PIPE SEALING TOOL WITH EXTERNAL AND INTERNAL CLAMP

CROSS REFERENCE TO PRIOR APPLICATIONS

[0001] This application claims priority from US Application number 12/715,168, filed on March 1, 2010. The aforementioned related application is incorporated herein by reference in its entirety.

FIELD

[0002] The present invention relates to an apparatus for sealing an open end of a pipe using frictional clamping means. In a preferred embodiment, the clamping means includes external and internal clamping components. Once sealed, the pipe can be subjected to pressurization for testing purposes etc.

BACKGROUND

[0003] In chemical or petrochemical plants etc., it is often necessary to convey fluidic materials (e.g. liquids) from one location to another. The conveyance of such material normally includes equipment such as conduits or pipes, storage or reaction vessels etc., which are generally manufactured from metal. The joining of separate pieces of the conveying equipment is generally achieved by welding the necessary pieces together. For example, when joining adjacent ends of pipe together, it is common for each end to be provided with flanges, that are welded to each respective end, which are then bolted together to form a seal. Such flanges may also be provided on holding tanks and other such vessels so that such vessels can be connected to pipes or other vessels. Alternatively, the connections between lengths of pipe or other equipment may be welded directly together (i.e. butt welded) to form the seal. In either case, it will be appreciated that each welded joint or section must form a complete seal so as to prevent leakage of the materials being transported. This is particularly the case when handling potentially hazardous materials such as flammable or toxic liquids.

[0004] For reasons of safety, it is often necessary to periodically test the integrity of the welds used in joining the various pieces of equipment (such as pipes, vessels, flanges and the like) together.

[0005] The prior art provides various tools for conducting weld integrity tests on conduits. For example, U.S. Patent numbers 6,131,441 and 5,844,127 (the entire disclosures of which are incorporated herein by reference) teach weld testing tools that isolate a particular section of a pipe (such section including a weld) and subject the section to a high pressure fluid within a constrained annular space defined by the tool and the inner surface of the pipe. The pressure of the fluid within the annular space is monitored whereby any pressure drop signifies a leak in the weld.

[0006] US Patent number 6,463,791 (the entire disclosure of which is incorporated herein by reference) teaches an apparatus for testing welds used to secure nozzles. As shown in Figure 1 of this reference, the apparatus comprises a first seal plate that is placed on the inner surface of the vessel (for example) and a second seal plate that is secured to the outer, flange portion of the nozzle. In this manner, the nozzle volume is sealed and a pressurizing fluid is introduced therein. Once the volume is filled, the pressure is monitored as above and any leakage detected. Although this apparatus provides an accurate and efficient means of testing welds on nozzles, the size and weight of the apparatus makes it inconvenient for use on large nozzles.

[0007] Further, applicant's co-pending U.S. application, serial number 11/771,158 (publication number US 2008/0121044), provides tools for testing the integrity of welds on pipes and the like. The entire disclosure of such application is incorporated herein by reference.

[0008] There exists a need for more easily sealing a section of a long pipe for conducting the type of stress tests mentioned above. In addition, there exists a need for an apparatus that is capable of exerting axial stresses on welds during such testing so as to simulate a "worst case scenario". In particular, there is a need for an apparatus that can be easily mounted on an open end of a pipe so as to effectively seal the pipe opening and maintain such seal during high pressurization of the pipe. Such apparatus would not subject the pipe to any damage or otherwise cause weakness thereto.

SUMMARY

[0008a] The invention is defined in the independent claims. Some optional features are defined in the dependent claims.

[0009] In one aspect, the present invention generally provides an apparatus for sealing an open end of a pipe comprising a means for frictionally engaging the interior and exterior surfaces of the pipe.

[0010] Thus, in one aspect, an apparatus for sealing an open end of a pipe comprising:

[0011] - a sealing plate sized to cover the open end of the pipe;

[0012] - a first compression ring and gripper ring assembly, sized to be provided over the outer surface of the pipe,

[0013] - a first means for connecting the first compression ring to the sealing plate and for urging the first compression ring towards the sealing plate;

[0014] - the first compression ring and the first gripper ring being provided in a cooperating arrangement, wherein urging of the first compression ring towards the sealing plate forces the first gripper ring against the outer surface of the pipe;

[0015] - a second compression ring and gripper ring assembly, sized to be provided within the diameter of the pipe;

[0016] - a second means for connecting the second compression ring to the sealing plate and for urging the second compression ring towards the sealing plate;

[0017] - the second compression ring and the second gripper ring being provided in a cooperating arrangement, wherein urging of the second compression ring towards the sealing plate forces the first gripper ring against the inner surface of the pipe; and,

[0018] - a backplate sized to be provided within the pipe, the backplate being connected to the sealing plate and being provided on an a side of the second compression ring opposite to the sealing plate is disclosed.

[0019] In a further embodiment, a method for sealing a section of a pipe having an open end, the method comprising:

[0020] - providing an apparatus having a first clamping means, for frictionally engaging the outer surface of the pipe, and a second clamping means, for frictionally engaging the inner surface of the pipe; and,

[0021] - forming a seal between the inner surface of the pipe and the second clamping means is disclosed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] These and other features will become more apparent in the following detailed description in which reference is made to the appended drawings wherein:

[0023] Figure 1 is a cross sectional view of one embodiment of the apparatus.

[0024] Figure 2 is a perspective view of the clamp of the apparatus of Figure 1.

[0025] Figure 3 is a cross sectional elevation of another embodiment of the clamp of Figure 1.

[0026] Figures 4, 4b, 5 and 6 are cross sectional views of further embodiments.

[0027] Figures 7 to 9 are cross sectional views of an embodiment having an external clamp.

[0028] Figure 10 is a perspective view of another aspect shown in Figure 9.

[0029] Figure 11 is side view of another aspect shown in Figure 10.

[0030] Figure 12 is an end view of a clamp shown in Figures 10 and 11.

[0031] Figure 13 is a side cross-sectional view of another embodiment of the external clamp.

[0032] Figure 14 is an end view of the embodiment shown in Figure 13.

[0033] Figure 15 is a side cross-sectional view of another embodiment of the external clamp.

