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BACKGROUND OF THE INVENTION

1. Field of the Invention:

This invention relates in general to gate valves, and in particular to an improved gate and seat which allows shearing of a wireline while maintaining post-shear seal integrity.

2. Description of the Prior Art:

During oil and gas production, wirelines are often lowered through some type of gate valve. Ideally, the wireline is removed from the well before the gate valve is closed. However, due to emergencies, or for other reasons, it sometimes becomes necessary to close the gate valve while the wireline is still located in the well and through the gate valve. In these situations, it is desirable for the gate and seat of the gate valve to be capable of shearing the wireline while retaining post-shear seal integrity.

Also of importance in gate valves used in the oil and gas industry is the durability of the sealing surfaces. Since the valves are opened and closed often, and usually under severe operating conditions, the durability of the sealing surfaces is important to avoid leakage and the necessity of having to frequently perform maintenance on the valves.

In the prior art, two types of coatings are generally used on valve gates. Some gate valves are coated with a layer of very hard material such as a carbide material. This type of coating offers great durability. However, use of this type of coating in valves that might have to shear a wireline is not recommended. This type of coating is generally brittle thereby being inherently subject to chipping. Also, this type of coating is generally thin, averaging between 0.003 inches and 0.005 inches. In this



1 section thickness, this coating is not capable of holding
2 an edge while cutting. Furthermore, since this coating is
3 not metallurgically bonded to the substrate material, high
4 shear stresses are developed at the coating-substrate
5 interface which promote cracking of the coating. Cracking
6 or chipping of the coating is not desirable because it
7 reduces sealing efficiency, thereby requiring replacement
8 of the gate more frequently.

9 Since coatings of very hard materials such as carbides
10 are not ideal for wireline cutting applications, wireline
11 shearing gates have been typically hardfaced with a hard
12 ductile material such as Stellite or Colmonoy to provide
13 protection against chipping when used for shearing.
14 However, large areas are sometimes difficult to coat with
15 these materials without cracking of the coating. Also,
16 such ductile materials have markedly inferior wear
17 characteristics compared to carbides and are easily
18 scratched or otherwise damaged.

19 Because of the above problem with coating or
20 hardfacing gates with either only an extremely hard
21 material or only a more ductile material, prior art gate
22 valves have not been suited for shearing wireline while
23 retaining post-shear seal integrity.



1 SUMMARY OF THE INVENTION

2 In this invention, the gate of a gate valve is coated
3 with a combination of materials to achieve a gate capable
4 of shearing wireline while retaining seal integrity. Since
5 ductility is desired at the shearing edge of the gate, and
6 extreme hardness is desired at the sealing surfaces of the
7 gate, this invention strategically locates, at appropriate
8 locations, materials having appropriate characteristics.

9 The shearing edges are constructed of an inlay of a
10 hard ductile material that provides protection against
11 chipping. The sealing surfaces, on the other hand, are
12 coated with an extremely hard material that provides
13 durability to the sealing surface. Although these
14 extremely hard sealing materials are very brittle and would
15 crack and chip if subjected to the high shearing stresses
16 encountered during shearing, this will be prevented by the
17 inlays of the more ductile material located at the shearing
18 edges that will isolate the brittle sealing material from
19 the majority of the shearing stresses.



1 **BRIEF DESCRIPTION OF THE DRAWINGS**

2 The novel features believed characteristic of the
3 invention are set forth in the appended claims. The
4 invention itself however, as well as a preferred mode of
5 use, and further objects and advantages thereof, will best
6 be understood by reference to the following detailed
7 description of an illustrative embodiment when read in
8 conjunction with the accompanying drawings, wherein:

9 **Figure 1** is a vertical sectional view illustrating a
10 typical gate valve.

11 **Figure 2** is a front view of a typical gate, but showing the
12 improvement according to this invention.

13 **Figure 3** is a side view of the gate shown in Figure 2.

14 **Figure 4** is a vertical sectional view of the gate shown in
15 Figure 1 taken along the line 4-4 in Figure 2.

