

GATE VALVES

The present invention relates to gate valves and, more specifically, it relates to gate valves having a secondary seal.

Gate valves have been commonly used for many years and have been employed in a variety of services such as in the oil and/or gas services of the petroleum industry. However, such valves have been designed for service involving pressures of only several thousand pounds per square inch. Today due to the depleted energy supply it has become necessary to explore and produce oil and gas under very high pressures of the range 30,000 psi (pounds per square inch) or more. Such high pressures have required greater sealing capacity and better safety features in such valves.

Prior art gate valves generally consist of a valve body having inlet and outlet conduits with a chamber there-between. A gate having an opening therethrough is disposed in a valve seat mounted within the chamber and the gate is mounted on a stem. The chamber is closed by a bonnet affixed to the valve housing. The stem reciprocates within the bonnet and is attached to a reciprocating apparatus for moving the gate between a closed position in which flow is blocked through the conduits and an open position in which flow is allowed through the conduits and the gate opening. Such a valve is illustrated in U.S. Patent Nos. 3,538,938 and 3,696,831.

It is also well known to seal between the valve seat and the valve housing by using an o-ring as shown in U.S. Patent Nos. 2,957,492 and 3,348,567 and non extrusion seals as shown in U.S. Patent No. 4,264,054. Further in automatic pressure sealed gate valves shown in

U.S. Patent Nos. 3,095,604; 3,538,938; and 3,696,831, fluent sealant rings are disposed around the valve seats to provide sealing between the valve housing and valve seats in response to line pressure on fluent sealant reservoirs in communication with the fluent sealant rings, and o-rings are installed on each side of the fluent sealant rings to isolate the fluent sealant in the fluent sealant rings from contamination by line fluids. This same principle is used for seals in wellheads as shown in U.S. Patent No. 2,952,479. It is also known to locate an o-ring seal on the end of the gate seat as shown in U.S. Patent No. 3,696,831. U.S. Patent Nos. 3,057,630 and 3,758,072 teach combining an elastomeric O-ring and a polyfluoroethylene polymer such as the brand "Teflon" or "nylon" or other low-friction plastic ring to make a seal ring. Further U.S. Patent No. 3,103,366 teaches a deformable metal ring, as for example of aluminum, with an inner deformable plastic ring of polytetrafluoroethylene whereby the metal ring can adapt itself to slightly varying recess clearances and prevent the plastic ring from extruding through the clearances under pressure.

Two piece seats are also known in the art for floating seats as shown by brochures of Model 20 gate valves of FMC, and for replaceable seals through non metallic inserts to seats of Seaboard as shown by its brochure and U.S. Patent Nos. 4,376,526 and 4,124,194. Another replaceable seal in seats is shown by U.S. Patent No. 4,163,544. A floating seat with a replaceable seal support element is shown by U.S. Patent No. 3,273,855.

Secondary seals where the gate forms a metal-to-metal seal with the seat and where a resilient seal is moved toward the gate when the gate is in the closed position to form a secondary fluid-tight seal with the gate is shown by U.S. Patent No. 4,377,273. Manual operations for removal of flow blocking plates and primary seal actuation after such removal are shown in U.S. Patent No. 2,203,989. Sliding seals are shown in U.S. Patent No. 2,471,941. Other valve seals are shown by U.S. Patent Nos. 3,472,270, 2,134,277, 2,776,813, 1,692,496 and 3,557,822.

As discussed in U.S. Patent No. 4,377,273, one problem frequently encountered in the case of gate valves is the lack of formation of adequate seals between the gate or gates and the seat or seats. In turn, if a seal is inadequate, the gate valves are often prone to leak through the seal. In U.S. Patent No. 4,377,273, an invention is disclosed which seeks to provide an adequate seal for gate valves in the form of a positive bidirectional cam actuated and deactuated resilient secondary fluid seal.

While the invention described in U.S. Patent No. 4,377,273 is believed to be advantageous for many applications, it has been found that there are applications in which other secondary seals may be provided. In particular, in high pressure situations wherein the formation of the secondary seal causes a significant pressure differential on the two sides of the gate and wherein the secondary seal is located on the downstream side, it has been found that for some applications, the drag on the secondary seal caused by movement of the gate to open when the secondary seal is fully effected may exaggerate the wear of the secondary seal. The additional drag on the gate also increases the effort required to open the valve. It is desirable in those instances to be able to deenergize or release the secondary seal prior to substantial linear movement of the gate across the seal.

In this regard, it is not necessary to totally withdraw the seal from the gate, but rather it is desirable to relieve the full pressure of the seal against the gate, or "deenergize" the seal, such that the pressure of the fluid moving through the valve will flow between the seal and the gate to preclude wear.

Additionally, in some high pressure situations wherein the secondary seal is fully effected or energized with no pressure in the valve body, and pressure is thereafter applied from the upstream side, there is no way for the fluid to enter into the body without leaking past the energized upstream secondary seal. Since the upstream secondary seal is mechanically energized, it is maintained until the

pressure load of the fluid overcomes the mechanical load. In some instances, the pressure of the fluid is great enough to blow past the seal once it overcomes the mechanical energy of the seal, thereby damaging the resilient sealing ring contained in the seal.

It is therefore desirable to provide a pressure relief means from a secondary seal subjected to such pressurized fluid under the above conditions, in which the fluid will force the seal away from the gate and allow movement of the fluid past the seal without damaging the resilient seal element when the pressure of the fluid reaches a selected value.

