METHOD FOR LAPPING, GRINDING, HONING AND POLISHING SEAL SURFACES ON INNER DIAMETER OF SEMI-BLIND CAVITY IN VALVE BODY

BACKGROUND OF INVENTION

1. Field of the Invention

[0001] The present invention relates in general to fabricating valve bodies and, in particular, to an improved system, method and apparatus for lapping, grinding, honing and polishing seal surfaces on inner diameters of semi-blind cavities in valves bodies.

2. Background of the Invention

[0002] A valve is a device that generally regulates the flow of a material by opening, closing, or partially obstructing a path through the valve. The material may be a gas, a liquid, a fluidized solid, or slurry. A variety of different types of valves exist, such as gate valves, and globe valves.

[0003] A gate valve typically consists of a valve body, a bonnet, a valve member, and a valve seat. The valve body and the bonnet form the area in the valve that contains and directs material through the valve. The valve body, for example, may have a bore that extends through the valve body. The valve member interacts with the valve body to control the flow of material passing through the valve by being positioned to close or restrict flow. For example, a sliding gate with an opening can function as a valve member such that the opening aligns with the passage in the valve body to allow flow. Alternatively, a solid portion of the sliding gate can be aligned partially or fully with the passage to restrict or block flow. The bonnet is attached to the valve to

hold other valve components, such as the valve member, in place and can be removed to provide access to the internal parts during maintenance.

[0004] In a gate valve, the valve seat is the interior surface in the valve body that contacts the gate to form a seal. The gate comes into contact with the seat when the valve is closed. The body and the seat could both come in a single piece of solid material or, alternatively, the seat could be a separate valve part that is attached or fixed to a seat pocket on the inside of the valve body.

[0005] When the seat is a separate valve part, the dimensions of the seat and seat pocket must correspond or the seat will not sit properly within the seat pocket of the valve body and leakage may occur. Thus, it is important that the dimensions of the seat pocket are precisely machined to prevent form errors and surface finish errors. The finishing tools used to correct or prevent such errors can thus be very expensive. Therefore, a more cost-effective technique for lapping, grinding, honing, and polishing seal surfaces on the seat pockets of a valve is desired.

SUMMARY OF THE INVENTION

[0006] In an embodiment of the present technique, a tool assembly comprising a cylindrical member, wheels of varying diameter and abrasive surface, and a rod for applying torque, are provided. A tool assembly allows for lapping, grinding, honing and polishing seal surfaces on inner diameters of semi-blind cavities in valve bodies. The tool can bring seat surfaces up to specification with the abrasive wheels having varying grit sizes. The wheels are provided in an array of sizes to form a set of tools for a range of diameters, abrasion and surface finish capacity. This design allows the first (i.e., smallest) tool to enter a cavity in a valve body to begin cutting. The wheel is attached to an end of the cylindrical member and rotated by applying torque through the rod that may traverse the opposite end of the cylindrical member. Once the small diameter wheel has completed its cutting operation, it can be replaced with the larger size wheels to increase the diameter of the cavity, or valve seat, being machined until the desired size is achieved. Wheels with finer abrasive can then used to improve the surface finish of the cavity while minimizing the material removal. When the desired diameter and/or surface finish has been achieved, a felt wheel may be used with a fine abrasive paste to provide the cavity with the final surface finish specification.

[0007] The use of the tool assembly to obtain a desired diameter and finish for valve seat sealing surfaces is cost-effective. In the past, expensive and specialized machining tools were required to obtain the desired diameter and finish.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] So that the manner in which the features and advantages of the present invention are attained and can be understood in more detail, a more particular description of the invention briefly summarized above may be had by reference to the embodiments thereof that are illustrated in the appended drawings. However, the drawings illustrate only some embodiments of the invention and therefore are not to be considered limiting of its scope as the invention may admit to other equally effective embodiments.

