US 20240133477A1

(19) United States

(12) Patent Application Publication

(10) Pub. No.: US 2024/0133477 A1

(43) Pub. Date: Apr. 25, 2024

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(54) **BLAST TUBE ASSEMBLIES**

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(21) Appl. No.: **18/381,973**

(22) Filed: **Oct. 18, 2023**

Related U.S. Application Data

(60) Provisional application No. 63/417,852, filed on Oct. 20, 2022.

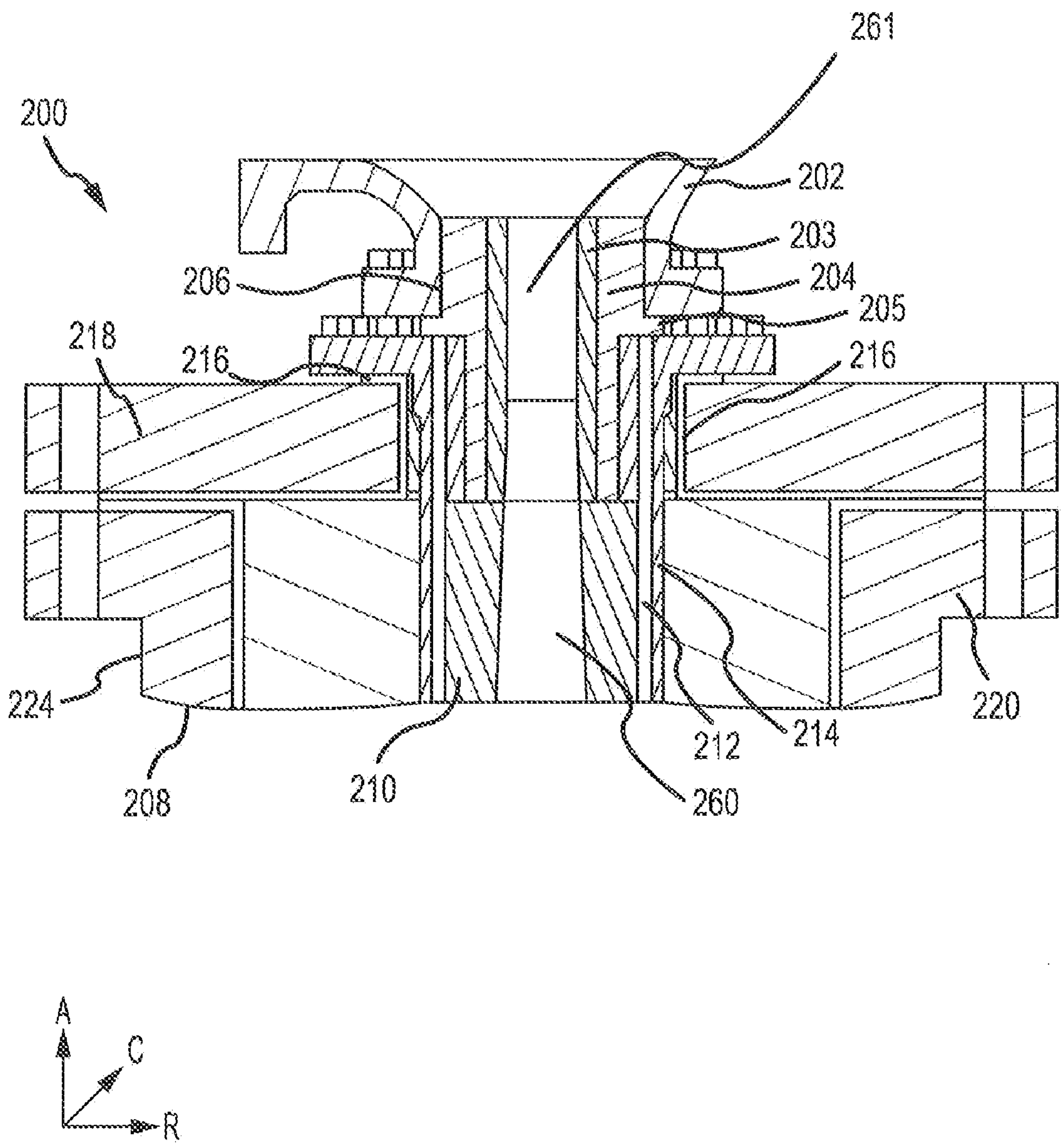
Publication Classification

(51) **Int. Cl.**
F16K 25/00 (2006.01)
F16K 25/04 (2006.01)

(52) **U.S. Cl.**
CPC *F16K 25/005* (2013.01); *F16K 25/04* (2013.01)

(57) **ABSTRACT**

A valve seat and blast tube assembly is provided herein. The valve seat and blast tube assembly may include a ceramic valve seat liner positioned within a valve seat housing. The valve seat may be configured to couple to a blast tube/choke assembly.