[0034] Figures 16 and 17 are front and side cross-sectional views of the compression ring shown in Figure 15.

[0035] Figures 18 and 19 are front and side cross-sectional views of the clamping ring shown in Figure 15.

[0036] Figures 20, 21 and 22 are front, side cross-sectional and detailed cross-sectional views of the gripper ring shown in Figure 15.

[0037] Figure 23 is a side cross-sectional view of an embodiment shown in Figure 15 wherein a plurality of external clamps are combined.

[0038] Figure 24 is a side cross-sectional view of an aspect comprising a combination external clamp and internal clamp.

[0039] Figures 25 and 26 are side cross-sectional and front views of the clamping plate shown in Figure 24.

[0040] Figures 27 and 28 are side cross-sectional and front views of the external compression ring shown in Figure 24.

[0041] Figures 29 and 30 are front and side cross-sectional views of the internal compression ring shown in Figure 24.

[0042] Figures 31 and 32 are front and side cross-sectional views of the backplate shown in Figure 24.

[0043] Figures 33, 34 and 35 are front, side cross-sectional and detailed cross-sectional views of the internal gripper ring shown in Figure 24.

DETAILED DESCRIPTION

[0044] Throughout the description the following terms will be assumed to have the following associated meanings:

[0045] “Vessel” - will be understood to mean any equipment or apparatus to which a nozzle is attached. As such, the term “vessel” will include vessels per se, pipes, drums, and any other similar equipment. It will be understood that the term “vessel” is used herein simply as a convenient way to encompass all such equipment or apparatus.

[0046] “Annular” - this term is used to describe a body having at least one outer diameter and at least one inner diameter. Thus, an “annular tube” will be assumed to be a hollow tube with an inner and outer diameter. An “annular disc” will be assumed to be an object having an outer diameter and a central aperture thereby providing an inner diameter.

[0047] “Axial” - this term will be used to describe a direction taken along the longitudinal axis of a pipe or conduit. Thus, “axial force” or “axial stress” will be understood as being a force applied in a direction parallel to the longitudinal axis of the conduit. Similarly, the term “axially extending” will be understood to mean extending in a direction parallel to the longitudinal axis of the pipe.

[0048] “Proximal” and “distal” - these terms will be used to describe the positions of various components once positioned over a pipe having an open end. The term “proximal” will be used to describe a position closer to the open end of the pipe. The term “distal” will be used to describe a position away from the open end of the pipe.

[0049] Figure 1 illustrates one aspect of the invention wherein an internal sealing apparatus for a pipe is shown. The sealing apparatus 10 is preferably sized to fit within the lumen of a pipe (or tube) 12. The apparatus 10 comprises a sealing plate 14 having a diameter slightly less than the internal diameter of the pipe 12. The plate includes a first face 16 and a second face 18, wherein the second face is adjacent a clamp 20. The second face 18 of the sealing plate 14 is provided with beveled edge 22 for accommodating an O-ring 24 or other such resilient sealing means.

[0050] The clamp 20 generally comprises an annular ring having an outer diameter sized to fit within the pipe 12. An annular shape for the clamp 20 is preferred to minimize its weight. However, the clamp 20 may also comprise a solid body. As will be understood by persons skilled in the art having reviewed the present disclosure, the outer diameter of the clamp 20 is preferably slightly less than the internal diameter of the pipe 12 so as to permit axial placement of the clamp 20. The clamp 20 is provided with one or more recesses or pockets 26 into which are placed magnets 28. Preferably, the magnets 28 comprise electromagnets that can be activated when desired.

[0051] The magnets 28 provided on the clamp 20 are designed to magnetically attract the wall of the pipe 12, which, as is commonly known in the art, is formed from a ferrous metal. The magnets 28 are designed to form a strong clamping force with the interior wall of the pipe 12 and, thereby, to anchor the clamp in a fixed axial position within the pipe 12. In a preferred embodiment, at least two or more magnets 28 are provided on the clamp 20 with such magnets being placed circumferentially around the annular clamp 20. Such an arrangement will serve to evenly secure the clamp 20 within the pipe 12. Although the

[0056] Either before the tightening of the nuts 32 or after, the magnets 28 provided on the clamp 20 are activated resulting in a strong attraction force being formed between the magnets 28 and the wall of the pipe 12. It will be understood that the magnets used are chosen so as to provide the required clamping force to prevent axial movement of the clamp 20 within the pipe 12. As mentioned above, the magnets 28 preferably comprise electro magnets. In such case, one or more power supply units (not shown) will be connected to the magnets 28 in order to activate same.

[0057] Once the clamp 20 is secured to the pipe 12 and the sealing plate 14 is secured and sealed against the clamp 20, the lumen of the pipe 12 facing the first face 16 of the sealing plate may then be pressurized with a gas or liquid without leakage beyond the sealing plate 14.

[0058] Figure 3 illustrates another embodiment of the clamp 20 having an annular structure wherein an inwardly extending flange 34 is provided to accommodate the bolts 30. The bolts may be permanently attached to the flange 34 (or the face of the clamp 20) by means of welds etc., may be integrally formed therewith, or may extend there-through and be secured with nuts (not shown).

[0059] Figure 4 illustrates the use of the sealing apparatus for the dual purposes of sealing and testing a pipe. As shown, a pair of apparatuses 10a and 10b is provided within a pipe 12 and positioned on opposite sides of a weld 36, the integrity of which is to be tested. Apparatus 10a is essentially identical to that shown in Figure 1 and as described above. As discussed above, apparatus 10a includes a sealing plate 14a joined to a clamps 20a by means of nuts and bolts 32a and 30a, respectively. Clamp 20a includes at least one magnet 28a, and preferably two or more magnets generally circumferentially equidistantly spaced. A seal is formed between the apparatus 10a and the inner wall of the pipe 12 by means of a resilient seal 24a, which may comprise an O-ring. The magnets 28a are activated to secure the clamp to the pipe 12 at the desired location. As explained above, such securing results when the attraction force of the magnets creates a tight friction engagement between the magnet and the pipe 12 surface.

