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STABILIZED CHECK VALVE

Abstract

In some implementations, a check valve may include a valve body, a hanger configured in the valve body and including a bore, a clapper rotatably connected to the hanger, wherein the clapper is configured to rotate between a closed position and an open position, a pin configured within the bore to rotatably connect the hanger and the clapper, wherein the pin is configured parallel to an axis of the bore, and first and second setting members configured at respective first and second opposite ends of the pin, wherein the first and second setting members are configured to at least partially restrict movement of the pin in respective first and second opposite directions parallel to the axis of the bore.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This patent application claims the benefit of priority to U.S. Non-provisional patent application Ser. No. 18/365,351, filed on Aug. 4, 2023, the contents of which are incorporated herein by reference in their entirety.

TECHNICAL FIELD

[0002] The present disclosure relates generally to valves and, for example, to a stabilized check valve.

BACKGROUND

[0003] A check valve (sometime referred to as a swing valve, a non-return valve, a one-way valve, or a flapper check valve) is a mechanical device designed to allow the flow of fluid in only one direction. The check valve may prevent backflow or reverse flow in a fluid passageway (e.g., a pipe), meaning the check valve stops the fluid from flowing in the opposite direction in the fluid passageway. When the fluid flows in the desired direction (forward flow) in the fluid passageway, the check valve opens allowing the fluid to pass through unrestricted. However, when the fluid flows in the opposite direction (reverse flow) in the fluid passageway, the check valve automatically closes, thereby blocking the passage of the fluid and preventing backflow.

[0004] In some examples, the fluid in the fluid passageway may experience dynamic flow conditions. The dynamic flow conditions (e.g., where the flow is turbulent and/or is associated with rapid changes in pressure and/or velocity) may place dynamic loads on one or more components of the check valve. The dynamic loads may cause the check valve to open and close rapidly in quick succession, resulting in chattering and vibrations. As another example, the dynamic loads may cause one or more movable elements of the check valve (such as a clapper or pin) to flutter or oscillate, leading to instability and inconsistent performance. The dynamic flow conditions may introduce stresses, cause fatigue failures, and/or cause premature wear of components of the check valve. For example, dynamic loads may cause vibrations in one or more movable components of the check valve may introduce additional stresses and/or cause premature wear of a pin (e.g., that enables a movement of the one or more movable components) and/or may cause the pin to contact component(s) of the fluid passageway (such as a valve body) causing damage to the component(s) of the check valve, such as the valve body.

[0005] The check valve of the present disclosure solves one or more of the problems set forth above and/or other problems in the art.

SUMMARY

[0006] A check valve may include a hanger including a bottom face having a concave recess extending into the bottom face; and a clapper rotatably connected to the hanger, the clapper including a first rounded surface extending from a top face of the clapper, and a second rounded surface extending from a bottom face of the clapper, wherein the first rounded surface and the concave recess are configured to form a mated interface when the clapper is in an open position.

[0007] A check valve may include a valve body, wherein the check valve is configured to control a direction of flow of a fluid in the valve body; a hanger configured in the valve body in a position that is approximately parallel to the direction of flow, wherein the hanger includes a first mating surface on a bottom face of the hanger; and a clapper rotatably connected to the hanger, wherein the clapper is configured to rotate between a closed position and an open position, wherein the clapper includes a second mating surface on a top face of the clapper, and wherein the first mating surface and the second mating surface are configured to form a mated interface when the clapper is

