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MECHANICAL JOINT RESTRAINT WITH WEDGE ASSEMBLIES INCLUDING COLLAR BOLTS

Abstract

A joint restraint assembly for a pipe, the joint restraint assembly including an annular body, and a wedge assembly received within an opening of a wedge housing of the annular body. The wedge assembly includes a bolt including a flange, and a low-friction material positioned between the flange and an interior surface of the wedge housing, which low-friction material is adapted to slidably engage the interior surface during relative movement between the wedge assembly and the wedge housing. A wedge member is attached to the bolt so that the flange is positioned between at least a portion of the low-friction material and at least a portion of the wedge member. The wedge member is adapted to engage the pipe.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS [0001] This application claims priority to, and the benefit of, the filing date of U.S. Patent Application No. 63/551,306, filed Feb. 8, 2024, the entire disclosure of which is hereby incorporated herein by reference and forms part of the present disclosure. [0002] This application is related to U.S. patent application Ser. No. 08/425,874, filed Apr. 21, 1995, now U.S. Pat. No. 5,544,922, the entire disclosure of which is hereby incorporated herein by reference and forms part of the present disclosure.

FIELD OF THE DISCLOSURE
[0003] The present disclosure relates, in general, to joint restraints, and more particularly, to wedge assemblies that increase the grip of a joint restraint with respect to pipes joined together using the joint restraint.
BACKGROUND
[0004] Some joint restraints are used to connect, seal, and prevent the disengagement of, axially-aligned pipes. In some applications, a first pipe is received within a second pipe, which includes an enlarged mouth, a packing cavity, and a terminal flange. In use, a joint restraint is connected to both the outer surface of the first pipe and the terminal flange of the second pipe, so as to hold the two pipes together. A wedge assembly of the joint restraint facilitates the connection of the first and second pipes by gripping the first pipe in a two-step mechanical action. After the joint restraint is connected to the flange, a twist-off nut of the wedge assembly is tightened to a predetermined torque at which point the wedge assembly is set against the outer surface of the first pipe, providing an initial grip on the first pipe. Upon pressurization of the piping system, the wedge assembly is forced rearward within the joint restraint. As the wedge assembly moves rearward, it is also forced downward (or wedged) by an inclined plane surface of the joint restraint, inducing a radially inward force on the wedge assembly. The radially inward force on the wedge assembly substantially increases the grip of the wedge assembly on the first pipe.
[0005] Once an initial grip force substantial enough to initiate the slidable engagement between the wedge assembly and the inclined plane surface has been achieved, promoting such slidable engagement may be desirable for one or more reasons such as, for example, improving grip strength and/or reducing the incidence of slippage between the wedge assembly and the pipe.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0006] FIG. **1** illustrates a perspective view of a pipe junction assembly including a joint restraint in a partially installed configuration, according to one or more embodiments;
[0007] FIG. **2** illustrates a perspective view of the joint restraint of FIG. **1**, including a wedge assembly, in an uninstalled configuration, according to one or more embodiments;
[0008] FIG. **3**A illustrates an exploded view of a portion of the joint restraint and the wedge assembly of FIG. **2**, the wedge assembly including a collar bolt and a cap, according to one or more embodiments;
[0009] FIG. **3**B illustrates another exploded view of the portion of the joint restraint and the wedge assembly of FIG. **2**, according to one or more embodiments;
[0010] FIG. **4**A illustrates a cross-sectional view of another portion of the joint restraint of FIG. **2**, taken along line **4**A-**4**A of FIG. **2**, according to one or more embodiments;
[0011] FIG. **4**B illustrates an enlarged view of portion **4**B of FIG. **4**A, according to one or more embodiments;
[0012] FIG. **5** illustrates a cross-sectional view of yet another portion the joint restraint of FIG. **2**,

taken along line **5**-**5** of FIG. **4**A, according to one or more embodiments;
[0013] FIG. **6**A illustrates a cross-sectional view of the pipe junction assembly of FIG. **1**, taken along line **6**A-**6**A of FIG. **1**, according to one or more embodiments;
[0014] FIG. **6**B illustrates a cross-sectional view similar to that of FIG. **6**A, but depicting the joint restraint of FIG. **1** in an installed configuration, according to one or more embodiments;
[0015] FIG. **6**C illustrates a cross-sectional view similar to that of each of FIGS. **6**A and **6**B, but depicting the joint restraint of FIG. **1** in an operational configuration, according to one or more embodiments;
[0016] FIG. **7**A illustrates an exploded view of another embodiment of the cap of the wedge assembly of FIG. **3**A, according to one or more embodiments; and
[0017] FIG. **7**B illustrates the another embodiment of the cap of the wedge assembly of FIG. **7**A in an assembled configuration, according to one or more embodiments.