[0060] Apparatus 10b of Figure 4 is similar to the apparatus 10a described above and similar elements are identified with similar reference numerals but with the letter “b” added for clarity. As shown, apparatus 10b is positioned within the pipe 12 on the opposite side of the weld 36 from apparatus 10a. In this manner, the two apparatuses 10a and 10b combine to seal off a section of the pipe 12 thereby forming a sealed space 37. In the case of

apparatus 10b, the sealing plate 14b is provided with at least one fluid port 38 through which the sealed space 37 can be filled with a pressurizing fluid (i.e. a liquid or a gas). In a preferred embodiment, as illustrated in Figure 4, two ports 38 are provided so that one is used to fill the space 37, for example with water, while the other is used to vent any air there-within. It will be appreciated that any number of ports 38 can be provided. One or more of the ports 38 is preferably connected to a pressure gauge or other similar device (not shown) to monitor the pressure created within the space 37. As will be known to persons skilled in the art, a test of the weld 36 involves applying a constant high pressure to the interior of the pipe and monitoring such pressure over a period of time. Any drop in pressure signifies a leak in the weld.

[0061] In use, the system illustrated in Figure 4 first involves placing and securing the apparatuses 10a and 10b in the manner described above. The sealed space 37 is then filled with a pressurizing fluid and, as described above, the pressure is monitored.

[0062] Apart from the testing function provided by the system shown in Figure 4, a further feature will also be understood. Specifically, by creating a sealed pressurized space 37 between the apparatuses 10a and 10b, it will be seen that the pressure applied to the weld 36 also provided a separating force between the two apparatuses. However, since the apparatuses are secured, or clamped, to the interior of the pipe, such separating force also serves to apply an axial force against the weld 36. In this way, the system shown in Figure 4 applies both radial and axial forces against the weld 36 thereby more accurately simulating a "worst case" scenario for conducting the weld test. It will be understood that such simulated stresses will provide more accurate results for the test.

[0063] Figure 4b illustrates a variation of the assembly shown in Figure 4. In the case of Figure 4b, the apparatus 10a and 10b are essentially the same as that discussed above in that each includes at least one clamp 20a and 20b, respectively, which are provided within a pipe 12. Clamps 20a and 20b include magnets 28a and 28b arranged in the same manner as described above. The main difference between the assembly shown in Figure 4 and 4b lies in the sealing plates 14a and 14b. In the case of Figure 4b, the sealing plates 14a and 14b are general of an annular disc shape, wherein each includes a generally central opening. As will be appreciated by persons skilled in the art, this allows the plates 14a and 14b to be of much reduced weight thereby facilitating use of the assembly in large diameter pipes.

[0064] In addition, the sealing plates 14a and 14b of Figure 4b are joined together by a tube 15 extending between each plate. The tube 15 includes an inner diameter that is preferably larger than the diameters of the openings provided in plates 14a and 14b. Further, the outer diameter of the tube 15 is less than the inner diameter of the pipe 12. When the assembly of apparatuses 10a and 10b is installed within a pipe 12, a sealed annular space 35 is thus formed between the two seals 24a and 24b, the outer surface of the tube 15 and the inner surface of the pipe 12. The tube 15 is also preferably provided with one or more ports as discussed above. In Figure 4b, two ports, 38 and 38' are shown. The ports are used to fill and/or vent the annular space 35 in the same manner as described above. As can be seen, the volume of the space 35 is minimized due to the presence of the tube 15 and, therefore, the volume of fluid required to fill the space is minimized.

[0065] Figure 5 illustrates the use of a sealing apparatus in a manner similar to that shown in Figure 4. In the example illustrated in Figure 5, a weld 40 is used to secure a flange 42 to the end of a pipe 12. It will be understood that pipe 12 may be a pipe used for conveying as described above or may be the conduit portion of a nozzle provided on a vessel and the like. In this example, an apparatus 10c essentially the same as that shown in Figure 1 is used to seal the pipe 12 on one side of a weld 40 opposite to the flange 42. In Figure 5, the elements of apparatus 10c that are similar to the apparatus of Figure 1 are shown with the same reference numerals but with the letter “c” added for clarity. The method of positioning and sealing the apparatus 10c is the same as described above. In this example, the open end of the flange 42 is sealed with a plate 44. The plate 44 is formed with a series of circumferentially spaced bolt holes that correspond with bolt holes that are normally present on the face of the flange 42. Once the bolt holes of the plate 44 are aligned with those of the flange 42, bolts 45 are inserted there-through and secured with nuts 46. As shown in Figure 5, nuts may be provided on both ends of the bolts 45. It will be understood that the bolts 45 may have one end with an integral or welded bolt head thereby avoiding the need for nuts on both ends thereof. It will be understood that any needed seal such as a gasket and the like (not shown) may be provided at the junction of the faces of the flange 42 and plate 44.

[0066] The plate 44 is provided with at least one port 38c in a manner similar to that described above with reference to Figure 4. The ports 38c serve to fill the sealed space 37c between the flange 42 and the sealing apparatus 10c. As shown in Figure 5, the sealed space 37c includes the weld 40 that secures the flange 42 to the end of the pipe 12.

[0067] In using the system shown in Figure 5, the sealing apparatus 10c is first installed within the pipe 12 in the manner described above. The plate 44 is then installed at the outer face of the flange 42. The plate 44 is secured to the flange 42 so as to form a pressure tight seal there-between. As mentioned above, any needed gaskets etc. can be used for this purpose. Once the plate 44 and the apparatus 10c are secured and clamped, a pressurized fluid is injected through one or more of the ports 38c so as to pressurize the space 37c. As discussed above with respect to Figure 4, the apparatus shown in Figure 5 also serves to apply both a radial as well as axial stress on the weld 40.

[0068] Figure 6 illustrates a further embodiment wherein the apparatus 10 of Figure 1 is provided within a pipe 12. However, in this example, the exterior surface of the pipe is provided with a retaining collar 48 comprising a generally annular body having an inner and outer diameter. The inner diameter of the collar 48 is provided with a number of circumferentially spaced magnets 50 designed to abut the outer surface of the pipe 12. The magnets 50 of the collar 48 are arranged so as to overlap magnets 28 provided on the clamp 20 when the collar 48 is positioned in the same axial position as the clamp 20. The magnets 50 of the collar 48 may be provided with a different power source or the same as that powering magnets 28 of the clamp 20.

