



- (51) International Patent Classification:
F01D 17/14 (2006.01) *F16K 5/00* (2006.01)
- (21) International Application Number:
PCT/US2016/054672
- (22) International Filing Date:
30 September 2016 (30.09.2016)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
62/244,794 22 October 2015 (22.10.2015) US
- (71) Applicant: DRESSER-RAND COMPANY [US/US]; 500 Paul Clark Drive, Olean, New York 14760 (US).
- (72) Inventors: JACHLEWSKI, Mark; 7947 County Road 20, Friendship, New York 14739 (US). FULLER, Bruce E.; 1299 State Route 244, Alfred Station, New York 14803 (US). RATAJEWSKI, Dariusz; 321 Charlotte Court, Unit 1, Schaumburg, Illinois 60193 (US). FELTZ, James; 3261 Madison Hill Road, Wellsville, New York 14895 (US).
- (74) Agent: BASU, Rana; Siemens Corporation- Intellectual Property Dept., 3501 Quadrangle Blvd. Ste. 230, Orlando, Florida 32817 (US).
- (81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.
- (84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU,

[Continued on next page]

(54) Title: BALL TRIP VALVE FOR A STEAM TURBINE

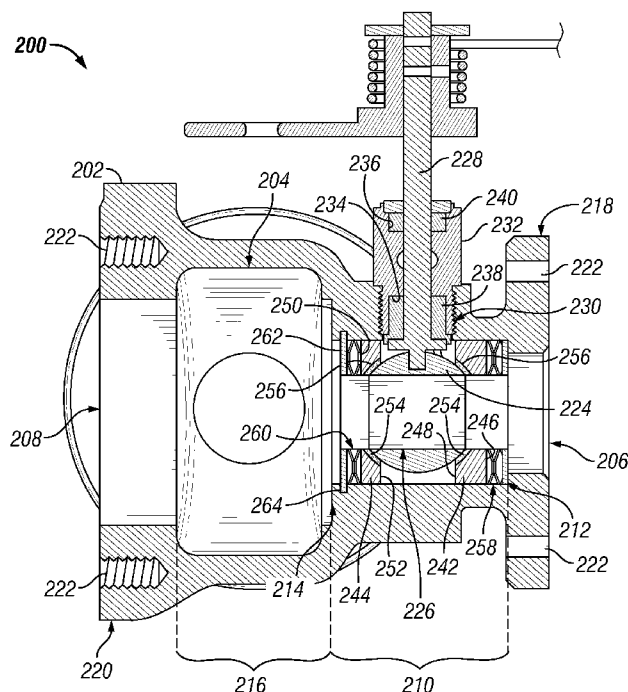


FIG. 2

(57) Abstract: A trip valve for a steam turbine is provided and a method for upgrading the trip valve. The trip valve (200) includes a valve body (202) defining a cavity (204), a first port (206) and a second port (208). The first and second ports are fluidly coupled with the cavity. A ball (224) defining a passage (206) is disposed in the cavity and configured to selectively provide fluid communication between the first and second ports via the passage thereof. First (242) and second (244) valve seats are disposed in the cavity and configured to at least partially support the ball in the cavity. The first valve seat is disposed between the ball and the first port, and the second valve seat is disposed between the ball and the second port. The trip valve further includes a first biasing member (258) and a second biasing member (260) configured to urge the first valve seat and the second valve seat, respectively, toward the ball.



LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, **Published:**
SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, — *with international search report (Art. 21(3))*
GW, KM, ML, MR, NE, SN, TD, TG).

BALL TRIP VALVE FOR A STEAM TURBINE

Background

[0001] Steam turbines may often be utilized in a myriad of industrial applications and processes to manage a pressurized working fluid (*i.e.*, pressurized steam) from a source of pressurized steam (*e.g.*, a boiler) over a broad range of pressures. In conventional steam turbines, energy of the pressurized steam may be converted to work to operate one or more downstream processes. Conventional steam turbines may often utilize one or more valves (*e.g.*, ball valve) configured to control a flow of the pressurized steam from the source to the steam turbine. For example, the steam turbines may often utilize a control valve configured to throttle a flow rate of the steam to the steam turbine, and a trip valve configured to allow or prevent the flow of the steam to the steam turbine.

[0002] A conventional trip valve 100 is illustrated in Figure 1, and may include a valve body 102 defining ports 104, 106 at opposite ends thereof, and a ball 108 disposed in the valve body 102 between the ports 104, 106. As illustrated in Figure 1, the ball 108 may define a passage 110 extending therethrough, and may be actuated or rotated between opened and closed positions with a valve stem 112 to allow or prevent the flow of the steam through the trip valve 100. As further illustrated in Figure 1, the conventional trip valve 100 may utilize carbon graphite rings 114 as bushings for the valve stem 112, and a single carbon graphite valve seat 116 configured to at least partially support the ball 108 and/or provide a seal around the ball 108. The conventional trip valve 100 may also include a setscrew 118 extending through the valve body 102 and configured to at least partially support the ball 108. While conventional trip valves 100 have proven to be effective for allowing or preventing the flow of the steam to the steam turbine, the trip valve 100 and/or one or more components thereof may degrade, thereby reducing the effective lifetime of the trip valve 100. For example, radial thermal growth or expansion of the ball 108 and/or actuation of the ball 108 via the valve stem 112 may result in forces (*e.g.*, radial force) being exerted on the valve seat 116 and/or the carbon rings 114, which may cause damage (*e.g.*, fracture, chip, *etc.*) thereto. Further, fragments or pieces of the damaged valve seat 116 and/or the damaged carbon rings 114 may be carried into the steam turbine, thereby restricting flow therethrough.