Also, seats that are press fitted into the valve body are difficult to replace, particularly in the field. Special tools are required to overcome the press fit and the valve body counterbore is subject to damage by gaulling between the seat OD and valve body counterbore during installation and removal of the seat. It is desirable to provide a seat that can be replaced easily without disturbing the press fit between the seat and the body.

According to the present invention we provide a gate valve comprising:

(a) a valve body having a valve chamber therein and a pair of flow passages aligned at opposite sides of the valve chamber, and additionally having a recess around the inner end of each of the aligned flow passages;

(b) a gate member having an imperforate section and a section having a flow passage therethrough, the gate member being disposed within the valve chamber and being reciprocally movable along a line substantially transverse to the valve chamber flow passages, between a gate position in which the valve is open and the flow passage of the gate member aligns with the valve chamber flow passages and a gate position in which the valve is closed and the imperforate section aligns with the valve chamber flow passages;

(c) valve seats, characterized in that:

(d) in each of the recesses around the inner end of the flow passages, at least one of the valve seats comprising a ring shaped seat against which the gate member slides between the open and closed position such that the gate forms a primary seal with the ring shaped seat when the gate is in the valve closed position;

(e) sealing means for sealingly engaging said gate to form a secondary seal, and

(f) urging means for urging said sealing means in sealing engagement with said gate when the valve is closed, said urging means including means for relieving the fluid pressure on said secondary seal which is to be positioned at the upstream side of said gate member.

The present invention will further be illustrated by reference to the appended drawings which illustrate particular embodiments of a gate valve constructed in accordance with the present invention and in which like parts are given like reference numerals, and wherein:

FIGURE 1 is a vertical axial cross section illustrating a preferred embodiment of a gate valve constructed in accordance with the present invention;

FIGURE 2 is a vertical cross section taken at line II-II of FIGURES 1 or 8A;

FIGURE 3 is a vertical axial cross section illustrating an alternative preferred embodiment of the gate valve incorporating the camming wedge in accordance with the present invention;

FIGURE 4 is a horizontal cross section of the gate assembly taken at line IV-IV of either FIGURES 3 or 8B;

FIGURE 5 is a plan view of a camming wedge constructed in accordance with the present invention;

FIGURE 6 is a side view of the camming wedge shown in FIGURE 5;

FIGURE 7 is a horizontal cross section of the gate assembly taken along line IV-IV of FIGURES 3 or 8B, illustrating an alternative embodiment of the camming wedge adapted for evenly applying secondary seals;

FIGURE 8A is a vertical axial cross section illustrating another preferred embodiment of a gate valve constructed in accordance with the present invention;

FIGURE 8B is a vertical axial cross section illustrating an alternative preferred embodiment of the gate valve incorporating the camming wedge in accordance with the present invention;

FIGURE 8C is a vertical axial cross section illustrating an alternative preferred embodiment of the gate valve incorporating a simplified secondary sealing assembly;

FIGURE 8D is a vertical cross section of the simplified secondary seal assembly used in FIGURE 9C;

FIGURE 8E is a perspective view of the valve seat having gate guides;

FIGURE 9 is a cross section of an alternate seal; and

FIGURE 10 is a vertical axial cross section illustrating the preferred embodiment of a gate valve constructed with a wedge having no lost motion and spring relief in accordance with the present invention.

Specific embodiments of a gate valve are illustrated which will accommodate the use of a secondary seal assembly. The gate valves illustrated are of a rising stem style similar to that shown in U.S. Patent 4,377,273, which is incorporated herein by reference.

Referring to FIGURES 1 and 8A, the gate valve 10 includes a valve body 11 which is hollow, having a valve chamber 12 therewithin. The upper or bonnet portion of the valve (not shown) may comprise a bonnet of any conventional form which provides a closure of the upper end of the chamber 12 and forms a seal between the valve body 11 and a stem 14.

The valve 10 includes a gate element 15 disposed within the chamber 12. The gate 15 has, generally, surfaces rectangular in section and is interconnected at the top with the stem 14. The stem 14 is adapted to raise and lower the gate 15 upon the selective movement of the stem 14.

Referring still to FIGURES 1 and 8A, the lower end of the stem 14 may take the form of a threaded stud 16 which is screwed and pinned into a tapped diametric opening 17 of a cylinder 18 which is received within a cylindrical opening 19 of the gate 15. The threaded stud 16 is connected to a cylindrical portion 21 of the stem 14 which is in turn received into an opening 20 of the gate 15. An upward conical formation 22 is formed around the stem 14 above the cylindrical portion 21 to provide a stop to prevent excessive upward movement of the stem by contact of formation 22 with the underside of the bonnet (not shown).

Vertical movement of the stem may be provided in a variety of manners. In the embodiment illustrated, the stem 14 may typically have threaded engagement with a yoke nut (not shown), so that rotation of the nut causes longitudinal movements of the stem 14 and the gate 15 in either direction.

It will be appreciated by those of skill in the art that these and other suitable means for attaching the stem 14 to the gate 15 may be utilized in accordance with the present invention.

Referring again to FIGURE 1 and 8A, two opposite formations 23, 24 project into the chamber 12 of the valve 10 around the inner ends of the opposed aligned flow passages 25, 26 of the valve body 11. The gate 15 has a flowport 15a therethrough which is positioned such that when the gate is moved upwardly in FIGURE 1 and 8A to be opened, the flow port 15a aligns with passages 25 and 26.