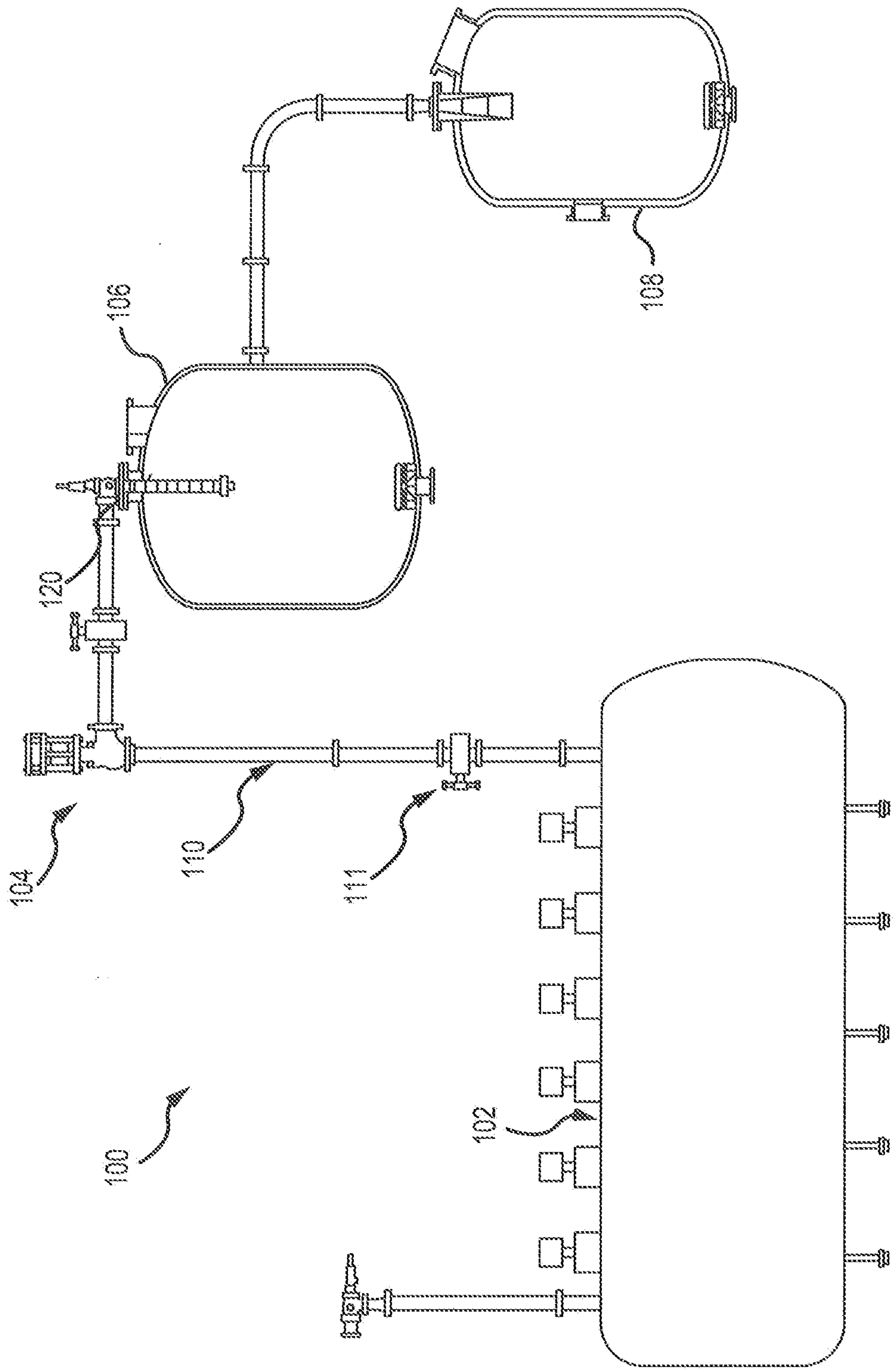


FIG. 1

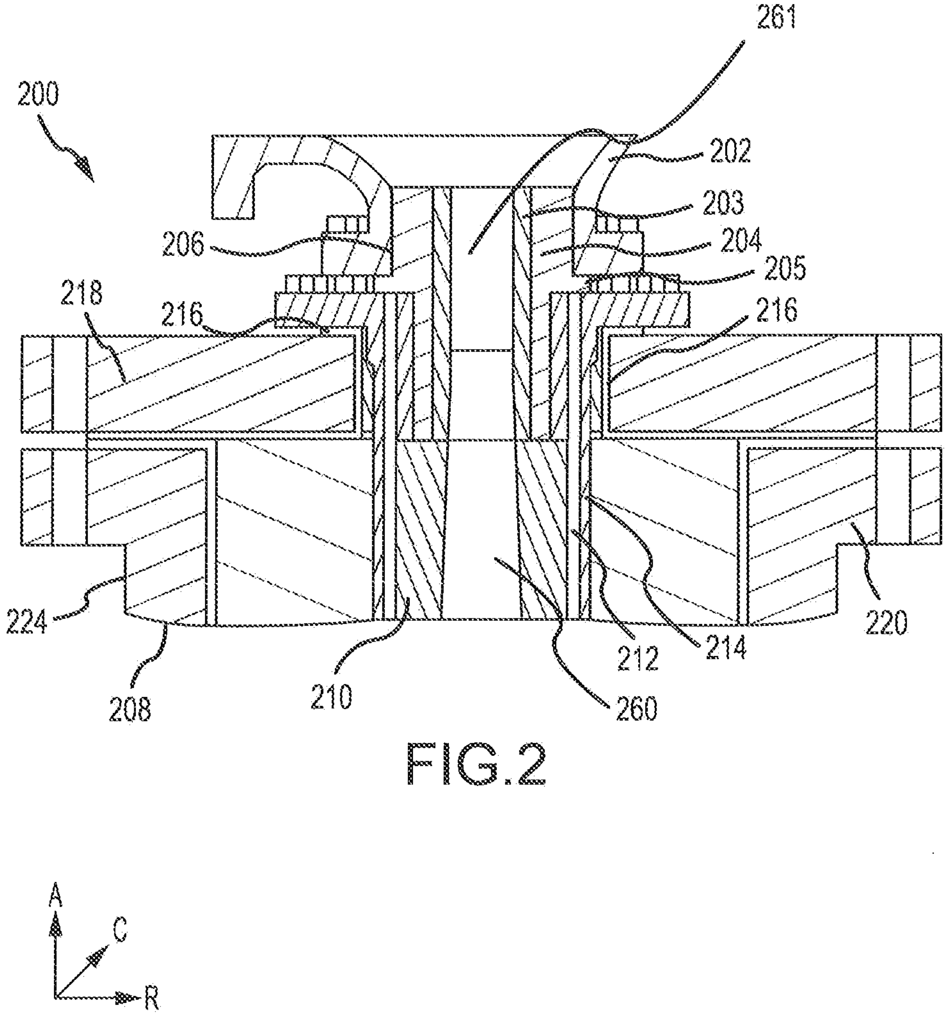

261
200
202
203
204
205
206
218
216
216
224
208
210
212
214
220
260
A
C
R

FIG.2

FIG. 2

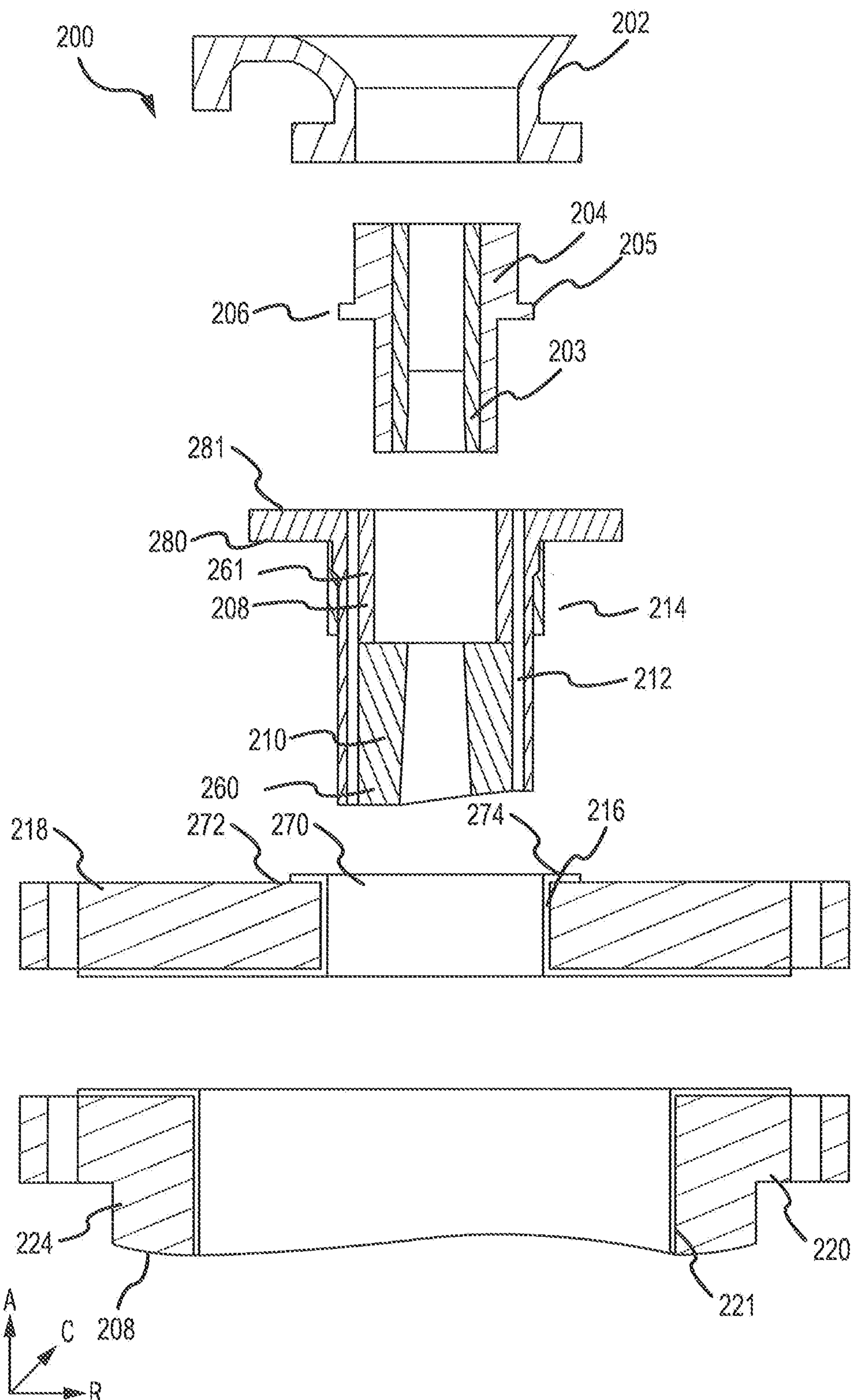

200
202
204
205
206
203
281
280
261
208
214
212
210
260
218
272
270
274
216
224
220
208
221
A
C
R

FIG. 3

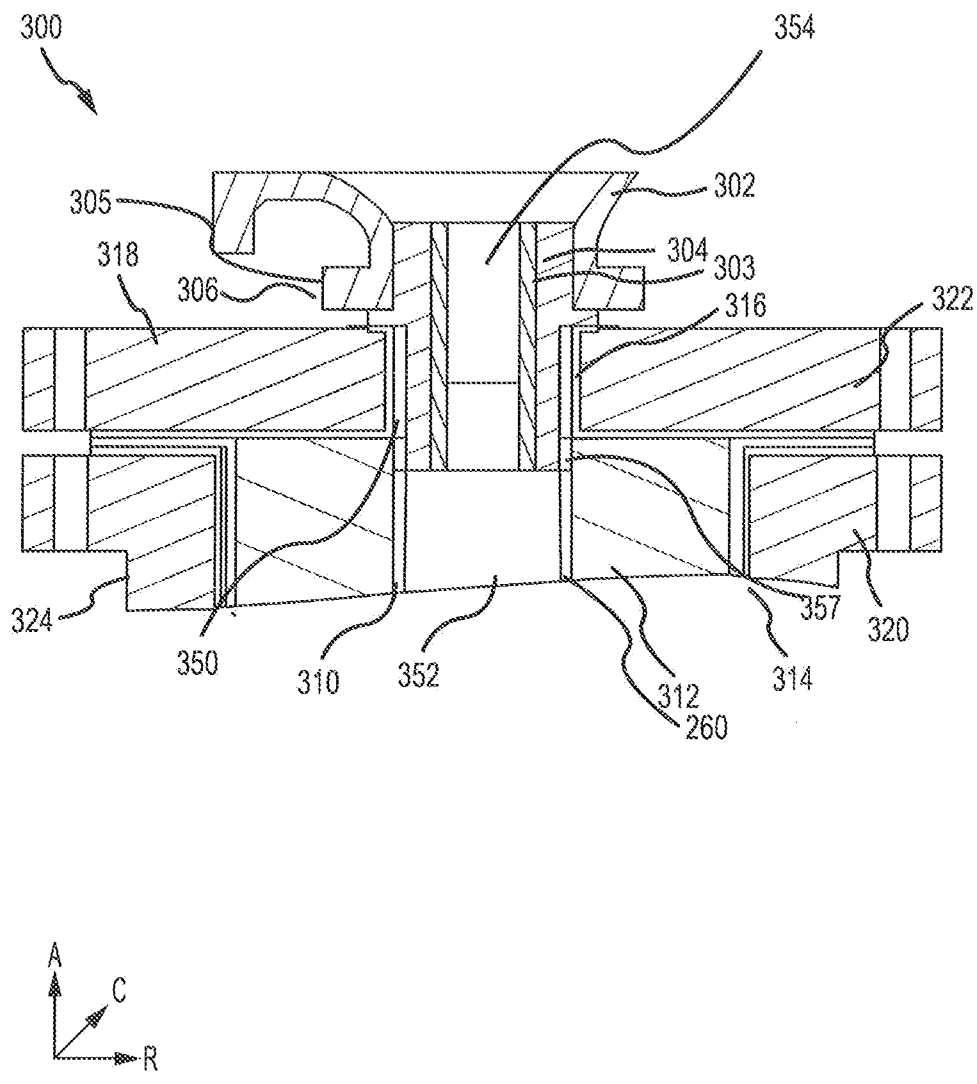

300
354
305
302
318
304
303
306
316
322
324
350
310
352
312
260
357
314
320
A
C
R

FIG. 4

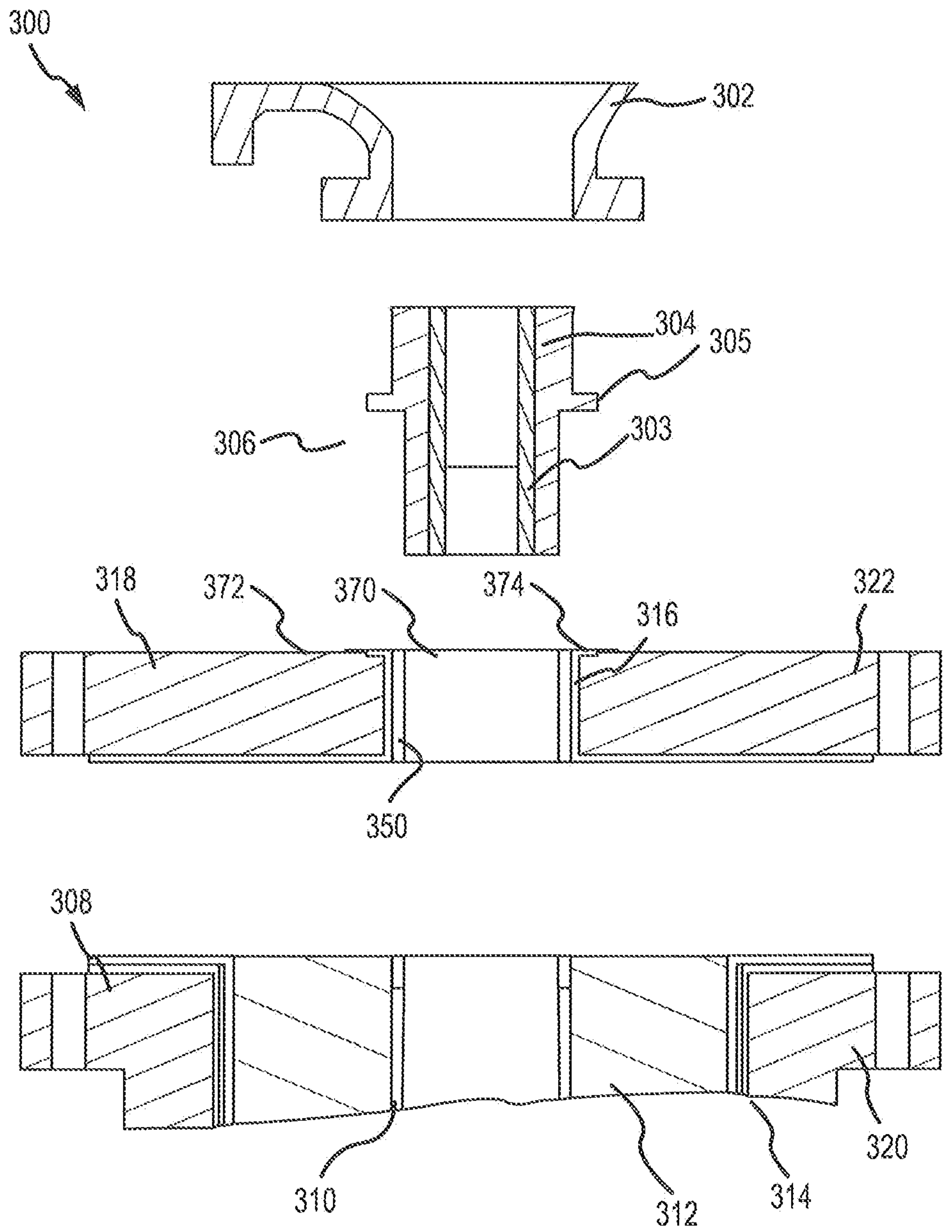

300
302
304
305
306
303
318
372
370
374
316
322
350
308
310
312
314
320

FIG. 5

BLAST TUBE ASSEMBLIES

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of and priority to U.S. Provisional Application Ser. No. 63/417,852, filed Oct. 20, 2022, the contents of which are hereby incorporated by reference in their entirety.

BACKGROUND

[0002] In various industrial processes, such as in metal refining, solids and liquids may be conveyed from one vessel to another under high temperatures and high pressures. Flow control may be desired between two vessels so that the flow may be stopped from time to time.