16 **Figure 5** is a front view of a typical seat, but showing the
17 improvement according to this invention.

18 **Figure 6** is a vertical sectional view of the seat shown in
19 Figure 5 taken along the line 6-6 in Figure 5.

20 **Figure 7** is the same sectional view shown in Figure 6, but
21 showing a different arrangement of the inlay and the
22 coating of the seat.

23 **Figures 8A-8D** are parts of a sectional view taken along the
24 line 8-8 in Figure 1 and showing the steps used in
25 connecting the inlay to the gate.



1 Figure 9 is a cross sectional view of the gate of Figure 2
2 and of the seat of Figure 5 showing the shearing of a
3 wireline.



1

DETAILED DESCRIPTION OF THE INVENTION

2 Referring to FIG. 1, valve 11 is a standard gate
3 valve. Valve 11 has a body 13, and a flow passage 15 that
4 extends transversely through body 13. Valve 11 has a gate
5 17 with a hole 19 therethrough. The gate 17 can be either
6 split as shown or it can be a single slab. Gate 17 is
7 shown with one half 17 in the closed position and the other
8 half 17' in the open position. Of course, both halves must
9 open and close together. The valve 11 shown in FIG. 1 is
10 a non-rising-stem type valve, however, this invention can
11 similarly be used on rising-stem type valves, in which case
12 the gate 17 would look like the gate 17 shown in FIG. 2.
13 Also shown in FIG. 1 are ring shaped valve seats 21 and 21'
14 which have holes 23 and 23' that register with the flow
15 passage 15 of the valve.

16 When gate 17 is in the open position, the hole 19 of
17 gate 17 registers with flow passage 15 of the valve 11
18 thereby allowing flow through the valve. When the gate is
19 closed, the hole 19 no longer registers with the flow
20 passage 15. Instead, the coating 25 (FIG. 2) registers
21 with the flow passage 15 and comes into contact with seat
22 21.

23 FIG. 2 shows gate 17 in more detail. The gate 17
24 shown in FIG. 2 is for a rising-stem type valve and is
25 therefore configured a little differently than gate 17
26 shown in FIG. 1.

27 Gate 17 has some features that are identical except
28 for being located on different sides of gate 17. For
29 convenience, some of the numerals representing such
30 features are followed by the letter "a" or the letter "b".
31 The numerals followed by the letter "a" refer to features
32 located on one side of gate 17, while the same numeral
33 followed by a letter "b" refers to the same feature, but
34 located on the other side of gate 17. For example,
35 Stellite inlay 27a refers to the Stellite inlay 27 located
36 on one side of gate 17, while Stellite inlay 27b refers to



1 the Stellite inlay 27 located on the other side of gate 17.
2 When one of these numerals is not followed by either the
3 letter "a" or the letter "b", then the reference is to the
4 feature in general, irrespective of the side of gate 17 on
5 which it is located.

6 According to this invention, gate 17 has an inlay 27
7 along its shearing edge. Inlay 27 is formed of a hard
8 ductile material. The hardness is desirable to facilitate
9 shearing of a wireline 29 (shown in FIG. 9). The harder
10 the material, the better it will shear the wireline.
11 However, extremely hard materials, such as carbides, are
12 also very brittle. Brittleness is not desired because
13 chipping occurs thereby reducing the sealing capability of
14 the gate. Some ductility is desirable because it prevents
15 chipping. The preferred embodiment of the invention uses
16 Stellite. Stellite is a hard ductile material. It is hard
17 enough to allow shearing of the wireline, but is more
18 ductile than carbide materials, thereby preventing
19 chipping.

20 The inlay 27 of Stellite is applied to gate 17 as
21 shown in FIGS. 8A-8D. Before drilling hole 19 (shown in
22 FIG. 2), a groove 31 is machined into gate 17. The groove
23 31 extends from one side of gate 17 to the other side of
24 gate 17 and intersects what will later become hole 19.
25 Still referring to FIGS. 8A-8D, groove 31 has a bottom
26 surface 33, and an inclined surface 35. Inclined surface
27 35 can be either perpendicular to bottom surface 33,
28 thereby creating a 90 degree angle between the bottom
29 surface and the inclined surface, or it can be inclined at
30 some other angle, such as the 45 degree angle shown in FIG.
31 8A. Groove 31 extends from one side of gate 17 to the
32 other side of gate 17 for ease of manufacture. The groove
33 31 could have a different configuration as long as it
34 allows a shearing edge to be formed around at least a
35 portion of hole 19.