A stepped annular recess 27 is formed around each of the flow passages 25, 26 concentrically into formations 23, 24. In the embodiment of Figures 1-3, a valve seat member 28 having an outwardly enlarged portion 29 is mounted in the bottom of the recess 27. In the embodiments of FIGURES 8A, 8B, 8C, 8D, a valve seat body member 128 is mounted in the bottom part of recess 27.

As shown in FIGURES 1 and 8A, a seal support ring 31, forming the main body portion of the supplemental or secondary seal, is disposed around the exterior surface of extended tubular portion 30 (FIGURE 1) or the ring-shaped seat face member 131 of the seat body member 128 (FIGURE 8A). The seal support ring 31 is generally ring-shaped and has an

inwardly relieved recess at its end toward the gate 15 such that the seal support ring 31 has an L-shaped configuration in cross section. The seal support ring 31 further includes a pair of extending portions 32, 33 which extend along the opposite sides of the gate 15 as best shown in FIGURE 2. Each extending portion 32, 33 has a short cylindrical pin 34 fixed to a flat inwardly facing surface along the gate 15. The gate 15 further includes a camming edge 35 disposed along each of its sides. Each camming edge 35 has a vertical portion 35a at its lower end, above which is provided a slanted portion 35b. The pins 34 are engaged with the camming edge 35 in a cam and follower manner. When the gate 15 is moved downwardly toward a closed position by downward movement of the stem 14, the pins 34 move along the edge 35 from a position along portion 35a (not shown) toward a position along portion 35b to move the ring support element 31 toward the gate as shown in FIGURES 1 and 9A.

In U.S. Patent No. 4,377,273, camming edges were provided by grooves 45 having front and back edges for closing and opening the secondary seal. As particularly shown in Figure 1, and all other Figures, and in U.S. Patent No. 4,377,273, incorporated herein by reference as set out above, the secondary seal should be initially made up mechanically to cause the secondary seal 36a to sealingly engage the face of gate 15 (presuming flow is from flow passage 26 to flow passage 25). Thereafter, if there is any leakage around the metal-to-metal seal, the force from the pressure of the fluid in the body of the valve acting on seal means 36 to force the seal 36a into engagement with the gate face will be significantly greater than the force from the pressure of the fluid in the body of the valve acting on seal means 36 to force the seal 36a out of the engagement with the gate face. Both of these forces will usually be significantly greater than the mechanical force of the spring member 40. It has been found, however, that the fluid pressure within the valve can be used to act to open the secondary seal, and that the back edge of the groove 45 shown in U.S. Patent No. 4,377,273 may be eliminated, as shown in FIGURES 1, 3, 8A and 8B of the present disclosure.

Referring still to FIGURES 1 and 8A a secondary seal member is provided which includes seal means 36 supported by the ring-shaped support element 31 such that movement of the seal support ring 31 forces the seal means 36 to engage the gate 15 to form a secondary seal.

The seal means 36 is comprised of a stepped annular ring having an inner recess 37 such that the seal means 36 is somewhat L-shaped in cross section. The seal means 36 may further include an annular resilient seal element 36a mounted to the seal means 36 by press fitting or other suitable means.

The valve 10 further includes a means for deenergizing the secondary seal prior to substantial linear movement of the gate 15 across the fully energized seal means 36. In the embodiment illustrated in FIGURES 1 and 8A the means for quickly deenergizing the secondary seal includes an energizing ring 38 slidably disposed within the inner recess 37 and a compressible, elastomeric seal ring 39 disposed between the energizing ring 38 and the seal means 36. The seal ring 39 may be comprised of any material having suitable compressible, elastomeric properties such that upon movement of the energizing ring 38 to compress the seal ring 39 when the secondary seal is effected, the seal ring 39 compresses and spreads outwardly to form a fluid tight, essentially incompressible seal. In an embodiment, the seal ring 39 is comprised of a compressible, elastomeric O-ring having a substantially circular cross-section. In the preferred embodiment of FIGURE 10, the seal ring 39 is comprised of a compressible elastomeric ring which incorporates an anti-extrusion element 150.

The preferred embodiment includes a means for providing pressure relief for the seal means 36. In the illustrated embodiment of FIGURES 1 and 8A, the pressure relief means includes a spring member 40 disposed between the base of the seal support ring 31 and the energizing ring 38. The spring member 40 has a selected spring constant of a value selected such that once a seal between the seal means 36 and the gate 15 is effected, the spring member 40 will compress when a given force is exerted on the seal means 36 (and more specifically against seal ring 39

in FIGURES 1 and 8A) by pressurized fluid from the upstream side (or from the passageway 26 shown in FIGURES 1 and 8A). The compression of the spring 40, in turn, allows the seal means 36 to move away from the gate 15 on the upstream side in order to prevent destruction of the resilient seal element 36a.

It will be understood that the selection of a particular spring constant is dependent upon the materials comprising seal means 36, seal ring 39, and seal element 36a, and their ability to withstand a certain threshold pressure. Such selection is a matter of design which will be known to those of skill in the art in view of the present disclosure.

