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GATE VALVE WITH POSITIVE GATE STOP

Abstract

A gate valve includes a valve body having a gate cavity, a bonnet mounted to the valve body over the cavity, a valve stem movably positioned in an axial stem bore in the bonnet, a gate positioned in the cavity and connected to the valve stem, a downwardly directed first stop surface fixed in position relative to the valve stem, and an upwardly directed second stop surface fixed in position relative to the bonnet. In operation, when the gate is moved downward from the open position to the closed position, the first stop surface will engage the second stop surface and thereby prevent the bottom of the gate from contacting the bottom of the gate cavity.

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Background/Summary

FIELD OF THE DISCLOSURE

[0001] The present disclosure is directed to a gate valve. More particularly, the disclosure is directed to a gate valve which includes a positive stop arrangement for preventing the bottom of the gate from contacting the bottom of the gate cavity as the gate is moved downward from the open position to the closed position.

BACKGROUND OF THE DISCLOSURE

[0002] Prior art gate valves typically include a valve body, a flowbore which extends through the valve body, a gate cavity which extends from a top opening in the valve body across the flowbore, and a gate which is movably positioned in the cavity. The gate includes a transverse through bore and may be positioned between a pair of seats having corresponding through holes which are aligned with the flowbore. The gate is connected to a valve stem which extends through a bonnet connected to the valve body over the top opening. The distal end of the valve stem is normally connected to a valve actuator which is operable to move the gate between an open position in which the through bore is aligned with the through holes and fluid is permitted to flow through the flowbore, and a closed position in which the through bore is offset from the through holes and fluid is prevented from flowing through the flowbore.

[0003] For gate valves to operate correctly, the gate must be allowed to “float” (i.e., move slightly in a direction parallel to the axis of the flowbore) when in the closed position in order to effect a proper seal with the valve seats. This “float” can be prevented if the gate is allowed to bottom out against the bottom of the cavity.

[0004] In manually operated gate valves having a handwheel, the “float” is provided by backing off the handwheel by a quarter turn after the gate bottoms out on the bottom of the cavity. In hydraulically operated gate valves, the hydraulic actuator is normally configured to automatically back off the gate, or to stop the gate before it contacts the bottom of the cavity.

[0005] However, the requirement to back off the handwheel a quarter turn can occasionally be overlooked. Also, hydraulically-operated gate valves can require specific configuration, calibration and setup to ensure the hydraulic actuator maintains the necessary float.

SUMMARY OF THE DISCLOSURE

[0006] In accordance with the present disclosure, a gate valve is provided which comprises a valve body having opposite first and second ends, a flowbore which extends through the valve body between the first and second ends, and a gate cavity which extends from a top opening in the valve body across the flowbore; a bonnet mounted to the valve body over the top opening, the bonnet comprising an axial stem bore connected to the gate cavity; a valve stem movably positioned in the stem bore, the valve stem comprising a first end which extends into the gate cavity; a gate connected to the first end of the valve stem, the gate comprising a transverse through bore and being movable by the valve stem between an open position in which the through bore is aligned with the flowbore and a closed position in which the through bore is offset from the flowbore; a downwardly directed first stop surface which is fixed in position relative to the valve stem; and an upwardly directed second stop surface which is fixed in position relative to the bonnet; wherein when the gate is moved downward from the open position to the closed position, the first stop surface will engage the second stop surface and thereby prevent a bottom of the gate from contacting a bottom of the gate cavity.

[0007] In accordance with an aspect of the disclosure, the gate valve may comprise a valve actuator mounted on the bonnet, the valve actuator comprising an actuator shaft connected to a second end of the valve stem.

[0008] In accordance with another aspect of the disclosure, the first stop surface may be connected to or formed integrally with the valve stem or the actuator shaft.

[0009] In accordance with a further aspect of the disclosure, the second stop surface may be connected to or formed integrally with the bonnet.

[0010] In accordance with yet another aspect of the disclosure, the actuator shaft may be connected to the valve stem through a positive stop member and the first stop surface may be formed on the positive stop member.

[0011] In accordance with another aspect of the disclosure, the second stop surface may be formed on a positive stop housing which is connected to the bonnet over the stem bore and includes an axial through hole through which the second end of the valve stem extends.

[0012] In accordance with a further aspect of the disclosure, the second stop surface may be formed on a packing nut secured in an upper end of the stem bore.

[0013] In accordance with yet another aspect of the disclosure, the second stop surface may be formed on the bonnet.

[0014] In accordance with an aspect of the disclosure, the first stop surface may be formed on the actuator shaft and the second stop surface may be formed on a positive stop housing which is connected to the bonnet over the stem bore and includes an axial through hole through which the second end of the valve stem extends.

[0015] In accordance with another aspect of the disclosure, the first stop surface may be formed on the actuator shaft and the second stop surface may be formed on a packing nut secured in an upper end of the stem bore.

[0016] In accordance with a further aspect of the disclosure, the first stop surface may be formed on the actuator shaft and the second stop surface may be formed on the bonnet.

