

Description

This invention relates to fluid control valves for very high temperature service, and more particularly to gate valves that will contain the operating pressure satisfactorily during and after exposure to a fire.

As reflected in the patent and other literature, much effort has been expended in recent years to provide industry, and especially that involved in oil and gas production, with stem operated valves that will withstand the destructive effects of fire or other high temperatures without losing their function of safe, fluid-tight control of high pressure systems. This effort has resulted in a variety of designs for valves with metal-to-metal seals, stem backseating, and fusible elements to prevent backseating during normal operating temperatures yet facilitate it when such temperatures are exceeded. However meritorious these designs might be, each has one or more disadvantages that prevents total satisfaction of the user.

US-A-3 842 854 discloses a valve according to the generic part of claim 1.

FR-A-2 511 470 discloses a gate valve having gate plates to open or close a through bore in a valve body. The gate plates have blank regions which in closed condition are pressed against respective valve seals in the valve body.

The present invention, considered as directed toward overcoming the disadvantages of the known fire-resistant stem operated valves, provides an improved metal-to-metal sealing system between the valve closure element and valve body according to claim 1.

As incorporated in a non-rising stem gate valve, the present invention comprises a seat element with an annular sealing surface of round cross-sectional configuration that establishes a fluid-tight metal-to-metal seal with the valve body.

Figure 1 is a view in central vertical section, with some parts in full, of a fire-resistant gate valve embodying features of the present invention.

Figure 2 is an enlargement of the stem bearing area in the upper portion of Figure 1.

Figure 3 is an enlargement of the stem backseat area in the central portion of Figure 1.

Figure 4 is an enlargement of the gate seat area in the lower portion of Figure 1.

Figure 5 is a view along the line 5—5 of Figure 1.

Figure 6 is a view along the line 6—6 of Figure 1.

Figure 7 is a view like Figure 4, but on a reduced scale, showing another form of gate seat with an annular metal sealing surface of round cross-sectional configuration.

Figure 8 is a view like Figure 3, showing another configuration of backseat for the valve stem.

Figure 9 is a view like Figure 2, but on a reduced scale, illustrating another embodiment of a fusible ring assembly according to the present invention.

Figure 10 is a view like Figure 2, showing yet another embodiment of a fusible ring assembly in accordance with the present invention.

As illustrated in Figure 1, the preferred embodiment of an improved fire-resistant gate valve 10 having features of the present invention comprises a body 12 with a flow passage 14, a valve chamber 16 intersected by the flow passage 14, a valve bonnet 18 releasably secured to the body 12 as by a plurality of circumferentially spaced studs 20 and nuts 22, a bonnet cap 24 secured to the bonnet 18 by threads 26, a valve gate 28 disposed in the chamber 16 to control flow through the passage 14, a valve stem 30 extending from the gate 28 through the bonnet 18 and the cap 24, and a handwheel 32 or other suitable means for rotating the stem 30. The stem 30 is threaded into a lift pin 34 (Figs. 1, 5 and 6) that resides in a transverse bore 36 through the gate 28, so that as the stem is rotated, the gate is translated between its closed position (illustrated) and its open position in the valve chamber 16 of the body 12. The valve chamber 16 is shown in its preferred embodiment, as a circular cavity but the cavity could be rectangular, square, etc., in cross section. The valve chamber 16 is used to align the valve gate 28 properly. The valve gate 28 would be shaped to conform with the valve chamber 16, circular, rectangular, square, etc.

Near the upper end of the bonnet 18 is an annular packing 38 that provides a fluid seal between the bonnet and the stem 30, and a gland-type packing nut 40, threaded into the bonnet, serves as a retainer for the packing. Above the packing nut 40 the stem 30 is surrounded by a pair of thrust bearing assemblies 42, 44 that facilitate easy rotation of the stem to open and/or close the valve.