[0009] FIG. 1 is a sectional isometric view of one embodiment of a gate valve constructed in accordance with the invention;

[0010] FIG. 2 is an enlarged sectional isometric view of one embodiment of a portion of a seat and seat pocket of the gate valve of FIG. 1, and is constructed in accordance with the invention;

[0011] FIG. 3 is a schematic side view of one embodiment of a surface finishing tool for gate valves and is constructed in accordance with the invention;

[0012] FIG. 4 is an isometric view of one embodiment of a set of tooling for the surface finishing tool of FIG. 3; and

[0013] FIG. 5 is a schematic side view of another embodiment of a surface finishing tool for gate valves and is constructed in accordance with the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0014] FIGS. 1 – 5 depict embodiments of an improved system, method and apparatus for lapping, grinding, honing and polishing seal surfaces on inner diameters of semi-blind cavities in valves bodies. With respect to FIG. 1, the present invention is described as it may be applied in conjunction with an exemplary technique, in this case a technique for finishing a surface within the bore of a gate valve assembly for controlling the flow of a fluid, such as oil and/or gas, and is represented generally by reference numeral 20. In addition, the illustrated embodiment of the gate valve 20 is a grease-less valve. However, the present technique may be used in valves other than gate valves and other than grease-less valves.

[0015] In the illustrated embodiment, the gate valve assembly 20 comprises a valve body 22 having a bore 24 extending though the valve body 22. The bore 24 has a first opening 26 and a second opening 28. In this embodiment, the gate valve 20 is a bi-directional valve. Therefore, the first opening 26 may be used as an inlet to the bore 24 in one configuration and as an outlet in another configuration, as can the second opening 28.

[0016] In addition, this embodiment of the valve 20 has a valve cavity 30 that is covered by a bonnet 32. A pair of seats 34 extends into the cavity 30 from seat pockets 36 formed on opposite sides of the cavity 30 in the bore 24 through the valve body 22. A gate 38 is housed in the cavity 30 between the seats 34. The gate 38 has an opening 40 and a solid portion 42 that are positioned to control flow through the gate valve 20. When the gate 38 is positioned with the opening 40 aligned with the bore 24, the valve 20 is open and fluids are able to pass through the

bore 24 via the opening 40 in the gate 38. When the gate 38 is positioned with the solid portion 42 aligned with the bore 24, the valve 20 is closed and fluids are blocked from flowing through the bore 24 by the solid portion 42 of the gate 38.

[0017] The valve 20 also has a valve stem 44 that extends through the bonnet 32 to enable a user to position the gate 38 in either the open or closed configuration. A hand wheel (not shown) or some other actuator may be used to position the valve stem 44. For example, a hydraulic actuator may be used to control the position of the gate 38. An electrical or pneumatic actuator may be used, as well.

[0018] Referring generally to FIG. 2, the seat 34 has a seat seal 46 that is used to form a seal between the seat 34 and the seat pocket 36. The seat seal 46 prevents flow from leaking from the bore 24 via the seat 34. In this embodiment, the seat seal 46 has a U-shaped portion 48 with a pair of sealing surfaces 50 that contact the seat pocket 36 on one side and the seat 34 on the opposite side of the seat seal 46. A standoff ring 52 is provided to extend between the back face 54 of the seat pocket 36 and the U-shaped sealing portion 48 of the seat seal 46. When installed in the seat pocket 36, the standoff ring 52 abuts the seat pocket back face 54 and urges the U-shaped sealing portion 48 of the seat seal 46 outward so that the sealing surfaces 50 of the seat seal 46 make contact with the seat pocket 36 and seat 34, respectively. In addition, the seat 34 has a seat spring 56 that urges the seat 34 against the gate 38.

[0019] The correspondence between the seat seal 46 and the seat pocket 36 enables a seal to be maintained without the use of grease. However, if the surface profile of the seat pocket 36 is rough or is not round, the sealing surfaces 50 of the seat seal 46 may not maintain a seal. Therefore, leakage from the bore 24 may occur. The surface profile of the seat pocket 36 may be

too rough for a proper seal due to chatter from the machining operations used to form the seat pocket 36, incidental damage to the surface finish, or some other cause. Similarly, the surface profile of the seat pocket 36 may have been machined somewhat oval rather than round. The surface profile of the seat pocket 36 may be repaired if it is not sufficiently smooth and/or round. For example, the seat pocket 36 may be machined to re-bore the seat pocket 36.

