

SPECIFICATION

Gate valve with expansible gate segments

- 5 This invention relates in general to gate valves and more particularly to gate valves having separate gate segments.

Gate valves used in the oil industry and other uses often must be capable of withstanding high

- 10 pressures, from 1,000 to 15,000 p.s.i.. One known type has two separate gates that are drawn past seats by a threaded stem. Sealing compound is stored in a reservoir that utilizes a piston and pressure sensing arrangement to force the
- 15 compound around the gates and seats to form the primary seal. One disadvantage of this valve is that some sealing compound is depleted every time the valve is closed, thus requiring periodic replenishing.

- Another gate valve is proposed in U.S. Patent No. 20 1 624 465. It utilizes a wedging action, relying on an end stop that has two wedging or converging surfaces, spreading the gate segments apart as they are forced downward. The lift nut also has tapered surfaces for spreading the upper portion of the gates
- 25 apart. The inclination of the end stop and the lift nut are such that the upper surface expands first. This may cause the gates to wedge tightly at the top prior to fully closing at the bottom. Also this valve does not have a back-up system should the primary seal
- 30 leak.

It is accordingly a general object of this invention to provide an improved gate valve.

- It is a further object of this invention to provide an improved gate valve that utilizes a wedging principle
- 35 to force the gates against the seats.

- It is a further object to this invention to provide an improved gate valve that utilizes a wedging action to force the gates against the seats and also has provisions for forming a secondary seal should the
- 40 primary seal leak.

In its broadest aspect the present invention provides a gate valve defined in claim 1.

- Further specific aspect of the invention are defined in greater detail in claims 2 to 7 which are appendent
- 45 to claim 1.

One embodiment of a gate valve in accordance with this invention will now be described by way of example with reference to the accompanying drawings in which:

- 50 *Figure 1* is a vertical sectional view of the gate valve;

Figure 2 is a perspective exploded view of portions of the gate valve of *Figure 1*; and

- Figure 3* is an enlarged elevational view of
- 55 portions of the valve of *Figure 1*.

- Referring to *Figure 1*, the gate valve has a body 11. A transverse flow passage 13 is divided into two coaxial passages by a central cavity 17. One of the passages 13 will be on the upstream side of the
- 60 cavity 17 and the other will be on the downstream side. The passages 13 are perpendicular to the central cavity 17, which extends both above and below them. Flanges 18 on the outer ends of passages 13 serve as connection means for
- 65 connecting the valve into a pipeline or to other

equipment.

- A stem 19 is rotatably mounted in the centre of cavity 17 with the stem axis perpendicular to the axis of passage 13. The upper end of stem 19 is retained
- 70 by conventional packing assembly 21 that withstands pressure and prevents axial movement of the stem. A handle 23 is rigidly connected to the top of stem 19 for rotating it. Threads 25 are formed on the lower end of stem 19.

- A pair of seat rings 27 are located in passages 13. Each passage has an enlarged bore on its inner end within which the seat rings 27 are tightly secured. As shown in *Figure 2*, each seat ring 27 is generally cylindrical, with an annular resilient seal 29 located
- 80 in a groove in the face of the seat ring. The seal groove for seal 29 is of a depth selected so that the seal protrudes slightly beyond the face, approximately 0.005 inch.

- Another annular groove 31 is formed in the exterior surface of seat ring 27 adjacent the end opposite the face. Sealant groove 31 is in communication with the groove containing seal 29 by a passage 33 drilled through the wall of the seat ring. A port 35 in the body 11 of the valve is in
- 90 communication with groove 31 of each seat ring 27. Port 35 leads to the exterior of body 11 and is adapted to receive a conventional check valve (not shown). The check valve, similar to a grease fitting, may be of various known types for introducing a sealant and maintaining it under pressure.
- 95

- A pair of gate segments 37 are carried slidingly in the central cavity 17. As shown also in *Figure 2*, each gate segment is a generally rectangular member of length greater than the width. The outer face of each
- 100 gate segment 37 has a solid portion or area, indicated as 39, that is of dimensions greater than the diameter of passages 13 to block flow through passages 13. An aperture 41 extends through each gate below the solid area. Aperture 41 is of the same
- 105 diameter as passages 13, and allows flow when the valve is not in the closed position. The axes of apertures 41 in each gate coincide and are parallel to the axes of passages 13. A sleeve 43 fits within apertures 41, connecting them together to prevent
- 110 foreign matter in the flowing fluid from entering the spaces between the gate segments.