[0003] What is needed, then, is an improved ball valve and method for upgrading a conventional ball valve.

Summary

[0004] Embodiments of the disclosure may provide a trip valve for a steam turbine. The trip valve may include a valve body defining a cavity and a ball disposed in the cavity. The valve body may also define a first port and a second port in fluid communication with the cavity, and the ball may define a passage extending therethrough. The ball may be configured to be rotated to selectively provide fluid communication between the first and second valve ports via the passage thereof. The trip valve may further include a first valve seat and a second valve seat configured to engage and at least partially support the ball in the cavity. The first valve seat may be disposed in the cavity between the ball and the first port, and the second valve seat may be disposed in the cavity between the ball and the second port. The trip valve may also include a first biasing member and a second biasing member. The first biasing member may be disposed adjacent the first valve seat, and the second biasing member may be disposed adjacent the second valve seat. The first and second biasing members may be configured to urge the first and second valve seats toward the ball, respectively.

[0005] Embodiments of the disclosure may also provide another trip valve for a steam turbine. The trip valve may include a valve body defining a cavity, and inlet, and an outlet, wherein the inlet and the outlet may be in fluid communication with the cavity. The trip valve may also include a ball disposed in the cavity. The ball may define a passage extending therethrough, and may be configured to be rotated to selectively provide fluid communication from the inlet to the outlet. The trip valve may further include a valve stem coupled with the ball and configured to rotate the ball. The trip valve may also include a bushing disposed about the valve stem. The bushing may be fabricated from alloy steel and configured to provide a bearing surface for the valve stem.

[0006] Embodiments of the disclosure may further provide a method for upgrading a trip valve. The method may include replacing at least one non-metallic valve seat with a first metallic valve seat. The method may also include disposing a first biasing member adjacent the first metallic valve seat. The method may further include

replacing at least one non-metallic bushing disposed about a valve stem of the trip valve with a metallic bushing.

Brief Description of the Drawings

[0007] The present disclosure is best understood from the following detailed description when read with the accompanying Figures. It is emphasized that, in accordance with the standard practice in the industry, various features are not drawn to scale. In fact, the dimensions of the various features may be arbitrarily increased or reduced for clarity of discussion.

[0008] Figure 1 illustrates a cross-sectional view of a conventional trip valve, according to the prior art.

[0009] Figure 2 illustrates a cross-sectional view of an exemplary trip valve, according to one or more embodiments disclosed.

[0010] Figure 3 illustrates a flowchart of a method 300 for upgrading a trip valve according to one or more embodiments disclosed.

Detailed Description

[0011] It is to be understood that the following disclosure describes several exemplary embodiments for implementing different features, structures, or functions of the invention. Exemplary embodiments of components, arrangements, and configurations are described below to simplify the present disclosure; however, these exemplary embodiments are provided merely as examples and are not intended to limit the scope of the invention. Additionally, the present disclosure may repeat reference numerals and/or letters in the various exemplary embodiments and across the Figures provided herein. This repetition is for the purpose of simplicity and clarity and does not in itself dictate a relationship between the various exemplary embodiments and/or configurations discussed in the various Figures. Moreover, the formation of a first feature over or on a second feature in the description that follows may include embodiments in which the first and second features are formed in direct contact, and may also include embodiments in which additional features may be formed interposing the first and second features, such that the first and second features may not be in direct contact. Finally, the exemplary embodiments presented

below may be combined in any combination of ways, *i.e.*, any element from one exemplary embodiment may be used in any other exemplary embodiment, without departing from the scope of the disclosure.

[0012] Additionally, certain terms are used throughout the following description and claims to refer to particular components. As one skilled in the art will appreciate, various entities may refer to the same component by different names, and as such, the naming convention for the elements described herein is not intended to limit the scope of the invention, unless otherwise specifically defined herein. Further, the naming convention used herein is not intended to distinguish between components that differ in name but not function. Further, in the following discussion and in the claims, the terms "including" and "comprising" are used in an open-ended fashion, and thus should be interpreted to mean "including, but not limited to." All numerical values in this disclosure may be exact or approximate values unless otherwise specifically stated. Accordingly, various embodiments of the disclosure may deviate from the numbers, values, and ranges disclosed herein without departing from the intended scope. Furthermore, as it is used in the claims or specification, the term "or" is intended to encompass both exclusive and inclusive cases, *i.e.*, "A or B" is intended to be synonymous with "at least one of A and B," unless otherwise expressly specified herein.