[0017] In accordance with yet another aspect of the disclosure, the first stop surface may be formed on a positive stop member which is connected to or formed integrally with the valve stem and the second stop surface may be formed on a positive stop housing which is connected to the bonnet over the stem bore and includes an axial through hole through which the second end of the valve stem extends.

[0018] In accordance with an aspect of the disclosure, the first stop surface may be formed on a positive stop member which is connected to or formed integrally with the valve stem and the second stop surface may be formed on a packing nut secured in an upper end of the stem bore.

[0019] In accordance with another aspect of the disclosure, the first stop surface may be formed on a positive stop member which is connected to or formed integrally with the valve stem and the second stop surface may be formed on the bonnet.

[0020] In accordance with a further aspect of the disclosure, the first stop surface may be formed on a positive stop member which is fixed in position relative to the valve stem and the second stop surface may be formed on a packing nut positioned in the stem bore and fixed in position relative to the bonnet.

[0021] In accordance with an aspect of the disclosure, the first stop surface may be formed on a positive stop member which is fixed in position relative to the valve stem and the second stop surface may be formed on the bonnet.

[0022] In accordance with another aspect of the disclosure, the valve actuator may comprise an actuator housing which is fixed in position relative to the bonnet, the second stop surface may be formed on a positive stop housing which is connected to the bonnet over the stem bore, and the actuator housing may be connected to the positive stop housing.

[0023] In accordance with a further aspect of the disclosure, the valve actuator may comprise a stem adapter having a first end which is operatively linked to the actuator shaft and a second end which is connected to a valve operator, the valve operator may comprise a rotary electric actuator which is connected to the actuator housing or to a support sleeve which is secured to the actuator housing, and the rotary electric actuator may include an output shaft connected to the stem adapter.

[0024] In accordance with yet another aspect of the disclosure, the first and second stop surfaces may be positioned outside of an actuator which is connected to the valve stem and is configured to move the gate between the open and closed positions.

[0025] In accordance with another aspect of the disclosure, the actuator does not have a positive

stop surface or position control functionality.

[0026] In accordance with a further aspect of the disclosure, the axial distance between the first stop surface and the bottom of the gate and/or the axial distance between the second stop surface and the bottom of the cavity may be adjustable.

[0027] In accordance with one aspect of the disclosure, the first stop surface may be rotationally associated with the valve stem such that rotation of the first stop surface relative to the valve stem results in axial translation of the first stop surface relative to the valve stem.

[0028] In accordance with another aspect of the disclosure, the second stop surface may be rotationally associated with the bonnet such that rotation of the second stop surface relative to the bonnet results in axial translation of the second stop surface relative to the bonnet.

[0029] The positive stop arrangement thus prevents the gate from bottoming out against the valve body (e.g., the bottom of the gate cavity) when the gate is moved downward from the open position to the closed position. The positive stop arrangement may include a downwardly directed first stop surface which is fixed in position relative to the valve stem and an upwardly directed second stop surface which is fixed in position relative to the bonnet. Accordingly, when the gate is moved downward from the open position to the closed position, the first stop surface will engage the second stop surface and thereby prevent the bottom of the gate from contacting the bottom of the gate cavity.

[0030] The positive stop arrangement of the present disclosure is beneficial because it is implemented in the gate valve itself, rather than the actuator. As a result, the gate valve can be agnostic with respect to the type of actuation and not require additional calibration or actions by a user, such as backing off a handwheel.

[0031] The positive stop arrangement of the present disclosure is particularly beneficial when the gate valve is used with an electric actuator. The positive stop arrangement eliminates the need for the electric actuator to stop the gate before it contacts the bottom of the cavity or to back off the gate if it does contact the bottom of the cavity. As a result, the electric actuator does not require costly position control functionality in order to stop or back off the gate, and it does not require an expensive variable speed or variable frequency drive in order to control the actuation speed. In essence, the positive stop arrangement enables the electric actuator to be an uncomplicated, inexpensive device which can simply be hooked up to a power source and run until the gate closes.

[0032] These and other objects and advantages of the present disclosure will be made apparent from the following detailed description, with reference to the accompanying drawings.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0033] FIG. 1 is a cross sectional view of an illustrative embodiment of a gate valve in accordance with the present disclosure;

[0034] FIG. 2 is an enlarged cross sectional view of the lower half of the gate valve shown in FIG. 1;

[0035] FIG. 3 is an enlarged cross sectional view of the upper half of the gate valve shown in FIG. 1;

[0036] FIG. 4 is an enlarged view of the portion of the gate valve enclosed by the dashed box B in FIG. 3;

[0037] FIG. 5 is a cross sectional view of the gate valve of FIG. 1 showing the handwheel having been replaced by an electric actuator;

[0038] FIG. 6 is a cross sectional view of another illustrative embodiment of a gate valve in accordance with the present disclosure;

[0039] FIG. 7 is an enlarged view of the portion of the gate valve enclosed by the dashed box B in

FIG. 6; and

[0040] FIGS. 8-16 are enlarged cross sectional views of some examples of positive stop arrangements according to the present disclosure.