DETAILED DESCRIPTION

[0018] The following disclosure provides many different embodiments. Specific examples of components and arrangements are described below to simplify the present disclosure. These are, of course, merely examples and are not intended to be limiting. In addition, the present disclosure may repeat reference numerals and/or letters in the various embodiments. This repetition is for the purpose of simplicity and clarity and does not in itself dictate a relationship between the various embodiments and/or configurations discussed.
[0019] Referring to FIG. **1**, a pipe junction assembly **100** is shown and described according to one or more embodiments. The pipe junction assembly includes a joint restraint **105**, a first pipe **110**, and a second pipe **115**. In one or more embodiments, the first pipe **110** is received through the joint restraint **105** such that the joint restraint **105** is mounted on the first pipe **110**. In one or more embodiments, the first pipe **110** is received within and coupled to the second pipe **115**. In one or more embodiments, the first pipe **110** may be a pipe, a pipe joint, a pipe junction, or a pipe fitting. In one or more embodiments, the second pipe **115** may be a pipe, a pipe joint, a pipe junction, or a pipe fitting.
[0020] In one or more embodiments, an end portion **145** (shown in FIGS. **6**A-**6**C) of the first pipe **110** is inserted into, or received within, an inner circular space **150** (shown in FIG. **2**) defined by the annular body **120** of the joint restraint **105**. The end portion **145** of the first pipe **110** is then received within, or coupled with, an enlarged mouth **155** formed at an axially adjacent end portion of the second pipe **115**. In one or more embodiments, the first pipe **110**, the second pipe **115**, and the joint restraint **105** are all coaxially aligned when assembled. In one or more embodiments, a packing material **160** (shown in FIGS. **6**A-**6**C) is provided at the opening of the enlarged mouth **155**. The packing material **160** is positioned circumferentially around the first pipe **110** and radially between the first pipe **110** and the second pipe **115** such that the packing material **160** provides a seal and facilitates sealing engagement of the first pipe **110** and the second pipe **115**.
[0021] The second pipe **115** includes an annular flange **165** located at an end portion of the enlarged mouth **155** of the second pipe **115** to facilitate attachment of the joint restraint **105** to the second pipe **115** and thus facilitate coupling of the first pipe **110** and the second pipe **115**. In one or more embodiments, the annular flange **165** includes a plurality of holes **170** extending through the annular flange parallel to an axial extension of the second pipe **115** to facilitate attachment to the joint restraint **105**. In one or more embodiments, the plurality of holes **170** are equally distributed circumferentially about the annular flange **165**.
[0022] FIG. **2** illustrates the joint restraint **105** of FIG. **1** in further detail. Referring to FIG. **2**, with continued reference to FIG. **1**, the joint restraint **105** includes a substantially annular body **120**, an annular projection **125**, a plurality of wedge assembly housings **130** each configured to receive at least a portion of a wedge assembly **135**, and a plurality of holes **140** extending through the annular body **120** of the joint restraint **105**.
[0023] In one or more embodiments, the plurality of holes **140** of the joint restraint **105** extend

through the annular body **120** parallel to an axial extension of the annular body **120** and parallel to an axial extension of the first pipe **110** on which the joint restraint **105** is mounted. In one or more embodiments, the plurality of holes **140** are equally distributed circumferentially about the annular body **120** of the joint restraint **105**. In one or more embodiments, the plurality of wedge assembly housings **130** are equally distributed circumferentially about the annular body **120**. In one or more embodiments, the distribution of the plurality of holes **140** is circumferentially offset from the distribution of the plurality of wedge assembly housings **130** such that at least one hole of the plurality of holes **140** is positioned circumferentially between every two wedge assembly housings **130**. In one or more embodiments, the radial and circumferential spacing of the plurality of holes **140** of the joint restraint **105** and of the plurality of holes **170** of the annular flange **165** are the same.

[0024] When the joint restraint **105** is mounted on the first pipe **110**, the annular body **120** may be rotated and oriented such that the plurality of holes **140** of the joint restraint **105** are axially aligned, and adapted to cooperate with, the plurality of holes **170** of the annular flange **165** such that each set of aligned holes is adapted to receive a bolt **175** with a head **180**. The bolt **175** is received through each set of aligned holes and a nut **182** is received onto the end of the bolt **175** opposite the head **180**. As the annular body **120** is connected to the annular flange **165** via tightening of each nut **182** onto each bolt **175**, the annular projection **125** pushes against the packing material **160** and packs the packing material **160** into the opening of the enlarged mouth **155**, creating the seal between the first pipe **110** and the second pipe **115**.

[0025] As shown in FIG. **2**, each wedge assembly housing **130** of the joint restraint **105** includes a housing block **185** adapted to receive one wedge assembly **135**. Each housing block **185** includes a front wall **205** integral with the annular body **120**, an axially opposing rear wall **210** (shown in FIG. **3**A) that is also integral with the annular body **120**, and an integral radially outer wall **200** that extends axially between the front wall **205** and the rear wall **210**. Each housing block **185** also includes an open mouth **195** that extends radially into a least a portion of the housing block **185** from a radially inner surface **215** of the annular body **120** such that the open mouth **195** of each housing block **185** faces, or is adjacent to, the first pipe **110** when the joint restraint **105** is installed on the first pipe **110**. Defined within each housing block **185** are a plurality of integral sidewalls **190** (shown in FIG. **3**B).

[0026] The radially outer wall **200** of each housing block **185** includes an external side **220**, an internal side **225** (shown in FIG. **3**B), and a non-threaded, substantially elliptical hole **230** extending through the radially outer wall **200** between the external side **220** and the internal side **225**. The radially outer wall **200** and the longitudinal axis of the elliptical hole **230** are inclined with respect to the longitudinal axis of the first pipe **110**. In the embodiment shown, the front wall **205** is radially taller than the rear wall **210** such that the radially outer wall **200** is inclined from the rear wall **210** to the front wall **205**.

[0027] FIG. **3**A illustrates an exploded view of a portion of the joint restraint **105** and of a wedge assembly **135** of the plurality of wedge assemblies **135**. Each housing block **185** is adapted to receive one wedge assembly **135** via each open mouth **195**. Each wedge assembly **135** includes a collar bolt **235** having a shank **240**, an integral flange **245** formed on the shank **240**, a threaded portion **250** below the flange **245**, and an upper portion **255** above the flange **245**. The upper portion **255** of the collar bolt **235** is adapted to be received in and through the elliptical hole **230** from the internal side **225** of the radially outer wall **200** before the joint restraint **105** is installed on the first pipe **110** (i.e., before the first pipe **110** is received through the annular space **150** of the annular body **120**). The flange **245** prevents the wedge assembly **135** from passing through the elliptical hole **230** in the radially outer wall **200**. One of ordinary skill in the art will recognize that other arrangements can prevent passage through the elliptical hole **230**, including the use of a stepped bolt diameter, wherein the diameter of the lower portion of the bolt is greater than that of the elliptical hole **230**.