[0013] Figure 2 illustrates a cross-sectional view of an exemplary trip valve 200 for a steam turbine, according to one or more embodiments. The trip valve 200 may include a housing or valve body 202 defining an inner chamber or cavity 204 and first and second ports 206, 208 in fluid communication with the cavity 204. The cavity 204 may include a first portion 210 substantially extending or defined between a first shoulder 212 and a second shoulder 214 of the valve body 202, and a second portion 216 substantially extending or defined between the second shoulder 214 and the second port 208.

[0014] The first and second ports 206, 208 may be disposed at opposite ends or end portions of the valve body 202, and may be utilized interchangeably as inlet and outlet ports. For example, a first port 206 may be an inlet port, and a second port 208 may be an outlet port. In another example, the first port 206 may be the outlet port, and the second port 208 may be the inlet port. The trip valve 200 may include one or more mounting flanges (two are shown 218, 220) coupled or integrally formed

with the valve body 202. The mounting flanges 218, 220 may extend from and be disposed about the ports 206, 208, and configured to detachably and fluidly couple the ports 206, 208 with pipelines, conduits, and/or the steam turbine (not shown). For example, as illustrated in Figure 2, a first mounting flange 218 and a second mounting flange 220 may each define a plurality of circumferentially-arrayed perforations or openings 222 at least partially extending therethrough. The circumferentially-arrayed openings 222 may be configured to receive one or more mechanical fasteners (not shown) to facilitate the coupling of the mounting flanges 218, 220 to corresponding flanges (not shown) of the pipeline and/or the steam turbine. Illustrative mechanical fasteners may include, but are not limited to, one or more bolts, studs and nuts, and/or any other known mechanical fasteners.

[0015] The trip valve 200 may include a ball 224 at least partially disposed in the cavity 204 and configured to control a flow of a working fluid (e.g., steam) through the trip valve 200. For example, as illustrated in Figure 2, the ball 224 may be disposed in the first portion 210 of the cavity 204 and configured to control the flow of the working fluid through the trip valve 200 from the first port 206 to the second port 208. The ball 224 may define a passage 226 extending therethrough, and the passage 226 may be configured to selectively provide fluid communication between the first and second ports 206, 208. For example, as illustrated in Figure 2, the ball 224 may be rotated to align the passage 226 with the ports 206, 208 to provide fluid communication between the ports 206, 208 and thereby actuate the trip valve 200 to an opened position. In another example, the ball 224 may be rotated such that the passage 226 is not in fluid communication with the ports 206, 208 to prevent fluid communication therebetween and thereby actuate the trip valve 200 to a closed position.

[0016] A rod or valve stem 228 may be coupled with the ball 224 and configured to rotate the ball 224 to actuate the trip valve 200 between the closed and opened positions. As illustrated in Figure 2, the valve body 202 may define an opening 230 extending therethrough, and the valve stem 228 may extend through the opening 230 to couple with the ball 224. The valve stem 228 may be supported by and/or retained in the opening 230 via a fitting 232 (e.g., pipe fitting) coupled or integrally formed with the valve body 202. For example, as illustrated in Figure 2, the fitting 232 may be coupled with the valve body 202 via threads. In another example, the fitting 232 may be metallurgically bonded or coupled with the valve body 202 via

welds (not shown). The fitting 232 and/or the valve body 202 may define one or more annular recesses (two are shown 234, 236) configured to receive respective bearings or bushings 238, 240. The bushings 238, 240 may be disposed about the valve stem 228 and configured to provide a bearing surface for the rotation of the valve stem 228. The bushings 238, 240 may be fabricated from a metallic material, such as a metal or a metal alloy. Illustrative metals and metal alloys may include, but are not limited to, stainless steel, carbon steel, titanium, a titanium alloy, a nickel alloy, or the like. In an exemplary embodiment, the bushings 238, 240 are fabricated from a hardened stainless steel.

[0017] The trip valve 200 may include one or more valve seats (two are shown 242, 244) configured to support the ball 224 and/or provide a seal around the ball 224. For example, each of the valve seats 242, 244 may be or include annular rings disposed on opposing sides of the ball 224 and configured to support and position the ball 224 in the first portion 210 of the cavity 204. In another example, the valve seats 242, 244 may engage the ball 224 and/or the valve body 202 to prevent a leakage flow therebetween. As illustrated in Figure 2, a first valve seat 242 may be disposed between the ball 224 and the first shoulder 212 of the valve body 202 such that a first annular surface 246 thereof faces or is oriented toward the first shoulder 212, and a second annular surface 248 thereof faces the ball 224. As further illustrated in Figure 2, a second valve seat 244 may be disposed between the ball 224 and the second shoulder 214 of the valve body 202 such that a first annular surface 250 thereof faces or is oriented toward the second shoulder 214, and a second annular surface 252 thereof faces the ball 224. At least a portion of each of the valve seats 242, 244 may be shaped and/or sized to sealingly engage the ball 224. For example, as illustrated in Figure 2, the second annular surfaces 248, 252 of the respective valve seats 242, 244 may be contoured to sealingly engage the ball 224. In another example, the outer circumferential surfaces of the respective valve seats 242, 244 may be sized and/or shaped to sealingly engage an inner surface of the valve body 202. In an exemplary embodiment, the first and second valve seats 242, 244 may fully support the ball 224 in the cavity 204 without the setscrew 118 utilized in the conventional trip valve 100 illustrated in Figure 1.

