

GATE VALVE BONNET ASSEMBLY WITH BUILT-IN SPEED REDUCER

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a gate valve bonnet assembly. More specifically, the present invention relates to a bonnet assembly having a built-in speed reducer which slows down the valve opening cycle of a pneumatically actuated gate valve while allowing rapid return during the valve closure cycle.

2. Description of Related Art

Gate valve pneumatic actuators are pressurized to the control pressures required to operate the gate valve. This stored energy in the actuator is balanced against the valve pressure and frictional forces. However, as soon as the gate is cracked open, the oppositional forces disappear, thereby causing rapid movement and slamming of the actuator and the internal components of the valve. This rapid movement is responsible for serious damage to the gate and seat sealing surfaces which are under very high contact stresses during the actuation or opening cycle. Sometimes the damage will render the valve incapable of further pressure sealing. The slamming action can also cause serious structural damage to the various linkages between the actuator and the valve bonnet.

The closing cycle of the valve gate is significantly different because the gate and seats are not under high contact stresses during the closing cycle. Therefore, rapid movement does not damage the sealing surfaces. In fact, during the closing cycle, it is desirable to have rapid movement of the valve to prevent excessive erosion of the gate and seats as the valve pinches closed.

Several actuator manufacturers are attempting to develop external speed reducing devices which can be mounted on top of pneumatic actuators. However, such add-on units adversely affect the overall length of the actuated valve assembly, which has become critical in limited space situations, such as in offshore applications.

The object of the present invention is to overcome the aforementioned drawbacks of the prior art and to provide a gate valve with a bonnet assembly having a built-in speed reducer.

This Sheet Has Been Replaced



SUMMARY OF THE INVENTION

The objects of the present invention are achieved by providing a bonnet assembly mounted on the body of a gate valve and including a bonnet housing having a central bore therethrough and a chamber along the central bore; a valve stem movably positioned within the central bore and including a first end coupled to the gate of the gate valve and a second end coupled to a valve actuator for moving the valve stem and gate between a closed position and an open position; a piston movably positioned within the chamber and having at least one damping hole therethrough; a flange attached to the valve stem against the piston for moving the piston from a first position to a second position when the valve stem is moved between the closed position and the open position; and a mechanism for independently moving the piston from the second position to the first position when the valve stem is moved between the open position and the closed position.

In one embodiment of the present invention, the piston is formed of an annular piston slidably received on the valve stem, the chamber within the bonnet housing is filled with hydraulic fluid and the device for independently moving the piston to the first position is a spring positioned with the chamber biasing the piston toward the flange. The valve stem and the piston may be cylindrical with a first seal between the piston and the bonnet housing and a second seal between the piston and the valve stem. Additionally, the flange can include a beveled edge with the piston further including a beveled portion for receiving the beveled edge to ensure a secure engagement between the components.

These and other objects of the present invention will be clarified in the description of the preferred embodiment taken together with the attached figures, wherein like reference numerals represent like characters throughout.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a cross-sectional view of the gate valve according to the present invention with the gate valve in the closed position;

Fig. 2 illustrates the bonnet assembly of the gate valve shown in Fig. 1 with the valve stem of the bonnet assembly in the open position;

This Sheet Has Been Replaced



Fig. 3 illustrates the bonnet assembly of Figs. 1 and 2 moving between the closed position and the open position; and

Fig. 4 is an enlarged view of portion IV of the bonnet assembly shown in Fig. 3.

5

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Fig. 1 illustrates a gate valve 10 according to the present invention. Gate valve 10 includes a valve body 11 defining a fluid flow passage 12 therethrough between an inlet 13 and an outlet 14. A gate chamber 16 extends through a portion of the body 11 at a right angle to and intersecting the fluid flow passage 12. The passage 12 includes a pair of enlarged portions adjacent the gate chamber 16 into which is fitted a pair of cylindrical valve seats 22 and 23. Each valve seat may include an annular sealing member mounted to provide a fluid tight seal between the valve seats 22 and 23 and the enlarged portion of the passage 12. Each of the valve seats 22 and 23 extends into the gate chamber 16, where it is in sliding contact with a flat valve gate 30 having a port 34 therethrough.

When the gate 30 is positioned in the closed position, as shown in Fig. 1, the gate 30 blocks the flow of fluid between the inlet 13 and the outlet 14 of the passage 12. When the gate 30 is moved into an open position, the gate port 34 interconnects the inlet 13 and outlet 14 of the passage 12 to allow fluid to flow between the inlet 13 and the outlet 14. However, fluid could also flow in the opposite direction from the outlet 14 to the inlet 13.