in the open position.
[0008] A check valve may include a hanger including a first mating surface on a bottom face of the hanger; and a clapper rotatably connected to the hanger, wherein the clapper is configured to rotate between a closed position and an open position, wherein the clapper includes a second mating surface on a top face of the clapper, and wherein the first mating surface and the second mating surface are configured to form a mated interface when the clapper is in the open position.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0009] FIG. **1** is a diagram illustrating a cross-section view of an example check valve.
[0010] FIG. **2** is a diagram illustrating a cross-section view of the example check valve.
[0011] FIG. **3** is a diagram illustrating an exploded view of the example check valve.
[0012] FIG. **4** is a diagram illustrating a perspective view of an example clapper.
[0013] FIG. **5** is a diagram illustrating a perspective view of an example hanger.
[0014] FIG. **6** is a diagram illustrating a perspective view of the example hanger.
DETAILED DESCRIPTION
[0015] This disclosure relates to a check valve, which is applicable to any machine or system that utilizes a fluid passageway (e.g., a fluid passageway that includes a check valve). For example, the machine or system may be a flowline system, a fluid delivery system, a pump, a pump system, a hydraulic system, an air compressor, a hydraulic fracturing system, a pneumatic system, a fuel delivery system, an engine, a fire extinguisher, a fire sprinkler system, a fluid pipeline (e.g., an oil pipeline, a steam pipeline, or a gas pipeline), a sewage or wastewater system, an irrigation system, and/or another type of machine or system.
[0016] FIG. **1** is a diagram illustrating a cross-section view of an example check valve **100**. The check valve **100** may be referred to as a clapper valve, a swing valve, a non-return valve, a one-way valve, and/or a flapper check valve, among other examples. The check valve **100** may be included in a machine or system, such as a flowline system or another machine or system in which a direction of fluid flow is controlled via the check valve **100**.
[0017] The check valve **100** includes a valve body **102**. The valve body **102** may form a fluid passageway **104** through which fluid is permitted to flow. The valve body **102** may include an inlet **106** and an outlet **108**. For example, the check valve **100** may be configured to enable fluid to flow from the inlet **106** to the outlet **108** (e.g., in a direction of flow **110**). The check valve **100** may be configured to prevent fluid from flowing from the outlet **108** to the inlet **106** (e.g., in a direction opposite the direction of flow **110**). The check valve **100** may include one or more flowline connectors **112**. The one or more flowline connectors **112** may be located proximate to the inlet **106** and the outlet **108**. The one or more flowline connectors **112** are adapted to couple the valve body **102** in a flowline so that fluid flow through the valve body **102** is permitted in the direction of flow **110** and prevented (or at least reduced) in a direction opposite the axial direction of flow **110**. For example, the check valve **100** may be included in a flowline system (e.g., where the one or more flowline connectors are connected to respective flowlines).
[0018] The check valve **100** includes a valve seat **114** connected to the valve body **102**. The check valve **100** includes a hanger **116** extending within the valve body **102** proximate the valve seat **14**. For example, the hanger **116** may be configured in the valve body **102** in a position that is approximately parallel to the direction of flow **110** (e.g., parallel to an axis **120** of the valve body **102** and/or the fluid passageway **104**).
[0019] The check valve **100** includes a clapper **122**. The clapper **122** may also be referred to as a flapper, a disc, a swing flap, and/or a moveable element, among other examples. The clapper **122** may be rotatably and/or pivotably connected to the hanger **116**. For example, the clapper **122** may

be rotatably and/or pivotably connected to the hanger **116** to enable the clapper **122** to be moveable from an open position (or open configuration) and a closed position (or a closed configuration). As shown by the arrow **124**, the clapper **122** is configured to rotate between the open position and the closed position. The rotation may be caused by a flow of fluid through the fluid passageway **104**. For example, as fluid flows in the direction of flow **110**, a force of the fluid flow may cause the clapper **122** to move to the open position. As fluid flows in a direction opposite the direction of flow **110**, force of the fluid flow may cause the clapper **122** to move to the closed position.

[0020] The open position is depicted in FIG. **1**. For example, in the open position, fluid flow is permitted through the valve body **102** (e.g., in the direction of flow **110**). In the closed position, the clapper **122** is seated against the valve seat **114** to at least partially (or fully) restrict fluid flow through the valve body **102**. For example, in the closed position, the clapper **122** is seated against the valve seat **114** such that a seal **126** (e.g., position on the clapper **122**) forms a seal with the valve seat **114** to at least partially (or fully) restrict fluid flow through the valve body **102** and/or through the fluid passageway **104**.

[0021] The clapper **122** may include a top face **128** and a bottom face **130**. The bottom face **130** of the clapper **122** is configured to face toward the direction of flow **110** in the valve body **102**. The top face **128** of the clapper **122** is configured to face away from the direction of flow **110** when the clapper **122** is in the closed position. The clapper **122** may be a single unitary piece (e.g., as shown in FIG. **1**). In some implementations, the clapper **122** may include multiple pieces connected to each other (e.g., the top face **128** may be included on a first piece of the clapper **122** and the bottom face **130** may be included on a second piece of the clapper **122**).