[0018] The valve seats 242, 244 may be fabricated from one or more metallic materials, such as metals or metal alloys. Illustrative metals and metal alloys may include, but are not limited to, stainless steel, carbon steel, titanium, a titanium alloy,

a nickel alloy, or the like, or any combination thereof. In an exemplary embodiment, the valve seats 242, 244 are fabricated from a hardened stainless steel. In at least one embodiment, the second annular surfaces 248, 252 of the respective valve seats 242, 244 may be coated with one or more wear resistant materials, lubricating materials, corrosion resistant materials, or the like, or any combination thereof. In another embodiment, the valve seats 242, 244 may include inlays 254 fabricated from one or more wear resistant materials, lubricating materials, corrosion resistant materials, or the like, or any combination thereof. For example, the inlays 254 may be fabricated from a superalloy, such as a nickel-based superalloy or a cobalt-based superalloy. Illustrative nickel-based superalloys may include, but are not limited to, Nimonic alloys, Inconel alloys, rhenium containing superalloys (e.g., Rene N5, CMSX-4®, PWA 1484, Rene N6, *etc.*), or the like. Illustrative cobalt-based superalloys may include, but are not limited to, FSX-414, Stellite®, Stellite® 21, Stellite® 31, MarM302, MarM509, Haynes-188, or the like. As illustrated in Figure 2, the valve seats 242, 244 may define grooves 256 extending annularly along the respective second annular surfaces 248, 252 thereof, and the inlays 254 may be at least partially disposed in the grooves 256 to engage the outer surface of the ball 224.

[0019] The trip valve 200 may include one or more biasing members (two are shown 258, 260) configured to hold the valve seats 242, 244 adjacent the ball 224 and/or urge the valve seats 242, 244 toward the ball 224. For example, as illustrated in Figure 2, a first biasing member 258 may be disposed between the first shoulder 212 and the first valve seat 242, and configured to urge the first valve seat 242 toward the ball 224 such that the second annular surface 248 and/or the inlay 254 disposed at the second annular surface 248 engages the outer surface of the ball 224. A backing member may be disposed between the first biasing member 258 and the first shoulder 212, and configured to at least partially retain the first biasing member 258 in the cavity 204. In at least one embodiment, illustrated in Figure 2, a second biasing member 260 may be disposed between a retaining member 262 (e.g., snap ring) and the second valve seat 244, and configured to urge the second valve seat 244 toward the ball 224 such that the second annular surface 252 and/or the inlay 254 disposed at the second annular surface 252 engages the outer surface of the ball 224. The retaining member 262 may be or include an annular member, such as a snap ring, a threaded ring, or a shrink-fit ring, configured to retain the second

biasing member 260 and the second valve seat 244 in the first portion 210 of the cavity 204. For example, the retaining member 262 may be a snap ring disposed in an annular groove 264. The retaining member 262 may also be an annular member coupled to the inner surface of the valve body 204 and/or the annular groove 264 via welds (e.g., tack welds). In another example, the retaining member 262 may be a threaded ring coupled to the inner surface of the valve body 204 via threads (not shown). In yet another example, the retaining member 262 may be an annular member coupled with the inner surface of the valve body 204 via an interference fit (e.g., shrink-fit). In another embodiment, the second biasing member 260, similar to the first biasing member 258 may be disposed between a shoulder (not shown) of the valve body 202 and the second valve seat 244.

[0020] The biasing members 258, 260 may be configured to reduce or prevent the displacement (e.g., axial and/or radial displacement) of the ball 224 in one or more directions. For example, the biasing members 258, 260 may be configured to reduce axial displacement of the ball 224 towards or away from the first port 206 and/or the second port 208. The biasing members 258, 260 may reduce the displacement of the ball 224 by providing or ensuring that a balance of forces are exerted on the ball 224 via the respective valve seats 242, 244. It should be appreciated that reducing the axial and/or radial displacement of the ball 224 may reduce deflecting or radial loads being exerted on the valve stem 228. The biasing members 258, 260 may also be configured to maintain engagement between the valve seats 242, 244 and the ball 224 during thermal expansion and/or contraction of the trip valve 200 and/or one or more components thereof. For example, in operation, the steam flowing through the trip valve 200 may heat the ball 224, thereby resulting in radial thermal expansion of the ball 224. As the radial thermal expansion of the ball 224 urges the first and second valve seats 242, 244 towards the first and second ports 206, 208, respectively, the first and second biasing members 258, 260 may urge the first and second valve seats 242, 244 toward the ball 224 to maintain engagement therebetween.