DETAILED DESCRIPTION OF THE DISCLOSURE

[0041] An illustrative embodiment of the gate valve of the present disclosure is shown in FIG. 1. The gate valve of this embodiment, which is indicated generally by reference number **10**, includes a valve body **12** having opposite first and second ends **14**, **16**, a flowbore **18** which extends through the valve body between the first and second ends **14**, **16**, and a gate cavity **20** which extends from a top opening **22** in the valve body across the flowbore and comprises a bottom **20a**. A valve bonnet **24** is mounted to the valve body **12** over the top opening **22** and may be removably secured to the valve body by conventional means, such as a plurality of bolts **26**.

[0042] The gate valve **10** further includes a valve stem **28** which extends through an axial stem bore **30** formed in the bonnet **24**. The valve stem **28** has a first end which is connected to a gate **32** positioned in the cavity **20** and a second end which is connected to a valve actuator **34** mounted to the bonnet **24**. Referring also to FIG. 2, the valve stem **28** may be sealed to the bonnet **24** using a conventional packing **36** positioned in, e.g., an enlarged diameter portion of the stem bore **28**. The packing **36** may be retained in the stem bore **28** using a suitable packing nut **38** which is threadedly connected to the stem bore or otherwise fixed in position relative to the bonnet **24**.

[0043] The gate **32** includes a transverse through bore **40** which, when the gate valve **10** is in the open position, is aligned with the flowbore **18**. The gate **32** may be slidably disposed between a pair of seats **42**, each of which includes an axial through hole **44** which is aligned with the flowbore **18**. In the open position of the gate valve **10**, the through bore **40** is aligned with the through holes **44** and fluid is therefore permitted to flow through the flowbore **18**. In the closed position of the gate valve **10**, which is shown in FIGS. 1 and 2, the through bore **40** is offset from the through holes **44** and fluid is therefore prevented from flowing through the flowbore **18**.

[0044] Although not required for purposes of the present disclosure, the gate valve **10** may also include a balancing stem **46** for balancing the force on the gate **32** which is generated by ambient pressure acting on the valve stem **28**. In this example, the balancing stem **46** is connected to a bottom end **48** of the gate **32** (i.e., the end of the gate opposite the valve stem **28**) and extends through an axial opening **50** in the valve body **12**. The balancing stem **46** is slidably received in an axial through bore **52** in a lower bonnet **54** mounted to the valve body **12** and is sealed thereto by a suitable packing **56** to thereby contain pressure in the cavity **20**.

[0045] Referring also to FIG. 3, the valve actuator **34** may include an actuator shaft **58** which is connected to the valve stem **28**. The actuator shaft **58** may be supported in an actuator housing **60** which is fixed in position relative to the bonnet **24**. A stem adapter **62** to which a valve operator, such as a handwheel **64**, is connected may be rotationally supported in the actuator housing **60**. The actuator shaft **58** may be operatively linked with the stem adapter **62** such that rotation of the handwheel **64** results in axial translation of the actuator shaft **58** and, thus, the valve stem **28** to thereby move the gate **32** between the open and closed positions. In some embodiments, the actuator **34** may comprise a conventional ball screw in which the actuator shaft **58** defines the screw shaft and the stem adapter **62** is linked to the actuator shaft through a ball nut.

[0046] The illustrative gate valve **10** is of a type in which the gate **32** is allowed to “float” (i.e., move slightly in a direction parallel to the axis of the flowbore **18**) when in the closed position in order to effect a proper seal with the valve seats **42**. This motion is facilitated by using connections between the valve stem **28** and the top of the gate **32** (and between the balancing stem **46**, if present, and the bottom of the gate) which permit movement of the gate relative to the valve stem (and the balancing stem, if present). Such connections are conventional and may include, for example, a slot and key connection or a pin and socket connection.

[0047] In prior art gate valves of this type, when the gate is moved downward from the open position to the closed position, the gate will eventually bottom out against the bottom of the cavity.

This will usually prevent the gate from being able to float within the cavity, which in turn will prevent the gate from forming an effective seal with the seats.

[0048] Therefore, after the gate bottoms out on the cavity, the gate must be raised slightly so that the bottom of the gate is spaced apart from the bottom of the cavity when in the closed position. In manually operated gate valves having a handwheel, for instance, the handwheel must be backed off a quarter turn after the gate bottoms out on the bottom of the cavity. In hydraulically operated gate valves, the hydraulic actuator is normally configured to automatically back off the gate.

[0049] However, the requirement to back off the handwheel a quarter turn can occasionally be overlooked. Also, should a need or desire to replace the handwheel with an electric actuator arise, such an actuator must normally include an expensive variable speed or variable frequency drive in order to control the speed of actuation or costly position control functionality, such as a valve positioner, in order to stop the gate before it contacts the bottom of the cavity or to back off the gate if it does contact the bottom of the cavity.