[0028] Each wedge assembly **135** further includes an internally reverse-threaded pipe-pressing member **260** attached to the bolt **175** so that the annular flange **165** is positioned between at least a portion of the cap **275** and at least a portion of the pipe-pressing member **260**. More particularly, the pipe-pressing member **260** is mounted on the threaded portion **250** of the shank **240** and adapted to be received within the open mouth **195** of each housing block **185** when the wedge assembly **135** is installed therein. When the pipe-pressing member **260** is received within the open mouth **195** of the housing block **185**, the pipe-pressing member **260** is prevented from turning. A bottom surface **265** (shown in FIG. **3**B) of the pipe-pressing member **260** includes gripping edges **270** that are adapted to securely bite into the wall of the first pipe **110**, as will be described in more detail below.

[0029] In one or more embodiments, the wedge assembly **135** may include a retainer clip positioned between the flange **245** and the pipe-pressing member **260** and adapted to retain the wedge assembly **135** within the housing block **185** via cooperation with associated retainer clip-stops defined by the integral sidewalls **190** of the housing block **185**, as shown and described in U.S. patent application Ser. No. 08/425,874, filed Apr. 21, 1995, now U.S. Pat. No. 5,544,922, the entire disclosure of which is hereby incorporated herein by reference and forms part of the present disclosure.

[0030] The wedge assembly **135** further includes a cap **275**. In the embodiment shown, the cap **275** includes a top portion, such as a top wall **285**, and a side portion, such as a side wall **290**, extending downward from the outer radial edge of the top wall **285**. In one or more embodiments, the top wall **285** is disk shaped with an opening **295** (or hole) extending through the center of the top wall **285**. The opening **295** extending through the top wall **285** is sized to receive the upper portion **255** of the collar bolt **235** so that the cap **275** may be installed from the top of the collar bolt **235** and positioned down around the upper portion **255** of the collar bolt **235**. In one or more embodiments, the side wall **290** of the cap **275** may be omitted, so that the cap **275** is a disk with just the top wall **285**. In one or more embodiments, instead of having a circular shape as shown in the figures, the top wall **285** has a square shape, a rectangular shape, a hexagonal shape, an oval shape, or another shape. In one more embodiments, instead of having the circular shape as shown in the figures, the top wall **285** has a square shape, a rectangular shape, a hexagonal shape, an oval shape, or another shape, and the side wall **290** has a shape other than the cylindrical shape shown in the figures.

[0031] FIG. **3**B illustrates another exploded view of the portion of the joint restraint **105** and of the wedge assembly **135** from a different perspective.

[0032] FIG. **4**A illustrates a cross-sectional view of the joint restraint **105** taken along line **4**A-**4**A of FIG. **2**. FIG. **4**B illustrates an enlarged view of portion **4**B of FIG. **4**A.

[0033] FIGS. **4**A and **4**B illustrate the wedge assembly **135** positioned within the housing block **185** of the joint restraint **105**. As shown, the cap **275** is positioned over at least a portion of an upper surface **280** of the flange **245** such that when the wedge assembly **135** is installed within the housing block **185** of the joint restraint **105**, the cap **275** is positioned between the upper surface **280** of the flange **245** and the internal side **225** of the radially outer wall **200** of the housing block **185**. When installed on the flange **245**, the top wall **285** of the cap **275** extends across the entire upper surface **280** of the flange **245** about the upper portion **255** of the collar bolt **235** and the side wall **290** of the cap **275** wraps over the outer radial edge of the flange **245** and extends downward around an outer surface **300** of the flange **245** along at least a portion of the longitudinal length of the flange **245**. The side wall **290** extending about the outer surface **300** of the flange **245** facilitates retention of the cap **275** on the flange **245** between the upper surface **280** of the flange **245** and the internal side **225** of the radially outer wall **200** of the housing block **185**.

[0034] In one or more embodiments, the side wall **290** of the cap **275** may be omitted such that the cap **275** includes only the top wall **285**; the top wall **285** is an example of a top portion of the cap **275**. In such embodiments, the cap **275** may be retained on the flange **245** between the upper surface **280** of the flange **245** and the internal side **225** of the radially outer wall **200** of the housing

block **185** solely by the extension of the upper portion **255** of the collar bolt **235** through the opening **295** in the top wall **285** of the cap **275**. In such embodiments, the cap **275** may resemble a disk, a washer, or a spacer.

[0035] In operation, as will be discussed in more detail below with respect to FIGS. **6**A-**6**C, the wedge assembly **135** translates or slides relative to the housing block **185** of the joint restraint **105** as the pipes are pressurized and, as a result of the pressurization, urged to separate. During this relative movement between the wedge assembly **135** and the housing block **185**, the upper surface **280** of the flange **245** slides against, and is forced downward by, the incline of the internal side **225** of the radially outer wall **200** of the housing block **185**. This downward force on the wedge assembly **135** causes the pipe-pressing member **260** to dig into and increase the grip of the joint restraint **105** on the first pipe **110**.

[0036] In order to promote the relative movement between the wedge assembly **135** and the housing block **185** to increase the grip on the first pipe **110**, the cap **275** is made of a material that is adapted to reduce the coefficient of friction between the sliding contact surfaces of the upper surface **280** of the flange **245** and the internal side **225** of the radially outer wall **200** of the housing block **185** without reducing the initial grip between the pipe-pressing member **260** and the first pipe **110**. By reducing the coefficient of friction between the flange **245** and the internal side **225** of the radially outer wall **200** of the housing block **185**, the wedging of the pipe-pressing member **260** radially against the first pipe **110** is improved while reducing any incidence of the pipe-pressing member **260** slipping or sliding axially along the surface of the first pipe **110**. These benefits are realized with respect to a variety of pipe joining applications, including applications utilizing large diameter piping with hard outer surfaces, which have traditionally been some of the more difficult types of pipes to grip and hold joined together.