[0022] The clapper **122** may be connected to the hanger **116** via a pin **132**. For example, the clapper **122** and the hanger **116** may be connected via a pin connection that includes the pin **132**. The check valve **100** may include a cap **134**. The cap **134** may secure the hanger **116** in position relative to the valve seat **114**. Additionally, the cap **134** may be removable (e.g., via a threaded connection with the valve body **102**) to enable access to other components of the check valve **100**, such as for maintenance and/or repair.

[0023] When the clapper is in the open position (e.g., as shown in FIG. **1**), the clapper **122** may be configured to contact the hanger **116** to form a mated interface **136**. For example, the mated interface **136** may be between the top face **128** of the clapper **122** and a bottom face **138** of the hanger **116**. As described in more detail elsewhere herein, the mated interface **136** may be associated with increased surface area due to one or more mating surfaces on the clapper **122** and/or the hanger **116**. The increased surface area increases friction at the mated interface **136**, thereby reducing the movement of the clapper **122** and/or the pin **132** when the clapper **122** is in the open position.

[0024] In some implementations, an angle **140** between the open position and the closed position of the clapper **122** satisfies a threshold. For example, the angle **140** may be close to 90 degrees. The threshold may be 85 degrees, 87.5 degrees, and/or another value close to 90 degrees. Increasing the angle **140** (e.g., to be close to 90 degrees) may reduce forces and/or stress placed on the clapper **122** (e.g., caused by fluid flow through the fluid passageway **104**), thereby reducing wear on the clapper **122**. In some implementations, the increased angle (e.g., the angle **140**) may be enabled via one or more features on the bottom face **130** of the clapper **122**, as described in more detail elsewhere herein.

[0025] As indicated above, FIG. **1** is provided as an example. Other examples may differ from what is described with regard to FIG. **1**.

[0026] FIG. **2** is a diagram illustrating a cross-section view of the example check valve **100**. The cross-section view is of the cross-section A-A depicted in FIG. **1**.

[0027] As shown in FIG. **2**, the pin **132** is configured to rotatably connect the hanger **116** and the clapper **122**. For example, the hanger **116** includes a bore **142** (e.g., shown in more detail in FIGS. **3**, **5**, and **6**). The pin is configured within the bore **142** to rotatably connect the hanger **116** and the clapper **122**. The clapper **122** may include a bore **144** (e.g., a second bore, shown in more detail in FIGS. **3** and **4**). The pin **132** is configured within the bore **142** and the bore **144**. For example, the pin **132** is configured to pass through the bore **142** and the bore **144** to enable the clapper **122** to rotate about an axis **146** defined by the pin **132**, the bore **142**, and/or the bore **144**.

[0028] The check valve **100** includes one or more setting members **148**. The one or more setting members **148** extend through the hanger **116** (e.g., to reduce a movement of the pin **132**). In one example, the check valve **100** may include two setting members **148**. For example, a first setting member **148** may be configured at (or near) a first end **150** of the pin **132** and a second setting member **148** may be configured at (or near) a second end **152** of the pin **132**. A setting member **148** may be a pin, a screw, a set screw, a bolt, a rivet, a threaded insert, and/or another mechanical component.

[0029] The one or more setting members **148** extend into the bore **142** (e.g., of the hanger **116**) and form one or more interfaces with the pin **132**. For example, a first interface between a first setting member **148** and the first end **150** of the pin **132** is formed. Additionally, a second interface between a second setting member **148** and the second end **152** of the pin **132** is formed. The one or more interfaces (e.g., the first interface and the second interface) may at least partially restrict a movement of the pin **132**. For example, the one or more interfaces (e.g., the first interface and the second interface) may at least partially restrict a movement of the pin **132** along the axis **146** (e.g., in directions parallel to the axis **146**). As a result, a likelihood that the pin **132** contacts the valve body **102** during operation is reduced.