[0050] According to the present disclosure, the gate valve **10** includes a positive stop arrangement for preventing the gate **32** from bottoming out against the valve body **12** (e.g., the bottom of the gate cavity **20**) when the gate is moved downward from the open position to the closed position. In particular, the positive stop arrangement may include a downwardly directed first stop surface which is fixed in position relative to the valve stem and an upwardly directed second stop surface which is fixed in position relative to the bonnet. Accordingly, when the gate is moved downward from the open position to the closed position, the first stop surface will engage the second stop surface and thereby prevent the bottom of the gate from contacting the bottom of the gate cavity.

[0051] In the illustrative embodiment of the disclosure shown in FIGS. **1-3**, the gate valve **10** includes a positive stop arrangement in the form of a downwardly directed first stop surface **66** which is fixed in position relative to the valve stem **28** and an upwardly directed second stop surface **68** which is fixed in position relative to the bonnet **24**. In some embodiments, the first stop surface **66** may be connected to or formed integrally with the valve stem **28** or the actuator shaft **58**. Likewise, the second stop surface **68** may be connected to or formed integrally with the bonnet **24**.

[0052] Referring also to FIG. **4**, which is an enlarged view of the portion of the gate valve **10** enclosed by the dashed box A in FIG. **3**, the first stop surface **66** may be formed, for example, on a positive stop member **70** which is connected between the valve stem **28** and the actuator shaft **58**. The positive stop member **70** may take the form of a connector having a female end **72** to which the second or top end of the valve stem **28** is connected and a male end **74** to which the bottom end of the actuator shaft **58** is connected. In this embodiment, the first stop surface **66** is formed on or proximate a bottom end of the positive stop member **70** coaxially with the valve stem **28**.

[0053] In the illustrative embodiment of the positive stop arrangement shown in FIGS. **1-4**, the second stop surface **68** may be formed on a positive stop housing **76** which is connected to the bonnet **24** over the stem bore **30** and includes an axial through hole **78** through which the second end of the valve stem **28** extends. The positive stop housing **76** may take the form of a connecting collar which includes a lower end **80** having a counterbore **82** secured to an upstanding neck portion **84** of the bonnet **24** and an upper end **86** having a socket **88** configured to receive the female end **72** of the positive stop member **70**. In this embodiment, the second stop surface **68** is formed on or proximate a bottom end of the socket **88** coaxially with the valve stem **28**. In some embodiments, the upper end **86** of the positive stop housing **76** may define a male connector which is secured in a corresponding receptacle **90** formed in the bottom of the actuator housing **60** to thereby connect the valve actuator **34** to the bonnet **24**.

[0054] In operation of the gate valve **10**, starting from the valve open position the handwheel **64** may be rotated to move the gate **32** downward towards its closed position. After the through bore **40** is fully offset from the through holes **44** (i.e., after the gate **32** is fully closed) but before the bottom **48** of the gate **32** contacts the bottom **20a** of the gate cavity **20**, the first stop surface **66** will

engage the second stop surface **68** and thereby prevent the gate from moving further downward. This may be accomplished by designing the gate valve **10** such that the distance between first stop surface **66** and the bottom **48** of the gate **32** is less than the distance between the second stop surface **68** and the bottom **20a** of the cavity **20**. In this manner, the engagement of the first stop surface **66** with the second stop surface **68** will prevent the bottom **48** of the gate **32** from contacting the bottom **20a** of the gate cavity **20**. As a result, the gate **32** will be allowed to float freely within the cavity **20** to ensure that it seals properly with the seats **42**.

[0055] One benefit of the present disclosure is that by associating the positive stop arrangement with the gate valve itself rather than the actuator, the gate valve is essentially agnostic with respect to the type of actuator that may be used. In other words, since the positive stop arrangement is incorporated into the gate valve and not the actuator (with the exception of the alternative embodiments discussed below in which the first stop surface is formed on the actuator shaft), the gate valve is compatible with any conventional actuator. For instance, actuation can be accomplished via the handwheel **68**, a hydraulic-actuator, an electric actuator or any other type of actuator without requiring additional configuration or calibration to accommodate a particular type of actuator.

[0056] Referring to FIG. 5, for example, the gate valve **10** described above is shown with the handwheel **64** replaced with an inexpensive electric actuator **92** which does not include, e.g., a valve positioner to control the position of the gate or a variable-speed or variable frequency drive to limit the speed of the actuation process. In this example, the electric actuator **92** may include an output shaft connected to the stem adapter **62** and a housing connected to a support sleeve **94** that in turn is secured by suitable means to the actuator housing **60** and/or the bonnet **24**.

[0057] In operation, the electric actuator **92** may be activated to move the gate **32** between its open and closed positions. With the gate **32** in the open position, the electric actuator **92** may be activated to move the gate **32** downward towards the closed position. As discussed above, after the gate **32** is fully closed but before the bottom **48** of the gate **32** contacts the bottom **20a** of the gate cavity **20**, the first stop surface **66** will engage the second stop surface **68** and thereby prevent the gate from moving further downward. In this manner, the gate **32** will be able to float freely within the cavity **20** to ensure that it seals properly with the seats **42**.