[0037] In one or more embodiments, the implementation of a low friction material between the flange **245** and the housing block **185** may take the form of the cap **275** as described above. In one or more other embodiments, the low friction material may be mounted, fastened, or adhered to the upper surface **280** of the flange **245** and/or to the internal side **225** of the radially outer wall **200**. In one or more other embodiments, pieces or strips of the low friction material may be mounted, fastened, or adhered to a portion of the upper surface **280** of the flange **245** and/or to the internal side **225** of the radially outer wall **200**. In one or more other embodiments, a low friction material may be sprayed, coated, or dipped onto the flange **245** and/or the internal side **225** of the radially outer wall **200**. In still other embodiments, a mechanical device may be implemented to reduce friction between the collar bolts **235** and the housing block **185**, such as a roller ball bearing. In addition, a grease could be used to reduce the friction between the flange **245** and the housing block **185**; however, grease would be a less suitable option as the grease could run onto the pipe and lead to slippage between the pipe-pressing member **260** and the first pipe **110**.

[0038] In one or more embodiments, the cap **275** is composed of a low friction material. In one or more embodiments, the low friction material is ultra-high molecular weight polyethylene (UHMW), but other materials are contemplated. In one or more other embodiments, the low friction material is nylon. In one or more other embodiments, the low friction material includes one or more of UHMW, nylon, one or more other low friction materials, or any combination thereof.

[0039] Once the wedge assemblies are assembled within the clamping block, a twist-off nut **305** may be attached to each wedge assembly **135** in accordance with U.S. patent application Ser. No. 06/737,807, filed May 23, 1985, now U.S. Pat. No. 4,627,774, the entire disclosure of which is hereby incorporated herein by reference and forms part of the present disclosure.

[0040] FIG. **5** illustrates another cross-sectional view of the joint restraint **105** of FIG. **4**A, taken along line **5-5** of FIG. **4**A.

[0041] Referring now to FIGS. **6**A-**6**C, with continued reference to FIGS. **1**-**5**, installation of the pipe junction assembly **100**, including the joint restraint **105**, will be described in further detail, according to one or more embodiments.

[0042] First, the joint restraint **105** is prepared for installation on the first pipe **110**. Each wedge assembly **135** is prepared by threadably engaging the threaded portion **250** of the shank **240** of the collar bolt **235** with the internally reverse-threaded pipe-pressing member **260**. Then the cap **275** is assembled onto the upper portion **255** of the collar bolt **235** and seated down onto the upper surface **280** of the flange **245**. The cap **275** is assembled onto the collar bolt **235** prior to the upper portion **255** of the collar bolt **235** being received through the elliptical hole **230** of the housing block **185**. In one or more embodiments, the cap **275**, or the low friction material, may be applied to the collar bolt **235** or to the housing block **185** prior to the pipe-pressing member **260** being assembled onto the collar bolt **235**.
[0043] Next, the wedge assembly **135** is received into the joint restraint **105** through the open mouth **195** of the housing block **185** and the upper portion **255** of the collar bolt **235** is received through the elliptical hole **230** in the radially outer wall **200** of the housing block **185**. The collar bolt **235** is prevented from extending entirely through the elliptical hole **230** by the flange **245**. In order to retain the wedge assembly **135** within the housing block **185** prior to the joint restraint **105** being installed onto the first pipe **110**, the twist-off nut **305** is attached to the collar bolt **235** on the external side **220** of the radially outer wall **200**. Each wedge assembly **135** is installed into the joint restraint **105** in this manner prior to installation of the joint restraint **105** onto the first pipe **110**.
[0044] In subsequent installation of the joint restraint **105**, the first pipe **110** is received within the annular space **150** defined by the annular body **120** of the joint restraint **105**. In one or more embodiments, the joint restraint **105** is placed onto and around the first pipe **110**. In one or more embodiments, the packing material **160** is also assembled onto the first pipe **110** after the joint restraint **105** has been assembled onto the first pipe **110**. The annular body **120** of the joint restraint **105** is then rotated until the holes **140** of the annular body **120** and the holes **170** of the annular flange **165** of the second pipe **115** are aligned such that bolts **175** may be inserted through each set of holes and engagingly mated with complementary nuts **182** in order to couple the joint restraint **105** to the second pipe **115**. The nuts **182** and bolts **175** are then tightened such that the annular body **120** and the annular flange **165** are drawn closer together and such that the annular projection **125** sealingly abuts against the packing material **160** and presses the packing material **160** into the enlarged mouth **155** of the second pipe **115**. The packing material **160** is compressed to seal the joint between the first and second pipes.
[0045] The disclosed joint restraint **105** is a dual-function device. As discussed, the joint restraint **105** seals and retrains the joint of the first and second pipes. The restraint gripping of the pipe follows a two-step mechanical action.
[0046] In FIG. **6**A, the joint restraint **105** is shown in a partially installed configuration. The joint restraint **105** and packing material **160** have been assembled onto the first pipe **110** and the nuts **182** and the bolts **175** have been tightened to secure the joint restraint **105** to the second pipe **115**. At this point, the pipe pressing member **260** has been threaded onto the threaded portion **250** of the collar bolt **235** such that the pipe pressing member **260** is positioned on the threaded portion **250** proximate to the flange **245** such that the pipe pressing member **260** is not in contact with the first pipe **110**. In one or more embodiments, the pipe pressing member **260** may be in contact with the first pipe **110** in the partially installed configuration but has not yet reached an initial pipe holding force.
[0047] In FIG. **6**B, the joint restraint **105** is shown in an installed configuration. In FIG. **6**B, each twist-off nut **305** has been rotated until the twist-off nut **305** sheared off, thereby obtaining the initial pipe holding force. As the torque limiting twist-off nuts **305** are turned, the reverse-threaded pipe pressing member **260** is backed-off of the threaded portion **250** of the collar bolt **235**. As the pipe pressing member **260** is backed-off of the collar bolt **235**, the pipe pressing member **260** is pressed against the first pipe **110** and the flange **245** of the collar bolt **235** is pressed against the internal side **225** of the radially outer wall **200**. Each twist-off nut **305** ultimately fails in torsional shear at a prescribed torque at which point gripping edges **270** of the pipe-pressing member **260** are

pressed and set against the outer surface of the first pipe **110** in a manner that provides sufficient initial grip on the first pipe **110** to prevent slippage or relative movement between the wedge assembly **135** and the first pipe **110**.