[0069] With the embodiment of Figure 6, it will be understood that the combination of the magnetic attraction forces of both sets of magnets 28 and 50 will serve to provide an enhanced clamping force for the apparatus. In other words, the collar 48 serves to reinforce the clamp 20. In a further embodiment, the polarity of the magnets 28 and 50 can be adjusted so as to form a magnetic attraction force there-between. In this manner, the combination of the clamp 20 and collar 50 can be used with non-ferrous pipes as well such as pipes made from aluminum or stainless steel etc. In such case, it will be understood that the magnets 28 and 50 will be provided with a pipe contact surface having a sufficient coefficient of friction to prevent the apparatus from sliding over the pipe 12. Similarly, even in the case of ferrous pipes, such a friction surface may be provided on the magnets 28 and/or 50.

[0070] It will be understood that the collar 48 may be used with any of the clamps discussed above.

[0071] Figure 7 illustrates a further embodiment for sealing an end of a pipe. As shown a pipe 12 having an open end 52 is provided with an end plate 54 adapted to close the open end. The end plate 54 is preferably provided with a circular race 56 for

provided with a friction enhancing surface to assist in preventing relative axial movement between the collar 68 and the pipe 12.

[0077] Once the clamping collar 68 is secured to the pipe 12 surface, the plate 54 is then mounted against the open end 52. The plate is mounted so that the end of the pipe 12 is received within the race 56. At this time, the bolts 64 are positioned and secured with bolts 66 and 74. As will be understood, tightening of the bolts results in the plate being forced against the open end 52 of the pipe 12 and, thereby, the end of the pipe being sealed.

[0078] Once the end of the pipe 12 is sealed with the plate 54, the interior of the pipe can then be pressurized to test, for example, any welds provided on the pipe.

[0079] In a further embodiment, as shown in Figure 8, the plate illustrated in Figure 7 can be provided with ports 39, which are similar to those shown as element numbers 38c in Figure 5. As will be understood, the apparatus shown in Figure 8 can be used to pressurize the interior of the pipe 12 so as to apply a radial and axial stress therein. In this manner, a weld on the pipe, downstream of the end 52 may be tested with the apparatus of Figure 8 without the need to localize the testing apparatus at the region of the weld. It will also be understood that the apparatus of Figure 8 can used in combination with, for example, the sealing apparatus 10 or 10c of Figures 1 or 5 so as to isolate a segment of a pipe for testing purposes.

[0080] A further embodiment of the apparatus of Figures 7 and 8 is illustrated in Figure 9 wherein like elements are indicated with like reference numerals. Elements that are similar but not identical are indicated with like reference numerals but with the letter “d” added for clarity. As can be seen, in the embodiment of Figure 9, the clamping collar 68d does not include any magnets for engaging the wall of the pipe 12. In the example of Figure 9, the clamping collar 68d is provided in two or more sections that are joined together by means of cooperating radially extending flanges 78. Each of the flanges 78 are provided with bolt holes 80 through which bolts (not shown) are passed. Nuts (not shown) cooperate with the bolts to join opposing flanges 78 together thereby securing the flanges together. The clamping collar 68d of Figure 9 is sized so that tightening of the flanges 78 to each other forms a strong frictional engagement with the outer surface of the pipe 12.

[0081] As discussed above with respect to other aspects, once the clamping collar, or clamp 68d is secured to the outer surface of the pipe, a sealing plate 54 may be secured to open end of the pipe 12. In the same manner as described above, the

sealing plate 54 is secured to the clamp 68d by means of an urging means. In the embodiment shown, such urging means is provided by a combination of nuts and bolts that join the clamp 68d to the sealing plate. Tightening of such nuts urges the sealing plate 54 towards the clamp 68d. In view of the frictional engagement of the clamp 68d to the outer surface of the pipe 12, it is prevented from movement with respect to the pipe 12. In particular, relative axial movement of the clamp 68d and the pipe 12 is prevented. In the result, the sealing plate 54 is pressed against the open end of the pipe 12 and, thereby seals such open end in the same manner as described above.

[0082] Figure 10 illustrates a further aspect wherein a clamp is provided on the outer surface of a pipe, adjacent an open end of thereof, and a sealing plate (or other similar means) is provided to seal the open end of the pipe. In the embodiment shown in Figure 10, the clamp 90 is similar in design to that shown in Figure 9. However, as illustrated, the clamp 90 is formed of a plurality of sections 92a, 92b, 92c etc., which are adapted to be joined together to form a circumferential collar (i.e. the clamp 90) around the surface of a pipe 12. In Figure 10, only sections 92a, 92b, 92c are shown. However, it will be understood that the clamp 90 shown in Figure 10 includes other sections that extend on the opposite side of the pipe shown therein. It will also be understood that the number of sections forming the clamp 90 will depend on the size (i.e. length) of each section and the outer diameter of the pipe. For example, for small diameter pipes, only two sections may be needed (as shown in Figure 9). However, for larger diameter pipes such as that shown in Figure 10, the clamp 90 may be provided in several sections.

[0083] The sections forming the clamp 90 are provided with a pair of radially extending, longitudinal “connecting” flanges, one at each end of the clamp section. The term “radially extending, longitudinal” refers to the orientation of the flanges when the clamp 90 is in use on a pipe. The term “connecting” refers to the use of such flanges in connecting adjacent clamp sections together. As shown and described further below, the connecting flanges extend radially outwardly away from the pipe 12. Further, these flanges extend in a direction parallel with the longitudinal axis of the pipe 12. As shown in Figure 10, clamp section 92b is shown with flanges 94b and 95b at the opposite ends thereof. Each of the connecting flanges extend in the same direction, perpendicularly to the body of the respective section. When the clamp 90 is assembled, as shown in Figure 10, the flanges extend radially outwardly, away from the pipe, and extend in a direction generally parallel to the longitudinal axis of the pipe 12. As shown, when the clamp 90 is in the assembled state over a pipe 12, the flanges of each adjacent section of the clamp 90 abut each other. For example, as

threaded portion and lengthening nuts associated with such threaded portions. Such means of lengthening a rod are known in the art. Similarly, any other means of lengthening the arms 112 may be used and the invention is not limited to any particular means for achieving such purpose. In certain cases, such as for example with large diameter pipes, the arms 112 of the reinforcement apparatus 110 may be provided with a support ring 120 to prevent or reduce movement of the arms 112 outside of the plane of the reinforcement apparatus 110. It will be understood that any number of arms 112 may be provided on the reinforcement apparatus 110.