[0058] Thus, the positive stop arrangement of the present disclosure eliminates the need for the electric actuator **92** to stop the gate **32** before it contacts the bottom of the cavity **20** or to back off the gate if it does contact the bottom of the cavity. As a result, the electric actuator **92** does not require costly position control functionality, such as a valve positioner, in order to stop or back off the gate **32**, and it does not require an expensive variable-speed or variable frequency drive in order to limit the speed of the actuation process. In essence, the positive stop arrangement enables the electric actuator **92** to be an uncomplicated, inexpensive device which can simply be hooked up to a power source and run until the gate closes.

[0059] Another illustrative embodiment of a gate valve according to the present disclosure is shown in FIG. 6. The gate valve of this embodiment, indicated generally by reference number **10'**, is similar in many respects to the gate valve **10** described above. Accordingly, the gate valve **10'** includes a valve body **12** having first and second ends **14**, **16**, a flowbore **18** which extends through the valve body between the first and second ends, and a gate cavity **20** which extends from a top opening **22** in the body across the flowbore. A bonnet **24** having an axial stem bore **30** is mounted to the valve body **12** over the top opening **22**. A valve stem **28** is movably positioned in the stem bore **30** and is sealed thereto by a conventional stem packing **36**. The packing **36** may be retained in the stem bore **30** using a suitable packing nut **38** which is threadedly connected to the stem bore or otherwise fixed in position relative to the bonnet **24**.

[0060] The valve stem **28** includes a first end which is connected to a gate **32** positioned in the cavity **20** and a second end which is connected to a valve actuator **34**. The gate **32** includes a transverse through bore **40** and is slidably disposed between a pair of seats **42**, each of which

includes an axial through hole **44** which is aligned with the flowbore **18**. In operation, the gate **32** is movable by the valve stem **28** between an open position in which the through bore **40** is aligned with the through holes **44** and fluid is therefore permitted to flow through the flowbore **18**, and a closed position, shown in FIG. 7, in which the through bore is offset from the through holes and fluid is therefore blocked from flowing through the flowbore.

[0061] In accordance with the present disclosure, the gate valve **10'** also includes a positive stop arrangement for preventing the bottom of the gate **32** from contacting the bottom of the cavity **20** when the gate is moved into the closed position. The positive stop arrangement may include a downwardly directed first stop surface **66** which is fixed in position relative to the valve stem **28** and an upwardly directed second stop surface **68** which is fixed in position relative to the bonnet **24**. Thus, when the gate **32** is moved downward from the open position to the closed position, the first stop surface **66** will engage the second stop surface **68** and thereby prevent the bottom **48** of the gate **32** from contacting the bottom **20a** of the gate cavity **30**.

[0062] Referring also to FIG. 7, which is an enlarged view of the portion of the gate valve **10'** enclosed by the dashed box B in FIG. 6, the first stop surface **66** may be formed on a positive stop member **96** in the form of a collar which is fixed in position relative to the valve stem **28** and/or the actuator stem **58** of the valve actuator **34**. For example, the positive stop member **96** may include a counterbore **98** which defines a seat **100** that is configured to engage a corresponding shoulder **102** formed on the valve stem **28**. The positive stop member **96** may be threaded or otherwise secured to the valve stem **28** or, as shown in FIG. 7, retained in position on the valve stem by the actuator shaft **58** (e.g., by engagement of a bottom end **104** of the actuator shaft **58** with a top end **106** of the positive stop member).

[0063] In this embodiment, the first stop surface **66** may be formed on a bottom end of the positive stop member **96** and the second stop surface **68** may be formed on the packing nut **38**. In the embodiment shown in FIG. 7, for example, the second stop surface **68** is formed on a top surface of the packing nut **38**. Thus, the positive stop arrangement of the present embodiment does not require a separate positive stop housing **76** for the second stop surface **68**. Also, instead of being connected to a positive stop housing as in the previous embodiments, the actuator housing **60** is connected directly to the upstanding neck portion **84** of the bonnet **24**.

[0064] In operation of the gate valve **10'**, the valve operator, which in FIG. 6 is depicted as a handwheel **64**, is rotated to move the gate **32** downward towards the closed position. After the gate **32** is fully closed but before the bottom **48** of the gate **32** contacts the bottom **20a** of the gate cavity **20**, the first stop surface **66** will engage the second stop surface **68** and thereby prevent the gate from moving further downward. In this manner, the gate **32** will be able to float freely within the cavity **20** to ensure that it seals properly with the seats **42**.

[0065] Further embodiments of positive stop arrangements in accordance with the present disclosure are shown in FIGS. 8-16.

[0066] The positive stop arrangement shown in FIG. 8 is somewhat similar to the embodiment shown in FIG. 4. However, in the present embodiment the positive stop member **70** is omitted and the first stop surface **66** is formed on the bottom end of the actuator shaft **58** of the valve actuator **34**. In this example, the valve stem **28** is connected directly to the actuator shaft **58** and the lower end **108** of the actuator shaft is configured to be received in the socket **88** in the upper end **86** of the positive stop housing **76**. As in the embodiment shown in FIG. 4, the second stop surface **68** is formed on or proximate a bottom end of the socket **88** coaxially with the valve stem **28**. The positive stop arrangement of the present embodiment is simplified by the elimination of the positive stop member **70**.

