The arcuate projections on prior art couplings for grooved pipe elements typically have arcuate surfaces with a radius of curvature that is marginally larger than the radius of curvature of the outer surface of the pipe element within the groove that it is intended to engage. For couplings used with grooved pipe elements, the radii of curvature of the arcuate surfaces are smaller than the radii of curvature of the outer surfaces of the pipe elements outside of the grooves so that the projections fit within and engage the grooves.

Methods of securing pipe elements in end to end relation comprise a sequential installation process when mechanical couplings according to the prior art are used. Typically, the coupling is received by the technician with the segments bolted together and the ring gasket captured within the segments' channels. The technician first disassembles the coupling by unbolting it, removes the ring gasket, lubricates it (if not pre-lubricated) and places it around the ends of the pipe elements to be joined. Installation of the ring gasket often requires that it be lubricated and stretched to accommodate the pipe elements. With the ring gasket in place on both pipe elements, the segments are then placed one at a time straddling the ends of the pipe elements and capturing the ring gasket against them. During placement, the segments engage the gasket, the projections are aligned with the grooves, the bolts are inserted through the lugs, the nuts are threaded onto the bolts and tightened, drawing the coupling segments toward one another, compressing the gasket and engaging the projections within the grooves.

As evident from the previous description, installation of mechanical pipe couplings according to the prior art requires that the technician typically handle at least seven individual piece parts (and more when the coupling has more than two segments), and must totally disassemble and reassemble the coupling. Significant time, effort and expense would be saved if the technician could install a mechanical pipe coupling without first totally disassembling it and then reassembling it, piece by piece.

Summary

According to a first aspect of the present invention, there is provided a preassembled combination for connecting a captured pipe element to a second pipe element, the combination comprising:

a preassembled coupling comprising:

a plurality of segments attached to one another end to end to form a loop around a central space, each of said segments comprising a first shoulder, a second shoulder, and a channel disposed between the first and second shoulders and facing the central space, wherein the first and second shoulders project radially-inwardly toward the central space, and

a flexible, resilient ring seal positioned in said channels, the ring seal comprising first and second lobes that each extend radially inwardly to define first and second ring inner seal surfaces, respectively; and

the captured pipe element, wherein the captured pipe element comprises

a first end disposed within the central space,

a circumferentially extending sealing surface that is aligned with the first ring inner seal surface,

an annular groove,

a pipe shoulder extending radially-outwardly, and

a bead extending radially-outwardly and disposed within the central space,

wherein the annular groove, sealing surface, and bead are all axially disposed between the first end and the pipe shoulder,

wherein the bead and sealing surface are both axially disposed between the annular groove and the first end,

wherein the bead extends radially outwardly farther than an inner radial extent of the first lobe,

wherein the coupling and bead are shaped and positioned such that the first end and bead are captured within the central space,

wherein the second shoulders of the plurality of segments are axially disposed between the bead and pipe shoulder and are aligned with the annular groove of the captured pipe element,

wherein the coupling is shaped and configured to permit an end of the second pipe element to be axially inserted into the central space, and

wherein the coupling is shaped and configured such that once the end of the second pipe element is properly inserted into the central space, the plurality of segments can be drawn toward one another and the central space and thereby cause (1) the first ring inner seal

surface to sealingly engage the sealing surface of the captured pipe element, (2) the second ring inner seal surface to sealingly engage a sealing surface of the second pipe element, (3) the second shoulders to engage the groove of the captured pipe element, and (4) the first shoulders to engage an annular groove of the second pipe element, thereby joining the second pipe element with the captured pipe element.

According to a second aspect of the present invention, there is provided a method of manufacturing the combination as defined in the first aspect, the method comprising, sequentially:

engaging the ring seal with a pipe element that will become the captured pipe element such that (1) interference between the bead and the first lobe impedes movement of said captured pipe element relative to the ring seal in a first axial direction, and (2) first ring inner seal surface is axially aligned with the sealing surface of the captured pipe element;

positioning the ring seal in the channel of at least one of the plurality of segments; and

attaching the plurality of segments to one another end to end to form the loop around the central space, thereby forming the preassembled coupling and capturing the captured pipe element within the central space to form the combination.

According to a third aspect of the present invention, there is provided a method of using the combination as defined in the first aspect, the method comprising:

axially inserting the end of the second pipe element into the central space while the coupling is preassembled and the first end of the captured pipe element is captured within the central space; and

while the end of the second pipe element is inserted into the central space, drawing the plurality of segments toward one another and the central space, thereby causing (1) the first ring inner seal surface to sealingly engage the sealing surface of the captured pipe element, (2) the second ring inner seal surface to sealingly engage the sealing surface of the second pipe element, (3) the second shoulders to engage the groove of the captured pipe element, and (4) the first shoulders to engage the annular groove of the second pipe element, thereby joining the second pipe element with the captured pipe element.

There is disclosed a coupling for joining pipe elements. In one example embodiment the coupling comprises first and second segments positioned end to end surrounding a central space for receiving the pipe elements. A spring assembly joins a first end of the first segment to a first end of the second segment. The spring assembly biases the segments away

are positioned respectively in the first and second channels. Each of the retainers comprises a band having oppositely disposed ends. A plurality of teeth are positioned along one edge of the band. The teeth project toward the central space. At least one tab is positioned along an opposite edge of the band. The band overlies the first floor. The at least one tab overlies the second floor when the retainers are positioned within the channels. An example may comprise a plurality of tabs.

By way of example, a third channel is positioned between the first and second channels in each of the segments. The third channels extend between the ends of the segments and facing the central space.