- Referring also to *Figure 3*, a recess 45 is formed in the inner face of each gate segment 37. Recess 45 is a channel extending completely across the inner face perpendicular to the axis of stem 19. Recess 45 has an upper wall 47 that extends perpendicular to the stem 19 axis. The lower wall has an inclined portion 49 that slopes downwardly at a selected angle α and a horizontal portion 51 that is parallel
- 120 with the upper wall 47. The upper wall 47 is joined to the inclined portion 49 by a vertical wall 53, thus inclined portion 49 defines a bevelled corner between horizontal portion 51 and vertical wall 53. Angle α is preferably 45 degrees with respect to the
- 125 axis of stem 19.

- Referring to *Figure 2*, a vertical recess or channel 55 extends down the inner face of each gate segment 37. The channels 55 intersect recesses 45 perpendicular to them, and terminate above
- 130 apertures 41 to provide access for stem 19 to extend.

The recesses 45 and channels 55 are formed at the same position on each gate segment to define respectively a horizontal passage and a vertical cylindrical cavity.

- 5 A bevelled surface 57 is located on each gate segment 37 at the lower edge of the inner face. As shown in Figure 3, the bevel 57 is at the corner of the bottom of the gate segment and the inner face. Bevelled surface 57 extends across the inner faces and is inclined at an angle β with respect to the axis of the stem. Angle β may be equal to angle α or less, and is preferably 30 degrees.

- A plurality of coil springs 59 are mounted to the inner face of one of the gate segments 37 and extend into mating holes (not shown) formed in the inner face of the other gate segment. The depth of the holes are selected so as to place the springs in compression when the gate segments are placed together, to urge the gate segments 37 against the seat rings 27.

- A lift nut 63 forms the connection between the gate segments 37 and the stem 19 for raising and lowering the gate segments. Lift nut 63 has a threaded sleeve 65 that is threaded to stem threads 25. A pair of generally T-shaped engaging members 67 are formed on opposite sides of and integrally with sleeve 65 through vertical portions 69. The engaging members 67 depend downwardly from sleeve 63 on vertical portions 69, and fit within recesses 45. Referring to Figure 3, each engaging member 67 has a pair of upper shoulders 71 on opposite sides of vertical portion 69. Shoulders 71 are parallel with recess upper walls 47 and bear against the upper walls 47 when lifting gate segments 37. The lower face of engaging member 67 has two sloping or bevelled portions 73 that are inclined at the same angle α of 45 degrees with respect to the stem 19 axis. Bevelled portions 73 are adapted to engage the recess portions 49. The height of engaging portion 67 is slightly less than the distance from the recess upper wall 47 to the lower wall portion 51, allowing some play when shifting between clockwise and counterclockwise stem rotation.

- An end stop 75 is secured in the bottom of central cavity 17 by an interference fit and welded. As shown in Figure 3, end stop 75 is generally a triangular prism, with converging sides 77 that protrude upwardly from the bottom of cavity 17, forming a flat ridge at the top of length less than the width of gate segments 37. The end stop 75 ridge is intersected by the stem 19 axis. The width of end stop 75 ridge is about 1/16 to 1/8 inch. The sides converge at an angle β that is about 30 degrees with respect to the stem 19 axis.

- In operation, the valve is in the fully open position when the gate segments 37 have been lifted to the position where apertures 41 are substantially coaxial with passages 13. The lift nut 63 will be in its highest position, with the threads 25 of stem 19 being received in the vertical channel 55. The shoulders 71 of the engaging member 67 bear against the recess upper walls 47 during lifting and in the fully open position.

- To move the closed position, the stem is rotated

- clockwise to move lift nut 63 downward. The bevelled corners 73 of the engaging members 67 bear against the recess inclined portions 49 to push the gate segments 37 downward. Eventually, the bottom of the gate segments will contact end stop 75. Gate segment bevels 57 will mate with the converging sides 77, sliding down them. The converging sides 77 serve as a wedge to drive the gate segments apart and tightly against seat rings 27, as shown by the phantom lines in Figure 3. For illustration purposes, the phantom lines are indicated at a greater amount of expansion than actually occurs. Since the angle of inclination is equal or less for end stop 75 than recess 45, the lower end of the gates will expand simultaneously with the upper end or before the upper end fully expands. Once wedged tightly against the seats, the upper end of the gate segments will expand against the seats due to the wedging action of recess inclined walls 49. Once fully wedged, a tight primary metal to metal seal is obtained, backed up by the resilient seal 29.

- If due to the pitting of the gate segments 37, or the inner faces of seat rings 27, or deterioration of the seal ring 29, leakage occurs, a secondary seal can be obtained. Conventional sealant for valves is introduced under pressure through the valve means, port 35, groove 31, and passage 33 to the seal ring 29. The sealant pressure must exceed line pressure plus frictional losses. The sealant, which is a thick viscous liquid similar to grease, forces the seal ring 29 to conform to the pits in the gate segments to seal. It also seals around and forms a seal itself, even if the resilient seal ring 29 has deteriorated.