[0087] As will be understood, in use, the reinforcement apparatus 110 would be positioned inside of the pipe 12 prior to placement of the sealing plate 104. Moreover, the reinforcement apparatus 110 would be positioned prior to establishing the clamping force of the clamp 90 on the pipe 12. In this way, as the clamp 90 is tightened over the outer wall of the pipe 12, the reinforcement apparatus 110 serves to prevent any inward deflection or deformation of the pipe 12.

[0088] In some cases, the inner surface of the clamp 90 (or 68d) may be provided with a gripping means such as teeth or ribs etc. However, in a preferred embodiment, the inner surface of the clamp (90, 68d etc.) is smooth as to prevent damage to the surface of the pipe 12.

[0089] Figure 11 illustrates another embodiment described in Figure 10. In Figure 11, the clamp 90 is shown as above, provided over a pipe 12 and proximal to an open end of the pipe to be sealed. However, as shown, a further circumferential clamp 122 is provided adjacent to the clamp 90. The clamp 122 is of the same general construction as clamp 90 described above. As illustrated, clamp 122 is positioned on the side of the clamp 90 opposite the opening of the pipe 12. As will be understood, the additional clamp 122 provides added clamping force. In order to establish a physical connection between the clamps, clamp 90 is provided with an additional radially extending circumferential flange 124 on a side opposite to the flange 100 described above. Clamp 122 includes at least one radially extending circumferential flange 126, on the side adjacent to the clamp 90. The flanges 124 and 126 are provided with a plurality of bolt holes that are aligned during installation so as to allow bolts 128 to extend there-through. Nuts 130 cooperate with the bolts 128 to securely connect the clamps 122 and 90 together. Preferably, bolt holes 128 are evenly spaced along the circumference of the flanges 124 and 126. As will be understood, connection of the clamps 122 and 90 serves to provide additional clamping

force since the clamping surface area is increased. In the above description, the clamps 122 and 90 and the respective flanges 124 and 126 have been described as singular elements. However, as described above, each is comprised of two or more clamp sections that are connected together to form such elements. As shown in Figure 11, the clamp 122 may be provided with a further radially extending circumferential flange 125 to which another clamp may be connected if necessary. It will be understood that any number of clamps can be combined in order to provide any desired level of clamping force.

[0090] As also shown in Figure 11, the sealing plate 130 comprises a bell-shaped element. The sealing plate 130 functions in the same manner as the sealing plate 104 described previously. However, the curved, or outwardly convex structure of the plate 130 allows, for example, a number of ports 132, 133, 134 to be provided over the surface thereof. The sealing plate 130 is secured to the clamp 90 using bolts 136 and associate nuts as described previously.

[0091] Figure 12 provides an isolated view of a clamp such as clamp 90 or 122 shown in Figures 10 and 11. As seen, the clamp of Figure 12 is comprised of six essentially identical sections 92. For convenience, when referring to the clamp sections collectively (or portions of such clamp sections), the element number 92 is used without the letter suffixes. Each section includes a curved inner surface 97 adapted to conform to the outer surface of a pipe (not shown) to which the clamp is to be secured. As described above, each section includes opposing radially extending, longitudinal connecting flanges 94 and 95, which, when the clamp is assembled, are placed in opposing arrangement as shown in Figure 12. Bolts 96 and associated nuts 98 serve to connect each section 92 together so as to form the clamp 90 for circumferentially fitting over the surface of a pipe. As described above, a space is preferably provided between at least some of the adjacent clamp sections 92 so as to allow sufficient clearance for the sections to be tightened towards each other, and thereby, tightened over the outer surface of the pipe. Such tightening serves to provide the necessary clamping force over the circumference of the pipe. Each of the sections 92 further includes a radially extending, circumferential sealing flange section 100 that is adapted to engage the sealing plate when the clamp is in use (as discussed above).

[0092] Figures 13 and 14 illustrate another embodiment. As shown the embodiment of Figures 13 and 14 functions in effectively the same manner as above. That is, in general, a pipe 12 is provided with a circumferential clamp 150 proximal to an open end of the pipe. The clamp 150 is tightened over the outer surface of the pipe 12 so as to secure

along the axis of the pipe 12, when the clamp 150 is in the assembled state there-over), wherein the bolt heads are proximal to the opening of the pipe 12. The terminal ends of the gripper bolts 178 are adapted to bear against the proximal ends of the gripper ring 174. Thus, in this arrangement, tightening of the bolts 178 forces the gripper ring 170 against the inner surface of the clamp 150 and, therefore, under the ramped surface 164 thereof or the shoe 166. In either case, the gripper ring 170, being of at least two sections, is deflected inwardly and forced against the outer surface of the pipe 12. With sufficient force applied by the tightening bolts, the gripper ring 170 is pressed tightly against the pipe surface to create a strong clamping force. This is continued until a sufficient clamping force is achieved wherein relative axial movement of between the clamp 150 and the pipe 12 is prevented.

[0098] In one aspect, the bolts 178 are received within cooperatively threaded openings 180. In other aspects, a nut and threaded rod arrangement can be used to achieve the same purpose. In other aspects, the bolts 178 may be replaced with hydraulic rams or magnetically driven rods etc. It will be appreciated that the invention is not limited to any specific means of advancing the gripper ring 170. The bolts 178, and correspondingly threaded openings 180, provide one such means. As shown in Figure 14, a plurality of bolts 178 are provided and are generally equally spaced circumferentially over the clamp. Such an arrangement is preferred since it serves to advance the gripper ring 170 equally over the circumference of the clamp 150.