The spring member 40 may be comprised of a number of suitable springs providing the desired spring constant for a particular design of sealing means. In the preferred embodiment, the spring member 40 is comprised of a belleville spring having a suitable spring constant selected to yield at a desired level of pressure. It may also be an O-ring seal.

Accordingly, the embodiments of the present invention illustrated in FIGURES 1, 8A and 8B provide both a means for upstream pressure relief and a means for quickly deenergizing the seal 36.

The gate valve of the present invention may include a cooperating cam means which comprises a camming wedge slidably mounted along opposite sides of the gate such that movement of the wedge is effected prior to the movement of the gate upon the opening of the gate, whereby the secondary seal is deenergized prior to movement of the gate across the seal. Referring to FIGURES 3 - 6 and 8B, in which like members to FIGURES 1 and 8A are given like reference numerals, the preferred embodiment of a gate valve incorporating such a camming wedge is shown. In the description of the embodiment shown in FIGURES 3-6 and 8B, the terms "vertical" and "horizontal" are used in reference to a valve having the orientation shown in FIGURES 3 or 8B, wherein a valve is shown in the upright position with the stem extending upwardly out of the top of the valve.

Referring first to FIGURES 5 and 6, the camming wedge 60 has a generally rectangular configuration having a lower recess 62 extending therein. The recess 62 includes camming edges 35 which are essentially identical in function and similar in configuration to the camming edges 35 shown in FIGURES 1 and 8A. In particular, the camming edge 35 has a vertical portion 35a at its lower end and an upper slanted portion 35b. As described for FIGURES 1 and 8A, the camming edge 35 engages in use with the pins 34 in a cam and follower manner such that when the gate 15 is moved downwardly to a closed position by the downward movement of the stem 14, the pins 34 move along the edge 35 from a position along edge 35a toward a position along edge 35b to move the ring support element 31 toward the gate 15 to form the secondary seal.

The wedge 60 also includes a pair of opposing tabs 64 extending outwardly from either side to engage within mating channels 126 in the gate 15 such that the gate 15 slidably supports the wedge 60 for longitudinal movement as shown in FIGURES 3, 8B and 4. The wedge 60 additionally comprises a horizontal slot 68 having a generally rectangular configuration in cross-section. As will be explained in greater detail below, the horizontal slot 68 is configured to fit onto the lower portion of the stem 14 such that play between the wedge 60 and the stem 14 in the vertical direction is minimized.

Referring to FIGURES 3 and 8B the lower portion of the stem 14 includes a longitudinal section 121 having a rectangular configuration in horizontal cross-section. A transverse member 116, also having rectangular sides and bottom, is secured to the longitudinal section 121 such that the two members are configured in the form of an inverted block T. As shown in FIGURES 3 and 8B, in the preferred embodiment, the horizontal width of the transverse member 116 is greater than the horizontal width of the longitudinal member 121, but less than the corresponding width of the gate 15. Further, the horizontal length of the transverse section 116 is greater than the horizontal length of the longitudinal member 121, but substantially equal to the corresponding horizontal length of the gate 15. As shown in FIGURES 3 and 8B, the

transverse section 116 is configured at each end to be slidably received within the horizontal slot 68 of the wedge 60 such that freedom of play between the wedge 60 and the horizontal slot 68 in the vertical direction is minimized.

The gate 15 includes a longitudinal slot 120 (FIGURES 3 and 8B) adapted to slidably receive the longitudinal section 121 and a transverse slot 117 adapted to slidably receive the transverse section 116. The longitudinal slot 120 is configured such that it slidably receives the longitudinal section 121 and provides limited freedom of latitudinal movement of the gate 15 in relation to the stem 14. The transverse slot 117 has a greater vertical dimension than the transverse section 116 such that a selected length 125 of vertical movement of the stem 14 is provided without corresponding movement of the gate 15.

For purposes of assembly, it should be understood that in the illustrated embodiment, the horizontal cross-sectional width of the longitudinal section 121 is not critical so long as a width is selected to provide suitable strength for the load expectations on the stem 14. Similarly, the horizontal cross-sectional length of the section 121 is not critical, but must be sufficiently less than the horizontal cross-sectional length of the gate 15 to accommodate the sliding of the stem 114 to one side of the gate 15 to accommodate installation of the wedges 60. This clearance is best illustrated in FIGURE 4. It will be appreciated that other configurations of the stem 14, wedge 60, and gate 15 may be utilized to accommodate assembly of the three members in accordance with the present invention.

Accordingly, when the valve 10 is in a closed position, as shown in FIGURES 3 and 8B the secondary seal has been effected by the downward movement of the camming wedge 60. When it is desired to open the valve, the upward movement of the stem 14 for the selected distance 125 will raise the camming wedge 60 without a corresponding movement of the gate 15. This "lost motion" allows the camming wedge 60 to substantially release the secondary seal before any upward movement of the gate 15 is provided.

In this regard, it should be noticed that upon the movement of the gate 15 downwardly to close the valve, the drag of the primary seal upon the gate 15 will cause the gate 15 to seek the highest position as shown in FIGURES 3 and 8B. Alternatively, lower stops could be provided for the gate 15 whereby the gate "bottoms out" against such a stop to insure that the freedom for lost motion is provided upon the upward movement of the stem 14.