36 After groove 31 is machined into gate 17, groove 31 is
37 welded full with Stellite to form inlay 27. The welding



1 process results in the Stellite protruding above surfaces
2 37 and 39 of gate 17, as shown in FIG. 8B. As shown in
3 Figure 3, surface 37 is the surface along the face of gate
4 17 that extends from the groove towards the portion of the
5 gate where hole 17 is located. Surface 39 is the surface
6 on the face of gate 17 that extends from the groove towards
7 the sealing portion of gate 17. Surfaces 37 and 39 are the
8 surfaces which are later coated with the very hard
9 material.

10 Referring again to Figure 8, the inlay 27 is then
11 ground down to leave a rectangular notch 41 of Stellite
12 protruding above surfaces 37 and 39, as shown in FIG. 8C.
13 The Stellite around the rectangular notch 41 is ground down
14 flush with the surfaces 37 and 39 of gate 17, as shown in
15 FIG. 8C.

16 Before the extremely hard coatings are applied to the
17 gate, hole 19 is drilled into gate 17 as shown in FIG. 2.
18 Once hole 19 has been drilled and inlay 27 has been
19 prepared as described above, surfaces 37 and 39, and the
20 portions of inlay 27 that have been ground flush with
21 surfaces 37 and 39 can be coated with an extremely hard
22 material such as tungsten carbide. The coating deposited
23 on surface 39 will be referred to as coating 25, while the
24 coating deposited on surface 37 will be referred to as
25 coating 43. Coatings 25 and 43 are deposited by a
26 conventional high energy deposition technique such as
27 Praxair's LW-45. The coating 25, deposited onto surface 39
28 and the portion of inlay 27 that is flush with surface 39,
29 will form the sealing surface that will contact against
30 seat 21. During opening and closing of the valve, coating
31 25 is subject to scratching and other damage which must be
32 prevented if the seal integrity of the valve is to be
33 preserved. Therefore, it is desirable for coating 25 to be
34 very durable. Because tungsten carbide is an extremely
35 hard material, it affords great durability.

36 In the preferred embodiment, both surfaces 37 and 39
37 are coated with tungsten carbide. However, since surface



1 37 does not perform any sealing functions, it need not be
2 coated. In the case that surface 37 is not coated, then
3 surface 37 should be made to be flush with coating 25 on
4 surface 39 and flush with the rectangular notch 41 of inlay
5 27.

6 The above process will result in the shearing edge of
7 hole 19 having reinforcements of Stellite as shown in FIG.
8 4. Hole 19 has a circular opening at each end of the hole.
9 The intersection of the opening of hole 19 and of surfaces
10 37a and 39a define a circumference. The above process
11 results in a Stellite shearing edge along at least a
12 portion of this circumference. Since only a portion of
13 this circumference acts as a shearing edge, only that
14 portion of the circumference needs to have the Stellite
15 shearing edge. However, the Stellite shearing edge can
16 extend completely around the circumference.

17 The above description discussed improving only one
18 side of gate 17. This would be the case where valve 11 is
19 of a type that uses two physically separated gates working
20 in unison as illustrated in FIG. 1. In such a case, only
21 one side of each gate would need to be improved. Each gate
22 would have a sealing surface and a back surface. The
23 sealing surface would be improved with Stellite inlay 27
24 and tungsten carbide coatings 43 and 25. The back surface
25 would be left in its natural state, since it performs no
26 sealing functions.

27 However, in a valve that uses only one gate, both the
28 sealing surface and the back surface would be sealing
29 surfaces, and both would need to be improved with Stellite
30 inlay 27a and 27b and tungsten carbide coatings 43a, 43b,
31 25a, and 25b.