[0021] The biasing members 258, 260 may be or include any force producing system or device. For example, as illustrated in Figure 2, the biasing members 258, 260 may include one or more springs (e.g., leaf springs, coil springs, wave-spring, etc.). In another example, the biasing members 258, 260 may be or include one or more Belleville washers. An overall spring constant of each of the biasing members 258,

260 may be varied (*i.e.*, increased or decreased) to optimize the biasing forces applied to the ball 224 and/or the valve seats 242, 244. For example, the spring constant of each of the biasing members 258, 260 may be varied to increase or decrease the biasing forces applied to the ball 224. In another example, the number of the biasing members 258, 260 may be increased or decreased to generally increase or decrease the biasing force applied to the ball 224. It should be appreciated that the spring constant of each of the biasing members 258, 260 may be greater than, less than, or equal to one another.

[0022] In at least one embodiment, the conventional trip valve 100 (illustrated in Figure 1) or a similar trip valve may be upgraded or updated to provide the exemplary trip valve 200 illustrated in Figure 2 via one or more methods. The method for upgrading the conventional trip valve 100 to the exemplary trip valve 200 may include modifying, removing, and/or replacing one or more components of the conventional trip valve 100. In at least one embodiment, the method for upgrading the conventional trip valve 100 may include coupling the retaining member 262 to the inner surface of the valve body 102. As previously discussed, coupling the retaining member 262 to the inner surface of the valve body 102 may include welding the retaining member 262 to the valve body 102, threading the retaining member 262 into the valve body 102, and/or disposing the retaining member 262 into the annular groove 264 of the valve body 102. For example, the method for upgrading the conventional trip valve 100 may include machining the inner surface of the valve body 102 to form the annular groove 264 (see Figure 2) configured to receive the retaining member 262. In another example, the method for upgrading the conventional trip valve 100 may include replacing the single carbon graphite valve seat 116 with the first valve seat 242, and replacing the carbon graphite rings 114 with the bushings 238 fabricated from the hardened stainless steel. In yet another example, the method for upgrading the conventional trip valve 100 may include removing the setscrew 118. The method for upgrading the conventional trip valve 100 to the exemplary trip valve 200 may also include adding one or more components to the conventional trip valve 100. For example, the method for upgrading the conventional trip valve 100 may include adding the second valve seat 244. In another example, the method for upgrading the conventional trip valve 100 may include adding the first and second biasing members 258, 260. In yet another example, the method for upgrading the conventional trip valve 100 may include

adding or disposing the retaining member 264 in the annular groove 264 to retain the second valve seat 244 and the second biasing member 260 in the first portion 210 of the cavity 204.

[0023] Figure 3 illustrates a flowchart of a method 300 for upgrading a trip valve according to one or more embodiments. The method 300 may include replacing at least one non-metallic valve seat with a first metallic valve seat, as shown at 302. The method 300 may also include disposing a first biasing member adjacent the first metallic valve seat, as shown at 304. The method 300 may further include replacing at least one non-metallic bushing disposed about a valve stem of the trip valve with a metallic bushing, as shown at 306.

[0024] The foregoing has outlined features of several embodiments so that those skilled in the art may better understand the present disclosure. Those skilled in the art should appreciate that they may readily use the present disclosure as a basis for designing or modifying other processes and structures for carrying out the same purposes and/or achieving the same advantages of the embodiments introduced herein. Those skilled in the art should also realize that such equivalent constructions do not depart from the spirit and scope of the present disclosure, and that they may make various changes, substitutions, and alterations herein without departing from the spirit and scope of the present disclosure.

Claims

We claim:

1. A trip valve for a steam turbine, comprising:
 - a valve body defining a cavity, a first port, and a second port, the first and second ports in fluid communication with the cavity;
 - a ball disposed in the cavity and defining a passage extending therethrough, the ball being configured to be rotated to selectively provide fluid communication between the first and second ports via the passage;
 - a first valve seat disposed in the cavity between the ball and the first port, the first valve seat being configured to engage and at least partially support the ball in the cavity;
 - a second valve seat disposed in the cavity between the ball and the second port, the second valve seat being configured to engage and at least partially support the ball in the cavity;
 - a first biasing member disposed adjacent the first valve seat and configured to urge the first valve seat toward the ball; and
 - a second biasing member disposed adjacent the second valve seat and configured to urge the second valve seat toward the ball.
2. The trip valve of claim 1, wherein the valve body defines a shoulder, and the first biasing member is disposed between the first valve seat and the shoulder.
3. The trip valve of claim 1, further comprising an annular retaining member coupled with the valve body, the second biasing member being disposed between the second valve seat and the annular retaining member.
4. The trip valve of claim 3, wherein the valve body defines an annular groove along an inner surface thereof, and the annular retaining member is disposed in the annular groove.
5. The trip valve of claim 1, wherein the first valve seat and the second valve seat are fabricated from alloy steel.

