high temperature, and also for desuperheating purposes, in a manner to be disclosed.

Means for introducing a controlled supply of quenching liquid from the chamber 32 to the outlet passage 13 and for providing controlled pressure communication between said outlet passage and chamber will now be described. The valve plug 24 is provided with a central longitudinal conduit 51 extending from the recess 42 below the guide bushing 41 to the lower end of the plug where it terminates substantially at the restricted portion of the orifice 19 and centrally thereof. As herein shown this passage is of larger capacity than the supply passage 50 referred to above. The lower end of the plug is preferably of parabolic shape, as indicated at 52, and is designed both to cooperate with the orifice 19 to effect the flow characteristics desired and also to form a central core in the controlled fluid by means of an abruptly terminating end portion 52 within which the quench liquid conduit 51 discharges. The arrangement of parts is such that the conduit is adapted to discharge into the central core of controlled fluid at a point of substantially maximum velocity and where the initial fluid expansion occurs.

The upper end of the central conduit 51 is controlled by a pilot valve member 53 formed on the end of the stem 37 and adapted to co-

operate with the conduit to control the flow of fluid between the chamber 32 and the valve outlet passage 13. The parts are so arranged that when the collar 43 engages the guide bushing 41 the pilot valve is open and permits fluid communication between the chamber 32 and the discharge passage 13 by means of ports 54 located in the upper end of the plug, and when the valve plug 24 is seated and the pilot valve member 53 engages the plug a positive closing pressure is exerted on the valve plug and the conduit 51 is closed. While the pilot valve is closed the upstream pressure is communicated to the chamber 32 by means of the restricted passage 44 and provides pressure off balance further tending to seat the plug 24. When the pilot is open the off balance is substantially eliminated, as the capacity of the conduit is greater than that of the supply passage 50, and at the same time quench liquid is introduced for desuperheating the controlled fluid. Thus the chamber 32 functions as a means for determining the condition of balance or off balance of the plug and as a means for supplying quench liquid to the controlled fluid, both functions being governed by the pilot valve.

As a further aid to atomization of the quench liquid I provide lateral ports 55 in the lower end of the valve plug 24 beneath its seat 26 which preferably incline downwardly toward the central passage 51 and terminate at the periphery thereof. The ports 55 are located adjacent to the seat 26 in a comparatively straight section 56 having cylindrical walls substantially parallel with the axis of the orifice and making a reasonably close fit with said orifice. The parts are so arranged that the cross-sectional area of the straight section 56 is preferably not less than 6 to 8 per cent in excess of the area of that portion of the valve plug 24 extending into the liner 25. This affords a slight off balance tending to urge the plug towards its seat and eliminates chattering due to the high velocity of fluid flow which would otherwise occur because of the provision for relative movement of the pilot valve 53 and plug 24. While a spring may be used for urging the pilot valve towards open position to prevent chattering I prefer the construction just described. I have found that it is usually necessary to provide a seating area 26 substantially 10 per cent greater than the area 24 and therefore when the valve is closed the area having a tendency to urge the valve towards its seat is substantially 10 per cent greater than when the valve is open. For this reason the valve tends to jump slightly when first lifted off its seat and the straight section 56 is extended below the ports 55 to prevent any substantial controlled fluid flow around the valve plug caused by this action.

In operation, when the main valve plug 24 and pilot valve member 53 are seated the flow of quench liquid from the supply chamber 32 to the conduit 51 is shut off and the upstream pressure builds up in the chamber 32 through the passage 44 affording additional pressure for closing the main valve. When the stem is raised the pilot member 53 opens, substantially equalizing the pressure in the chamber 32 with that on the downstream side of the valve, and at the same time admitting the quench liquid into the central conduit. The main valve plug is then raised from its seat by the stem due to the engagement of the collar 43 with the guide bushing 41, and the atomizing ports 55 conduct a

portion of the controlled fluid into the central conduit 51 imparting a spinning motion to the quench liquid as shown diagrammatically in Fig. 5, and the main flow of control fluid passes around the end of the plug forming a core which envelops the atomized liquid and causes it to be completely dispersed.

Under some conditions it may be beneficial to introduce the quench liquid at a pressure which is about two pounds less than the pressure in the discharge passage 13 for I find that an aspirating effect is produced which will overcome the two-pound differential and will cause the quench liquid to flow to the discharge passage. Under these conditions a check valve 57 should be used in the supply line 48 to prevent a return of quench liquid through the supply line when the control valve is closed. It may also be desirable under certain conditions to introduce liquid through the connection 45 in order to prevent the formation of deposits in the inlet passage 12 when the valve is closed and to lubricate the valve plug when the valve is open. Under these conditions the liquid may be supplied at a pressure somewhat higher than the valve inlet pressure without interfering with the introduction of quench liquid through the flush connection 49 at a considerably lower pressure because of the relatively lower flow permitted by the restricted passage 44 between the plug and the liner.