Between the bearing assemblies 42, 44 is a fusible ring assembly 46 (Figures 1 and 2) that axially supports the stem 30 in its illustrated position during normal operating temperatures. The assembly 46 comprises an axially-split sleeve 48 with an annular radial flange 48a extending outwardly from its lower end, a retaining ring 50 with an annular radial flange 50a extending inwardly from its upper end, and a fusible ring 52 sandwiched between the flanges 48a, 50a. The sleeve 48 is formed by two equal half-round segments (only one shown) that fit around a reduced diameter stem portion 30b (seen best in Figure 2) and between opposed annular shoulders 30c, 30d. The retaining ring 50 freely surrounds the sleeve 48 and the fusible ring 52, and has one or more lateral ports 54 through which material of the ring 52 can exit after being melted by a fire or other sufficiently elevated temperature.

As seen best in Figure 3, extending radially outwardly from the stem 30 below the bonnet 18 and above the stem's threaded portion 30a is an annular backseat flange 56 with an upwardly facing annular metallic sealing surface 56a of round cross-sectional configuration. The lower portion of the bonnet bore 58 is counterbored at 60 to provide an annular radial surface 62 that functions as a seat for the sealing surface 56a. The backseat flange 56 also can be provided with O-

rings 64, 66 to function as sealing elements between the flange and the bonnet 18 at normal temperatures.

When the fusible ring 52 melts, as in response to exposure of the valve 10 to a fire or other sufficiently high temperature, the fluid pressure in the valve body forces the stem 30 upwardly until the sealing surface 56a of the stem flange 56 comes to rest against the bonnet seat surface 62, thereby effecting a metal-to-metal backseat of the stem on the bonnet and preventing escape of fluid through the bonnet bore 58. As the foregoing occurs, the split sleeve 48 is carried upwardly with the stem 30.

In order that positive stem backseating can be achieved, even at relatively low valve pressures, a helical spring 68 (seen best in Figure 2), residing in a counterbore 40a in the upper portion of the packing nut 40 and compressed between the nut and the bearing assembly 42, is included to move that bearing assembly, and thus also the split sleeve 48 and the stem 30, upwardly when the fusible ring 52 melts.

As illustrated in Figure 1 and 4, the downstream side 28a of the valve gate 28 is sealed in fluid-tight manner to the valve body 12 by a seat comprising a uniquely-shaped sleeve-like metal seat element 70 residing in a counterbore 72 in the body flow passage 14. The seat element 70 includes an annular sealing lip 74 with a sealing surface 74a of round cross-sectional configuration. Before installation, the outside diameter of the sealing surface 74a is slightly greater than the diameter of the counterbore 72 so that when the element 70 is installed in functional position the sealing surface presses against the counterbore to provide a metal-to-metal seal between the element 70 and the valve body 12. An O-ring 76, carried in an external groove 78 in the element 70, can be included to prevent pressure at normal operating temperatures from migrating from the flow passage 14 and between the element 70 and the counterbore 72 to the lip 74.

On the upstream side 28b of the gate 28 another sleeve-like seat element 80 (Figure 1), residing in a counterbore 82 in the flow passage 14, is biased against the gate by one or more Belleville springs (two shown), and this axial load also produces an initial seal between the downstream side 28a of the gate 28 and the upstream end 70a of the element 70.

Another version of the downstream seat element is shown as 90 in Figure 7. The sleeve-like element 90 has an annular sealing surface 92 of round cross-sectional configuration on its downstream radial end surface 94, and this sealing surface bears against and cooperates with an opposed radial surface 96 in the valve body counterbore 72 to provide a fluid-tight metal-to-metal seal between the valve body 12 and the element 90. Additional sealing capability at normal temperatures and low pressures can be obtained by including an O-ring 98 in a circumferential groove 100 on the outer surface of the element 90.

An alternate backseat design for the valve stem 30 is illustrated in Figure 8, this design comprising a frusto-conical enlarged portion 110 of the stem above its threaded portion 30a, and a complementary beveled inlet 112 to the bonnet bore 58. The beveled inlet 112 functions as a seat for the frusto-conical stem portion 110, so that when the fusible ring 52 melts the stem 30 will rise until the stem portion 110 comes to rest against the beveled inlet, thereby providing a fluid-tight metal-to-metal seal between the stem and the bonnet.

Figure 9 illustrates a modified embodiment of the fusible ring assembly 46. In this embodiment there is no retainer ring, such as that at 50 in Figures 1 and 2, and the fusible ring 52 is in direct contact with the upper bearing assembly 44.