[0048] In FIG. **6**C, the joint restraint **105** is shown in an operational configuration. After the initial pipe holding force is obtained by torquing down each twist off nut **305**, the pipeline is pressurized. The pressurization of the pipeline urges the joint to separate, which causes the wedge assembly **135** to be forced rearward within the housing block **185**, as shown in FIG. **6**C. Depending on the flow direction of the fluid through the pipe junction assembly **100**, either the wedge assembly **135** and the first pipe **110** will move relative to the rest of the joint restraint **105** and relative to the second pipe **115**, or the joint restraint **105** and the second pipe **115** will move relative to the wedge assembly **135** and relative to the first pipe **110**. The initial pipe holding force ensures the wedge assembly **135** and the first pipe **110** move together.

[0049] In FIG. **6**C, arrow A indicates the flow direction of the fluid through the pipe junction assembly **100** in one or more embodiments. In FIG. **6**C, arrow A indicates that, as a result of the flow direction of the fluid, the first pipe **110** and the wedge assembly **135** move relative to the rest of the joint restraint **105** and relative to the second pipe **115**. Because the flow direction is from right to left in FIG. **6**C, the first pipe **110** is urged to separate from and move relative to the second pipe **115** and relative to the joint restraint **105**. As the first pipe **110** moves relative to the second pipe **115**, the wedge assembly **135** moves with the first pipe **110** and thus is urged rearward within the housing block **185**.

[0050] The relative movement between the wedge assembly **135** and the housing block **185** induces a radial inward force while engaging in rearward travel due to the inclined plane surface of the radially outer wall **200** of the housing block **185** in which the wedge assembly **135** resides. As the wedge assembly **135** moves rearward in the housing block **185**, the gripping edges **270** of the pipe-pressing member **260** further engage the outer surface of the first pipe **110**, adding more restraint force to the initial grip (i.e., the initial pipe holding force). In the embodiment shown in FIG. **6**C, the gripping edges **270** of the pipe-pressing member **260** dig into, bite into, or eat into the outer surface of the first pipe **110**. The ultimate gripping force developed by the initial pipe holding force plus the actuation-forced grip define the ultimate pressure resistance and rating of the device.

[0051] The more dominate of the two forces is the actuation force due to the inclined plane rather than the initial torque induced force. Without this wedging action, the total performance of the joint restraint is significantly reduced; however, the wedging action is predicated on the initial grip holding sufficiently enough to slidably engage the inclined plane. Thus, once the initial grip is sufficient to initiate the wedging action without slippage of the wedge assembly relative to the first pipe, it is beneficial to encourage this wedging action by reasonable means. Reducing the frictional resistance of sliding by reducing the coefficient of friction between the sliding contact surfaces of the collar bolt and the block housing is therefore beneficial.

[0052] A significant reduction in the sliding friction is promoted by the use of the low friction material positioned between the annular flange of the collar bolt and the internal side of the outer wall of the housing block. In some embodiments, as disclosed above, this low friction material may take the form of the cap inserted over the upper portion of the collar bolt and wrapping over the outer radial edge of the annular flange to keep it in place.

[0053] FIG. **7**A illustrates an exploded view of another embodiment of the cap **275** and of the collar bolt **235**. FIG. **7**B illustrates an assembled view of the another embodiment of the cap **275** and of the collar bolt **235**. The embodiment of the cap **275** and the collar bolt **235** shown in FIGS. **7**A and **7**B may be part of the joint restraint **105**, instead of the corresponding embodiment of the cap **275** and the collar bolt **235** shown in the figures preceding FIGS. **7**A and **7**B; in several embodiments, the operation of the joint restraint **105** with the embodiment of the cap **275** and the collar bolt **235** shown in FIGS. **7**A and **7**B is identical to the above-described operation of the joint restraint **105**, which is described with reference to the figures preceding FIGS. **7**A and **7**B,

including the embodiment of the cap **275** and the collar bolt **235** shown in the figures preceding FIGS. **7**A and **7**B. In the embodiment shown in FIGS. **7**A and **7**B, the cap **275** includes a substantially disk-shaped top portion, such as top wall **285**, with an opening **295** (or hole) extending through the center of the top wall **285**, but the cap **275** does not include any side portion extending from either an outer radial edge of the top wall **285** or otherwise. The opening **295** extending through the top wall **285** is sized to receive the upper portion **255** of the collar bolt **235** so that the cap **275** may be installed from the top of the collar bolt **235** and positioned down around the upper portion **255** of the collar bolt **235**. In one or more embodiments, the cap **275** includes or is made of a low friction material, as described above.

[0054] In one or more embodiments, the cap **275** may include one or more segments or pieces. In one or more embodiments, the cap **275** may be mounted, fastened, or adhered to the upper surface **280** of the flange **245** and/or to the internal side **225** of the radially outer wall **200**. In one or more embodiments, the cap **275** may include one or more pieces or strips that may be mounted, fastened, or adhered to a portion of the upper surface **280** of the flange **245** and/or to the internal side **225** of the radially outer wall **200**. In one or more other embodiments, a low friction material may be sprayed, coated, or dipped onto the flange **245** and/or the internal side **225** of the radially outer wall **200**. In one or more embodiments, the cap **275** or the top wall **285** of the cap may have a diameter that is less than or equal to a diameter of the flange **245**.