Referring again to FIGURE 6, an alternative design for the camming edges 35 shown in FIGURES 1, 3, 8A and 8B is disclosed which provides a means for limiting the force with which the secondary seal is effected. In particular, the camming edges 35 may be configured to include an upper vertical portion 35c (shown ghosted). The vertical portion 35c is disposed substantially parallel to the side of the gate 15 in use such that the engagement of the follower pin 34 with the edge 35c will cease movement of the ring shaped support element 31 toward the gate 15 and will thereby cease further tightening of the secondary seal.

Referring now to FIGURE 7, there is shown an alternative embodiment of the camming wedge 60 of FIGURES 5-6 adapted to center the gate 15 between opposing secondary seals such that the secondary seals are evenly applied. As shown in FIGURE 7, the wedge 60 may have the same basic configuration in horizontal cross-section as the wedge 60 shown in FIGURE 4. In the embodiment shown in FIGURE 7, however, the wedge 60 is of a dimension such that when the wedge 60 is mounted onto the gate 15, clearance is provided between the tabs 64 and the bottom of the mating channels 126 and between the wedge 60 and the gate 15 in order to allow latitudinal movement of the wedge 60 in relation to the gate 15 as shown by the arrow 66.

Accordingly, when wedges having clearance for such latitudinal movement are mounted to the gate 15 as shown in FIGURE 7, the wedges float to compensate for misalignment of the gate between opposing secondary seals and insure that the seals are evenly applied to the opposing sides of the gate 15.

Referring to FIGURE 10, the preferred embodiment of use of a wedge 116 without space 125 of FIGURES 3 and 8B and with the spring 40 of FIGURES 1 and 8A is shown. The lack of space 125 yields a transverse slot 117 substantially as wide as wedge 116. Additionally, this embodiment may have the multi-piece seat 128 of FIGURES 8A and 8B. In addition, as seen in FIGURE 11, the yoke includes a preferred method of limiting tightening of the secondary seal by compression of spring 40. The inward travel of seal support ring 31 toward gate 15 is limited to prevent compressing spring 40 solid. The limitation of the travel of seal support ring 31 is accomplished by inner face 153 of seal support ring 31 abutting gate 15. The seal support ring 31 is then prevented from scouring the face of gate 15 by stopping any further downward movement of the gate 15 after seal support ring face 153 contacts the gate 15. Downward movement of the gate is limited by stopping the downward movement of stem 14. Limitation of the downward movement of the stem 14 is accomplished by supplying a stop nut 154 on the outer end of stem 14 and adjusting stop nut 154 to stop on a stem nut 155 located between bonnet 156 and handle 157. The adjustment of stop nut 154 to a position where it stops against stem nut 155 should coincide with the abutting of seal support ring surface 153 with the face of gate 15. Limiting the downward movement of the stem 14 also prevents overstressing camming wedge 60, seal support ring 31, gate 15, and stem 14.

Referring to FIGURE 8C for an alternate secondary seal, seat body member 148 includes tubular portion 149 to slidably engage ring shaped secondary seal member 140. Secondary seal member 140 includes an annular ring body having an annular resilient element 140a mounted to the inward facing surface 142 of the body of secondary seal member 140 by press fitting or other suitable seal means. Secondary seal member 140 further includes an O-ring, "T" ring or other suitable seal ring 140b received in a groove 150 of the body adapted to sealingly engage the outward facing surface of tubular member 149. In the illustrated embodiment of FIGURE 8C, the secondary seal means includes a spring

member 141 disposed between secondary seal member 140 and the shoulder 144 on seat body member 148. Alternately, an annular ring extension 152 (Figure 8D) may be a part of seat body members 148 to form a pocket 145 for the spring 141. Spring member 141 maintains the contact between the secondary seal means and the gate 15 at surface 142. The spring member 141 will compress when a given force is exerted on the secondary seal means by pressurized fluid from the upstream side allowing the secondary seal means to move away from the gate 15 on the upstream side in order to prevent destruction of the resilient seal element 140a on the upstream side.

In the preferred embodiment of FIGURE 8C, seal members 140 incorporate gate guides 143 which extend along opposite sides of the gate 15 as best shown on FIGURES 8D and 8E.

The spring 141 may be made of a belleville spring, elastomeric "O"-ring or other suitable material.

The instant invention has been disclosed in connection with specific embodiments. However it will be apparent to those skilled in the art that variations from the illustrated embodiments may be undertaken without departing from the spirit and scope of the invention. For example, the camming wedge 60 of FIGURE 7 could further be incorporated into the embodiment shown in FIGURES 1 and 8A, without the provision for lost motion between the gate and the stem upon the opening of the valve. Additionally, the pressure release means or spring member could be incorporated into the embodiment shown in FIGURES 3 and 8B to insure that the seal means 36 would yield when a selected pressure level was reached upstream.. Also the split seat mechanism could be incorporated into the embodiments of FIGURE 8C.

Accordingly, because many varying and different embodiments may be made within the scope of the inventive concept herein taught including equivalent structures or materials hereafter thought of, and because many modifications may be made in the embodiments herein detailed in

accordance with the descriptive requirements of the law, it is to be understood that the details herein are to be interpreted as illustrative and not in a limiting sense.

"Teflon" is a registered trade mark.