SUMMARY

[0003] In various embodiments, a valve seat and blast tube assembly comprising a valve seat coaxially disposed within a blast tube/choke assembly, the valve seat comprising a valve seat housing, a flash vessel flange comprising a central aperture, the valve seat disposed within the central aperture and extending through the central aperture, the blast tube/choke assembly comprising a distal face, the distal face extending radially with respect to the flash vessel flange and contacting at least one of proximal face of the flash vessel flange or a proximal face of a cladding.

[0004] In various embodiments, a valve seat and blast tube assembly comprising a valve seat coaxially disposed within a blast tube/choke assembly, the valve seat comprising a valve seat housing, a compliant sleeve disposed circumferentially around the valve seat housing, a flash vessel flange comprising a central aperture, the valve seat disposed within the central aperture and extending through the central aperture, the valve seat housing comprising a valve seat housing flange, the valve seat housing flange extending radially with respect to the flash vessel flange and contacting at least one of a proximal face of the flash vessel flange, a proximal face of a cladding, or the compliant sleeve.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] Various embodiments are particularly pointed out and distinctly claimed in the concluding portion of the specification. Below is a summary of the drawing figures, wherein like numerals denote like elements and wherein:

[0006] FIG. **1** illustrates an industrial process having a plug valve in accordance with various embodiments;

[0007] FIG. **2** illustrates a cross section view of a valve seat and blast tube assembly in accordance with various embodiments;

[0008] FIG. **3** illustrates an exploded view of the valve seat and blast tube assembly of FIG. **2**, in accordance with various embodiments;

[0009] FIG. **4** illustrates a cross section view of a valve seat and blast tube assembly in accordance with various embodiments;

[0010] FIG. **5** illustrates an exploded view of the valve seat and blast tube assembly of FIG. **4**, in accordance with various embodiments.