[0055] In one or more embodiments, instead of having the disk shape or circular shape as shown in FIGS. **7**A and **7**B, the cap **275** of the embodiment shown in FIGS. **7**A and **7**B has a square shape, a rectangular shape, a hexagonal shape, an oval shape, or another shape.

[0056] In one or more embodiments, the low friction material may be an ultra-high molecular weight polyethylene (UHMW), but other materials are contemplated. In one or more other embodiments, the low friction material may be nylon. In one or more other embodiments, the low friction material may include one or more of UHMW, nylon, one or more other low friction materials, or any combination thereof.

[0057] The present disclosure introduces a joint restraint assembly for a pipe, the joint restraint assembly including: an annular body including a wedge housing, the wedge housing including: a housing block; an opening extending from a radially interior surface of the annular body into at least a portion of the housing block; and an interior surface of the housing block, wherein the interior surface is defined by the opening and inclined with respect to the axial extension of the annular body; and a wedge assembly received within the opening of the wedge housing of the annular body, the wedge assembly including: a bolt including a flange; a low-friction material positioned between the flange and the interior surface of the housing block, and adapted to slidably engage the interior surface of the housing block during relative movement between the wedge assembly and the wedge housing; and a wedge member attached to the bolt so that the flange is positioned between at least a portion of the low-friction material and at least a portion of the wedge member, wherein the wedge member is adapted to engage the pipe. In an embodiment, the joint restraint assembly includes: a plurality of wedge housings including the wedge housing, the plurality of wedge housings being distributed equally about the annular body; and a plurality of wedge assemblies including the wedge assembly, each of the plurality of wedge assemblies being received within a respective one of the plurality of wedge housings. In an embodiment, the joint restraint assembly includes a cap including the low-friction material and positioned on the flange, wherein a top portion of the cap is positioned on an upper surface of the flange adjacent the interior surface of the housing block. In an embodiment, the low-friction material includes ultra-high molecular weight polyethylene (UHMW) and/or nylon. In an embodiment, the cap further includes a side portion extending from an outer radial edge of the top portion; wherein the side portion of the cap extends around an outer surface of the flange along at least a portion of a longitudinal length of the flange; and wherein the side portion of the cap facilitates retention of the cap on the flange. In an embodiment, the bolt further includes an upper portion extending above the upper

surface of the flange opposite a lower portion of the bolt; wherein the wedge housing further includes a hole extending through the interior surface of the housing block in communication with the opening of the wedge housing; and wherein the hole is sized such that the upper portion of the bolt extends through the hole and such that the flange is prevented from extending through the hole. In an embodiment, the cap further includes a hole extending through the top portion; and wherein the cap is assembled onto the flange such that the upper portion of the bolt extends through the hole in the top portion of the cap and further facilitates the retention of the cap on the flange. In an embodiment, the joint restraint assembly includes a coating including the low-friction material applied to an upper surface of the flange adjacent the interior surface of the housing block.

[0058] The present disclosure also introduces a system including: a joint restraint assembly, the joint restraint assembly including: an annular body including a wedge housing, the wedge housing including: a housing block; an opening extending from a radially interior surface of the annular body into at least a portion of the housing block; and an interior surface of the housing block, wherein the interior surface is defined by the opening and inclined with respect to the axial extension of the annular body; and a wedge assembly received within the opening of the wedge housing of the annular body, the wedge assembly including: a bolt including a flange; a low-friction material positioned between the flange and the interior surface of the housing block, and adapted to slidably engage the interior surface of the housing block during relative movement between the wedge assembly and the wedge housing; and a wedge member attached to the bolt so that the flange is positioned between at least a portion of the low-friction material and at least a portion of the wedge member; a first pipe received through the annular body of the joint restraint assembly; and a second pipe including an enlarged mouth and an annular flange formed at an end portion of the enlarged mouth; wherein a portion of the first pipe is received within the enlarged mouth of the second pipe; and wherein the annular body of the joint restraint assembly is attached to the annular flange of the second pipe via a plurality of fasteners. In an embodiment, the system includes a packing material positioned around the first pipe and within the enlarged mouth to facilitate sealing engagement of the first and second pipe. In an embodiment, the wedge assembly of the joint restraint assembly further includes: a cap including the low-friction material and positioned on the flange of the bolt, wherein a top portion of the cap is positioned on an upper surface of the flange adjacent the interior surface of the housing block. In an embodiment, the cap further includes a side portion extending from an outer radial edge of the top portion; wherein the side portion of the cap extends around an outer surface of the flange along at least a portion of a longitudinal length of the flange; and wherein the side portion of the cap facilitates retention of the cap on the flange. In an embodiment, the bolt further includes an upper portion extending above the upper surface of the flange opposite a lower portion of the bolt; wherein the wedge housing further includes a hole extending through the interior surface of the housing block in communication with the opening of the wedge housing; and wherein the hole is sized such that the upper portion of the bolt extends through the hole and such that the flange is prevented from extending through the hole. In an embodiment, the cap further includes a hole extending though the top portion; and wherein the cap is assembled onto the flange such that the upper portion of the bolt extends through the hole in the top portion of the cap and further facilitates the retention of the cap on the flange. In an embodiment, the system includes a coating including the low-friction material applied to an upper surface of the flange adjacent the interior surface of the housing block.