According to the present invention, gate valve 10 also includes a bonnet assembly 40. Bonnet assembly 40 comprises a bonnet housing 41 having a bonnet housing cap 41A. Bonnet housing 41 is attached to the body 11 of gate valve 10 by a plurality of cap screws 42. The bonnet housing 41 includes a central bore 43 extending therethrough with a piston chamber 45 positioned along the central bore 43. A valve stem 48 is movably positioned within the central bore 43 with a first end of the valve stem 48 attached to the gate 30 and a second end of the valve stem 48 attached to a pneumatic valve actuator 50 (shown schematically in Fig. 1). The valve actuator 50 will move the valve stem 48 and the gate 30 between the closed position and the open position.

This Sheet Has Been Replaced



Appropriate packing 52 is provided around the valve stem 48 below the piston chamber 45 to seal off piston chamber 45 from gate chamber 16. The packing 52 is secured in place by a packing nut 54, and a passage 56 extends to the bore 43 through the bonnet housing 41 at a position below the packing 52 for purposes of testing packing 52.

5 In addition, bonnet assembly 40 includes O-rings 58 for sealing against the cylindrical valve stem 48 at a position above the piston chamber 45.

Bonnet assembly 40 also comprises an annular cylindrical piston 60 movably positioned within the piston chamber 45 and slidably received on the valve stem 48. The details of the piston 60 can most clearly be seen in the enlargement shown in Fig. 4. The piston 60 includes a first seal 61 between the piston 60 and the bonnet housing cap 41A and a second seal 62 between the piston 60 and the valve stem 48. The piston 60 additionally includes preferably a plurality of damping holes 64 extending therethrough, evenly spaced around the piston 60. The upper surface of the piston 60 includes an outwardly beveled portion 66 adjacent the hole receiving the valve stem 48. Additionally, the lower surface of piston 60 includes an annular groove 68 formed therein for purposes of centering a spring 74, which is discussed below.

Bonnet assembly 40 further includes a piston retaining flange 70 securely attached to the valve stem 48. The flange 70 includes a beveled lower edge 72 which is adapted to abut and engage with the beveled portion 66 of the piston 60 when the valve stem 48 is moved downward from the valve closed position, shown in Fig. 1.

A spring 74 is positioned within the piston chamber 45 with one end portion of the spring 74 received within the annular groove 68 of the piston 60. The spring 74 biases the piston 60 toward the flange 70. The bonnet housing cap 41A includes a port 76 extending to the piston chamber 45, allowing for filling the piston chamber 45 with appropriate hydraulic fluid.

The present bonnet assembly 40 will slow down the opening speed of pneumatically actuated valves, preventing gate 30, seat 22 and seat 23 from damage which otherwise results from rapid movement of gate 30 under the influence of the stored pressure energy of the pneumatic actuator 50. Additionally, the present bonnet assembly 40 permits the use of the bonnet assembly 40 with any brand of pneumatic or diaphragm actuators.



The gate valve 10 according to the present invention operates as follows. As the pneumatic actuator 50 starts to exert a valve opening force to the valve stem 48 to move the valve stem 48 from the closed position shown in Fig. 1 to the open position shown in Fig. 2, that force will be transferred to the flange 70 which will in turn transfer the force to the piston 60 through an engagement between the beveled lower edge 72 and beveled portion 66. The flange 70 is preferably a split ring to allow assembly onto the valve stem 48, and is retained in place by a retainer ring 75. The beveled lower edge 72 of flange 70 and beveled portion 66 of piston 60 ensure that flange 70 will not separate under load. Since the portion of the piston chamber 45 below the piston 60 is full of hydraulic fluid, any downward movement of the piston 60 will be possible only when the hydraulic fluid has been displaced under the piston 60 into the space above the piston 60 through the damping holes 64. This restrictive fluid flow through the damping holes 64 will slow down the speed of the piston 60 and valve stem 48, thereby reducing the speed of the valve opening cycle. Fig. 2 illustrates the bonnet assembly in the fully open position.

The speed reduction of the present invention only operates with the opening cycle and does not affect the closing cycle of the gate valve 10. As shown in Fig. 3, when the gate valve 10 is closing, the valve stem 48 will move independently of the piston 60, and is thereby free to act in a fast-acting capacity. The spring 74 will return the piston 60 to the position illustrated in Fig. 1 independently of the movement of valve stem 48.