DETAILED DESCRIPTION

[0011] The detailed description of exemplary embodiments herein makes reference to the accompanying drawings, which show exemplary embodiments by way of illustration and its best mode. While these exemplary embodiments are described in sufficient detail to enable those skilled in the art to practice the inventions, it should be understood that other embodiments may be realized and that logical, chemical and mechanical changes may be made without departing from the spirit and scope of the inventions. Thus, the detailed description herein is presented for purposes of illustration only and not of limitation. For example, the steps recited in any of the method or process descriptions may be executed in any order and are not necessarily limited to the order presented. Moreover, many of the functions or steps may be outsourced to or performed by one or more third parties. Furthermore, any reference to singular includes plural embodiments, and any reference to more than one component or step may include a singular embodiment or step. Also, any reference to attached, fixed, connected or the like may include permanent, removable, temporary, partial, full and/or any other possible attachment option.

[0012] Valve seat and blast tube assemblies disclosed herein provide, in various embodiments, an ability to accommodate various thicknesses of flash vessel flanges. Given that the systems discussed herein are anticipated to be used in contexts of high speed flow, in some cases supersonic flow, at elevated temperatures, mating a valve seat and blast tube becomes relevant to managing the flow while reducing or tending to reduce part life and easing the ability to repair on site, in various embodiments. In various embodiments, by configuring the blast tube to reach the top (most proximal portion) of the flash vessel flange, and, in various embodiments, extend completely through the flash vessel flange, then flash vessel flange thickness becomes less relevant to the mating of the valve seat and blast tube. In that regard, the thickness of the flash vessel flange can fluctuate without causing interference with how the valve seat and the blast tube mate.

[0013] A mixture of solids and liquids, which may be referred to as slurry, may be subjected to high temperatures and/or high pressures in autoclave **102**. For example, ore may be mixed with strong acids (e.g. H_2SO_4) or strong bases (e.g., NaOH or NH_3) and may be subjected to temperatures of from 80° C. to 300° C. or greater and total pressures of from about 10 psi (~68 kPa) to 900 psi (~6,205 kPa). The slurry may have a pH of between 1 to 4 (in an acidic application) or between about 10 to 14 (in a basic application). Such a process may be referred to as pressure leaching.

[0014] Autoclave **102** may be sized according to industrial need, but is in various embodiments greater than 200 m^3. The size of discharge line **110** may also vary, but is in various embodiments greater than 50 mm in diameter.

[0015] Plug valve **104** may comprise an angle-type isolation valve, and, in various embodiments, may be considered a full bore or nearly full bore valve. Plug valve **104** may be configured in a "flow under" orientation in that flow tends to force the valve open, in contrast to a "flow over" valve where flow tends to force the valve closed. In that regard, slurry is configured to flow from autoclave **102** to high pressure flash tank **106**.

[0016] With reference to FIGS. **2** and **3**, a valve seat and blast tube assembly **200** is shown in cross section. Axial-

Radial-Circumferential (A-R-C) axes are shown for convenience in this and other Figures. It should be noted that a first component shown displaced in a positive axial direction with respect to a second component may be referred to as distal to the second component. Valve seat and blast tube assembly **200** may be used in a variety of valve configurations, including valve **120** coupled to high pressure flash tank **106**, among others. Valve seat and blast tube assembly **200** may be coupled to high pressure flash tank **106** downstream of plug valve **120**.

[0017] Valve seat and blast tube assembly **200** may join valve body **202** to flash vessel nozzle **224**. Valve body **202** and flash vessel nozzle **224** may comprise one or more metal materials, such as various metals and metal alloys as is known in the industry. A plug head may be configured to interface with valve seat **206** to prevent mass flow from valve body **202** through valve seat and blast tube assembly **200** and more specifically, through valve seat **206**. Valve seat and blast tube assembly **200** allows fluid communication between valve body **202** through flash vessel flange **218**.

[0018] In various embodiments, the plug head may comprise a ceramic material. Ceramics are especially well suited to high erosion applications. The plug head may have a varying geometry. For example, the geometry may be spherical, parabolic, flat, or any other suitable geometric configuration. There may further be a translating shaft coupled to the plug head. In various embodiments, the plug head can comprise one or more metals, such as, for example, various steel alloys, stainless steel, titanium, ceramics such as silicon carbide (SiC), boron carbide (B_4C), tungsten carbide (WC), and zirconia (ZrO_2), and nickel chromium alloys, such as an austenitic nickel-chromium alloy such as the austenitic nickel-chromium alloy sold under the trademark INCONEL. Nickel chromium alloys may be well suited to high temperature environments.

[0019] Valve seat **206** comprises valve seat housing **204** and valve seat liner **203**. Valve seat housing **204** may be disposed coaxial to valve seat liner **203**, though in various embodiments valve seat housing **204** may not be disposed coaxial to valve seat liner **203**. Valve seat housing **204** may be mated to valve seat liner **203** through any suitable method of joinery, for example, an interference fit or a press fit, among others. Adhesives, mortar, or other joinery compound may further be used to couple valve seat housing **204** to valve seat liner **203**.

[0020] In various embodiments, valve seat liner **203** can comprise one or more ceramics such as silicon carbide (SiC), boron carbide (B_4C), tungsten carbide (WC), and zirconia (ZrO_2). Valve seat liner **203** is generally cylindrical in geometry, having a constant inner diameter (ID) for at least a portion of valve seat liner **203**'s axial length, though the ID may taper (decrease) or flare (increase) from axial end to axial end in various embodiments. In various embodiments, valve seat liner **203** spans the axial length of blast tube assembly **200**.