[0059] The present disclosure also introduces a method of installing a joint restraint assembly, including: assembling a wedge assembly of the joint restraint assembly, including: threading a wedge member onto a lower portion of a bolt; and positioning a cap including a low-friction material onto a flange of the bolt; inserting the wedge assembly into a wedge housing of an annular body of the joint restraint assembly; wherein the wedge housing includes an interior surface that is inclined with respect to the axial extension of the annular body; and wherein, when the wedge assembly is inserted into the wedge housing: the cap is positioned between the annular flange and

the interior surface of the wedge housing, and adapted to slidably engage the interior surface of the wedge housing during relative movement between the wedge assembly and the wedge housing; and an upper portion of the bolt extends through a hole extending through the interior surface of the wedge housing; and threading a nut onto the upper portion of the bolt extending through the hole extending through the interior surface such that the wedge assembly is retained within the wedge housing. In an embodiment, the method includes inserting a first pipe through the annular body of the joint restraint assembly; inserting an end of the first pipe into an enlarged mouth portion of a second pipe; wherein an end of the enlarged mouth portion of the second pipe includes an annular flange; and attaching the annular body of the joint restraint assembly to the annular flange of the second pipe using a plurality of fasteners. In an embodiment, the method includes positioning a packing material around the first pipe and within the enlarged mouth portion of the second pipe. In an embodiment, the method includes pressurizing the first and second pipes; wherein pressurizing the first and second pipes forces the wedge assembly to slide along the interior surface of the wedge housing; and wherein the incline of the interior surface of the wedge housing forces the wedge member downward onto the first pipe as the wedge assembly slides relative to the interior wall of the wedge housing. In an embodiment, positioning the cap onto the flange of the bolt includes extending the upper portion of the bolt through a hole extending through the cap and sliding the cap down onto the flange.

[0060] The present disclosure also introduces an apparatus, which apparatus has been described according to one or more aspects of the present disclosure.

[0061] The present disclosure also introduces one or more other joint restraint assemblies, which have been described according to one or more aspects of the present disclosure.

[0062] The present disclosure also introduces one or more other systems, which have been described according to one or more aspects of the present disclosure.

[0063] The present disclosure also introduces one or more other methods, which have been described according to one or more aspects of the present disclosure.

[0064] The present disclosure also introduces an assembly, which assembly has been described according to one or more aspects of the present disclosure.

[0065] The present disclosure also introduces a kit, which kit has been described according to one or more aspects of the present disclosure.

[0066] The present disclosure also introduces an anchor bolt, which anchor bolt has been described according to one or more aspects of the present disclosure.

[0067] The present disclosure also introduces a cap, which cap has been described according to one or more aspects of the present disclosure.

[0068] The present disclosure also introduces a mechanical joint restraint, which mechanical joint restraint has been described according to one or more aspects of the present disclosure.

[0069] It is understood that variations may be made in the foregoing without departing from the scope of the present disclosure.

[0070] In several embodiments, the elements and teachings of the various embodiments may be combined in whole or in part in some or all of the embodiments. In addition, one or more of the elements and teachings of the various embodiments may be omitted, at least in part, and/or combined, at least in part, with one or more of the other elements and teachings of the various embodiments.

[0071] Any spatial references, such as, for example, “upper,” “lower,” “above,” “below,” “between,” “bottom,” “vertical,” “horizontal,” “angular,” “upwards,” “downwards,” “side-to-side,” “left-to-right,” “right-to-left,” “top-to-bottom,” “bottom-to-top,” “top,” “bottom,” “bottom-up,” “top-down,” etc., are for the purpose of illustration only and do not limit the specific orientation or location of the structure described above.

[0072] In several embodiments, while different steps, processes, and procedures are described as appearing as distinct acts, one or more of the steps, one or more of the processes, and/or one or

more of the procedures may also be performed in different orders, simultaneously and/or sequentially. In several embodiments, the steps, processes, and/or procedures may be merged into one or more steps, processes and/or procedures.
[0073] In several embodiments, one or more of the operational steps in each embodiment may be omitted. Moreover, in some instances, some features of the present disclosure may be employed without a corresponding use of the other features. Moreover, one or more of the embodiments disclosed above, or variations thereof, may be combined in whole or in part with any one or more of the other embodiments described above, or variations thereof.
[0074] Although several embodiments have been described in detail above, the embodiments described are illustrative only and are not limiting, and those skilled in the art will readily appreciate that many other modifications, changes and/or substitutions are possible in the embodiments without materially departing from the novel teachings and advantages of the present disclosure. Accordingly, all such modifications, changes, and/or substitutions are intended to be included within the scope of this disclosure as defined in the following claims. In the claims, any means-plus-function clauses are intended to cover the structures described herein as performing the recited function and not only structural equivalents, but also equivalent structures. Moreover, it is the express intention of the applicant not to invoke 35 U.S.C. § 112(f) for any limitations of any of the claims herein, except for those in which the claim expressly uses the word “means” together with an associated function.

Claims

1. A joint restraint assembly for a pipe, the joint restraint assembly comprising: an annular body comprising a wedge housing, the wedge housing comprising: a housing block; an opening extending from a radially interior surface of the annular body into at least a portion of the housing block; and an interior surface of the housing block, wherein the interior surface is defined by the opening and inclined with respect to the axial extension of the annular body; and a wedge assembly received within the opening of the wedge housing of the annular body, the wedge assembly comprising: a bolt comprising a flange; a low-friction material positioned between the flange and the interior surface of the housing block, and adapted to slidably engage the interior surface of the housing block during relative movement between the wedge assembly and the wedge housing; and a wedge member attached to the bolt so that the flange is positioned between at least a portion of the low-friction material and at least a portion of the wedge member, wherein the wedge member is adapted to engage the pipe.
2. The joint restraint assembly of claim 1, further comprising: a plurality of wedge housings including the wedge housing, the plurality of wedge housings being distributed equally about the annular body; and a plurality of wedge assemblies including the wedge assembly, each of the plurality of wedge assemblies being received within a respective one of the plurality of wedge housings.
3. The joint restraint assembly of claim 1, further comprising: a cap comprising the low-friction material and positioned on the flange, wherein a top portion of the cap is positioned on an upper surface of the flange adjacent the interior surface of the housing block.
4. The joint restraint assembly of claim 3, wherein the low-friction material comprises ultra-high molecular weight polyethylene (UHMW) and/or nylon.
5. The joint restraint assembly of claim 3, wherein the cap further comprises a side portion extending from an outer radial edge of the top portion; wherein the side portion of the cap extends around an outer surface of the flange along at least a portion of a longitudinal length of the flange; and wherein the side portion of the cap facilitates retention of the cap on the flange.
6. The joint restraint assembly of claim 3, wherein the bolt further comprises an upper portion extending above the upper surface of the flange opposite a lower portion of the bolt; wherein the