The damping holes 64 provided in the piston 60 provide appropriate restriction of the fluid passage. The number and size of the damping holes 64 will vary according to the size of gate valve 10 and the degree of damping desired. Additionally, as discussed above, due to the relative movement between the valve stem 48 and the piston 60, the speed reduction is only effective for the valve opening cycle.

The relative positions of the flange 70 and spring 74 with respect to the piston 60 may be reversed if the opening and closing conditions of the gate valve 10 are reversed, such as if the port 34 of the gate 30 were in the lower half of the gate 30 whereby the positions of valve stem 48 and gate 30 in Fig. 1 corresponded to a valve open condition.

This and other various modifications will be apparent to those of ordinary skill in the art without departing from the spirit and scope of the present invention.



Consequently, the scope of the present invention is intended to be defined by the attached claims.

This Sheet Has Been Replaced





WHAT IS CLAIMED IS:

1. A bonnet assembly for a gate valve which comprises a valve body having an inlet and an outlet and a valve gate reciprocable within the valve body between an open position, wherein the inlet and outlet are in communication, and a closed position, wherein the inlet is closed off from the outlet, the bonnet assembly comprising:

a bonnet housing adapted to be attached to the valve body, said bonnet housing having a central bore therethrough and a chamber along said central bore;

a valve stem movably positioned within said central bore and having a first end adapted to be coupled to the valve gate and a second end adapted to be coupled to a valve actuator means for moving said valve stem and the valve gate between the closed position and the open position;

a piston movably positioned within said chamber, said piston having at least one damping hole therethrough;

a flange fixedly attached to said valve stem and adapted to abut against said piston to move said piston from a first position to a second position when said valve stem is moved between said closed position and said open position; and

means independent of the valve stem for moving said piston from the second position to the first position when said valve stem is moved between said open position and said closed position.

2. A bonnet assembly as defined in claim 1 wherein said piston is an annular piston slidably received on said valve stem.

3. A bonnet assembly as defined in claim 1 further including hydraulic fluid filling said chamber.

4. A bonnet assembly as defined in claim 1 wherein said independent piston moving means includes a spring positioned within said chamber.

5. A bonnet assembly as defined in claim 4 wherein said spring biases said piston toward said flange.

6. A bonnet assembly as defined in claim 1 wherein said valve stem and said piston are substantially cylindrical.





7. A bonnet assembly as defined in claim 6 wherein said piston is an annular piston slidably received on said valve stem.

8. A bonnet assembly as defined in claim 7 further including a first piston seal sealing between said piston and said bonnet housing and a second piston seal sealing between said piston and said valve stem.

9. A bonnet assembly as defined in claim 7 wherein said flange includes a beveled edge engaging said piston, and said piston includes a beveled portion for receiving said beveled edge.

10. A valve comprising:
a body having a flow passage therethrough between an inlet and an outlet and a gate chamber within said body intersecting said flow passage;

a gate having a port therethrough positioned within said gate chamber, the gate being movable between a first closed position blocking the flow of fluid between said inlet and said outlet and a second open position connecting said inlet with said outlet through said port;

a valve actuator;

a bonnet assembly mounted on said body, said bonnet assembly including a bonnet housing adapted to be attached to a body of the gate valve, said bonnet housing having a central bore therethrough and a chamber along said central bore;

a valve stem movably positioned within said central bore with a first end coupled to said gate and a second end coupled to said valve actuator which will move said valve stem and said gate between said closed position and said open position ;

a piston movably positioned within said chamber, said piston having at least one damping hole therethrough;

a flange attached to said valve stem and abutting against said piston to move said piston from a first position to a second position when said valve stem is moved between said closed position and said open position; and

means independent of said valve stem for moving said piston from the second position to the first position when said valve stem is moved between said open position and said closed position.





11. A valve as defined in claim 10 further including hydraulic fluid filling said chamber.

12. A valve as defined in claim 10 wherein said piston is an annular piston slidably received on said valve stem.

13. A valve as defined in claim 10 wherein said independent piston moving means includes a spring positioned in said chamber.

14. A valve as defined in claim 13 wherein said spring biases said piston toward said flange.

15. A valve as defined in claim 1 wherein said valve stem and said piston are substantially cylindrical.

16. A valve as defined in claim 15 wherein said piston is an annular piston slidably received on said valve stem.

17. A valve as defined in claim 16 further including a first piston seal sealing between said piston and said bonnet housing and a second piston seal sealing between said piston and said valve stem.

18. A valve as defined in claim 16 wherein said flange includes a beveled edge engaging said piston, and said piston including a beveled portion for receiving said beveled edge.