[0021] Valve seat housing **204** may comprise one or more metals, such as, for example, various steel alloys, stainless steel, titanium, titanium alloys (e.g. Ti-6AI-4V), and nickel chromium alloys, such as an austenitic nickel-chromium alloy such as the austenitic nickel-chromium alloy sold under the trademark INCONEL. Nickel chromium alloys may be well suited to high temperature environments. Valve seat housing **204** may comprise valve seat housing flange **205** that may contact, abut, or otherwise adjoin valve body **202**. Valve seat housing **204** may fit within an aperture of flash vessel flange **218** and be disposed coaxial therewith. In that regard, the distal most portion of valve seat housing **204** and flash vessel flange **218** may be formed in any suitable geometry, but in various embodiments, flash vessel flange **218** comprises an annular disk having a central aperture **270**. Cladding **216** lines the central aperture **270** of flash vessel flange **218** along flash vessel flange **218**'s axial length and extends about at least one radial face of flash vessel flange **218**. Cladding **216** may comprise any suitable material, including various steel alloys, stainless steel, titanium, titanium alloys (e.g. Ti-6AI-4V), and nickel chromium alloys, such as an austenitic nickel-chromium alloy such as the austenitic nickel-chromium alloy sold under the trademark INCONEL. In that regard, cladding **216** contacts the distal face **280** of blast tube/choke assembly **214**.

[0022] Valve seat housing flange **205** extends radially with respect to flash vessel flange **218** and couples to, abuts, or otherwise adjoins a proximal face **281** of blast tube/choke assembly **214**. In that regard, valve seat housing flange **205** prevents valve seat **206** from leaving central aperture **270** through interference between the valve seat housing flange **205** and distal face **281** of blast tube/choke assembly **214**. In turn, proximal face **280** of blast tube/choke assembly **214** prevents blast tube/choke assembly **214** from leaving central aperture **270** through interference between the proximal face **281** of blast tube/choke assembly **214** and at least one of the proximal face **272** of flash vessel flange **218** or a proximal face **274** of cladding **216**.

[0023] Blast tube/choke assembly **214** at least partially receives valve seat **206** and is disposed coaxial thereto. Blast tube/choke assembly **214** comprises blast tube liner **210**, binder **212**, and blast tube housing **208**.

[0024] Blast tube housing **208** may comprise any suitable material, including various steel alloys, stainless steel, titanium, titanium alloys (e.g. Ti-6AI-4V), and nickel chromium alloys, such as an austenitic nickel-chromium alloy such as the austenitic nickel-chromium alloy sold under the trademark INCONEL. Blast tube housing **208** is received by the central aperture of flash vessel flange **218**. Blast tube housing **208** may contact cladding **216**. Binder **212** comprises a compound used to join and/or thermally insulate blast tube liner **210**. Binder **212** may comprise mortar, acid resistant bricks, and/or PTFE. Binder **212** acts to retain blast tube liner **210** within blast tube housing **208** but also acts to thermally insulate blast tube liner **210**. Thermal insulation tends to reduce the effects of thermal creep on blast tube housing **208**.

[0025] Blast tube liner **210** may comprise one or more ceramics such as silicon carbide (SiC), boron carbide (B_4C), tungsten carbide (WC), and zirconia (ZrO_2). Blast tube liner **210** may be divided into two portions, upper blast tube liner **261** and lower blast tube liner **260**. Upper blast tube liner **261** is disposed proximal to lower blast tube liner **260**.

[0026] Upper blast tube liner **261** is configured with a constant or nearly constant ID across the axial length. In this manner, upper blast tube liner **261** receives valve seat housing **204**. More specifically, valve seat housing **204** is received within upper blast tube liner **261**. In that regard, upper blast tube liner **261** may contact the outer diameter surface of valve seat housing **204**.

[0027] Lower blast tube liner **260** is disposed proximal to upper blast tube liner **261**. In various embodiments, lower blast tube liner **260** and upper blast tube liner **261** are illustrated as two separate, discrete components that may abut one another. However, in various embodiments, lower blast tube liner **260** and upper blast tube liner **261** may comprise a single, monolithic component that has a varying inner surface geometry and/or ID variation across the axial length.

[0028] Lower blast tube liner **260** comprises a proximal step to receive valve seat housing **204** and prevent valve seat housing **204** from moving in an axial distal direction. Moreover, lower blast tube liner **260** comprises an ID that is less than the ID of upper blast tube liner **261**. In various embodiments, the ID of lower blast tube liner **260** may be configured to be the same as, or approximately the same as, the ID of valve seat liner **203**, where the term "approximately" in this context only mean +/−5%. By matching the ID of valve seat liner **203**, lower blast tube liner **260** may help control the radial expansion of the flow of fluid within valve seat liner **203**. Lower blast tube liner **260** has an increasing ID diameter toward the proximal end of lower blast tube liner **260**, taking a flared geometry.

[0029] Blast tube/choke assembly **214** may axially extend through the central aperture **270** of flash vessel flange **218**. In various embodiments, blast tube/choke assembly **214** terminates at or approximately near the distal radial face of flash vessel flange **218**, though in various embodiments, blast tube/choke assembly **214** may axially extend past this point.

[0030] Flash vessel nozzle **224** is disposed distal to flash vessel flange **218**. Flash vessel nozzle **224** may be coupled to flash vessel. Flash vessel nozzle **224** includes flash vessel nozzle flange **220** that is configured to mate with flash vessel flange **218**. Cladding **221**, similar to cladding **216**, surrounds the inner diameter of flash vessel nozzle **224** and extends radially outward across at least a portion of flash vessel nozzle flange **220**.

[0031] With reference to FIGS. **4** and **5**, a valve seat and blast tube assembly **300** is shown in cross section. Axial-Radial-Circumferential (A-R-C) axes are shown for convenience. Valve seat and blast tube assembly **300** may be used in a variety of valve configurations, including in valve **120** among others. Valve seat and blast tube assembly **300** may be coupled to high pressure flash tank **106** downstream of plug valve **120**.

[0032] Valve seat and blast tube assembly **300** may join valve body **302** to flash vessel nozzle **324**. Valve body **302** and flash vessel nozzle **324** may comprise one or more metal materials, such as various metals and metal alloys as is known in the industry. A plug head may be configured to interface with valve seat **306** to prevent mass flow from valve body **302** through valve seat and blast tube assembly **300** and more specifically, through valve seat **306**. Valve seat and blast tube assembly **300** allows fluid communication between valve body **302** through flash vessel flange **318**.