[0067] The positive stop arrangement shown in FIG. 9 is somewhat similar to the embodiment shown in FIG. 4. However, in the embodiment shown in FIG. 9, the positive stop housing **76** is eliminated and the second stop surface **68** is formed on a top surface of the packing nut **38**. In this embodiment, the receptacle **90** in the bottom end of the actuator housing **60** is connected directly to

the upstanding neck portion **84** of the bonnet **24**, and the female end **72** of the positive stop member **70** extends through an axial bore **110** in the actuator housing and engages the packing nut **38**. As in the embodiment shown in FIG. **4**, the first stop surface **66** is formed on or proximate a bottom end of the positive stop member **70** coaxially with the valve stem **28**. The positive stop arrangement of the present embodiment is simplified by the elimination of the positive stop housing **76**.

[0068] The positive stop arrangement shown in FIG. **10** combines the benefits of the embodiments shown in FIGS. **8** and **9**. In the embodiment of FIG. **10**, both the positive stop member **70** and the positive stop housing **76** are eliminated. As in the embodiment of FIG. **8**, the first stop surface **66** is formed on the bottom end of the actuator shaft **58** of the valve actuator **34**. As in the embodiment of FIG. **9**, the second stop surface **68** is formed on a top surface of the packing nut **38**. In this embodiment, the actuator housing **60** is secured directly to the upstanding neck portion **84** of the bonnet **24**, and the lower end **108** of the actuator shaft **58** extends through an axial bore **110** in the actuator housing to the packing nut **38**. The positive stop arrangement of the present embodiment is simplified by the elimination of both the positive stop member **70** and the positive stop housing **76**.

[0069] The positive stop arrangement shown in FIG. **11** is somewhat similar to the embodiment shown in FIG. **9**. In the present embodiment, however, the second stop surface **68** is formed on a top surface of the upstanding neck portion **84** of the bonnet **24**, not on a top surface of the packing nut **38**. The first stop surface **66** is formed on the bottom end of the positive stop member **70**, which in the present embodiment is provided with an axially extending rim portion **112** configured to straddle the top of the packing nut **38** and directly engage the top surface of the neck portion **84**. By having the first stop surface **66** engage the top surface of the neck portion **84** instead of the top surface of the packing nut **38**, potential damage to the packing nut can be avoided. In addition, the positive stop arrangement of the present embodiment is simplified by the elimination of the positive stop housing **76**.

[0070] The positive stop arrangement shown in FIG. **12** is somewhat similar to the embodiments shown in FIGS. **10** and **11**. Similar to the embodiment shown in FIG. **10**, the first stop surface **66** is formed on the bottom end of the actuator shaft **58** of the valve actuator **34**. Similar to the embodiment shown in FIG. **11**, the second stop surface **68** is formed on a top surface of the upstanding neck portion **84** of the bonnet **24**, not on a top surface of the packing nut **38**. In this embodiment, the first stop surface **66** is formed on a rim portion **114** which extends axially from the bottom of the actuator shaft **58** and is configured to straddle the top of the packing nut **38** and directly engage the neck portion **84** of the bonnet **24**. By having the first stop surface **66** engage the neck portion **84** instead of the packing nut **38**, potential damage to the packing nut can be avoided. Also, the positive stop arrangement of the present embodiment is simplified by the elimination of both the positive stop member **70** and the positive stop housing **76**.

[0071] The positive stop arrangement shown in FIG. **13** is somewhat similar to the embodiment shown in FIG. **4**. In the embodiment of FIG. **13**, however, instead of being a separate component, the positive stop member **70** is formed integrally with the upper end of the valve stem **28**. In this embodiment, the first stop surface **66** is formed on an annular shoulder **116** located at the bottom of a radially enlarged portion **118** of the valve stem **28**. As in the embodiment of FIG. **4**, the second stop surface **68** is formed on or proximate the bottom of the socket **88** in the upper end **86** the positive stop housing **76**. The positive stop arrangement of FIG. **13** is simplified by combining the positive stop member **70** with the valve stem **28**. In order to facilitate assembly, the first end of the valve stem **28** (i.e., the end which connects to the gate) may need to be configured to enable it to be inserted downwardly through the stem packing **36**, the packing nut **38** and the stem bore **30** in the bonnet **24**.