In an example embodiment, the teeth are oriented angularly with respect to a line extending radially from an axis arranged coaxially with the central space. In a further example, the at least one tab is oriented perpendicularly to a line extending radially from an axis arranged coaxially with the central space. Further by way of example, the at least one tab is offset from the band toward an axis arranged coaxially with the central space. In a specific example embodiment, the at least one tab projects toward the third channel.

In an example embodiment, a first aperture is positioned in at least one of the segments. The first aperture may be aligned with the first channel and provide a line of sight toward the central space. In an example embodiment the first aperture is positioned between the first and second segments. The first aperture may comprise a trough positioned at an interface between the first and second segments by way of example. A further example comprises a second aperture in at least one of the segments. The second aperture may be aligned with the second channel and provide a line of sight toward the central space. The second aperture may be positioned between the first and second segments and may comprise a trough positioned at an interface between the two segments for example.

In an example embodiment a ring seal is positioned within the third channels. The ring seal has an inner surface sized to receive the pipe elements and an outer surface sized to support the segments in spaced apart relation sufficient to permit insertion of the pipe elements into the central space while the segments are attached to one another. Further by way of example, the

retainer bands may be sized to cooperate with the ring seals to support the housing portions in the spaced apart relation.

In another example embodiment, each of the first and second segments comprises first and second shoulders positioned on opposite sides of each of the segments. The shoulders extend lengthwise along the segments and project toward the central space. The shoulders define a channel therebetween. A first arcuate surface is positioned on the first shoulder, and a second arcuate surface is positioned on the second shoulder. The arcuate surfaces face the central space in this example. A plurality of projections may be positioned on each of the first and second arcuate surfaces. The projections project toward the central space. In an example embodiment, the first arcuate surface may have a first radius of curvature and the second arcuate surface may have a second radius of curvature wherein the second radius of curvature is less than the first radius of curvature.

In an example embodiment a ring seal is positioned within the channel. The ring seal has an inner surface sized to receive the pipe elements and an outer surface sized to support the segments in spaced apart relation sufficient to permit insertion of the pipe elements into the central space while the segments are attached to one another.

In combination, a coupling and a first pipe element. The coupling is for joining a second pipe element to the first pipe element. In an example embodiment, he coupling comprises first and second segments positioned end to end surrounding a central space for receiving the pipe elements. First and second shoulders are positioned on opposite sides of each of the segments. The shoulders extend lengthwise along the segments and project toward the central space. A first arcuate surface is positioned on the first shoulder. A second arcuate surface is positioned on the second shoulder. The arcuate surfaces face the central space. A spring assembly joins a first end of the first segment to a first end of the second segment. The spring assembly biases the segments away from one another. An adjustable attachment assembly joins a second end of the first segment to a second end of the second segment. The adjustable attachment assembly is adapted to draw the first and second segments toward one another and into engagement with the pipe elements. The first pipe element comprises a rim projecting outwardly from the first pipe element and extending

circumferentially. The rim is positioned in spaced relation to an end of the first pipe element. The rim engages the first shoulder and is captured within the central space.

In an example embodiment the rim is defined by a circumferential groove in the first pipe element. In another example embodiment the rim is defined by a circumferential bead which projects radially outwardly from the first pipe element.

In an example embodiment the spring assembly comprises a first boss projecting from the first end of the first segment. A second boss projects from the first end of the second segment and is positioned adjacent to the first boss. A first fulcrum is positioned on the first boss and contacts the second boss. The segments pivot about the first fulcrum. A link extends between and capturing the first and second bosses.

An example embodiment may further comprise a second fulcrum positioned on the second boss. The second fulcrum contacts the first fulcrum. A first land may be positioned contiguous with the first fulcrum on the first boss, and a second land may be positioned contiguous with the second fulcrum on the second boss. The first and second lands are oriented angularly with respect to a plane defining an interface between the first and second segments. In another example embodiment of a combination, a first head projects from the first boss, and a second head projects from the second boss. The link engages the first and second heads for retaining the link to the bosses. In an example embodiment the link comprises a ring encircling the first and second bosses.

In an example embodiment of the combination, the adjustable attachment assembly comprises a first lug attached to the second end of the first segment. A second lug is attached to the second end of the second segment and is positioned in facing relation with the first lug. Each lug defines a respective hole. A fastener extends between the first and second lugs. The fastener is received within the respective holes. The fastener is adjustable for drawing the segments toward one another against the biasing of the spring assembly.

In a further example embodiment the combination comprises a channel positioned between the first and second shoulders in each of the segments. The channels extend between the ends of the segments and face the central space. Further by way of example, a ring seal is

positioned within the channels. The ring seal has an inner surface sized to receive the pipe elements and an outer surface sized to support the segments in spaced apart relation sufficient to permit insertion of the second pipe element into the central space while the segments are attached to one another and the first pipe element is captured within the central space.

A plurality of projections may be positioned on each of the first and second arcuate surfaces in an example embodiment of the combination. The projections project toward the central space. An example embodiment may further comprise at least one aperture in at least one of the segments. The at least one aperture may be positioned between the first and second segments. In an example embodiment, the at least one aperture comprises a trough positioned at an interface between the first and second segments.

There is disclosed a method of assembling the combination coupling and pipe element. In one example embodiment the method comprises:

positioning the first pipe element with the rim engaged with the first shoulder of the first segment;

engaging the first end of the first segment with the first end of the second segment to form the spring assembly;

supporting the first and second segments in spaced apart relation sufficient to permit insertion of the second pipe element into the central space while capturing the first pipe element within the central space;

attaching the second end of the first segment to the second end of the second segment using the adjustable attachment assembly.

Further by way of example, the method may comprise:

engaging the first pipe element with a ring seal;

positioning the ring seal within a channel defined by the first and second shoulders of the first segment.