[0030] The clapper **122** may include one or more features **154** on the bottom face **130**. The one or more features **154** may facilitate a mating between the top face **128** of the clapper **122** and the bottom face **138** of the hanger **116** (e.g., the one or more features **154** may facilitate the forming of the mated interface **136** when the clapper **122** is in the open position shown in FIGS. **1** and **2**). The one or more features **154** extend from (e.g., extend away from) the bottom face **130**. As an example, the one or more features **154** include a rounded surface extending from the bottom face **130** of the clapper **122**. The rounded surface may be a spherical surface. In other examples, the one or more features may have a different shape and/or geometry extending away from the bottom face **130** of the clapper **122**. The one or more features **154** may increase a force placed on the clapper **122** when fluid flows through the fluid passageway **104** in the direction of flow **110**. For example, the rounded surface extending from the bottom face **130** may increase the force placed on the clapper **122** when fluid flows through the fluid passageway **104** in the direction of flow **110**. This increased force improves the connection (e.g., increases the force at) the mated interface **136**, thereby reducing movement of one or more components of the check valve **100** when the clapper **122** is in the open position. Additionally, this increased force enables the angle **140** to be larger (e.g., closer to 90 degrees), thereby reducing wear on the clapper **122**. As another example, the rounded surface (e.g., the spherical surface) extending from the bottom face **130** of the clapper **122** may reduce wear on the seal **126**. For example, the rounded surface (e.g., the spherical surface) extending from the bottom face **130** of the clapper **122** may re-route or re-direct flow of fluid through the fluid passageway **104** away from the seal **126**, thereby reducing wear on the seal **126**. For example, rounded surface (e.g., the spherical surface) extending from the bottom face **130** of the clapper **122** may cause fluid to flow away from the seal **126** (e.g., thereby reducing a velocity of the fluid at a boundary with seal **126**).

[0031] As indicated above, FIG. **2** is provided as an example. Other examples may differ from what is described with regard to FIG. **2**.

[0032] FIG. **3** is a diagram illustrating an exploded view of the example check valve **100**. FIG. **3** depicts the clapper **122** in an orientation associated with the closed position of the clapper **122** (e.g., the closed configuration or closed position of the check valve **100**).

[0033] The one or more setting members **148** may pass through a top face **156** of the hanger **116**. For example, the top face **156** may include one or more apertures **158** to enable the one or more setting members **148** to be configured in the bore **142**. A setting member **148** may include a threaded portion **160**. The threaded portion **160** may be threaded into a corresponding threaded hole (or tapped hole) in the hanger **116** (e.g., to fix the setting member **148** in place within the bore **142**). In other examples, different means (e.g., other than threads) may be used to fix a position of the one or more setting members **148**, such as a nut, a clip, an adhesive, a clamp, a magnet, a weld, and/or another means. Therefore, when configured within the bore **142** (e.g., after the pin **132** has been configured within the bore **142** and the bore **144**), the one or more setting members **148** may at least partially restrict or prevent a movement of the pin **132** (e.g., along the axis **146**).

[0034] The clapper **122** and the hanger **116** may include one or more mating surfaces associated with forming the mated interface **136**. For example, the clapper **122** includes a first mating surface **162**. The hanger **116** includes a second mating surface **164**. The first mating surface **162** and the second mating surface **164** may include corresponding geometry (e.g., to increase a surface area of the mated interface **136** as compared to an interface between the top face **128** of the clapper **122** and the bottom face **138** of the hanger **116**). For example, the first mating surface **162** is on the top face **128** of the clapper **122**. The second mating surface **164** is on the bottom face **138** of the hanger **116**. The first mating surface **162** extends from (e.g., extends away from) the top face **128** and the second mating surface **164** extends into the bottom face **138**. In other examples, the first mating surface **162** extends into the top face **128** and the second mating surface **164** extends from (e.g., extends away from) the bottom face **138**.

[0035] The first mating surface **162** and the second mating surface **164** may have corresponding geometries. For example, the first mating surface **162** and the second mating surface **164** may both be rounded surfaces, may both be rectangular surfaces, may both be hexagonal surfaces, and/or may both be surfaces having another geometry. As an example, as shown in FIG. **3**, the first mating surface **162** and the second mating surface **164** may both be curved surfaces (e.g., spherical surfaces). For example, first mating surface **162** and the second mating surface **164** may be spherical surfaces. A spherical surface may be curved and/or rounded along a plurality of directions. A spherical surface may be curved and/or rounded 360 degrees around a central axis. In some implementations, a spherical surface may be a three-dimensional surface that has the shape of a sphere. For example, a spherical surface may have an approximately constant curvature at any point on the spherical surface.