[0072] The positive stop arrangement shown in FIG. **14** is somewhat similar to the embodiments shown in FIGS. **9** and **13**. Similar to the embodiment of FIG. **9**, in the present embodiment the positive stop housing **76** is eliminated, the actuator housing **60** is connected directly to the upstanding neck portion **84** of the bonnet **24**, and the second stop surface **68** is formed on a top

surface of the packing nut **38**. Similar to the embodiment of FIG. **13**, the positive stop member **70** is formed integrally with the upper end of the valve stem **28** and the first stop surface **66** is formed on an annular shoulder **116** located at the bottom of a radially enlarged portion **118** of the valve stem **28**. The positive stop arrangement of FIG. **13** is simplified by eliminating the positive stop housing **76** and combining the positive stop member **70** with the valve stem **28**. As with the embodiment of FIG. **13**, the first end of the valve stem **28** (i.e., the end which connects to the gate) may need to be configured to enable it to be inserted downwardly through the stem packing **36**, the packing nut **38** and the stem bore **30** in the bonnet **24**.

[0073] The positive stop arrangement shown in FIG. **15** is somewhat similar to the embodiment shown in FIG. **11**. Accordingly, in the present embodiment the positive stop housing **76** is eliminated, the actuator housing **60** is connected directly to the upstanding neck portion **84** of the bonnet **24**, the first stop surface **66** is formed on a rim **112** which extends axially from the bottom of the positive stop member **70** and is configured to straddle the top of the packing nut **38**, and the second stop surface **68** is formed on the top surface of the neck portion **84**. However, instead of being a separate member, the positive stop member **70** is formed integrally with the upper end of the valve stem **28**.

[0074] In this embodiment, by having the first stop surface **66** engage the neck portion **84** instead of the packing nut **38**, potential damage to the packing nut can be avoided. Also, the positive stop arrangement is simplified by eliminating the positive stop housing **76** and combining the positive stop member **70** with the valve stem **28**. As with the embodiments of FIGS. **13** and **14**, the first end of the valve stem **28** (i.e., the end which connects to the gate) may need to be configured to enable it to be inserted downwardly through the stem packing **36**, the packing nut **38** and the stem bore **30** in the bonnet **24**.

[0075] The positive stop arrangement shown in FIG. **16** is somewhat similar to the embodiment of FIG. **9**. However, in the present embodiment the second stop surface **68** is formed on a top surface of the upstanding neck portion **84** of the bonnet **24** and the first stop surface **66** is formed on a rim portion **120** which extends axially from the bottom of the positive stop member **96**. As shown in FIG. **16**, the rim portion **120** is configured to straddle the top of the packing nut **38** and directly engage the top surface of the neck portion **84**. By having the first stop surface **66** engage the neck portion **84** instead of the packing nut **38**, potential damage to the packing nut can be avoided.

[0076] As described above in connection with the embodiment of FIG. **9**, the positive stop member **96** may be retained in position on the valve stem **28** by the bottom of the actuator shaft **58**. Alternatively, the positive stop member **96** may be secured to the valve stem **28**, such as by threads, or formed integrally with the valve stem. If the positive stop member **96** is formed integrally with the valve stem **28**, the first end of the valve stem (i.e., the end which connects to the gate) may need to be configured to enable it to be inserted downwardly through the stem packing **36**, the packing nut **38** and the stem bore **30** in the bonnet **24**.

[0077] In accordance with a further aspect of the present disclosure, the gate valve embodiments described above may be configured such that the axial distance between the first stop surface **66** and the bottom **48** of the gate **32** and/or the axial distance between the second stop surface **68** and the bottom **20a** of the cavity **20** is adjustable. In accordance with one embodiment of the disclosure, this may be accomplished by rotationally associating the first stop surface with the valve stem such that rotation of the first stop surface relative to the valve stem results in axial translation of the first stop surface relative to the valve stem and/or rotationally associating the second stop surface with the bonnet such that rotation of the second stop surface relative to the bonnet results in axial translation of the second stop surface relative to the bonnet.

[0078] For example, the positive stop member **70**, **96** may be threadedly connected to the top of the valve stem **28** in such a manner that rotation of the positive stop member **70/96** relative to the valve stem **28** will result in axial translation of the positive stop member relative to the valve stem, which in turn will adjust the axial distance between the first stop surface **66** and the bottom of the gate **32**.

[0079] Alternatively or in addition, the positive stop housing **76** may be threadedly connected to the neck portion **84** of the bonnet **24** in such a manner that rotation of the positive stop housing relative to the bonnet will result in axial translation of the positive stop housing relative to the bonnet, which in turn will adjust the axial position between the second stop surface **68** and the bottom of the cavity **20**.

[0080] Such adjustability is independent of the type of actuator employed and enables the positive stop arrangement to be calibrated to ensure that the axial distance between first stop surface **66** and the bottom **48** of the gate **32** is less than the axial distance between the second stop surface **68** and the bottom **20a** of the cavity **20**. Such spacing will ensure that the gate **32** is free to float within the cavity **20** and thereby form an effective seal with the seats **42**.

[0081] It should be recognized that, while the present disclosure has been presented with reference to certain embodiments, those skilled in the art may develop a wide variation of structural and operational details without departing from the principles of the disclosure. For example, the various elements shown in the different embodiments may be combined in a manner not illustrated above. Therefore, the following claims are to be construed to cover all equivalents falling within the true scope and spirit of the disclosure.