[0033] In various embodiments, the plug head may comprise a ceramic material. Ceramics are especially well suited to high erosion applications. The plug head may have a varying geometry. For example, the geometry may be spherical, parabolic, flat, or any other suitable geometric configuration. There may further be a translating shaft coupled to the plug head. In various embodiments, the plug head can comprise one or more metals, such as, for example, various steel alloys, stainless steel, titanium, ceramics such as silicon carbide (SiC), boron carbide (B_4C), tungsten carbide (WC), and zirconia (ZrO_2), and nickel chromium alloys, such as an austenitic nickel-chromium alloy such as the austenitic nickel-chromium alloy sold under the trademark INCONEL. Nickel chromium alloys may be well suited to high temperature environments.

[0034] Valve seat **306** comprises valve seat housing **304** and valve seat liner **303**. Valve seat housing **304** may be disposed coaxial to valve seat liner **303**, though in various embodiments valve seat housing **304** may not be disposed coaxial to valve seat liner **303**. Valve seat housing **304** may be mated to valve seat liner **303** through any suitable method of joinery, for example, an interference fit or a press fit, among others. Adhesives, mortar, or other joinery compound may further be used to couple valve seat housing **304** to valve seat liner **303**.

[0035] In various embodiments, valve seat liner **303** can comprise one or more ceramics such as silicon carbide (SiC), boron carbide (B_4C), tungsten carbide (WC), and zirconia (ZrO_2). Valve seat liner **303** is generally cylindrical in geometry, having a constant inner diameter (ID) for at least a portion of valve seat liner **303**'s axial length, though the ID may taper (decrease) or flare (increase) from axial end to axial end in various embodiments. In various embodiments, valve seat liner **303** spans the axial length of blast tube assembly **300**. As illustrated, valve seat liner **303** has a constant ID from proximal end to distal end.

[0036] Valve seat housing **304** may comprise one or more metals, such as, for example, various steel alloys, stainless steel, titanium, titanium alloys (e.g. Ti-6AI-4V), and nickel chromium alloys, such as an austenitic nickel-chromium alloy such as the austenitic nickel-chromium alloy sold under the trademark INCONEL. Nickel chromium alloys may be well suited to high temperature environments. Valve seat housing **304** may comprise valve seat housing flange **305** that may contact, abut, or otherwise adjoin valve body **302**. Valve seat housing **304** may fit within an aperture of flash vessel flange **318** and be disposed coaxial therewith. In that regard, the distal most portion of valve seat housing **304** and flash vessel flange **318** may be formed in any suitable geometry, but in various embodiments, flash vessel flange **318** comprises an annular disk having a central aperture **370**. Cladding **316** lines the central aperture **370** of flash vessel flange **318** along flash vessel flange **318**'s axial length and extends about at least one radial face of flash vessel flange **318**. Cladding **316** may comprise any suitable material, including various steel alloys, stainless steel, titanium, titanium alloys (e.g. Ti-6AI-4V), and nickel chromium alloys, such as an austenitic nickel-chromium alloy such as the austenitic nickel-chromium alloy sold under the trademark INCONEL.

[0037] Compliant sleeve **350** is disposed radially inward of cladding **316**. Compliant sleeve **350** is configured to be disposed within and/or at least partially line the axial surface of the central aperture **370** of flash vessel flange **318**. Compliant sleeve **350** may have a constant ID throughout the axial length of compliant sleeve **350**. Compliant sleeve **350** may comprise one or more of thermoplastics and/or thermosets and/or polymeric materials. Compliant material include, for example, rubber, silicone, synthetic rubbers, polytetrafluoroethylene (PTFE), expanded PTFE, and other similar materials. For example, compliant sleeve **350** can comprise rigid or semi-rigid PTFE. In various embodiments, compliant sleeve **350** comprises carbon filled PTFE. Carbon filled PTFE may comprise a mixture of PTFE and a carbon form, for example, carbon powder. Carbon filled PTFE may comprise from 0.2% carbon powder to 40% carbon powder by weight, with the balance of the weight being PTFE. Carbon filled PTFE may comprise PTFE and graphite. In various embodiments, compliant sleeve **350** comprises a non-polymeric material, such as a silicon-based compound or a metallic material. For example, at elevated temperatures (such as, for example, above 260° C.), a silicon-based compound or metallic material may have a higher coefficient of thermal expansion (CTE), which may improve performance of compliant sleeve **350** (as compared to the performance of a polymeric material at the same elevated temperature).

[0038] Valve seat housing flange **305** extends radially with respect to flash vessel flange **318** and couples to, abuts, or otherwise adjoins a proximal face **372** of flash vessel flange **318**. In that regard, valve seat housing flange **305** prevents valve seat **306** from leaving central aperture **370** through interference between the valve seat housing flange **305** and at least one of the proximal face **372** of flash vessel flange **318** or a proximal face **274** of cladding **216**.

[0039] Compliant sleeve **350** may act to allow valve seat **306** to be easily removed from flash vessel flange **318** during servicing. Moreover, compliant sleeve **350** may have a higher CTE than cladding **316** and/or valve seat housing **304** and/or flash vessel flange **318**. In that regard, in response to increased temperatures, compliant sleeve **350** may expand at a higher rate, thus creating a more secure seal.

[0040] Blast tube/choke assembly **314** at least partially receives valve seat **306** and is disposed coaxial thereto. Blast tube/choke assembly **314** comprises blast tube liner **310**, binder **312**, and blast tube housing **308**.

[0041] Blast tube housing **308** may comprise any suitable material, including various steel alloys, stainless steel, titanium, titanium alloys (e.g. Ti-6AI-4V), and nickel chromium alloys, such as an austenitic nickel-chromium alloy such as the austenitic nickel-chromium alloy sold under the trademark INCONEL. Blast tube housing **308** is received by the central aperture of flash vessel flange **318** may contact cladding **316**. Binder **312** comprises a compound used to join and/or thermally insulate blast tube liner **310**. Binder **312** may comprise mortar, acid resistant bricks, and/or PTFE. Binder **312** acts to retain blast tube liner **310** within blast tube housing **308** but also acts to thermally insulate blast tube liner **310**. Thermal insulation tends to reduce the effects of thermal creep on blast tube housing **308**. Blast tube liner **310** may comprise one or more ceramics such as silicon carbide (SiC), boron carbide (B_4C), tungsten carbide (WC), and zirconia (ZrO_2).