[0036] For example, the first mating surface **162** is a rounded surface extending from the top face **128** of the clapper **122**. In such examples, the second mating surface **164** is a concave recess extending into the bottom face **138** of the hanger **116**. Alternatively, the first mating surface **162** is a concave recess extending into the top face **128** of the clapper **122** and the second mating surface **164** is a rounded surface extending from (e.g., extending away from) the bottom face **138** of the hanger **116**. The rounded surfaces may be associated with increased surface area (e.g., when the mated interface **136** is formed) as compared to other geometries.

[0037] The rounded surface of the first mating surface **162** (e.g., rounded surface extending away from the top face **128** of the clapper **122**) has a first radius. The rounded surface of the second mating surface **164** (e.g., the concave recess) has a second radius. The first radius and the second radius are within a tolerance. In other words, a difference between the first radius and the second radius satisfies a threshold (e.g., the difference may be less than or equal to the threshold). In some examples, the first radius and the second radius are the same. The first radius and the second radius being similar and/or the same increases the surface area of the mated interface **136**.

[0038] As indicated above, FIG. **3** is provided as an example. Other examples may differ from what is described with regard to FIG. **3**.

[0039] FIG. **4** is a diagram illustrating a perspective view of an example clapper **122**.

[0040] The clapper **122** includes a generally disk-shaped valve member **166** extending about a central axis **168**. The valve member **166** includes a circumferentially-extending exterior surface **170** situated axially between the top face **128** and the bottom face **130**. The exterior surface **170** delineates the outer periphery of the valve member **166**.

[0041] The bottom face **130** may include the seal **126**. For example, the bottom face **130** includes an external annular groove that is formed in the bottom face **130** and/or the exterior surface **170** of the valve member **166**. The seal **126** is configured in the external annular groove (e.g., extends within the external annular groove) and includes a circumferentially-extending exterior surface extending adjacent the exterior surface **170** of the valve member **166**.

[0042] The clapper **122** includes a hinge block **172**. The hinge block **172** is connected to the valve member **166** at the top face **128**. The hinge block **172** is integrally formed with the valve member **166**. The hinge block **172** includes a proximal end portion **174**, located at or near the central axis **168** of the valve member **166**, and a distal end portion **176**, extending radially beyond the exterior surface **170** of the valve member **166**. The bore **144** (e.g., a generally cylindrical passageway) is formed through the hinge block **172** proximate the distal end portion **176**. The bore **144** may extend approximately perpendicular to the central axis **168**. The hinge block **172** is configured to extend between hinge blocks of the hanger **116** (e.g., depicted in FIGS. **5** and **6**) so that the bore **144** of the clapper **122** is substantially aligned with the bore **142** of the hanger **116**.

[0043] As indicated above, FIG. **4** is provided as an example. Other examples may differ from what is described with regard to FIG. **4**.

[0044] FIG. **5** is a diagram illustrating a perspective view of an example hanger **116**.

[0045] The hanger **116** includes a generally disk-shaped annular body **178** extending about a central axis. The annular body **178** includes a central opening **180**, the bottom face **138**, and the top face **156**. An external lip **182** is formed in the periphery of the annular body **178**. The external lip **182** may be a shoulder. The central opening **180** may enable access to other components of the check valve **100** (such as the clapper **122**) when the check valve **100** is assembled (e.g., without disassembling the check valve **100**). As shown elsewhere herein, a top portion of the clapper **122** (e.g., at least a portion of the first mating surface **162**) may extend through the central opening **180** (e.g., when the clapper **122** is in the closed position). For example, the central opening **180** enables the top portion of the clapper **122** to fit with the hanger **116** when the clapper **122** is in the closed position.

[0046] The hanger **116** includes one or more hinge blocks **184**. For example, as shown in FIG. **5**, the hanger **116** includes two hinge blocks **184** separated by a distance. The bore **142** (e.g., a generally cylindrical passageway) may pass through each hinge block **184** of the hanger **116**. For example, when configured, the hinge block **172** of the clapper **122** may be configured between the hinge blocks **184** of the hanger **116** such that the bore **142** aligns with the bore **144**. The pin **132** may be configured within the aligned bores (e.g., the bore **142** and the bore **144**) to rotatably connect the clapper **122** to the hanger **116**.

[0047] Each hinge block **184** may include an aperture **186**. A setting member **148** may be configured within an aperture **186** when the check valve **100** is configured. For example, the aperture(s) **186** may be threaded holes. The threaded portion **160** of the setting member **148** may be threaded into the aperture **186** to fix the setting member **148** in place. In other example, the threaded portion **160** may pass through the aperture **186** and another component (e.g., a nut or a clip) may fix the setting member **148** in place (e.g., via contact with the bottom face **138**).