Another modified embodiment of fusible ring assembly is illustrated in Figure 10. In this embodiment, the lower bearing assembly 142 has a significantly larger outside diameter than its counterpart 42 (Figures 1 and 2) and underlies the lower end of the retainer ring 50. Accordingly, in the Figure 10 embodiment the fusible ring 52 provides no support function to either of the bearing assemblies 142, 44, and when this fusible ring melts the stem 30 and the split sleeve 48 rise until the stem backseats on the bonnet, but the lower bearing assembly 142 remains in its illustrated position.

Claims

1. A valve (10) comprising a body (12) with a metallic surface flow passage (14) extending therethrough and a chamber (16) intersected by said flow passage (14);

a valve closure element (28) positioned in said chamber (16) to control flow through said flow passage (14);

a bonnet (18) secured to said body (12) and having a bore (58) communicating with said chamber (16);

a valve stem (30) extending through said bore (58) and connected to said closure member (28); and

seal means (70, 90) for providing a fluid-tight seal between said body (12) and said valve closure element (28), said seal means (70, 90) comprising a one-piece, sleeve-like seat (70, 90) having a central longitudinal axis, said seat (70, 90) positioned in said flow passage (14) and extending into contact (28a) with said valve closure element (28), characterized in that said seat (70, 90) having as a portion thereof an annular metallic ridgelike sealing surface (74a, 92) of round cross-sectional configuration, said cross section taken with respect to said central longitudinal axis, said metallic sealing surface (74a, 92) pressing against the surface (72, 96) of said flow passage (14) to form a fluid-tight metal-to-metal seal therewith.

2. A valve according to claim 1, characterized in that said sealing surface (74a) forming a seal with an annular surface (72) of said flow passage (14).

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When the fusible ring 52 melts, as in response to exposure of the valve 10 to a fire or other sufficiently high temperature, the fluid pressure in the valve body forces the stem 30 upwardly until the sealing surface 56a of the stem flange 56 comes to rest against the bonnet seat surface 62, thereby effecting a metal-to-metal backseat of the stem on the bonnet and preventing escape of fluid through the bonnet bore 58. As the foregoing occurs, the split sleeve 48 is carried upwardly with the stem 30.

In order that positive stem backseating can be achieved, even at relatively low valve pressures, a helical spring 68 (seen best in Figure 2), residing in a counterbore 40a in the upper portion of the packing nut 40 and compressed between the nut and the bearing assembly 42, is included to move that bearing assembly, and thus also the split sleeve 48 and the stem 30, upwardly when the fusible ring 52 melts.

As illustrated in Figure 1 and 4, the downstream side 28a of the valve gate 28 is sealed in fluid-tight manner to the valve body 12 by a seat comprising a uniquely-shaped sleeve-like metal seat element 70 residing in a counterbore 72 in the body flow passage 14. The seat element 70 includes an annular sealing lip 74 with a sealing surface 74a of round cross-sectional configuration. Before installation, the outside diameter of the sealing surface 74a is slightly greater than the diameter of the counterbore 72 so that when the element 70 is installed in functional position the sealing surface presses against the counterbore to provide a metal-to-metal seal between the element 70 and the valve body 12. An O-ring 76, carried in an external groove 78 in the element 70, can be included to prevent pressure at normal operating temperatures from migrating from the flow passage 14 and between the element 70 and the counterbore 72 to the lip 74.

On the upstream side 28b of the gate 28 another sleeve-like seat element 80 (Figure 1), residing in a counterbore 82 in the flow passage 14, is biased against the gate by one or more Belleville springs (two shown), and this axial load also produces an initial seal between the downstream side 28a of the gate 28 and the upstream end 70a of the element 70.

Another version of the downstream seat element is shown as 90 in Figure 7. The sleeve-like element 90 has an annular sealing surface 92 of round cross-sectional configuration on its downstream radial end surface 94, and this sealing surface bears against and cooperates with an opposed radial surface 96 in the valve body counterbore 72 to provide a fluid-tight metal-to-metal seal between the valve body 12 and the element 90. Additional sealing capability at normal temperatures and low pressures can be obtained by including an O-ring 98 in a circumferential groove 100 on the outer surface of the element 90.