- It should be apparent that an invention having significant advantages has been provided. The gate valve provides sealing for high pressures by utilizing a wedging action to force the gate segments against the seat rings. The equal or different taper angles at the top and bottom cause the bottom to expand simultaneously with or before the top. This avoids any possibility of the upper portion expanding and wedging in a manner that would prevent any further downward and outer movement of the lower portion of the gate segments. The seal ring and sealant passages provide an effective secondary sealing system should leaking of the primary seal occur.

CLAIMS

1. A gate valve comprising in combination:
a body with an upstream passage and a downstream passage separated by a central cavity;
a threaded stem extending into the central cavity transverse to the passages;
handle means for rotating the stem;
a pair of seat rings mounted in the passages at their inner ends and opposing each other, each seat ring being a cylinder with an inner end having an annular seal groove, the outer wall of the cylinder having an annular sealant groove formed in its surface, the cylinder further having a passage communicating the seal groove with the sealant groove;
a single, non-metallic, resilient seal ring located in



The recesses 45 and channels 55 are formed at the same position on each gate segment to define respectively a horizontal passage and a vertical cylindrical cavity.

- 5 A bevelled surface 57 is located on each gate segment 37 at the lower edge of the inner face. As shown in Figure 3, the bevel 57 is at the corner of the bottom of the gate segment and the inner face. Bevelled surface 57 extends across the inner faces
10 and is inclined at an angle β with respect to the axis of the stem. Angle β may be equal to angle α or less, and is preferably 30 degrees.

- A plurality of coil springs 59 are mounted to the inner face of one of the gate segments 37 and extend
15 into mating holes (not shown) formed in the inner face of the other gate segment. The depth of the holes are selected so as to place the springs in compression when the gate segments are placed together, to urge the gate segments 37 against the
20 seat rings 27.

- A lift nut 63 forms the connection between the gate segments 37 and the stem 19 for raising and lowering the gate segments. Lift nut 63 has a threaded sleeve 65 that is threaded to stem threads
25 25. A pair of generally T-shaped engaging members 67 are formed on opposite sides of and integrally with sleeve 65 through vertical portions 69. The engaging members 67 depend downwardly from sleeve 63 on vertical portions 69, and fit within
30 recesses 45. Referring to Figure 3, each engaging member 67 has a pair of upper shoulders 71 on opposite sides of vertical portion 69. Shoulders 71 are parallel with recess upper walls 47 and bear against the upper walls 47 when lifting gate
35 segments 37. The lower face of engaging member 67 has two sloping or bevelled portions 73 that are inclined at the same angle α of 45 degrees with respect to the stem 19 axis. Bevelled portions 73 are adapted to engage the recess portions 49. The height
40 of engaging portion 67 is slightly less than the distance from the recess upper wall 47 to the lower wall portion 51, allowing some play when shifting between clockwise and counterclockwise stem rotation.

- 45 An end stop 75 is secured in the bottom of central cavity 17 by an interference fit and welded. As shown in Figure 3, end stop 75 is generally a triangular prism, with converging sides 77 that protrude upwardly from the bottom of cavity 17,
50 forming a flat ridge at the top of length less than the width of gate segments 37. The end stop 75 ridge is intersected by the stem 19 axis. The width of end stop 75 ridge is about 1/16 to 1/8 inch. The sides converge at an angle β that is about 30 degrees with
55 respect to the stem 19 axis.

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60 position, with the threads 25 of stem 19 being received in the vertical channel 55. The shoulders 71 of the engaging member 67 bear against the recess upper walls 47 during lifting and in the fully open position.

- 65 To move the closed position, the stem is rotated

- clockwise to move lift nut 63 downward. The bevelled corners 73 of the engaging members 67 bear against the recess inclined portions 49 to push the gate segments 37 downward. Eventually, the
70 bottom of the gate segments will contact end stop 75. Gate segment bevels 57 will mate with the converging sides 77, sliding down them. The converging sides 77 serve as a wedge to drive the gate segments apart and tightly against seat rings
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80 lower end of the gates will expand simultaneously with the upper end or before the upper end fully expands. Once wedged tightly against the seats, the upper end of the gate segments will expand against the seats due to the wedging action of recess
85 inclined walls 49. Once fully wedged, a tight primary metal to metal seal is obtained, backed up by the resilient seal 29.