While the structure illustrated in the accompanying drawing embodies a practical adaptation of the invention, it will be understood that modifications may be made without departing from the spirit of the invention as defined in the appended claims.

Having thus described my invention, I claim:

1. In a pressure fluid control valve having inlet and outlet passages with a control orifice therebetween, the combination with a valve plug movable relatively to said orifice for governing the flow of fluid through said valve and means for operating said plug, of a conduit for directing a stream of quench liquid into said orifice, at a point apart from its walls, in the direction of controlled fluid flow and substantially parallel to the orifice axis, and means for supplying quench liquid to said conduit.

2. In a fluid pressure control valve having inlet and outlet passages with a control orifice therebetween the combination with a valve plug movable relatively to said orifice for governing the flow of fluid through said valve and means for operating said plug, of a conduit for directing a stream of quench liquid into said orifice substantially at the axis thereof and in a direction substantially parallel to said axis, and means for supplying quench liquid through said conduit.

3. In a fluid pressure control valve having inlet and outlet passages with a control orifice therebetween the combination with a valve plug movable relatively to said orifice for governing the flow of fluid through said valve and means for operating said plug, of a conduit in said valve plug for directing a flow of quench liquid into said orifice in the direction of controlled fluid flow and substantially parallel with the orifice axis, and means for supplying quench liquid to said conduit.

4. In a fluid pressure control valve having inlet and outlet passages with a control orifice therebetween, the combination with a valve plug movable axially to said orifice for governing the

flow of fluid through said valve and means for operating said plug, of a conduit in said valve plug for directing a stream of quench liquid into said orifice in the direction of controlled fluid flow and substantially parallel with the orifice axis, and means for supplying quench liquid to said conduit.

5. In a fluid pressure control valve having inlet and outlet passages with a control orifice therebetween the combination with a cylindrical valve plug having an axis coincident with the axis of said orifice for governing the flow of fluid through said valve and means for operating said plug, of a conduit in said valve plug substantially coincident with the axis of said plug, said conduit terminating substantially at the restricted portion of said orifice, and means for supplying quench liquid to said conduit.

6. In a fluid pressure control valve having an inlet passage and an outlet, the combination with a nozzle including an orifice having an expanding discharge passage communicating from said inlet passage to said outlet, of a valve plug movable relatively to said orifice for governing the flow of fluid through said valve and means for operating said plug, a conduit for directing a stream of quench liquid into said orifice, at a point apart from its walls, in the direction of controlled fluid flow and substantially parallel to the orifice axis, and means for supplying quench liquid to said conduit.

7. In a fluid pressure control valve having an inlet passage and an outlet, the combination with a nozzle including an orifice having a gradually converging throat communicating with said inlet passage and a gradually diverging discharge, of a valve plug movable relatively to said orifice for governing the flow of fluid through said valve, means for operating said plug, a conduit for directing quench liquid into said orifice, at a point apart from its walls, in the direction of controlled fluid flow and substantially parallel to the orifice axis, and means for supplying quench liquid to said conduit.

8. In a fluid pressure control valve having an inlet and an outlet the combination with a nozzle including an orifice and an expanded discharge passage communicating between said inlet and said outlet, of a valve plug movable axially toward and away from said orifice for governing the flow of fluid through said valve, means for operating said plug, a conduit in said valve plug communicating with said orifice substantially at the axis thereof, and means for supplying quench liquid to said conduit.

9. In a fluid pressure control valve having inlet and outlet passages and a control orifice therebetween, the combination with a single seated valve plug cooperating with said orifice and movable relatively thereto for governing the flow of fluid through said valve, of means for operating said plug, a combined liquid supply and fluid pressure chamber in said control valve having a restricted communication with said inlet passage, means for supplying quench liquid to said chamber, a pressure responsive member in said chamber connected with said valve plug, a fluid conduit from said supply chamber to the downstream side of said control valve, a pilot valve controlling said conduit, and means for operating said pilot valve to close same when said main plug is seated and to open same when said main plug is opened.

10. In a pressure control valve in combination with a single seated valve plug for controlling

the flow of fluid through said valve of a combined pressure balancing and liquid supply chamber having a restricted communication with the inlet side of said valve and a free communication with the discharge side of said valve, means for supplying quench liquid to said chamber, a pilot valve for controlling the flow of fluid between said supply chamber and said valve discharge, and means for operating said valve plug and said pilot to open said pilot when said plug is moved toward open position and to close said pilot when said plug is closed.