[0048] As shown in FIG. **5**, the second mating surface **164** extends into the bottom face **138**. For example, the second mating surface **164** is a concave surface or a rounded surface (e.g., a spherical surface) extending into the bottom face **138**. The second mating surface **164** is configured to mate with the first mating surface **162** of the clapper **122** when the clapper **122** is in the open position. For example, the first mating surface **162** and the second mating surface **164** are configured to increase the surface area of the mated interface **136**, as described in more detail elsewhere herein.

[0049] As indicated above, FIG. **5** is provided as an example. Other examples may differ from what is described with regard to FIG. **5**.

[0050] FIG. **6** is a diagram illustrating a perspective view of the example hanger **116**.

[0051] The second mating surface **164** (e.g., the concave recess) may extend from the bottom face **138** toward the top face **156** of the hanger **116**. For example, the second mating surface **164** may extend into the annular body **178** of the hanger **116**. In association with the first mating surface **162** extending from the top face **128** of the clapper **122**, this increases the surface area of the mated interface **136** (e.g., between the clapper **122** and the hanger **116**) when the clapper **122** is in the open position.

[0052] The top face **156** of the hanger **116** may include the one or more apertures **158**. The one or more apertures **158** enable the one or more setting members **148** to be configured in the bore **142**. For example, when the check valve **100** is assembled, a setting member **148** may pass through the aperture **158**, be fixed via the aperture **186**, and be configured in the bore **142** (e.g., the bore through a hinge block **184** of the hanger **116**). The one or more apertures **158** may be generally cylindrical passageways from the top face **156** into the bore **142**. As described elsewhere herein, when the one or more setting members **148** are fixed in the bore **142** (e.g., via the aperture(s) **158** and the aperture(s) **186**), the one or more setting members **148** may at least partially restrict or prevent a movement of the pin **132** (e.g., in a direction that is parallel to an axis of the bore **142**).

[0053] As indicated above, FIG. **6** is provided as an example. Other examples may differ from what is described with regard to FIG. **6**.

INDUSTRIAL APPLICABILITY

[0054] In some examples, fluid in a fluid passageway of a check valve may experience dynamic flow conditions. The dynamic flow conditions (e.g., where the flow is turbulent and/or is associated with rapid changes in pressure and/or velocity) may place dynamic loads on one or more components of the check valve, such as a clapper, a hanger, and/or a pin. The dynamic loads may cause the check valve to open and close rapidly in quick succession, resulting in chattering and vibrations. As another example, the dynamic loads may cause one or more movable elements of the check valve (such as a clapper or pin) to flutter or oscillate, leading to instability and inconsistent performance. The dynamic flow conditions may introduce stresses, cause fatigue failures, and/or cause premature wear of components of the check valve. For example, dynamic loads may cause vibrations in one or more movable components of the check valve may introduce additional stresses and/or cause premature wear of a pin (e.g., that enables a movement of the one or more movable components) and/or wear of a bore in which the pin is configured. Additionally, the dynamic loads may cause vibrations in one or more movable components of the check valve may cause the pin to contact component(s) of the fluid passageway (such as a valve body) causing damage to the component(s) of the check valve (such as the valve body).

[0055] Some implementations described herein enable a stabilized check valve. For example, the check valve described herein may be stabilized in that a mating interface between the clapper and the hanger of the check valve is associated with increased surface area. The increased surface area may increase friction between the clapper and the hanger. The increased friction may stabilize a movement of the clapper (e.g., may reduce a movement of the clapper) when the clapper is in an open position (e.g., an under dynamic loads caused by fluid passing through the check valve). As a result, the reduced movement of the clapper may transfer loads and/or stresses from the pin (e.g., and/or from an interface between the pin and/or one or more bores) to the mating interface between the clapper and the hanger. This reduces wear of the pin and/or the one or more bores. By reducing the wear of the pin and/or the one or more bores, the check valve may experiences an improved lifespan. For example, by reducing the wear of the pin and/or the one or more bores, a likelihood of misalignment between the clapper and the valve body of the check valve when the clapper is in the closed position is reduced (e.g., improving the likelihood that a seal of the clapper is enabled to form an effective seal preventing fluid from flowing in an undesired direction through the check valve).