6. The trip valve of claim 5, wherein the first valve seat and the second valve seat each comprise an inlay fabricated from a superalloy.
7. The trip valve of claim 1, further comprising a valve stem coupled with the ball and configured to rotate the ball to selectively provide fluid communication between the first and second ports via the passage.
8. The trip valve of claim 7, further comprising a bushing disposed about the valve stem and fabricated from alloy steel.
9. The trip valve of claim 1, wherein the trip valve does not comprise a setscrew configured to at least partially support the ball in the cavity.
10. A trip valve for a steam turbine, comprising:
 - a valve body defining a cavity, an inlet, and an outlet, the inlet and the outlet being in fluid communication with the cavity;
 - a ball disposed in the cavity and defining a passage extending therethrough, the ball being configured to be rotated to selectively provide fluid communication from the inlet to the outlet;
 - a valve stem coupled with the ball and configured to rotate the ball; and
 - a bushing disposed about the valve stem and fabricated from alloy steel, the bushing configured to provide a bearing surface for the valve stem.
11. The trip valve of claim 10, further comprising a first valve seat disposed in the cavity adjacent the ball and configured to engage and at least partially support the ball in the cavity.
12. The trip valve of claim 11, further comprising a second valve seat disposed in the cavity and configured to engage and at least partially support the ball in the cavity.
13. The trip valve of claim 12, further comprising:
 - a first biasing member disposed adjacent the first valve seat and configured to urge the first valve seat toward the ball; and

a second biasing member disposed adjacent the second valve seat and configured to urge the second valve seat toward the ball.

14. The trip valve of claim 13, wherein the valve body defines a shoulder and an annular groove along an inner surface thereof.

15. The trip valve of claim 14, further comprising a retaining member disposed in the annular groove, wherein:

the first biasing member is disposed between the first valve seat and the shoulder, and

the second biasing member is disposed between the second valve seat and the retaining member.

16. The trip valve of claim 15, wherein the first valve seat and the second valve seat are each fabricated from hardened steel and comprise an inlay fabricated from a superalloy.

17. A method for upgrading a trip valve, comprising:
replacing at least one non-metallic valve seat with a first metallic valve seat;
disposing a first biasing member adjacent the first metallic valve seat; and
replacing at least one non-metallic bushing disposed about a valve stem of the trip valve with a metallic bushing.

18. The method of claim 17, further comprising coupling a retaining member with an inner surface of a valve body of the trip valve.

19. The method of claim 18, wherein coupling the retaining member with the inner surface of the valve body comprises:

machining the inner surface of the valve body of the trip valve to form an annular groove; and

disposing the retaining member in the annular groove.

20. The method of claim 19, further comprising:
disposing a second metallic valve seat adjacent a ball of the trip valve;

disposing a second biasing member between the retaining member and the second metallic valve seat; and

eliminating a setscrew configured to at least partially support the ball within the valve body.