wedge housing further comprises a hole extending through the interior surface of the housing block in communication with the opening of the wedge housing; and wherein the hole is sized such that the upper portion of the bolt extends through the hole and such that the flange is prevented from extending through the hole.

7. The joint restraint assembly of claim 6, wherein the cap further comprises a hole extending through the top portion; and wherein the cap is assembled onto the flange such that the upper portion of the bolt extends through the hole in the top portion of the cap and facilitates the retention of the cap on the flange.

8. The joint restraint assembly of claim 1, further comprising: a coating comprising the low-friction material applied to an upper surface of the flange adjacent the interior surface of the housing block.

9. A system, comprising: a joint restraint assembly, the joint restraint assembly comprising: an annular body comprising a wedge housing, the wedge housing comprising: a housing block; an opening extending from a radially interior surface of the annular body into at least a portion of the housing block; and an interior surface of the housing block, wherein the interior surface is defined by the opening and inclined with respect to the axial extension of the annular body; and a wedge assembly received within the opening of the wedge housing of the annular body, the wedge assembly comprising: a bolt comprising a flange; a low-friction material positioned between the flange and the interior surface of the housing block, and adapted to slidably engage the interior surface of the housing block during relative movement between the wedge assembly and the wedge housing; and a wedge member attached to the bolt so that the flange is positioned between at least a portion of the low-friction material and at least a portion of the wedge member; a first pipe received through the annular body of the joint restraint assembly; and a second pipe comprising an enlarged mouth and an annular flange formed at an end portion of the enlarged mouth; wherein a portion of the first pipe is received within the enlarged mouth of the second pipe; and wherein the annular body of the joint restraint assembly is attached to the annular flange of the second pipe via a plurality of fasteners.

10. The system of claim 9, further comprising: a packing material positioned around the first pipe and within the enlarged mouth to facilitate sealing engagement of the first and second pipe.

11. The system of claim 9, wherein the wedge assembly of the joint restraint assembly further comprises: a cap comprising the low-friction material and positioned on the flange of the bolt, wherein a top portion of the cap is positioned on an upper surface of the flange adjacent the interior surface of the housing block.

12. The system of claim 11, wherein the cap further comprises a side portion extending from an outer radial edge of the top portion; wherein the side portion of the cap extends around an outer surface of the flange along at least a portion of a longitudinal length of the flange; and wherein the side portion of the cap facilitates retention of the cap on the flange.

13. The system of claim 11, wherein the bolt further comprises an upper portion extending above the upper surface of the flange opposite a lower portion of the bolt; wherein the wedge housing further comprises a hole extending through the interior surface of the housing block in communication with the opening of the wedge housing; and wherein the hole is sized such that the upper portion of the bolt extends through the hole and such that the flange is prevented from extending through the hole.

14. The system of claim 13, wherein the cap further comprises a hole extending though the top portion; and wherein the cap is assembled onto the flange such that the upper portion of the bolt extends through the hole in the top portion of the cap and facilitates the retention of the cap on the flange.

15. The system of claim 9, further comprising: a coating comprising the low-friction material applied to an upper surface of the flange adjacent the interior surface of the housing block.

16. A method of installing a joint restraint assembly, the method comprising: assembling a wedge assembly of the joint restraint assembly, comprising: threading a wedge member onto a lower

portion of a bolt; and positioning a cap comprising a low-friction material onto a flange of the bolt; inserting the wedge assembly into a wedge housing of an annular body of the joint restraint assembly; wherein the wedge housing comprises an interior surface that is inclined with respect to the axial extension of the annular body; and wherein, when the wedge assembly is inserted into the wedge housing: the cap is positioned between the annular flange and the interior surface of the wedge housing, and adapted to slidably engage the interior surface of the wedge housing during relative movement between the wedge assembly and the wedge housing; and an upper portion of the bolt extends through a hole extending through the interior surface of the wedge housing; and threading a nut onto the upper portion of the bolt extending through the hole extending through the interior surface such that the wedge assembly is retained within the wedge housing.

17. The method of claim 16, further comprising: inserting a first pipe through the annular body of the joint restraint assembly; inserting an end of the first pipe into an enlarged mouth portion of a second pipe; wherein an end of the enlarged mouth portion of the second pipe comprises an annular flange; and attaching the annular body of the joint restraint assembly to the annular flange of the second pipe using a plurality of fasteners.

18. The method of claim 17, further comprising: positioning a packing material around the first pipe and within the enlarged mouth portion of the second pipe.

19. The method of claim 17, further comprising: pressurizing the first and second pipes; wherein pressurizing the first and second pipes forces the wedge assembly to slide along the interior surface of the wedge housing; and wherein the incline of the interior surface of the wedge housing forces the wedge member downward onto the first pipe as the wedge assembly slides relative to the interior wall of the wedge housing.

20. The method of claim 19, wherein positioning the cap onto the flange of the bolt comprises extending the upper portion of the bolt through a hole extending through the cap and sliding the cap down onto the flange.