[0099] The circumferential sealing flange 174 is also provided with a plurality of generally circumferentially spaced bolt holes 182. Similarly, the sealing plate 152 is also provided with corresponding bolt holes 184. When the apparatus is positioned on the pipe 12, the sealing plate 152 is oriented so as to align bolt holes 184 with bolt holes 182 provided on the flange 174. Once in this orientation, “sealing” bolts 186 are inserted through bolt holes 184 and 182 and nuts 188 are used to urge sealing plate 174 towards the clamp 150. As discussed in reference to other embodiments, the sealing plate 152 is preferably provided with a groove or race 190 having dimensions sufficient to receive the open end of the pipe 12 therein. In order to form a secure seal between the sealing plate 152 and the open end of the pipe 12, a sealing material 192 is preferably provided within the groove 190. The sealing material may be an O-ring, a gasket material or any other sealing material as described herein or as would be apparent to persons skilled in the art.

[00103] Figures 15 to 22 illustrate features of another embodiment. As shown in Figure 15, the apparatus includes a clamp 200 that is adapted to be secured to the outer wall of a pipe 12. The clamp includes a first, compression or squeeze ring 202 and a second, or clamping ring 204. The first and second rings 202 and 204 are preferably unitary structures that are generally annular in shape. The rings 202 and 204 have respective internal and external diameters, with the internal diameters of each being slightly larger than the outer diameter of the pipe 12 so as to allow the rings to be slidably provided over the pipe. The clamp 200 further includes a generally annular gripper ring 206, which also has an internal diameter and an external diameter. The internal diameter of the gripper ring 206 is reducible, as described further below. However, in its initial state, the internal diameter of the gripper ring 206 is greater than the external diameter of the pipe 12 so as to allow the ring 206 to be slidably provided thereover. Gripper ring 206 is preferably formed of two or more sections. As shown in Figure 20, the gripper ring 206 is formed, according to one embodiment, in two sections 206a and 206b. The purpose of such multiple sections for the gripper ring 206 will become apparent in the following description.

[00104] As shown in Figure 15, the clamp 200 is formed by first providing the compression ring 202 over the outer surface of the pipe 12. This is achieved by sliding the ring 202 over the pipe, adjacent an open end thereof. The gripper ring 206 is next positioned adjacent the compression ring 202. As mentioned above, the gripper ring 206 is preferably provided in two or more sections. Next the clamping ring 204 is positioned over the pipe as shown in Figure 15. The compression ring 202 and clamping ring 204 are each provided with a plurality of bolt holes, 208 and 210, respectively, as shown in Figures 16 and 18. In positioning the portions of the clamp 200 over the pipe, the bolt holes 208 and 210 of the compression ring 202 and clamping ring 204 are aligned. Once in this position, “clamping” bolts 212 are inserted into the aligned bolt holes and such bolts are tightened with nuts 214. As will be understood in reviewing Figure 15, as the nuts 214 are tightened, the clamping plate and compression plate are urged towards each other to produce the required clamping force to secure the clamp 200 over the outer diameter of the pipe 12.

[00105] The compression ring 202 is preferably provided with a beveled inner diameter. Thus, the internal diameter of the compression ring 202 is provided with a ramped surface 214 (as shown in Figures 15 and 17), such that a smaller inner diameter is provided distal to the open end of the pipe 12 and a larger inner diameter is provided proximal to such open end. The gripper ring 206 also comprises a generally annular shaped structure but having a

generally constant inner diameter, which faces the outer surface of the pipe 12 when the apparatus is in use. The outer diameter of the gripper ring 206 includes a ramped surface 216 (as shown in Figures 15, 21 and 22). This results in the gripper ring 206 having a larger outer diameter proximal to the opening of the pipe 12 and a smaller outer diameter distal to the pipe opening. The clamping ring 204 is generally annular in shape is does not necessarily include any beveled or ramped surfaces. However, the inner diameter of the clamping ring 204 is smaller than the outer diameter of the gripper ring 206. This arrangement of the compression ring, gripper ring and clamping ring is shown in Figure 15.

[00106] As shown, in assembling the apparatus over a pipe 12, the compression ring 202 is first slid over the pipe 12, followed by the gripper ring 206 and finally the clamping ring 204. It is noted that the thin, distal portion of the gripper ring 206 is adapted to be inserted between the proximal end of the compression ring 202 and the outer wall of the pipe 12. As the nuts 214 are tightened and the compression ring 202 is advanced against the clamping ring 204, the gripper ring 206 is therefore urged against the outer wall of the pipe 12. The proximal end of the gripper ring 206 is biased against the clamping ring 204 and, therefore, prevented from axial movement with respect to the clamping ring. As explained above, the gripper ring 206 is preferably provided in two or more sections, as illustrated in Figure 20. Where the gripper ring 206 is provided in two sections, as shown in Figure 20, each of such sections 206a and 206b have a generally arc shaped structure. The ends of each section, 206a and 206b, are preferably separated by space 207. The spaces 207 allow the sections of the gripper ring 206 to be moved radially inwardly towards each other, thereby resulting in a reduction of the inner diameter of the gripper ring 206. Thus, as the gripper ring 206 is urged towards the wall of the pipe 12, the sections forming the gripper ring 206 are urged together, thereby reducing the inner diameter of the annular gripper ring 206 and radially compressing the gripper ring 206 over the outer wall of the pipe 12 to form a tight, clamping engagement therewith. Thus, tightening of the nuts 214 results in the clamp 200 being secured to the pipe wall so as to prevent relative axial movement there-between.