[0020] Referring now to FIGS. 3 and 4, embodiments of an improved system, method and apparatus for lapping, grinding, honing and polishing seal surfaces on the inner diameters of semi-blind cavities in valves bodies are shown. In one embodiment, a round, fixed abrasive tool 61 has an abrasive wheel 63 fixed to the distal end 64 of an outside diameter of a central cylindrical shaft 65. In one embodiment (FIG. 5), the shaft 65 may be supported on or adjacent its ends 64, 66 by bushings 70. The grit sizes of the abrasive on the wheels 63 (see, e.g., FIG. 4) may be provided in the range of 325 to 1200 mesh, for example. The wheels 63 are provided in an array of sizes, as shown, to form a set of tools for a range of diameters, abrasion and surface finish capacity. This design allows the first (i.e., smallest) tool to enter the cavity defined within the cylindrical surface 36 and begin cutting. Additional larger sizes of the wheels 63 increase the diameter of the cavity being machined until the desired size is achieved.

[0021] The shaft 65 is inserted into the bore 24 (FIG. 3) and the cylindrical tool shape may be used to radially constrain the device 61. The bushings 70 (FIG. 5) are located in the bore 24 for precise, additional support of the shaft 65. Both pockets 36 are machined with this process. In one embodiment, this tool 61 is not designed to machine axial surfaces 54, but only radial or cylindrical surfaces 36. Axial surface 64 is normal to the axis of bore 24. The abrasive tool 61 is pushed forward (i.e., to the left in FIG. 3) to machine the front radial pocket (i.e., left side 36 in

FIG. 3), and the abrasive tool 61 is pulled rearward (i.e., to the right) to machine the rear radial pocket 36 (i.e., right side 36).

[0022] The assembled tooling 61 may be rotated by hand or machine-driven. For example, in FIG. 3, a handle 67 is mounted to the proximal end 66 of shaft 65. Without one of the wheels 63 (and, e.g., one of the bushings 70) attached, the distal end 64 of the shaft 65 is axially positioned within valve cavity 30. A selected one of the wheels 63 is then attached to distal end 64 and secured thereto while in cavity 30. While rotating the tool 61 by hand, the wheel 63 has sufficient taper to allow its leading edges to enter the cavities 36 and allow the abrasive to engage the inside diameter of the cavity wall 36. The tool 61 is continually rotated and slowly fed into the cavity 36 until the wheel 63 is fully inserted into the cavity to treat the surfaces 36.

[0023] After sufficient lapping, grinding, honing and/or polishing has occurred with a selected one of the wheels, the smaller diameter wheel is replaced by a next larger diameter wheel, and the process is repeated as needed. When the diameter of the cavity has been enlarged to the lower end of the desired range of diameters, the wheels with finer abrasive are then used to improve the surface finish of the cavity while minimizing the material removal. When the desired diameter and/or surface finish has been achieved, a felt wheel may be used with a fine abrasive paste to provide the cavity with the final surface finish specification.

[0024] Form errors and surface finish errors contributing to leakage in high pressure valves were corrected to achieve superior sealing in extreme subsea applications. In the machining of super alloys and super alloy coated parts, there is difficulty in the machining of the super alloy. Special tooling and expensive machinery are required to perform these processes. The invention machines the surfaces to allow an existing machining process to be used to rough machine a part

at a low cost and with precision. The part is then finished machined using hand operated tooling that requires no high cost equipment. The valves operate with better sealing and without the need of new equipment to perform the operation. The industry standard is a machining practice and the new method had not been applied to this application.

[0025] While the invention has been shown or described in only some of its forms, it should be apparent to those skilled in the art that it is not so limited, but is susceptible to various changes without departing from the scope of the invention.