An alternate backseat design for the valve stem 30 is illustrated in Figure 8, this design comprising a frusto-conical enlarged portion 110 of the stem above its threaded portion 30a, and a complementary beveled inlet 112 to the bonnet bore 58. The beveled inlet 112 functions as a seat for the frusto-conical stem portion 110, so that when the fusible ring 52 melts the stem 30 will rise until the stem portion 110 comes to rest against the beveled inlet, thereby providing a fluid-tight metal-to-metal seal between the stem and the bonnet.

Figure 9 illustrates a modified embodiment of the fusible ring assembly 46. In this embodiment there is no retainer ring, such as that at 50 in Figures 1 and 2, and the fusible ring 52 is in direct contact with the upper bearing assembly 44.

Another modified embodiment of fusible ring assembly is illustrated in Figure 10. In this embodiment, the lower bearing assembly 142 has a significantly larger outside diameter than its counterpart 42 (Figures 1 and 2) and underlies the lower end of the retainer ring 50. Accordingly, in the Figure 10 embodiment the fusible ring 52 provides no support function to either of the bearing assemblies 142, 44, and when this fusible ring melts the stem 30 and the split sleeve 48 rise until the stem backseats on the bonnet, but the lower bearing assembly 142 remains in its illustrated position.

Claims

1. A valve (10) comprising a body (12) with a metallic surface flow passage (14) extending therethrough and a chamber (16) intersected by said flow passage (14);

a valve closure element (28) positioned in said chamber (16) to control flow through said flow passage (14);

a bonnet (18) secured to said body (12) and having a bore (58) communicating with said chamber (16);

a valve stem (30) extending through said bore (58) and connected to said closure member (28); and

seal means (70, 90) for providing a fluid-tight seal between said body (12) and said valve closure element (28), said seal means (70, 90) comprising a one-piece, sleeve-like seat (70, 90) having a central longitudinal axis, said seat (70, 90) positioned in said flow passage (14) and extending into contact (28a) with said valve closure element (28), characterized in that said seat (70, 90) having as a portion thereof an annular metallic ridgelike sealing surface (74a, 92) of round cross-sectional configuration, said cross section taken with respect to said central longitudinal axis, said metallic sealing surface (74a, 92) pressing against the surface (72, 96) of said flow passage (14) to form a fluid-tight metal-to-metal seal therewith.

2. A valve according to claim 1, characterized in that said sealing surface (74a) forming a seal with an annular surface (72) of said flow passage (14).



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3. A valve according to claim 2, characterized in that said sealing surface (74a) residing on an annular liplike portion (74) of said seal (70), and wherein the diameter of said liplike portion (74) of said sealing surface (74a) is greater than the diameter (72) of said flow passage surface against which said seal (70) is formed.

4. A valve according to claim 1, characterized in that said sealing surface (92) forming a seal (90) with a radial surface (96) of said flow passage (14).

5. A valve according to claim 4, characterized by spring means (84) biasing said sealing surface (92) against said radial surface (96).

6. A valve according to claim 1, characterized by means (56, 110) for backseating said stem (30) on said bonnet (18) in response to axial movement of said stem (30) with respect to said bonnet (18).

7. A valve according to claim 6, characterized in that said backseating means (56, 62) comprises an annular radial flange (56) on said stem (30) with an axially facing annular ridgelike sealing surface (56a, 110) of rounded axial cross-sectional configuration, and an annular flat radial seat (62, 112) on said bonnet (18) that cooperates with said sealing surface (56a, 110) to establish a fluid-tight seal.

8. A valve according to claim 6, characterized by fusible means (46) for retaining said stem (30) in unbackseated condition.

9. A valve according to claim 8, characterized in that said fusible means (46) comprises a ring (52) of fusible material and a sleeve (48) with an outwardly extending radial flange (48a), said sleeve (48) surrounding and secured (30c, d) to said stem (30) for unitary axial movement therewith, said ring (52) surrounding said sleeve (48) adjacent said flange (48a), and a retaining ring (50) surrounding said stem (30) and cooperating with said sleeve (48) to sandwich said fusible ring (52) therebetween.