11. In a control valve the combination with a valve plug for controlling the flow of fluid through said valve, of a conduit for introducing quench liquid directly to the discharge side of said valve, and means associated with said conduit for atomizing quench liquid therein before it discharges from said conduit.

12. In a valve for controlling fluid flow the combination with an orifice of a valve plug having a seating portion cooperating with said orifice to control the flow of fluid therethrough, a quench liquid conduit in said valve plug having an opening at the end thereof and communicating with a source of quench liquid supply, a lateral port for communicating fluid pressure externally of said plug to said conduit, said port being located on the discharge side of the seating portion of said plug, and means for moving said plug relatively to the valve orifice to control the flow of fluid through said valve.

13. In a fluid pressure control valve the combination with a control orifice and a valve plug adapted to be reciprocated relatively thereto, of a pressure chamber into which said valve plug extends, a restricted passage from said chamber to the control valve inlet side of said orifice, a fluid conduit from said chamber to the discharge side of said orifice, a pilot valve plug movable relatively to said main valve plug for controlling said conduit and actuating said main valve plug, means for supplying quench liquid to said chamber, and means for operating said pilot valve.

14. In a valve for controlling fluid flow, the combination with an orifice, of a valve plug, a flow controlling portion at an end of said plug for cooperating with said orifice to regulate the flow of fluid therethrough, a cylindrical portion adjacent said flow controlling portion adapted to have a relatively close fit with said orifice to materially reduce the flow of fluid therethrough, a quench liquid conduit in said plug communicating with a source of quench liquid supply and having an opening at the said end of said plug, an atomizing port in said cylindrical portion having an outer opening at the exterior wall of said portion and an inner opening at said conduit whereby the outer opening of said port may be at the inlet side of said orifice when said controlling portion is cooperating therewith and may be at the discharge side of said orifice when said cylindrical portion is cooperating therewith, and means for operating said valve plug.

15. In a valve for controlling fluid flow, the combination with an orifice having a seat, of a valve plug, a flow controlling portion at an end of said plug for cooperating with said orifice and regulating fluid flow therethrough, a cylindrical portion adjacent said flow controlling portion and adapted to cooperate with said orifice to materially reduce the flow of fluid therethrough, a seat on said plug adjacent said cylindrical portion adapted to cooperate with said orifice seat,

a quench liquid conduit in said plug communicating with a source of quench liquid supply and having an opening at the said end of said plug, an atomizing port in said cylindrical portion having an outer opening at the exterior wall thereof and an inner opening at said conduit whereby said conduit is in free communication with fluid pressure at the inlet side of said orifice when said flow controlling portion is cooperating with said orifice and is cut off from said pressure when said valve is seated, and means for operating said valve plug.

16. In a valve for controlling fluid flow having a control orifice and a plug cooperating therewith, the combination of a quench fluid conduit in said valve plug having an opening at the end thereof for introducing quench liquid directly to the discharge side of said valve, an atomizing port in said plug connecting said conduit with the inlet side of said valve during at least a portion of the travel of said plug for conducting controlled fluid from the inlet side of said valve to said conduit, and means for operating said valve plug.

17. In a fluid pressure control valve having inlet and outlet passages and a control orifice therebetween, the combination with a main valve plug cooperating with said orifice and movable relatively thereto for governing the flow of fluid through said valve, of a fluid pressure chamber in said control valve having a comparatively restricted fluid connection with said inlet passage and a comparatively unrestricted fluid connection with said outlet passage, said main valve having a part subjected to pressure in said fluid pressure chamber, a pilot valve having a plug for actuating said main valve plug and for governing the passage of fluid through said unrestricted fluid connection, a stem for operating said pilot plug, means for actuating said stem whereby said unrestricted fluid connection is open when said main valve is open, and means effective when said pilot valve is opened to maintain said pilot valve in open position under varying conditions of fluid flow through the main valve orifice.

18. In a fluid pressure control valve having inlet and outlet passages and a control orifice therebetween, the combination with a main valve plug having a closure portion cooperating with said orifice and movable relatively thereto for governing the flow of fluid through said valve, of a fluid pressure chamber in said control valve having a comparatively restricted fluid connection with said inlet passage and a comparatively unrestricted fluid connection with said outlet passage, said main valve plug having a portion subjected to pressure in said pressure chamber, a pilot valve having a stem and plug for actuating said main valve plug and for controlling fluid flow through said unrestricted fluid connection, and means for actuating said stem whereby said unrestricted fluid connection is open when said main valve is open, the cross-sectional area of the closure portion of said main valve being greater than the cross-sectional area of the portion subjected to pressure in said chamber to provide a condition of off balance in a closing direction whereby when said pilot valve is opened said pilot valve is maintained in open position under varying conditions of fluid flow through the main valve orifice.

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