[0056] For example, the clapper may include a first mating surface and the hanger may include a second mating surface. When the clapper is in the open position, the first mating surface and the second mating surface may contact each other to form the mated interface. In some examples, the first mating surface may be a rounded surface extending from the top face of the clapper and the second mating surface may be a concave recess extending into the bottom face of the hanger. The mating surfaces may have corresponding geometries (e.g., one surface may extend away from a first component in a given geometry and the other surface may extend into a second component in the given geometry) to increase the surface area of the mated interface. For example, the given geometry may be a rounded or spherical geometry (e.g., which has a relatively increased surface area for the mated interface compared to other geometries). Moreover, by configuring the mated interface to be between the clapper and the hanger, stresses, wear, and/or forces caused by the fluid passing through the check valve may be isolated to replaceable components of the check valve. For example, by configuring the mated interface to be between the clapper and the hanger, a likelihood of additional wear and/or stresses to a valve body of the check valve (e.g., caused by moving components of the check valve) is reduced.

[0057] In some implementations, the clapper may include one or more features extending away from the bottom face of the clapper. For example, the clapper may include a rounded surface extending away from the bottom face of the clapper. The one or more features (e.g., the rounded surface) may increase a force on the clapper caused by fluid traveling through the check valve in an intended or permitted direction of flow. The increased force provides additional force to stabilize the clapper in the open position (e.g., via the additional friction at the mated interface). Further, the increased force enables an angle of the clapper (e.g., an angle between the open position and a closed position) to be increased (e.g., closer to 90 degrees). The increased angle reduces wear on the clapper caused by the fluid passing through the check valve.

[0058] In some implementations, the check valve may include one or more setting members. The one or more setting members are configured to at least partially reduce or prevent a movement of the pin of the check valve. By configuring the one or more setting members to at least partially reduce or prevent a movement of the pin, a likelihood that the pin contacts other components of the check valve (such as the valve body) is reduced. By reducing the likelihood that the pin contacts other components of the check valve, a likelihood of wear and/or premature failure of the pin and/or the other components is reduced.

[0059] The foregoing disclosure provides illustration and description, but is not intended to be exhaustive or to limit the implementations to the precise forms disclosed. Modifications and variations may be made in light of the above disclosure or may be acquired from practice of the implementations. Furthermore, any of the implementations described herein may be combined unless the foregoing disclosure expressly provides a reason that one or more implementations cannot be combined. Even though particular combinations of features are recited in the claims and/or disclosed in the specification, these combinations are not intended to limit the disclosure of various implementations. Although each dependent claim listed below may directly depend on only one claim, the disclosure of various implementations includes each dependent claim in combination with every other claim in the claim set.

[0060] As used herein, satisfying a threshold may, depending on the context, refer to a value being greater than the threshold, greater than or equal to the threshold, less than the threshold, less than or equal to the threshold, equal to the threshold, not equal to the threshold, or the like. As used herein, "a," "an," and a "set" are intended to include one or more items, and may be used interchangeably with "one or more." Further, as used herein, the article "the" is intended to include one or more items referenced in connection with the article "the" and may be used interchangeably with "the one or more." Further, the phrase "based on" is intended to mean "based, at least in part, on" unless explicitly stated otherwise. Also, as used herein, the term "or" is intended to be inclusive when used in a series and may be used interchangeably with "and/or," unless explicitly stated otherwise (e.g., if used in combination with "either" or "only one of"). Further, spatially relative terms, such as "below," "lower," "above," "upper," "bottom," "top," and the like, may be used herein for ease of description to describe one element or feature's relationship to another element(s) or feature(s) as illustrated in the figures. The spatially relative terms are intended to encompass different orientations of the apparatus, device, and/or element in use or operation in addition to the orientation depicted in the figures. The apparatus may be otherwise oriented (rotated 90 degrees or at other orientations) and the spatially relative descriptors used herein may likewise be interpreted accordingly.