CLAIMS:

1. A gate valve(10), comprising:

(a) a valve body having a valve chamber therein and a pair of flow passages aligned at opposite sides of the valve chamber, and additionally having a recess around the inner end of each of the aligned flow passages;

(b) a gate member (15) having an imperforate section and a section having a flow passage therethrough, the gate member being disposed within the valve chamber and being reciprocally movable along a line substantially transverse to the valve chamber flow passages, between a gate position in which the valve is open and the flow passage of the gate member aligns with the valve chamber flow passages and a gate position in which the valve is closed and the imperforate section aligns with the valve chamber flow passages;

(c) valve seats (28, (128 & 131) 148), characterized in that:

(d) in each of the recesses around the inner end of the flow passages, at least one of the valve seats comprises a ring shaped seat against which the gate member slides between the open and closed position such that the gate forms a primary seal with the ring shaped seat when the gate is in the valve closed position;

(e) sealing means for sealingly engaging said gate



to form a secondary seal, and

(f) urging means (31, 34, 35, 140a, 140b, 40, 48 39, 141) for urging said sealing means in sealing engagement with said gate when the valve is closed, said urging means including means for relieving the fluid pressure on said secondary seal which is to be positioned at the upstream side of said gate member.

2. A gate valve as claimed in claim 1, characterized in that said sealing means includes a seal support ring (36, 140) slidably disposed around the ring shaped seat (28, (128 & 131) 148), the seal support ring (36, 140) having an inner recess therearound at the end adjacent the gate (15), and elastomeric seal member (36a, 140a) disposed in the inner recess of the seal support ring (36, 140).



3. The gate valve of claim 2, characterized in that said urging means includes a spring member (141, 40) having a selected spring constant and positioned between the seal support ring (36, 140) and the valve seat (28, 148, [128 & 131]) in which the spring member is positioned to provide actuation of the seal support ring (36, 140) against the gate and pressure relief for the elastomeric seal member (36a, 140a).

4. The gate valve of claim 2, characterized in that the gate (15) forms a primary seal with the ring shaped seat (148, 28 [128 & 131]) when the gate is in the valve closed position and a secondary seal with the gate is formed by said elastomeric seal member (36a, 140a) which surrounds the ring shaped valve seat (148, 28, [128 & 131]).

5. The gate valve of claim 3, characterized in that the spring member (141, 40) has a selected spring constant adapted to provide pressure relief at a predetermined pressure.

6. The gate valve of claim 1, characterized in that the sealing means includes an elastomeric seal (36a, 140a) engageable with the gate.

7. The gate valve of claim 3, characterized in that the ring shaped seat includes a ring shaped extension (152, 144) and the spring member (141, 40) is positioned between the seal support ring (36, 140) and the ring shaped extension (152, 144).

8. The gate valve of claim 1, characterized in that the sealing means includes a ring-shaped support element (31) including extended portions (32, 33) extending to and juxtaposed with sides of the gate (15) and seal means supported by said ring-shaped seat member (28, [128 & 131]) facing the gate for sealingly engaging the gate and wherein the urging means includes cooperating cam means (31, 34, 35) associated with the gate and the ring-shaped support element (31) for moving the ring-shaped support element (31) toward the gate when the gate is moved toward the closed position to form a secondary seal between the secondary seal member and the gate, and for deenergizing the secondary seal prior to substantial movement of the gate toward the open position.



9. The gate valve of claim 8, characterized in that the cooperating cam means includes:

(a) a camming edge (35) disposed along opposite sides of the gate (15);

(b) a pin follower (34) carried by the extended portions (32, 33) and adapted to engage with the camming edge (35);

(c) an energizing ring (40) disposed between the ring-shaped support element (31) and the seal means; and

(d) a compressible, elastomeric seal ring (39) disposed between the energizing ring and the seal means.

10. The gate valve of claim 9, characterized in that the energizing ring (40) is a spring member having a selected spring constant in which the spring member is adapted to provide pressure relief for the seal means.

11. The gate valve of claim 9, characterized in that the camming wedge surface includes a substantially vertical surface (35c) positioned to cause the pin follower (34) to rise substantially vertically to maintain the position of the energizing ring (40), whereby the mechanical force on the spring is prevented from additional increase.

12. The gate valve of claim 8, characterized in that the cooperating cam means includes :

(a) a camming wedge (60) slidably mounted along opposite sides of the gate (15) having means (14, 116, 117, 125) for moving the wedge (60) prior to movement of the gate upon initiation of movement of the gate to the open position, the wedge including a camming edge surface (35); and

(b) a pin follower (34) carried by the extended portions (32, 33) and adapted to engage with the camming edge surface (35) of the camming wedge.

13. The gate valve of claim 1, characterized in that the ring-shaped seat member includes;

(f) a seat body member (128) press fit to the valve body; and

(g) a seat face member (131) removably mounted on the seat body member (128) having a surface (134) abutting with and forming a metal-to-metal seal with the gate (15).



14. The gate valve of claim 12, characterized in that the seat face member (131) is threaded onto the seat body member (128).

15. The gate valve of claim 14, characterized in that the ring-shaped seat member (131) further includes a resilient seal ring (133) sealing between the seat body member (128) and the seat face member (131).

16. The gate valve of claim 13, characterized in that the ring-shaped seat member further includes seat sealing means for sealing between the seat body member and the seat face member.

17. The gate valve of claim 16, characterized in that the seat sealing means includes a metal-to-metal seal between oppositely facing (132) surfaces of the seat body member and the seat face member.

18. The gate valve of claim 16, 17, characterized in that the seat sealing means includes a resilient seal ring (133) sealing between the seat body member and the seat face member.