1/3

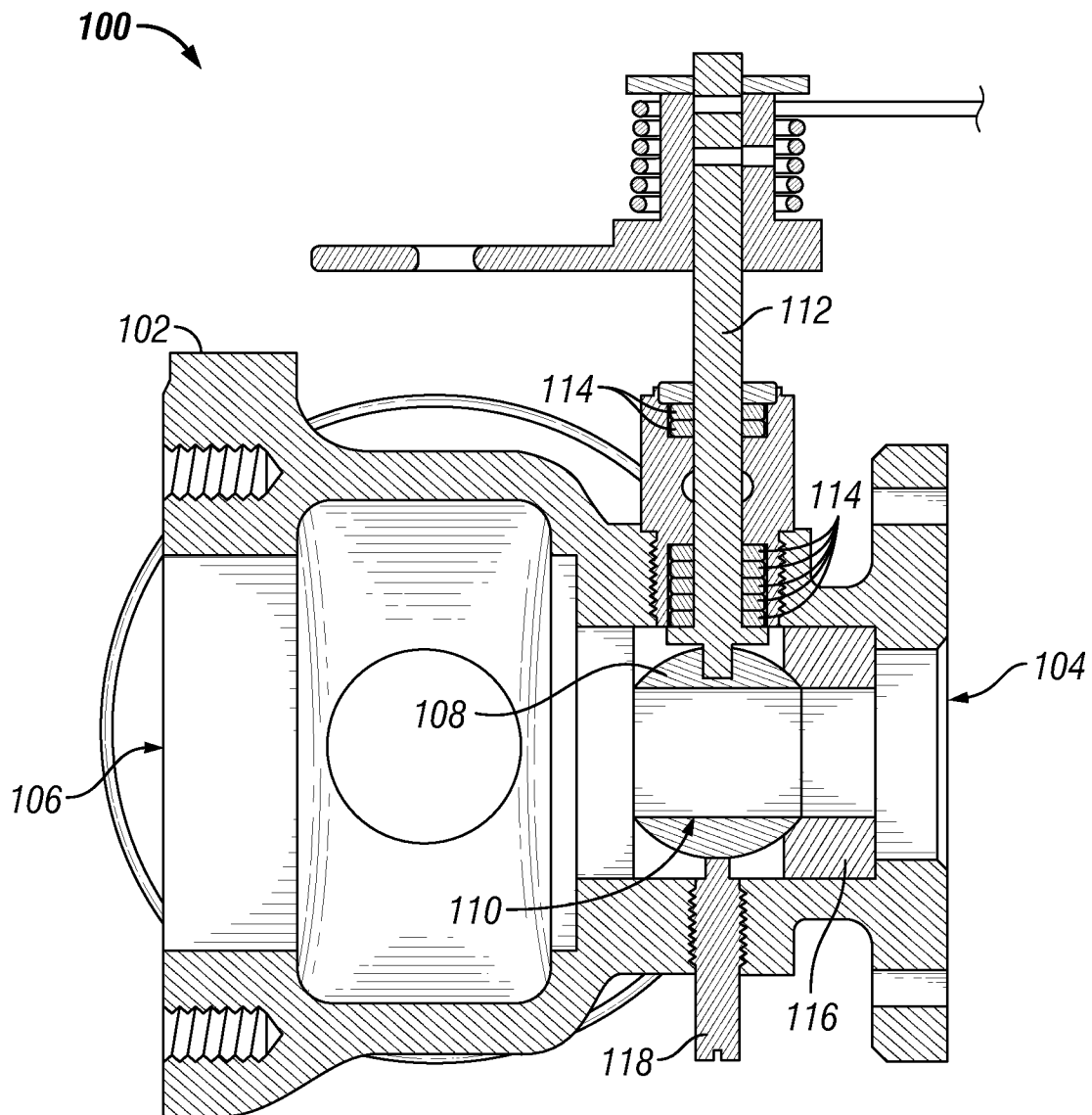


FIG. 1
(Prior Art)

2/3

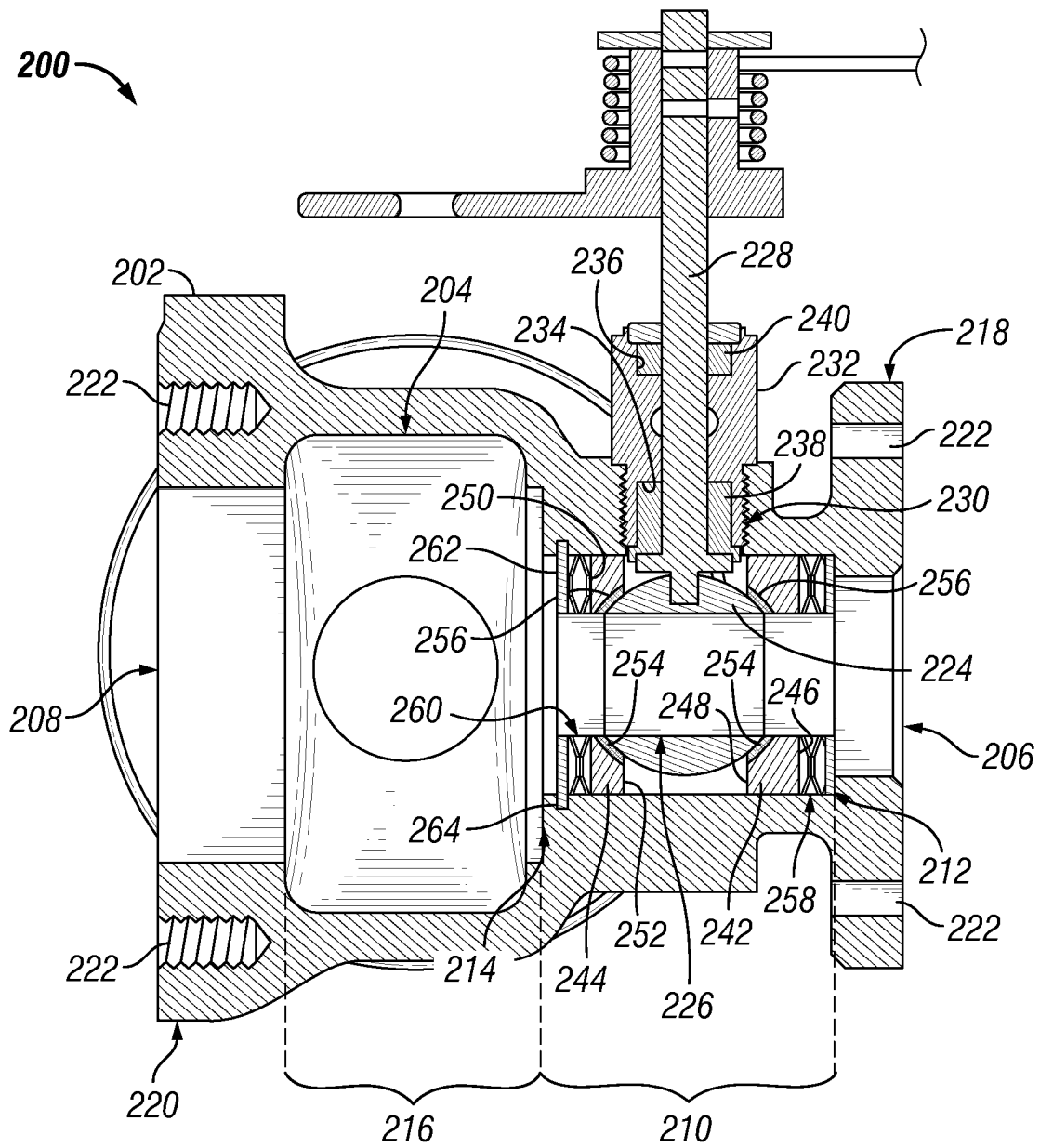
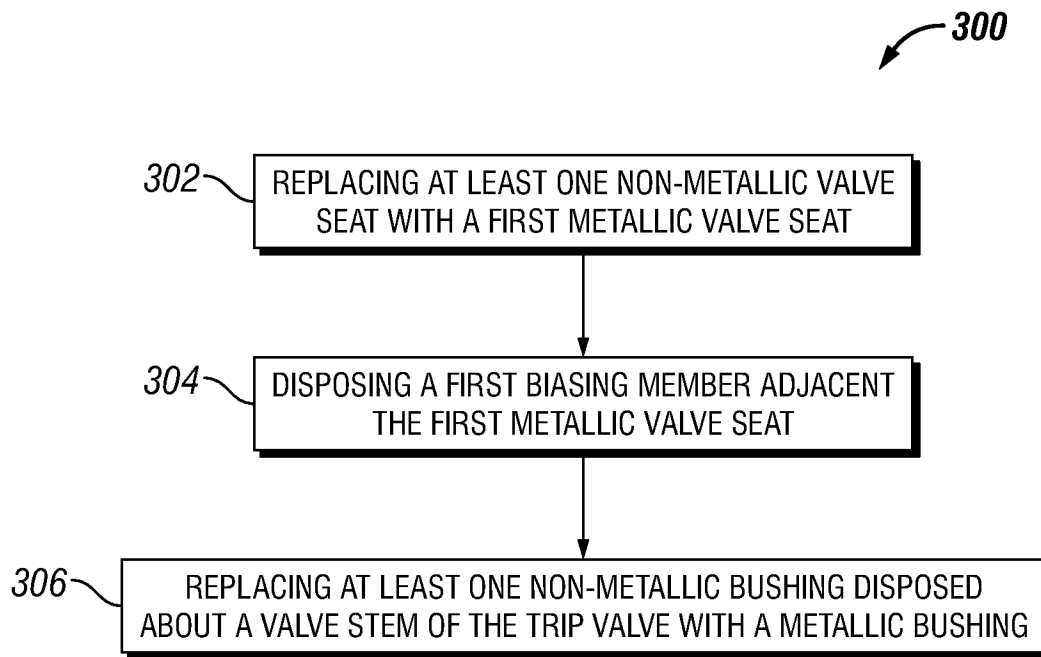