- If due to the pitting of the gate segments 37, or the inner faces of seat rings 27, or deterioration of the
90 seal ring 29, leakage occurs, a secondary seal can be obtained. Conventional sealant for valves is introduced under pressure through the valve means, port 35, groove 31, and passage 33 to the seal ring 29. The sealant pressure must exceed line pressure
95 plus frictional losses. The sealant, which is a thick viscous liquid similar to grease, forces the seal ring 29 to conform to the pits in the gate segments to seal. It also seals around and forms a seal itself, even if the resilient seal ring 29 has deteriorated.

- 100 It should be apparent that an invention having significant advantages has been provided. The gate valve provides sealing for high pressures by utilizing a wedging action to force the gate segments against the seat rings. The equal or different taper angles at
105 the top and bottom cause the bottom to expand simultaneously with or before the top. This avoids any possibility of the upper portion expanding and wedging in a manner that would prevent any further downward and outer movement of the lower portion
110 of the gate segments. The seal ring and sealant passages provide an effective secondary sealing system should leaking of the primary seal occur.

CLAIMS

- 115 1. A gate valve comprising in combination:
a body with an upstream passage and a downstream passage separated by a central cavity;
a threaded stem extending into the central cavity
120 transverse to the passages;
handle means for rotating the stem;
a pair of seat rings mounted in the passages at their inner ends and opposing each other, each seat ring being a cylinder with an inner end having an
125 annular seal groove, the outer wall of the cylinder having an annular sealant groove formed in its surface, the cylinder further having a passage communicating the seal groove with the sealant groove;
130 a single, non-metallic, resilient seal ring located in



the seal groove, the seal ring being substantially the radial width of the sealant groove and having a flat face;

- a pair of gate segments carried slidingly in the
- 5 cavity between the seat rings, the gate segments being two separable sections, each having opposing inner faces, and outer faces that have a solid area for blocking flow through the passages in the closed position, the gate segments further having coaxial
- 10 apertures extending through them below the solid areas for allowing flow through the passages in the open position, each gate segment having a recess formed on its inner face above the aperture, each recess having an upper wall extending
- 15 perpendicular to the axis of the stem, and a lower wall having a portion sloping downwardly at a selected angle α with respect to the axis of the stem, the recesses being located opposite each other, each gate segment further having the lower edge of its
- 20 inner face bevelled at a selected angle β with respect to the axis of the stem;

- lift nut means for raising and lowering the gate segments upon rotation of the stem, the lift nut means having a threaded sleeve for threadingly
- 25 engaging the stem, and an engaging member connected to the sleeve and located in the opposing recesses, the engaging member having a pair of upwardly facing shoulders, each adapted to bear against one of the recess upper walls to draw the
- 30 gate segments upward as the stem is rotated to the closed position, the engaging member having a lower surface with portions inclined at the angle α with respect to the axis of the stem for bearing against the lower walls of the recesses as the stem is
- 35 rotated to the closed position; and

- an end stop located on the bottom of the cavity, the end stop protruding upward from the bottom of the cavity and converging at the selected angle 2β , the end stop engaging the bevels on the gate
- 40 segments as the stem is rotated to the closed position, the end stop and engaging member co-operating to urge the gate segments apart to seal tightly against the seat rings as a primary seal means; and

- 45 passage means leading to the exterior of the body and in communication with each of the sealant grooves for the introduction and maintenance of sealant under pressure, to force each seal ring face tightly against one of the gate segments as
- 50 secondary seal means.

2. The gate valve according to claim 1 wherein each seat ring comprises a cylinder secured in one of the passages with an inner end protruding into the cavity, the inner end of each cylinder having annular
- 55 seal groove, the outer wall of each cylinder having an annular sealant groove, and passage means extending from the seal groove to the sealant groove; and wherein a resilient seal ring is located in the seal groove; and a valve means is located on the
- 60 exterior of the body and in communication with the sealant groove for the introduction and maintenance of sealant under pressure at the seal, as a secondary seal means.

3. The gate valve according to either of claims 1
- 65 or 2 wherein the gate segments are generally

rectangular, with the recesses on each extending across the inner face, each recess being separated by a vertical channel formed in the inner face for providing clearance for the stem to extend.

- 70 4. The gate valve according to any one of the claims 1 to 3 wherein the engaging member comprises two portions depending downwardly from and on opposite sides of the sleeve.

5. The gate valve according to any one of claims
- 75 1 to 4 wherein the angle α is about 45 degrees and the angle β is about 30 degrees.

6. The gate valve according to any one of claims 1 to 5 wherein the converging surfaces of the end stop comprise a triangular prism.

- 80 7. A gate valve substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

Printed for Her Majesty's Stationery Office, by Croydon Printing Company Limited, Croydon, Surrey, 1982.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.