19. The gate valve of claim 8, characterized in that the cooperating cam means includes:

(a) a camming wedge (60) slidably mounted along opposite sides of the gate, the wedge including a camming edge surface (35); and

(b) a pin follower (34) carried by the extended portions (32, 33) and adapted to engage with the camming edge surface of the camming wedge.

20. The gate valve of claim 19, characterized in that there is a spring member (40) having a selected spring constant positioned between the ring-shaped support element (31) and the seal means in order to provide pressure relief for said seal means.

21. The gate valve of claim 8, characterized in that the cooperating cam means includes limiting means for limiting the movement by the cooperating cam means of the ring-shaped support element toward the gate (15).



22. The gate valve of claim 1, characterized in that the sealing means includes a seal support ring (31) slidably disposed around said ring-shaped seat, the seal support ring having an inner recess therearound at the end adjacent the gate; an elastomeric seal member (36a) disposed in the inner recess of the seal support ring (36); and wherein said urging means (31, 34, 35, 38, 39 40) is associated with the seal support ring (31) and said gate (15) for drawing the seal support ring (31) toward the gate (15) when the gate (15) is moved from the valve open position toward the valve closed position to force the elastomeric seal member (36a) into sealing engagement with the gate after the gate has reached the closed position to form a secondary seal after the formation of the primary seal, and for moving the seal support ring (31) such that the secondary seal is deenergized prior to substantial movement of the gate across the elastomeric seal member (36a) whereby drag and wear of the elastomeric seal member (36a) by the gate are minimized upon the movement of the gate (15) to the open position.

23. The gate valve of claim 22, characterized in that said urging means includes;

(a) a camming edge (35) disposed along opposite sides of the gate member (15);

(b) pin follower means (34) carried by the seal support ring (31) and adapted to engage with said camming edges;

(c) an energizing ring (38) disposed between the seal support ring (31) and the elastomeric seal member (36a); and

(d) an elastomeric seal ring (39) disposed between the energizing ring (38) and the elastomeric seal member (36a).

24. The gate valve of claim 23, characterized in that there is a spring member (40) having a selected spring constant positioned between the energizing ring (38) and the seal support ring (31) in which the spring member provides pressure relief for the elastomeric seal member (36a).

25. The gate valve of claim 9, 10, 23, 24 characterized in that the elastomeric seal ring (39) is an O-ring comprised of elastomeric material.



26. The gate valve of claim 9, 23, characterized in that the elastomeric seal ring (39) includes elastomeric material and anti-extrusion material (150), and the anti-extrusion material positioned to prevent extrusion of the elastomeric material under pressure.

27. The gate valve of claim 22, characterized in that said urging means includes:

(a) a camming wedge (60) slidably mounted along opposite sides of the gate such that movement of the wedge is effected prior to movement of the gate upon opening of the gate, the wedge including a camming edge surface (35) ; and

(b) pin follower means (34) carried by the seal support ring (31) and adapted to engage with the camming edge surface (35) of the camming wedge.

28. The gate valve of claim 27, characterized in that the fit of the camming wedge mounting along opposite sides of the gate includes clearance between the camming wedge and the gate to allow the gate to freely float with respect to the camming wedge within the limits of the clearance between the wedge tabs (64) and the gate.

29. The gate valve of claim 22, characterized in that said urging means includes:

(a) a camming wedge (60) slidably mounted along opposite sides of the gate, the wedge including a camming edge surface (35) ; and

(b) pin follower means (34) carried by the seal support ring (31) and adapted to engage with the camming edge surface (35) of the camming wedge.

30. The gate valve of claim 12, 19, 21, characterized in that the camming wedge surface (35) includes a substantially vertical surface (35c) positioned to cause the pin follower (34) to rise substantially vertically to maintain the position of the ring-shaped seal member (31) , whereby the mechanical force on the secondary seal is prevented from additional increase.



31. The gate valve of claim 30, characterized in that the limiting means includes a stop (154) having prevention means for preventing movement of the gate (15) relative to the ring-shaped support element (31) substantially on contact of the ring-shaped support element with the surface of the gate.

32. The gate valve of claim 12, 19, 29, characterized in that the fit of the camming wedge (60) mounting along opposite sides of the gate (15) includes clearance between the camming wedge (60) and the gate (15) to allow the gate (15) to freely float with respect to the camming wedge (60) within the limits of the clearance between the wedge (60) and the gate (15).

33. The gate valve of claim 22, characterized in that the urging means includes limiting means for limiting the movement by the means of the seal support ring toward the gate (15).

34. The gate valve of claim 1, characterized in that said sealing means includes a pair of seal support rings (36) slidably disposed around said ring shaped seats, the seal support rings having an inner recess therearound at the end adjacent the gate; an elastomeric seal member (36a) disposed in the inner recess of the seal support rings; and said urging means is associated with at least one of said seal rings and said gate for drawing the seal support ring (36) toward the gate when the gate is moved from the valve open position toward the valve closed position to force the elastomeric seal member (36a) into sealing engagement with the gate (15) after the gate has reached the closed position to form a secondary seal after the formation of the primary seal.

35. The gate valve of claim 34, characterized in that said urging means includes a Belleville spring member (40).

36. The gate valve of claim 34, characterized in that the urging means includes limiting means (35c) for limiting the movement by the means of a ring-shaped support element (31) toward the gate.