[00107] Returning to Figure 15, the apparatus is also provided with a sealing plate 220, which functions generally in the same manner as described previously with respect to other embodiments. In the embodiment of Figure 15, the sealing plate 220 includes a flange portion 222 having an outer diameter greater than that of the pipe 12 and an inner diameter less than that of the pipe 12. The flange portion 222 is provided with a groove or race 224 that is adapted to receive the open end of the pipe 12. The groove 224 includes a sealing member or membrane 226 that is capable of forming a seal between the

groove 224 and the open end of the pipe 12. The flange portion 222 includes a plurality of bolt holes 228 for receiving “sealing” bolts 230. The sealing bolts 230 are adapted to extend to the clamp 200 and be connected thereto. Nuts 232 are also provided, which cooperate with the sealing bolts 230 to advance the sealing plate 220 towards the clamp 200. In the result, the sealing plate is forced against the open end of the pipe 12 and the opening of the pipe is sealed within the groove 224. Such sealing action is similar to that described above with respect to other embodiments. In one embodiment, the bolts 230 may be secured to the clamping ring 204 of the clamp. In another embodiment, as illustrated in Figure 15, the sealing bolts 230 and clamping bolts 212 may comprise the same entity. Thus, the single bolt serves to join the clamping and compression rings together as well as to urge the sealing plate 220 towards the clamp 200. In such case, the bolts 217 are elongated and capable of extending through the bolt holes 228 in the flange portion 222 of the sealing plate 220. Thus, the two sets of nuts 214 and 232 would engage the same bolt but would serve to provide, respectively, the required clamping force and sealing force. It will be understood that the use of a single set of bolts may be advantageous in terms of reducing the number of elements of the apparatus. However, the apparatus will be understood to function equally with separate sealing and clamping bolts. In such case, two sets of circumferentially spaced bolt holes will be provided on the clamping plate 204. One set will be used to receive the clamping bolts 212 and the other set will be used to receive the sealing bolts 230.

[00108] The sealing plate 220 also includes a body portion 234 that is preferably integral with the flange portion 222. The body portion 234 of the sealing plate 220 may comprise a generally flat, plate-like structure as described previously. However, in the embodiment shown in Figure 15, the body portion 234 has a convex shape, protruding beyond the opening of the pipe 12. The body portion 234 may then be provided with a number of ports 236, to which may be connected pressurizing means (such as a hose to supply a pressurizing fluid to the interior portion of the pipe 12), evacuation means (such as a hose to drain the pressurized fluid from the pipe 12), pressure gauges, temperature gauges, relief valves etc. Various other devices for connection to the ports 236 will be apparent to persons skilled in the art.

[00109] Figure 23 illustrates a variation of the apparatus shown in Figure 15, and illustrates another embodiment of the clamp, shown generally at 250. In Figure 23, the sealing plate 220 is essentially the same as that discussed previously. Further, the clamping ring 204 of the clamp 250 is also as described above. However, as shown, the clamp 250 of

Figure 23 is provided with a plurality of compression rings 202 and gripper rings 206. As will be understood, by providing a plurality of compression and gripper rings, 202 and 206, the amount of clamping force offered by the clamp 250 is increased. In the result, the clamp of Figure 23 is able to withstand higher pipe pressures than the clamp of Figure 15. The number of additional compression rings and clamping rings will vary based on the desired clamping force required and it will be understood that any number of such rings may be provided for any given clamp.

[00110] In order to ensure that each compression ring 202 acts upon a respective gripper ring 206, each of the compression rings 202 are separated by a separation ring 252. As will be understood, the separation rings 252 serve to prevent binding between each of the compression rings and to ensure that each of such compression rings act upon respective gripper rings 206. The separation rings 252 may comprise, for example, O-rings.

[00111] It will be understood that in situations where a given length of a pipe is to be tested, both ends of the pipe can be sealed using any of the sealing apparatus described above. In such case, the ends of the pipe will each be provided with the same or different ones of the apparatus. Each end of the pipe would thus be sealed and the interior of the pipe may then be pressurized for conducting an integrity test.

[00112] As described above, in some of the embodiments, the clamp includes a gripper plate (formed of two or more sections) that is provided with a ramped surface adapted to engage an oppositely ramped surface on another portion of the clamp. In some cases, such oppositely ramped surface is provided on the clamp body or on a compression or “squeeze” ring as described above. It will be noted in the described embodiments that the gripper plate is positioned so that the thinner portion of the gripper plate is oriented away from the pipe opening. As seen, for example in Figures 13 and 15, and as will be understood by persons skilled in the art, such an orientation would be preferred. Specifically, once the clamp is tightened against the exterior surface of the pipe, the clamp would be securely engaged and the sealing plate is then attached thereto so as to seal the open end of the pipe. Subsequently, when the interior of the pipe is pressurized (such as in cases where a pressure test is conducted on the pipe), it will be understood that such pressure will act to force the sealing plate of the apparatus away from the pipe opening in the axial direction. However, since the sealing plate is secured to the clamp by means of the sealing bolts (i.e. the bolts connecting the sealing plate to the clamp), the axial movement of the sealing plate would also exert an axial force on the clamp. In the result,

the clamp body or compression ring would be forced to travel over the gripper ring due to the opposed ramped surfaces. As will be understood, such movement would cause the gripper ring to be further compressed against the external surface of the pipe and, thereby, result in strengthening the gripping force between the gripper ring and the exterior of the pipe. Thus, even in the situation where a high pressure applies an axial force on the clamp, a corresponding increase in clamping force results. The above mentioned orientation of the gripper ring and the other clamp components comprises a preferred arrangement of the apparatus, so as to allow increased clamping force upon application of an axial force (such as due to pressurization of the pipe). However, it will be understood that the orientation of the gripper ring and the clamp body or the compression ring may be reversed while still providing an adequate clamping force on the pipe. For example, such reversed orientation may be used in cases where the pipe is not pressurized or where the required pressurization is minimal.

[00113] In the above description, reference is made to the use of bolts for securing sections of the clamp together and for securing the sealing plate to the clamp. Such bolts are described as extending through bolt holes provided in respective flanges. However, although such arrangement is preferred, it will be appreciated that other means may be used to achieve the desired purpose. For example, the respective flange may be urged together using compression clamps etc. Magnetic means may also be used to urge the respective elements towards each other. In addition, the above description has referred to the use of threaded bolts having nuts provided on each end thereof. However, in another embodiment, the bolts may include heads, whereby only a single nut is required to achieve the required tightening. For this reason, the aforementioned bolts and equivalent elements that serve a connection function (i.e. connecting two or more other elements together) may be referred to generally as “connecting elements”.