[0042] Blast tube/choke assembly **314** couples to flash vessel flange **318**. Valve seat **306** extends distally beyond flash vessel flange **318** to seat within blast tube/choke assembly **314**. In that regard, valve seat **306** abuts, meets, or otherwise adjoins blast tube/choke assembly **314**. Seal ring **357** may circumferentially surround valve seat housing **304** and axially abut blast tube liner **310**. Seal ring **357** may be sized and configured to transition valve seat housing **304** to blast tube liner **310** while reducing or tending to reduce interference with flow dynamics. Blast tube liner **310** may have a larger ID than the ID of valve seat liner **303** Though in various embodiments blast tube liner **310** may have the same ID as valve seat liner **303** as illustrated, the ID of blast tube liner **310** may be larger than valve seat liner **303** In that regard, distal interior volume **352** has a larger ID than proximal interior volume **354**. Such configuration impacts flow dynamics and may be used in various scenarios as indicated by flow dynamic needs.

[0043] Benefits and other advantages have been described herein with regard to specific embodiments. Furthermore, the connecting lines shown in the various figures contained herein are intended to represent exemplary functional relationships and/or physical couplings between the various elements. It should be noted that many alternative or additional functional relationships or physical connections may be present in a practical system. However, the benefits, advantages, and any elements that may cause any benefit or advantage to occur or become more pronounced are not to be construed as critical, required, or essential features or elements of the disclosure. The scope of the disclosure is accordingly to be limited by nothing other than the appended claims, in which reference to an element in the singular is not intended to mean "one and only one" unless explicitly so stated, but rather "one or more." Moreover, where a phrase similar to "at least one of A, B, or C" is used in the claims, it is intended that the phrase be interpreted to mean that A alone may be present in an embodiment, B alone may be present in an embodiment, C alone may be present in an embodiment, or that any combination of the elements A, B and C may be present in a single embodiment; for example, A and B, A and C, B and C, or A and B and C.

[0044] Systems, methods and apparatus are provided herein. In the detailed description herein, references to "various embodiments", "one embodiment", "an embodiment", "an example embodiment", etc., indicate that the embodiment described may include a particular feature, structure, or characteristic, but every embodiment may not necessarily include the particular feature, structure, or characteristic. Moreover, such phrases are not necessarily referring to the same embodiment. Further, when a particular feature, structure, or characteristic is described in connection with an embodiment, it is submitted that it is within the knowledge of one skilled in the art to affect such feature, structure, or characteristic in connection with other embodiments whether or not explicitly described. After reading the description, it will be apparent to one skilled in the relevant art(s) how to implement the disclosure in alternative embodiments.

[0045] Furthermore, no element, component, or method step in the present disclosure is intended to be dedicated to the public regardless of whether the element, component, or method step is explicitly recited in the claims. No claim element is intended to invoke 35 U.S.C. 112(f) unless the element is expressly recited using the phrase "means for." As used herein, the terms "comprises", "comprising", or any other variation thereof, are intended to cover a non-exclusive inclusion, such that a process, method, article, or apparatus that comprises a list of elements does not include only those elements but may include other elements not expressly listed or inherent to such process, method, article, or apparatus.

1. A valve seat and blast tube assembly comprising:

a valve seat coaxially disposed within a blast tube/choke assembly, the valve seat comprising a valve seat housing;

a flash vessel flange comprising a central aperture, the valve seat disposed within the central aperture and extending through the central aperture, the blast tube/choke assembly comprising a distal face, the distal face extending radially with respect to the flash vessel flange and contacting at least one of proximal face of the flash vessel flange or a proximal face of a cladding.

2. The valve seat and blast tube assembly of claim **1**, wherein the cladding lines the central aperture and circumferentially surrounds the valve seat housing.

3. The valve seat and blast tube assembly of claim **2**, wherein the cladding contacts a distal face of the flash vessel flange.

4. The valve seat and blast tube assembly of claim **3**, wherein the valve seat comprises a ceramic valve seat liner comprising at least one of silicon carbide (SiC), boron carbide (B_4C), tungsten carbide (WC), and zirconia (ZrO_2).

5. The valve seat and blast tube assembly of claim **4**, wherein the blast tube/choke assembly comprises a ceramic blast tube liner.

6. The valve seat and blast tube assembly of claim **5**, wherein the ceramic blast tube liner contacts the ceramic valve seat liner.

7. The valve seat and blast tube assembly of claim **6**, wherein an inner diameter of the ceramic valve seat liner increases in a distal direction.

8. The valve seat and blast tube assembly of claim **5**, wherein an inner diameter of the ceramic valve seat liner is less than an inner diameter of the ceramic blast tube liner.

9. The valve seat and blast tube assembly of claim **8**, further comprising a valve body coupled to the valve seat.

10. The valve seat and blast tube assembly of claim **9**, further comprising mortar disposed radially outward of the ceramic blast tube liner.

11. A valve seat and blast tube assembly comprising:

a valve seat coaxially disposed within a blast tube/choke assembly, the valve seat comprising a valve seat housing;

a compliant sleeve disposed circumferentially around the valve seat housing;

a flash vessel flange comprising a central aperture, the valve seat disposed within the central aperture and extending through the central aperture, the valve seat housing comprising a valve seat housing flange, the valve seat housing flange extending radially with respect to the flash vessel flange and contacting at least one of a proximal face of the flash vessel flange, a proximal face of a cladding, or the compliant sleeve.

12. The valve seat and blast tube assembly of claim **11**, wherein the cladding lines the central aperture and circumferentially surrounds the compliant sleeve.

13. The valve seat and blast tube assembly of claim **12**, wherein the cladding contacts a distal face of the flash vessel flange.

14. The valve seat and blast tube assembly of claim **13**, wherein the valve seat comprises a ceramic valve seat liner comprising at least one of silicon carbide (SiC), boron carbide (B_4C), tungsten carbide (WC), and zirconia (ZrO_2).

15. The valve seat and blast tube assembly of claim **14**, wherein the blast tube/choke assembly comprises a ceramic blast tube liner.

16. The valve seat and blast tube assembly of claim **14**, wherein a seal ring contacts a proximal portion of the blast tube.

17. The valve seat and blast tube assembly of claim **16**, wherein an inner diameter of the ceramic valve seat liner is constant through an axial length of the ceramic valve seat liner.

18. The valve seat and blast tube assembly of claim **16**, wherein the seal ring circumferentially surrounds the valve seat housing.

19. The valve seat and blast tube assembly of claim **18**, further comprising a valve body coupled to the valve seat.

20. The valve seat and blast tube assembly of claim **9**, further comprising mortar disposed radially outward of the ceramic blast tube liner.

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