Claims

1. A check valve, comprising: a valve body, wherein the check valve is configured to control a direction of flow of a fluid in the valve body; a hanger configured in the valve body and including a bore; a clapper rotatably connected to the hanger, wherein the clapper is configured to rotate between a closed position and an open position; a pin configured within the bore to rotatably connect the hanger and the clapper, wherein the pin is configured parallel to an axis of the bore; and first and second setting members configured at respective first and second opposite ends of the pin, wherein the first and second setting members are configured to at least partially restrict movement of the pin in respective first and second opposite directions parallel to the axis of the bore.
2. The check valve of claim 1, wherein the first end of the pin is facing in the first direction along the axis, and wherein the first setting member forms a first interface, configured perpendicular to the axis, with the first end of the pin.
3. The check valve of claim 2, wherein the second end of the pin is facing in the second direction along the axis, and wherein the second setting member forms a second interface, configured perpendicular to the axis, with the second end of the pin.
4. The check valve of claim 1, further comprising first and second apertures configured in a top face of the hanger, wherein the first and second setting members are configured within the respective first and second apertures, and wherein the first and second apertures are configured wider apart than a hinge block of the clapper.
5. The check valve of claim 1, further comprising first and second apertures configured in a top face of the hanger, wherein the first and second setting members are configured within the respective first and second apertures, and wherein the first and second apertures are configured wider apart than the respective first and second opposite ends of the pin.
6. The check valve of claim 1, further comprising first and second apertures configured in a top face of the hanger, wherein the first and second setting members are configured within the respective first and second apertures, and wherein the first and second apertures are configured wider apart than a total length of the pin.
7. The check valve of claim 1, wherein the first and second setting members are configured wider apart than the respective first and second opposite ends of the pin.
8. The check valve of claim 1, further comprising first and second apertures configured in a bottom face of the hanger, wherein the first and second setting members are configured within the respective first and second apertures.
9. The check valve of claim 8, wherein each of the first and second setting members includes a first portion that forms an interface with the respective first or second end of the pin and a second portion that is threaded with the respective first or second aperture.
10. The check valve of claim 1, further comprising first and second apertures configured in a bottom face of the hanger radially outside a mating surface of the hanger, wherein the first and second setting members are configured within the respective first and second apertures.
11. The check valve of claim 1, wherein the first and second setting members comprise a pin, a screw, a set screw, a bolt, a rivet, or a threaded insert.
12. A valve assembly, comprising: a hanger including a bore; a clapper rotatably connected to the

hanger, wherein the clapper is configured to rotate between a closed position and an open position; a pin configured within the bore to rotatably connect the hanger and the clapper, wherein the pin is configured parallel to an axis of the bore; and one or more setting members configured at respective first or second opposite ends of the pin, wherein the one or more setting members are configured to at least partially restrict movement of the pin in respective first or second opposite directions parallel to the axis of the bore.

13. The valve assembly of claim 12, wherein the first end of the pin is facing in the first direction along the axis, and wherein a first setting member, of the one or more setting members, forms a first interface, configured perpendicular to the axis, with the first end of the pin.

14. The valve assembly of claim 13, further comprising a first aperture configured in a top face of the hanger, wherein the first setting member is configured within the first aperture.

15. The valve assembly of claim 14, further comprising a second aperture configured in a bottom face of the hanger, wherein the first setting member is configured within the second aperture.

16. The valve assembly of claim 15, wherein the second aperture is radially outside a mating surface of the hanger.

17. A check valve, comprising: a valve body, wherein the check valve is configured to control a direction of flow of a fluid in the valve body; a hanger configured in the valve body and including a bore; a clapper rotatably connected to the hanger via a hinge block of the clapper, wherein the clapper is configured to rotate between a closed position and an open position; first and second apertures configured in a top face of the hanger, wherein the first and second apertures are configured wider apart than the hinge block; a pin configured within the bore to rotatably connect the hanger and the clapper, wherein the pin is configured parallel to an axis of the bore; and first and second setting members configured within the respective first and second apertures, wherein the first and second setting members are configured to at least partially restrict movement of the pin in respective first and second opposite directions parallel to the axis of the bore.

18. The check valve of claim 17, wherein the first and second setting members are configured at respective first and second opposite ends of the pin.

19. The check valve of claim 18, wherein the first end of the pin is facing in the first direction along the axis, and wherein the first setting member forms a first interface, configured perpendicular to the axis, with the first end of the pin.

20. The check valve of claim 19, wherein the second end of the pin is facing in the second direction along the axis, and wherein the second setting member forms a second interface, configured perpendicular to the axis, with the second end of the pin.