[00114] As illustrated in Figures 7 to 23 and as described above, the circumferential clamp that is secured to the external surface of a pipe is preferably positioned distally of the open end of the pipe by at least a short distance. As will be understood, such positioning provides a degree of separation between the clamp and the sealing plate, thereby allowing the sealing plate to be sufficiently sealed against the end of the pipe without being hindered by the clamp itself. Furthermore, it will be understood that placing a circumferential clamp close to an end of the pipe, and subjecting the pipe to a strong radially compressive force may damage the end of the pipe and prevent it from being connectable to other pipes or to other apparatus (such as vessels, flanges etc.). It will be understood that the above

described internal reinforcement (such as shown at 110 in Figure 10) may be used in combination with any of the external clamps described herein. In addition, having the ability to axially position the clamp at any location along the length of the pipe allows for a desired amount of clearance in the event that a weld is located near the open end of the pipe.

[00115] It will be understood that the external clamp and sealing plate can also be used on pipes that include a bend. For example, in a pipe comprising an elbow, the clamp may be positioned on one side of the bend with the sealing plate covering the pipe opening on an opposite side of the bend. In such case, the connecting elements between the clamp and the sealing plate may be adapted or oriented to provide the same sealing force as described above. For example, the clamp may be provided with an extension for cooperating with the connecting elements to engage the sealing plate. Various other such modifications are also possible.

[00116] It will be understood by persons skilled in the art that any number of, and types of embodiments of, the clamp can be used in combination. Such combined use would depend upon the specific use being contemplated and the specific combination will be apparent to persons skilled in the art. For example, the embodiment of Figure 11 may be combined with the embodiment of Figure 23 etc. In this example, the embodiment of Figure 23 can form a downstream “anchor” while the embodiment of Figure 11 is used upstream.

[00117] As discussed above, the apparatus is preferably used for sealing an end of a pipe so that the interior of the pipe can be pressurized such as for testing the integrity of the pipe. In one example, the integrity test is used for testing a weld that may be present on the pipe. Such a weld may serve to connect two pipe segments or to connect the pipe to another apparatus.

[00118] It will be understood that the above discussion has used geometric terms such as annular, disc, circumference, etc., for ease of reference. However, these terms should not be construed as limiting the invention to any specific shape of nozzle or pipe and various modifications of the apparatus will be apparent to persons skilled in the art to adapt same to any shape or design.

[00119] A further embodiment is illustrated in Figures 24 to 35. This embodiment, comprises a combined internal and external clamp shown generally at 500. As shown in Figure 24, the combination clamp 500 includes an external

the internal compression ring 402 is provided with a ramped surface 414, as shown in Figures 24 and 30. The ramped surface 414 serves to provide the internal compression ring 402 with a slightly smaller outer diameter on the side facing the opening of the pipe 12.

[00125] The internal clamp 400 also includes an internal gripper ring 406 that is also provided preferably in two or more sections, such as sections 406a and 406b shown in Figures 33 and 34. The actual number of sections will depend on the diameter of the ring 406. The internal gripper ring 416 comprises a generally flat outer diameter surface, while the inner diameter is provided with a ramped surface 416, that is designed to cooperate with the ramped surface 414 of the internal compression ring 402. As shown in Figure 24, the ramped surfaces 414 and 416 are oppositely oriented, whereby the ramped surface 416 of the internal gripper ring 406 is adapted to slide over the ramped surface 414 of the internal compression ring 402, upon urging of the clamp sections together, thereby causing the internal gripper ring 406 to bear against the inner surface of the pipe 12.

[00126] The inner compression ring 402 is provided with a plurality of boltholes 408 as shown in Figure 39. A similar set of boltholes 409 is provided on clamping plate 304, as shown in Figure 26. A plurality of bolts 412 are provided through the boltholes 408 and 409 and, in one embodiment, extend into cooperatively threaded openings 411 provided on the backplate 401. Thus, when the internal clamp is in use, the backplate 401 is first inserted into the pipe 12 followed by the sealing member 403, the internal compression ring 402 and then the internal gripper ring 406. The bolts 412 are then inserted through the boltholes 408 and 409 and the ends of such bolts 412 are threaded into the openings 411. Once the bolts 412 are tightened into the openings 411, nuts 414 are provided on the bolts 412, which are tightened to pull together the various elements of the internal clamp 400. Thus, as will be understood, as the internal clamp 400 is tightened, the resilient member 403 is pressed between the backplate 401 and internal compression ring 402, whereby the resilient member is urged against the inner surface of the pipe 12, thereby forming a seal therewith. To facilitate the formation of the seal, one or both of the backplate 401 or internal compression ring 402 may be provided with a beveled edge for directing the sealing member 403 radially outwardly to form the seal with the inner surface of the pipe 12.

[00127] In the above description, the backplate 401 is described as having threaded openings 411 for receiving the bolts 412. However, it will be understood that variations of this connecting means may be employed in the invention without affecting its method of operation. For example, the bolts 412 may be fixedly attached to the backplate 401.

We Claim:

1. A method for closing and sealing an open end of a pipe in preparation for fluid pressure testing of the pipe comprising:

positioning an external clamp over an outer surface of the pipe, said clamp having cooperating, contacting, oppositely oriented ramped surfaces;

positioning an internal clamp within an inner surface of the pipe, said clamp comprising a backplate at its rear end, cooperating, contacting, oppositely oriented ramped surfaces and an annular, deformable, resilient sealing member between the backplate and the front portion of the internal clamp;

so that the clamps are aligned in opposed relation on the pipe end;

positioning a clamping plate against the open end of the pipe;

connecting the external clamp with the clamping plate with clamping bolts and cooperating nuts to urge said clamp toward said plate so that the ramped surfaces of said clamp cooperate to cause the clamp to compress against the open end of the pipe;

connecting the backplate with the clamping plate with clamping bolts and cooperating nuts to urge said backplate toward the clamping plate so as to compress and deform the resilient sealing member into sealing engagement with the inner surface of the pipe and simultaneously actuate the ramped surfaces of the internal clamp to cooperate and cause said internal clamp to compress against the inner surface of the pipe;

whereby the backplate, clamping plate and resilient sealing member combine to close and seal the open end of the pipe and the internal and external clamps clamp onto the pipe.