32 In the preferred embodiment of this invention, seats
33 21 have an inlay 45 of a hard ductile material that forms
34 a shearing edge. The hardness is desirable to facilitate
35 shearing of the wireline. The harder the material, the
36 better it will shear the wireline. However, some of the
37 very hard materials are also very brittle. Brittleness is



1 not desired because chipping occurs thereby reducing the
2 sealing capability of the seat. Some ductility is
3 desirable because it prevents chipping. The preferred
4 embodiment of the invention uses Stellite for inlay 45.

5 In the preferred embodiment, inlay 45 is applied to
6 seat 21 by a process similar to the process used for
7 applying inlay 27 to gate 17. Referring to FIG. 6, a
8 groove is machined into the circumference defined by the
9 intersection of hole 23 and of sealing surface 47 of the
10 seat 21. The Stellite inlay 45 is then welded into the
11 groove and machined to remove the excess portions of inlay
12 45. The remainder of surface 47 is then coated with a
13 coating 49 of an extremely hard material such as tungsten
14 carbide. The coating 49 is deposited so that coating 49
15 and the outward surface of the inlay 45 are flush, thereby
16 providing a smooth sealing surface. Tungsten carbide is an
17 extremely hard material that affords great durability.
18 Since the coating 49 deposited onto surface 47 will form
19 the sealing surface that will contact against the sealing
20 surface of gate 17, this coating needs to be very durable
21 to preserve the integrity of the seal. Tungsten carbide
22 provides such durability.

23 Although the seat described above has both Stellite
24 inlay 45 and tungsten carbide coating 49, it would also be
25 feasible to use only a Stellite inlay 45 that extends
26 across the entire surface 47 of seat 21, as shown in FIG.
27 7.

28 The desired thicknesses in the preferred embodiment
29 for inlays 27 and 45 and for coatings 25, 43, and 49 are as
30 follows. After grinding, the Stellite inlays 27 and 45
31 should preferably be about 0.080 inches. However,
32 thicknesses between 0.060 inches and 0.100 inches have also
33 been found to be acceptable. Thicker inlays should also be
34 theoretically acceptable, however, most of the processes
35 used to apply the Stellite to the gate limit the maximum
36 thickness to about 0.100 inches. The preferable thickness
37 of carbide coatings 25, 43, and 49 is 0.005 inches.

1 However, thicknesses between 0.003 inches and 0.006 inches
2 have also been found to be acceptable.

3 As described above, the preferred embodiment uses
4 Stellite for inlays 27 and 45 and tungsten carbide for
5 coatings 25, 43, and 49. However, different materials,
6 having similar characteristics could also be used. The
7 following criteria should be used in selecting appropriate
8 materials. The material used for coatings 25, 43 and 49
9 should be a very hard, wear resistant material. The
10 preferred embodiment uses tungsten carbide for coating 25,
11 43, and 49. The hardness of the tungsten carbide coatings
12 of the preferred embodiment is in excess of 65 on the
13 Rockwell C hardness scale. Such hardness is sufficient to
14 provide a wear resistant sealing surface that is not easily
15 scratched.

16 The material for inlays 27 and 45 should be a hard
17 material that is relatively ductile when compared to the
18 material used for coatings 25, 43 and 49. The material
19 selected for inlays 27 and 45 must be sufficiently hard to
20 allow shearing of a wireline extending through the valve
21 11, and must also be sufficiently ductile so that a small
22 deformation will not cause fracture of the material. The
23 preferred embodiment uses Stellite for inlays 27 and 45.
24 The hardness of the Stellite used in the preferred
25 embodiment is in the range of about 40 to 50 on the
26 Rockwell C hardness scale. This hardness is sufficient to
27 allow shearing of a wireline. However, Stellite was also
28 selected for the preferred embodiment because it is
29 relatively ductile when compared to the material used for
30 coatings 25, 43 and 49, and will not chip or fracture when
31 subjected to the deformations caused during shearing of a
32 wireline.