37. The gate valve of claim 1, characterized in that said sealing means includes

a seal support ring (36) slidably disposed around each of said ring-shaped seats, the seal support rings having an inner recess therearound at the end adjacent the gate;

an elastomeric seal member (36a) disposed in the inner recess of the seal support rings; and said urging means is associated with said seal support ring and said gate for evenly drawing said seal support ring toward the gate when the gate is moved from the valve open position toward the valve closed position to substantially evenly force the elastomeric seal member (36a) into sealing engagement with the gate after the gate (15) has reached the closed position to form a secondary seal after the formation of the primary seal.

38. The gate valve of claim 37, characterized in that the urging means includes:

(a) a camming wedge (60) including opposing camming edge surfaces, the camming wedge being slidably mounted along opposite sides of the gate for movement parallel to the gate and transverse to said valve chamber flow passages; and

(b) pin follower means (34) carried by each seal support ring (31) and adapted to engage with the camming edge surfaces of the camming wedges.

39. The gate valve of claim 38, characterized in that the camming wedge surface includes means (35c) for maintaining the position of the seal support ring (31), whereby the mechanical force on the secondary seal is prevented from additional increase.



40. The gate valve of claim 1, characterized in that said sealing means includes:

a seal support ring (36) slidably disposed around each of said ring-shaped seats, the seal support rings having an inner recess therearound at the end adjacent the gate;

an elastomeric seal member (36a) disposed in the inner recess of the seal support rings; and said urging means is associated with said seal support rings and said gate (15) for forcing the seal support rings toward the gate to substantially evenly force the elastomeric seal members (36a) into sealing engagement with the gate after the gate has reached the closed position to form opposing secondary seals after the formation of the primary seals.

41. The gate valve of claim 1, characterized in that said sealing means includes:

a seal support ring slidably disposed around each of said ring-shaped seats, the seal support rings having an inner recess therearound at the end adjacent the gate;

the sealing means including a secondary seal member disposed around at least one of the ring-shaped seat members and adapted to reciprocate on the ring-shaped seat member, the secondary seal member comprising-

a first means responsive to the movement of the gate toward the closed position to mechanically force the seal member into engagement with the face of the gate, a second means responsive to fluid pressure in the valve body for holding the seal member in sealing engagement with the face of the gate, and a third means responsive to the limitation of movement of the gate toward the open position--to mechanically force the seal member out of sealing engagement with the face of the gate.

42. The gate valve of claim 41, characterized in that the first means includes means for limiting the movement by the first means of the seal member in engagement with the face of the gate.



43. The gate valve of claim 1, characterized in that said sealing means includes a third means responsive to the initiation of movement of the gate toward the open position to mechanically force the seal member out of sealing engagement with the face of the gate.

44. The gate valve of claim 1, characterized in that said sealing means includes:

a seal support ring (31) slidably disposed around each of said ring-shaped seats, the seal support rings having an inner recess therearound at the end adjacent the gate;

a seal support ring (36) slidably disposed around each said ring-shaped seat, the seal support ring having an inner recess therearound at the end adjacent the gate; an elastomeric seal member (36a) disposed in the inner recess of the seal support ring (36); and said urging means includes a spring member (40) having a selected spring constant positioned between the seal support ring (31) and the elastomeric seal member (36a) in which the spring member provides pressure relief for the elastomeric seal member (36a); and

urging means associated with said seal support ring (31) and said gate for drawing said seal support ring (31) toward the gate when the gate is moved from the valve open position toward the valve closed position to force the elastomeric seal members into sealing engagement with the gate after the gate has reached the closed position to form a secondary seal after the formation of the primary seal.

45. The gate valve of claim 44, characterized in that the urging means includes:

(a) a camming wedge (60) including opposing camming edge surfaces (35), the camming wedge being slidably mounted along opposite sides of the gate for movement parallel to the gate and transverse to said valve chamber flow; and

(b) pin follower means (34) carried by each seal support ring (31) and adapted to engage with the camming edge surfaces (35) of the camming wedges (60).

46. The valve of claims 3, 10, 24, 44, characterized in that said spring member (141, 40) is a belleville spring.



47. The gate valve of Claim 1, characterized in that said sealing means includes a seal support ring (140) slidably disposed around each of said ring shaped seat members, the seal support rings (140) having an inner recess therearound at the end adjacent the gate;

the sealing means further including a first seal ring (140b) disposed around at least one of the ring-shaped seats and adapted to reciprocate on the ring-shaped seat, the urging means including;

a fluid pressure actuated first means responsive to the movement of the gate toward the closed position to force the seal member into engagement with the face of the gate and responsive to fluid pressure in the valve body for holding the seal support ring in sealing engagement with the face of the gate.

48. The gate valve of Claim 47, characterized in that;

said first means includes first elastomeric seal ring (140b);

said seal support ring (140) has a recess (150) facing said seat, said first seal ring (140b) positioned in said recess and sealingly engaging said seat member.

49. The gate valve of Claim 48, characterized in that said seal support ring (140) has a second elastomeric seal ring (140a) said first seal ring (140b) has a ring diameter less than the ring diameter



of the said second seal ring (140a).

50. The gate valve of Claim 1 or 48, characterized in that said urging means includes a spring (141) maintaining contact between said secondary seal means and said gate.

51. A gate valve substantially as described with reference to any of the examples illustrated in the accompanying drawings.



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