FIG. 2

3/3**FIG. 3**

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2016/054672

A. CLASSIFICATION OF SUBJECT MATTER
 INV. F01D17/14 F16K5/00
 ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
 F01D F16K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 103 603 964 A (WUXI SMART AUTO CONTROL ENGINEERING CO LTD) 26 February 2014 (2014-02-26)	1-3, 7-14,16
Y	the whole document	1-7,9, 15,17-20
X	----- CN 203 880 127 U (RAYMOND BEIJING VALVE MFG CO LTD) 15 October 2014 (2014-10-15)	1-3,5-7, 9
Y	the whole document	4,8, 10-13, 16-18,20
X	----- EP 2 505 882 A1 (TYCO VALVES & CONTROLS ITALIA S R L [IT]) 3 October 2012 (2012-10-03)	1-3,5-7, 9
Y	paragraphs [0045] - [0065]; figures 1-4	8,10-14, 16-18,20
	----- -/-	



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

8 December 2016

Date of mailing of the international search report

19/12/2016

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
 NL - 2280 HV Rijswijk
 Tel. (+31-70) 340-2040,
 Fax: (+31-70) 340-3016

Authorized officer

Koch, Rafael

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2016/054672

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 201 028 043 Y (RONGGUI WANG [CN]) 27 February 2008 (2008-02-27)	1-3,7,9
Y	the whole document	5,6, 10-13, 16-18,20
Y	----- CN 201 462 038 U (NANTONG POWER STATION VALVE CO LTD) 12 May 2010 (2010-05-12) figure 1 -----	1-4,7, 9-15, 18-20

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2016/054672

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
CN 103603964	A	26-02-2014	NONE	
CN 203880127	U	15-10-2014	NONE	
EP 2505882	A1	03-10-2012	EP 2505882 A1	03-10-2012
			RU 2012112057 A	10-10-2013
CN 201028043	Y	27-02-2008	NONE	
CN 201462038	U	12-05-2010	NONE	