33 Referring now to FIG. 9, wireline 29 is shown
34 extending through seat 21', gate 17, and seat 21. Gate 17
35 is shown in a nearly closed position. If gate 17 were in
36 its open position, hole 19 would be aligned with the flow
37 passages defined by holes 23 and 23' of seats 21 and 21'.



1 If gate 17 were in its closed position, then coatings 25a
2 and 25b would be completely obstructing the flow passage
3 defined by holes 23 and 23'. As shown in FIG.9, gate 17 is
4 moving from its open position to its closed position as
5 indicated by the arrow.

6 As gate 17 continues its movement from the open
7 position to the closed position, wireline 29 will
8 eventually come into contact with inlay 27a on gate 17 and
9 with inlay 45' on seat 21'. Wireline 29 will also
10 eventually come into contact with inlay 27b on gate 17 and
11 with inlay 45 on seat 21. As increasing force is applied
12 to gate 17, there will be a shearing action between inlay
13 27a and inlay 45' and between inlay 27b and inlay 45. This
14 shearing action will result in the shearing of wireline 29.
15 Once wireline 29 is sheared, gate 17 will be able to
16 continue to its closed position.

17 Once the gate is in its closed position, and assuming
18 that pressure is higher at seat 21 than at seat 21', then
19 coating 25a will come into contact with coating 49', and
20 possibly inlay 45', thereby creating a seal that will
21 prevent flow through the valve 11.

22 Since the shearing edges are formed by Stellite inlays
23 27 and 45, the shear stresses will mainly be born by those
24 edges, thereby insulating the carbide coatings 25 and 49
25 from the high shear stresses developed by the shearing of
26 the wireline. Since coatings 25 and 49 will not have
27 encountered the high shearing stresses, chipping of those
28 coatings will not occur, and the sealing integrity of the
29 seal will have been preserved.

30 While the invention has been particularly shown
31 and described with reference to a preferred embodiment, it
32 will be understood by those skilled in the art that various
33 changes in form and detail may be made therein without
34 departing from the spirit and scope of the invention.

35 What is claimed is:

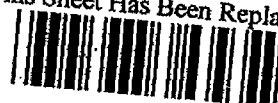




1 1. In a gate valve comprising a body, a flow passage, at
2 least one gate having a hole therethrough which registers
3 with the flow passage when the gate is in an open position,
4 and at least one seat located in the flow passage and to
5 which the gate seals when in a closed position, the gate
6 comprising in combination:

7 a shearing edge located on an edge of the hole for
8 shearing a wireline in the flow passage, the shearing edge
9 being formed of a material harder than the material of the
10 gate; and

11 the gate having a sealing surface that slidably
12 engages the seat as the gate moves to the closed position,
13 the sealing surface being a coating of material having more
14 hardness than the material of the shearing edge.





- 1 2. A gate valve according to Claim 1 wherein the seat
- 2 further comprises a shearing edge made of a material harder
- 3 than the material of the gate.





1 3. A gate valve according to Claim 1 wherein the seat
2 further comprises a shearing edge made of a material harder
3 than the material of the gate, and a sealing surface made
4 of a material having more hardness than the material of the
5 shearing edge.





- 1 4. The gate valve according to Claim 1 wherein the
2 material of the shearing surface is Stellite.





* C L M S *

- 1 5. The gate valve according to Claim 1 wherein the
- 2 material of the sealing surface is tungsten carbide.





1 6. In a gate valve comprising a body, a flow passage, at
2 least one steel gate having a hole therethrough which
3 registers with the flow passage when the gate is in an open
4 position, and at least one seat located in the flow passage
5 and to which the gate seals when in a closed position, the
6 gate comprising in combination:

7 a flat sealing surface on one side of the gate for
8 slidably engaging the seat, the sealing surface having a
9 carbide coating;

10 a flat back surface on an opposite side of the gate
11 that is parallel to the sealing surface;

12 the hole having a first circular opening intersecting
13 the sealing surface and a second circular opening
14 intersecting the back surface;

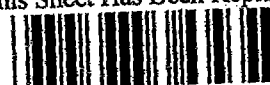
15 the first circular opening defining a first
16 circumference and the second circular opening defining a
17 second circumference; and

18 a shearing portion made of a shearing material harder
19 than steel and more ductile than the carbide of the sealing
20 surface located at least partially around the first
21 circumference for shearing in the event of an emergency a
22 wireline extending through the flow passage.