Claims

1. A gate valve comprising: a valve body having opposite first and second ends, a flowbore which extends through the valve body between the first and second ends, and a gate cavity which extends from a top opening in the valve body across the flowbore; a bonnet mounted to the valve body over the top opening, the bonnet comprising an axial stem bore connected to the gate cavity; a valve stem movably positioned in the stem bore, the valve stem comprising a first end which extends into the gate cavity; a gate connected to the first end of the valve stem, the gate comprising a transverse through bore and being movable by the valve stem between an open position in which the through bore is aligned with the flowbore and a closed position in which the through bore is offset from the flowbore; a downwardly directed first stop surface which is fixed in position relative to the valve stem; and an upwardly directed second stop surface which is fixed in position relative to the bonnet; wherein when the gate is moved downward from the open position to the closed position, the first stop surface will engage the second stop surface and thereby prevent a bottom of the gate from contacting a bottom of the gate cavity.
2. The gate valve of claim 1, further comprising a valve actuator mounted on the bonnet, the valve actuator comprising an actuator shaft connected to a second end of the valve stem.
3. The gate valve of claim 2, wherein the first stop surface is connected to or formed integrally with the valve stem or the actuator shaft.
4. The gate valve of claim 2 or 3, wherein the second stop surface is connected to or formed integrally with the bonnet.
5. The gate valve of claim 2, wherein the actuator shaft is connected to the valve stem through a positive stop member, and wherein the first stop surface is formed on the positive stop member.
6. The gate valve of claim 5, wherein the second stop surface is formed on a positive stop housing which is connected to the bonnet over the stem bore and includes an axial through hole through which the second end of the valve stem extends.
7. The gate valve of claim 5, wherein the second stop surface is formed on a packing nut secured in an upper end of the stem bore.
8. The gate valve of claim 5, wherein the second stop surface is formed on the bonnet.
9. The gate valve of claim 2, wherein the first stop surface is formed on the actuator shaft and the second stop surface is formed on a positive stop housing which is connected to the bonnet over the stem bore and includes an axial through hole through which the second end of the valve stem extends.

- 10.** The gate valve of claim 2, wherein the first stop surface is formed on the actuator shaft and the second stop surface is formed on a packing nut secured in an upper end of the stem bore.
 - 11.** The gate valve of claim 2, wherein the first stop surface is formed on the actuator shaft and the second stop surface is formed on the bonnet.
 - 12.** The gate valve of claim 2, wherein the first stop surface is formed on a positive stop member which is connected to or formed integrally with the valve stem and the second stop surface is formed on a positive stop housing which is connected to the bonnet over the stem bore and includes an axial through hole through which the second end of the valve stem extends.
 - 13.** The gate valve of claim 2, wherein the first stop surface is formed on a positive stop member which is connected to or formed integrally with the valve stem and the second stop surface is formed on a packing nut secured in an upper end of the stem bore.
 - 14.** The gate valve of claim 2, wherein the first stop surface is formed on a positive stop member which is connected to or formed integrally with the valve stem and the second stop surface is formed on the bonnet.
 - 15.** The gate valve of claim 2, wherein the first stop surface is formed on a positive stop member which is fixed in position relative to the valve stem and the second stop surface is formed on a packing nut positioned in the stem bore and fixed in position relative to the bonnet.
 - 16.** The gate valve of claim 2, wherein the first stop surface is formed on a positive stop member which is fixed in position relative to the valve stem and the second stop surface is formed on the bonnet.
 - 17.** The gate valve of claim 2, wherein the valve actuator comprises an actuator housing which is fixed in position relative to the bonnet; wherein the second stop surface is formed on a positive stop housing which is connected to the bonnet over the stem bore, and wherein the actuator housing is connected to the positive stop housing.
 - 18.** The gate valve of claim 17, wherein the valve actuator comprises a stem adapter having a first end which is operatively linked to the actuator shaft and a second end which is connected to a valve operator; wherein the valve operator comprises a rotary electric actuator which is connected to the actuator housing or to a support sleeve which is secured to the actuator housing; and wherein the rotary electric actuator includes an output shaft connected to the stem adapter.
 - 19.** The gate valve of claim 1, wherein the first and second stop surfaces are positioned outside of an actuator which is connected to the valve stem and is configured to move the gate between the open and closed positions.
 - 20.** The gate valve of claim 19, wherein the actuator does not have a positive stop surface or position control functionality.
 - 21.** The gate valve of claim 1, wherein the axial distance between the first stop surface and the bottom of the gate and/or the axial distance between the second stop surface and the bottom of the cavity is adjustable.
 - 22.** The gate valve of claim 1, wherein the first stop surface is rotationally associated with the valve stem such that rotation of the first stop surface relative to the valve stem results in axial translation of the first stop surface relative to the valve stem.
 - 23.** The gate valve of claim 1 or 22, wherein the second stop surface is rotationally associated with the bonnet such that rotation of the second stop surface relative to the bonnet results in axial translation of the second stop surface relative to the bonnet.
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