CLAIMS

What is claimed is:

1. A method of finishing a surface (50) of a seat pocket (36) of a gate valve (20), the gate valve (20) having a body (22) with a central chamber (30) intersected by co-axial flow passages (26, 28), the seat pocket (36) being a counterbore formed at an intersection of one of the flow passages (26, 28) with the central chamber (30), a distal end (64) of a cylinder member (65) inserted into one of the flow passages (26, 28) and into the chamber (30) in the valve body (22), the method characterized by:

attaching a wheel (63) having an abrasive circumferential surface to the distal end (64) of the drive shaft (65);

inserting a leading edge of the wheel (63) into the seat pocket (36);

rotating the drive shaft (65) and the wheel (63) drive shaft (65) as the abrasive surface on the wheel (63) engages the inside diameter of the seat pocket (36); and

applying axial force to a proximal end (66) of the drive shaft (65) to advance the wheel (63) into the seat pocket (36) as it rotates.

2. The method of claim 1, wherein the wheel (63) has a larger diameter than the flow passage (26, 28) in which it is inserted, and the step of attaching a wheel (63) further comprising attaching the wheel (63) while the distal end (64) of the drive shaft (65) is in the chamber (30).

3. The method of claim 1, wherein the drive shaft (65) has an outer diameter selected such that it closely fits within said one of the flow passages (26, 28).

4. The method of claim 1, further comprising inserting the drive shaft (65) within a bushing (70) and placing the bushing (70) within said one of the flow passages (26, 28) so as to maintain the drive shaft (65) coaxial with an axis of said one of the flow passages (26, 28).

5. The method of claim 1, wherein:

the step of applying axial force to a proximal end (66) of the drive shaft (65) comprises axially pushing on the drive shaft (65).

6. The method of claim 1, wherein:

the step of applying axial force to a proximal end (66) of the drive shaft (65) step comprises axially pulling the drive shaft (65).

7. The method of claim 1, wherein the surface to be finished is for a first and a second seat pocket (36) of a gate valve (20), further comprising:

while the distal end (64) is in the chamber (30), attaching a wheel (63) having an abrasive circumferential surface to the distal end (64) of the drive shaft (65), the wheel (63) having an outer diameter greater than an inner diameter of the first and second flow passages (26, 28);

inserting a leading edge of the wheel (63) into the first seat pocket (36);

at a proximal end (66) of the drive shaft (65), rotating the drive shaft (65) and the wheel (63) as the abrasive surface on the wheel (63) engages the inside diameter of the first seat pocket (36); and

applying axial force to the proximal end (66) of the drive shaft (65) to advance the wheel (63) into the first seat pocket (36) as it rotates;

withdrawing the wheel (36) from the first seat pocket (36) and inserting the leading edge of the wheel (63) into the second seat pocket (36);

rotating the drive shaft (65) and the wheel (63) as the abrasive surface on the wheel (63) engages the inside diameter of the second seat pocket (36), applying an axial force to the proximal end (66) of the drive shaft (65) to advance the wheel (63) into the second seat pocket (36) as it rotates, the direction of the axial force being opposite to that applied to advance the wheel (63) into the first seat pocket (36).

8. The method of claim 7, wherein the drive shaft (65) has an outer diameter selected such that it closely fits within said one of the flow passages (26, 28).

9. The method of claim 7, further comprising inserting the drive shaft (65) within a bushing (70) and placing the bushing (70) within said one of the flow passages (26, 28) so as to maintain the drive shaft (65) coaxial with an axis of said one of the flow passages (26, 28).

10. The method of claim 7, wherein:

the step of applying axial force to a proximal end (66) of the drive shaft (65) comprises axially pushing on the drive shaft (65).

11. The method of claim 7, wherein:

the step of rotating the drive shaft (65) and the wheel (63) as the abrasive surface on the wheel (63) engages the inside diameter of the second seat pocket (36), applying an axial force to the proximal end (66) of the drive shaft (65) comprises axially pulling on the drive shaft (65).