- 1 7. The gate valve according to Claim 6 wherein the
- 2 shearing material is Stellite.



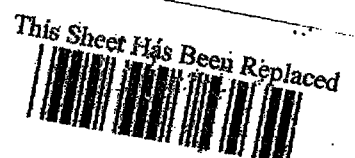


- 1 8. The gate valve according to Claim 6 wherein the
- 2 carbide coating is tungsten carbide.





- 1 9. The gate valve according to Claim 6 wherein the seat
- 2 comprises a shearing edge made of a material harder than
- 3 steel and more ductile than tungsten carbide.





- 1 10. The gate valve according to Claim 6 wherein the seat
2 additionally comprises a carbide coating located on at
3 least part of a portion contacted by the gate.





- 1 11. The gate valve according to Claim 6 wherein the
- 2 shearing portion is located on both the first circumference
- 3 and the second circumference.





1 12. In a gate valve comprising a body, a flow passage, at
2 least one gate having a hole therethrough which registers
3 with the flow passage when the gate is in an open position,
4 and at least one seat located in the flow passage and to
5 which the gate seals when in a closed position, the gate
6 comprising in combination:

7 a flat sealing surface on one side of the gate for
8 slidingly engaging the seat, the sealing surface having a
9 carbide coating;

10 a flat back surface on an opposite side of the gate
11 that is parallel to the sealing surface, the back surface
12 having a carbide coating;

13 the hole having a first circular opening intersecting
14 the sealing surface and a second circular opening
15 intersecting the back surface;

16 a first groove across the sealing surface intersecting
17 the first circular opening;

18 a second groove across the back surface intersecting
19 the second circular opening; and

20 an inlay in both the first and second groove of a
21 shearing material harder than steel and more ductile than
22 the carbide coating of the sealing surface.





- 1 13. The gate valve according to Claim 12 wherein the
- 2 shearing material is Stellite.



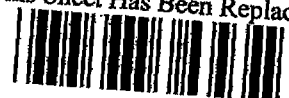


- 1 14. The gate valve according to Claim 12 wherein the
- 2 carbide coating is tungsten carbide.





1 15. The gate valve according to Claim 12 wherein the seat
2 comprises a shearing edge made of a material harder than
3 steel and more ductile than tungsten carbide.





- 1 16. The gate valve according to Claim 12 wherein the seat
- 2 additionally comprises a carbide coating located on at
- 3 least part of a portion contacted by the gate.





1 17. A method of hardfacing at least one gate for a gate
2 valve, the gate having a hole therethrough, a sealing
3 surface on one side of the gate for slidingly engaging the
4 seat, a flat back surface on an opposite side of the gate
5 that is parallel to the sealing surface, the hole having a
6 first circular opening intersecting the sealing surface and
7 a second circular opening intersecting the back surface,
8 the first circular opening defining a first circumference,
9 and the second circular opening defining a second
10 circumference, comprising the steps of:

11 forming a groove in the sealing surface from one side
12 edge to the other side edge and intersecting the first
13 circumference;

14 depositing by welding an inlay in the groove of a
15 shearing material harder than steel;

16 grinding the inlay to provide a smooth surface; then

17 depositing a carbide coating around the inlay and over
18 the sealing surface.





1 18. The method of Claim 17 wherein the step of depositing
2 a shearing material in the groove is performed by
3 depositing Stellite in the groove.



- 1 19. The method of Claim 17 wherein the step of depositing
- 2 a carbide coating around the inlay is performed by
- 3 depositing tungsten carbide.





1 20. The method of Claim 17 wherein the steps of forming a
2 groove, depositing an inlay, grinding the inlay, and
3 depositing a carbide coating are also performed on the back
4 surface.