Patentansprüche

1. Ventil (10) mit einem Körper (12) mit einem sich dadurch erstreckenden Strömungsdurchgang (14) mit einer metallischen Oberfläche und einer von dem Strömungsdurchgang (14) gekreuzten Kammer (16), mit einem Ventilschließelement (28) in der Kammer zum Steuern der Strömung durch den Strömungsdurchgang (14), mit einer Kappe (18), die an dem Körper (12) befestigt ist und eine Bohrung (58) aufweist, die mit der Kammer (16) in Verbindung steht, mit einer Ventilspindel (30), welche sich durch die Bohrung (58) erstreckt und mit dem Ventilschließglied (28) verbunden ist, und mit einer Dichteinrichtung (70, 90), welche eine fluiddichte Abdichtung zwischen dem Körper (12) und dem Ventilschließglied (28) schafft, wobei die Dichteinrichtung (70, 90) einen einstückigen, hülsenförmigen Sitz (70, 90) mit einer Mittellängsachse umfaßt, wobei der Sitz (70, 90) in dem Strömungsdurchgang (14) angeordnet ist und sich in Kontakt (28a) mit dem Ventilschließglied

(28) erstreckt, dadurch gekennzeichnet, daß der Sitz (70, 90) als ein Abschnitt eine ringförmige, metallische, rückenartige Dichtfläche (74a, 92) mit einer bezüglich der Mittellängsachse runden Querschnittsausbildung aufweist, und daß die metallische Dichtfläche (74a, 92) gegen die Oberfläche (72, 96) des Strömungsdurchganges (14) drückt, um damit eine fluiddichte Metall-auf-Metall-Abdichtung zu schaffen.

2. Ventil nach Anspruch 1, dadurch gekennzeichnet, daß die Dichtfläche (74a) mit einer ringförmigen Oberfläche (72) des Strömungsdurchganges (14) eine Dichtung bildet.

3. Ventil nach Anspruch 2, dadurch gekennzeichnet, daß die Dichtfläche (74a) an einem ringförmigen lippenartigen Abschnitt (74) der Dichtung (70) liegt, und daß der Durchmesser des lippenförmigen Abschnittes (74) der Dichtfläche (74a) größer als der Durchmesser (72) der Strömungskanalfläche ist, gegen welche die Dichtung (70) anliegt.

4. Ventil nach Anspruch 1, dadurch gekennzeichnet, daß die Dichtfläche (92) eine Dichtung (90) mit einer Radialfläche (96) des Strömungsdurchganges (14) bildet.

5. Ventil nach Anspruch 4, dadurch gekennzeichnet, daß eine Federeinrichtung (84) die Dichtfläche (92) gegen die Radialfläche (96) vorspannt.

6. Ventil nach Anspruch 1, dadurch gekennzeichnet, daß eine Einrichtung (56, 110) vorgesehen ist, um die Ventilspindel (30) in Ansprechen auf eine Axialbewegung der Ventilspindel (30) gegen die Kappe (18) an letzterer anliegen zu lassen.

7. Ventil nach Anspruch 6, dadurch gekennzeichnet, daß die Einrichtung (56, 62) einen ringförmigen Radialflansch (56) an der Ventilspindel (30) mit einer in Achsrichtung weisenden ringförmigen rippenartigen Dichtfläche (56a, 110) mit abgerundeter axialer Querschnittsausbildung und einen ringförmigen, flachen Radialsitz (62, 112) an der Kappe (18) umfaßt, welcher mit der Dichtfläche (56a, 110) zusammenwirkt, um eine fluiddichte Abdichtung zu schaffen.

8. Ventil nach Anspruch 6, gekennzeichnet durch eine schmelzbare Einrichtung (46), um die Ventilspindel (30) in ihrer nicht am Sitz befindlichen Lage zu halten.

9. Ventil nach Anspruch 8, dadurch gekennzeichnet, daß die schmelzbare Einrichtung (46) einen Ring (52) aus schmelzbarem Material und eine Hülse (48) mit einem sich auswärts erstreckenden Radialflansch (48a) umfaßt, daß die Hülse (48) die Ventilspindel (30) umgibt und an ihr zwecks gemeinsamer Axialbewegung befestigt ist, daß der Ring (52) die Hülse (48) neben dem Flansch (48a) umgibt, und daß ein Haltering (50) die Ventilspindel (30) umgibt und mit der Hülse (48) zusammenwirkt, um dazwischen den schmelzbaren Ring (52) aufzunehmen.

Revendications

1. Vanne (10) comprenant un corps (12) qui est



traversé d'un passage d'écoulement (14) à surface métallique, et une chambre (16) coupée par ledit passage d'écoulement (4);

un élément obturateur de vanne (28) positionné dans ladite chambre (16) pour commander l'écoulement à travers ledit passage d'écoulement (14);

un chapeau (18) fixé audit corps (12) et possédant un alésage (58) qui communique avec ladite chambre (16);

une tige de vanne (30) qui passe dans ledit alésage (58) et est reliée audit élément obturateur (28); et des moyens d'étanchéité (70, 90) destinés à établir un joint étanche aux fluides entre ledit corps (12) et ledit obturateur (28) de la vanne, lesdits moyens d'étanchéité (70, 90) comprenant un siège d'une seule pièce (70, 90) en forme de manchon, qui présente un axe longitudinal central, ledit siège (70, 90) étant positionné dans ledit passage d'écoulement (14) et se prolongeant pour entrer en contact (en 28a) avec ledit élément obturateur (28) de la vanne, caractérisé en ce que ledit siège (70, 90) possède, en tant que partie intégrante, une surface d'étanchéité annulaire (74a, 92), présentant la forme d'une nervure et à configuration de section ronde, ladite section étant par rapport audit axe longitudinal central, ladite surface d'étanchéité métallique (74a, 92) pressant contre la surface (72, 96) dudit passage d'écoulement (14) pour former un joint étanche aux fluides métal sur métal avec ce passage.

2. Vanne selon la revendication 1, caractérisée en ce que ladite surface d'étanchéité (74a) forme un joint étanche avec une surface annulaire (72) dudit passage d'écoulement (14).

3. Vanne selon la revendication 3, caractérisée en ce que ladite surface d'étanchéité (74a) est formée sur une partie annulaire (74) en forme de lèvre dudit joint (70), et dans laquelle le diamètre de ladite partie (74) en forme de lèvre de ladite surface d'étanchéité (74a) est plus grand que le diamètre (72) de ladite surface du passage d'écoulement contre laquelle ledit joint (70) est formé.

4. Vanne selon la revendication 1, caractérisée en ce que ladite surface d'étanchéité (92) forme un joint (90) avec une surface radiale (96) dudit passage d'écoulement (14).

5. Vanne selon la revendication 4, caractérisée par des moyens élastiques (84) qui tendent à appliquer ladite surface d'étanchéité (92) contre ladite surface radiale (96).

6. Vanne selon la revendication 1, caractérisée par des moyens (56, 110) servant à donner appui sur siège arrière à ladite tige (30) contre ledit chapeau (18) en réponse à un mouvement axial de ladite tige (30) par rapport audit chapeau (18).

7. Vanne selon la revendication 6, caractérisée en ce que lesdits moyens d'appui sur siège arrière (56, 62) comprennent une collerette radiale annulaire (56) prévue sur ladite tige (30) et possédant une surface d'étanchéité annulaire (56a, 110) qui regarde dans une direction axiale, en forme de nervure et à configuration de section axiale arrondie, et un siège radial annulaire plat (62, 112) prévu sur ledit chapeau (18) qui coopère avec ladite surface d'étanchéité (56a, 110) pour établir un joint étanche aux fluides.

8. Vanne selon la revendication 6, caractérisée par des moyens fusibles (46) destinés à retenir ladite tige (30) dans l'état hors d'appui sur siège arrière.

9. Vanne selon la revendication 8, caractérisée en ce que lesdits moyens fusibles (46) comprennent une bague (52) de matière fusible, un manchon (48) muni d'une collerette radiale (48a) en saillie vers l'extérieur, ladite collerette (48) entourant ladite tige (30) et étant fixée (en 30c, d) à cette tige pour se déplacer en mouvement axial solidaiement avec cette tige, ladite bague (52) entourant ledit manchon (48) dans la région adjacente à ladite collerette (48a), et une bague de retenue (50) qui entoure ladite tige (30) et qui coopère avec ledit manchon (48) pour maintenir ladite bague fusible (52) entre ces deux éléments.

