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ADJUSTABLE REPAIR CLAMP FOR BELL AND SPIGOT JOINTS

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4 Sheets-Sheet 4
My invention consists in the novel features hereinafter described, reference being had to the accompanying drawings which show several embodiments of the invention so outlined by me for purposes of illustration, and said invention is fully disclosed in the following description and claims.

My invention is a novel repair clamp or leak clamp for bell and spigot joints in pipe lines, and adjustable radially to accommodate variations in the external diameters of the pipes with which they are to be used. These clamps are used in large numbers for the repair of bell and spigot pipe lines laid many years ago when little or no attempt had been made to standardize the diameters of such pipes, and when very wide variations or tolerances were permitted. Even with modern bell and spigot pipe which is held to fairly close tolerances, it is made in different classes, frequently involving different thicknesses of pipe wall for the same standard internal diameter, and, especially in the larger sizes, the range of variation of the outside diameters of the various classes of pipe of the same nominal diameter, is very great. Thus, for example; in the normal sixteen inch size, it is found desirable to provide clamping rings suitable to pipes ranging from 17.20 inches to 18 inches in outside diameter, or to meet actual conditions.

These repair clamps usually comprise a clamp ring, provided with an annular packing recess, a packing for said recess having a cylindrical inner face to engage the spigot, and an annular face to engage the face of the bell and the solid packing of lead or cement therein, a bull ring to surround the bell and form an anchor for the bolts, and a plurality of through bolts and nuts for connecting the clamp ring and bull ring, and forcing the packing into tight engagement with the bell and spigot. For efficient results, it is necessary that the inner edge of the clamping ring should come as close as possible to the exterior of the spigot to prevent cold flowing of the packing, usually rubber or rubber composition, therebetween. Furthermore, as the circumference of the clamping bolts must clear the exterior of the bell, the strain of the bolts is applied at a considerable radial distance from the circle of resistance, i. e., the packing, resulting in a tendency of the clamping ring to "roll" or flex in a direction to turn inside out, which prevents the full application of the bolt strain or load upon the packing.

According to my invention I form the clamping ring of a comparatively large number of independently movable segments of comparatively short length, each receiving usually a single bolt connected therewith at a point removed outwardly from the packing recess (although in most cases it may receive two or more), these segments being held in circular arrangement around the pipe by non-elastic confining or tension element, engaging portions of the segment at a distance from the face of the ring containing the packing recess, and positively preventing outward radial movement of the segments at such points in a direction substantially perpendicular to the bolts. The recessed portions of the segments, however, can move radially inwardly under the strain of the bolts to bring them into the desired close relation with the spigot, and accommodate a very wide range in the variation thereof, while the resultant of the bolt strain on the ring segments will be applied in an inclined direction, toward the packing ring, and will be greater than either the force exerted directly by the bolts, or the resistance directly sustained by the tension means. In effect, each segment becomes a lever having a radial turning movement on a point adjacent to its engagement with the tension element to render the diameter of the ring adjustable and to apply the bolt strain to the packing in the most efficient manner. The tension element may consist of bands extending around the entire series of segments, or of links connecting the segments, or of a sectional ring connected with the segments, and may be separable from or permanently connected with all or some of the clamping ring segments. Where it is connected with all of the segments, provision is made for separating portions of the tension element at one or more points to facilitate placing the ring sections around the pipe. The tension element may also in some instances be adjustable as to length, if desired.

The large number of ring sections causes them to more perfectly fit the contour of the pipe, which results in dividing up the variation in pipe diameter, accommodated by the ring, so that the separation or gap between the ends of adjacent segments will ordinarily be small. If desired, these points of separation may be bridged over, is of sufficient width to necessitate it, in order to prevent cold flowing of the packing therethrough. This may be accomplished by means of bridge plates which may be entirely separate from clamping ring, or secured thereto.

The joint between the clamping ring sections and the tension member is more or less non-rigid and facilitates change in the direction of the resultant of force, when the bolts are tightened, to apply such resultant force most effectively to
the gasket and the location of these joints in a plane removed from the plane of the packing recess and gasket longitudinally with respect to the axis of the ring increases the length of the turning movement of each section.

The specific construction of the clamping ring segments with special reference to the engagement therewith of the tension element, and also with respect to the form of the packing recess, together with the cross section of the packing, may be varied in many ways, a number of which are shown in the various embodiments of the invention hereinafter described.

The bull ring is also made adjustable to accommodate the wide variations in the bells, and to this end I prefer to form it in sections with overlapping portions having a plurality of opposed toothed surfaces, held together by the through bolts, or by separate short or "section" bolts, and providing an adjustment equal to one or more teeth at each joint between the sections of the bull ring which provides a wide range of adjustment.

My invention also comprises certain novel features of construction and combination of parts hereinafter fully described and particularly pointed out in the claims.

Referring to the accompanying drawings, which show several embodiments of my invention, selected by me for purposes of illustration,

Fig. 1 is a sectional view of an adjustable repair clamp embodying my invention, applied to a bell and spigot joint, the parts of which are shown partly in section and partly in elevation.

Fig. 2 is an elevation of a portion of the clamp illustrated in Fig. 1, broken away and showing three complete clamping ring segments.

Fig. 3 is a detail sectional view of the connector for the ends of the tension member shown in Fig. 1.

Fig. 4 is a detail section on line 4—4 of Fig. 3.

Fig. 5 is an elevation of a portion of the bull ring shown in Fig. 1, broken away.

Fig. 6 is a detail section on line 6—6 of Fig. 5.

Fig. 7 is a detail section of clamping ring segments showing a slight modification.

Fig. 8 is a similar view showing another slight modification.

Fig. 9 is a detail perspective view of one form of bridge piece, detached.

Fig. 10 is a detail perspective view of a portion of the packing showing a bridge piece molded therein.

Fig. 11 is a detail sectional view of a clamping ring segment and packing and adjacent portions of the bell and spigot joint, and illustrating a modified form of packing recess and packing.

Fig. 12 is a view similar to Fig. 11, showing another modification.

Fig. 13 is a view similar to Fig. 11, showing still another modification.

Fig. 14 is a view similar to Fig. 11, showing still another modification.

Fig. 15 is a view similar to Fig. 2, showing a clamp having a modified form of clamping ring segments and tension element.

Fig. 16 is a sectional view of the clamp shown in Fig. 15 on line 16—16 thereof.

Fig. 17 is a detail view of one of the links shown in Figs. 15 and 16.

Fig. 18 is a view similar to Fig. 2, showing a clamp comprising a further modified form of clamping ring segments, and tension element and bridge piece.

Fig. 19 is a section on line 19—19 of Fig. 18.

Fig. 20 is a detail view of one of the clamping ring segments shown in Figs. 18 and 19.

Fig. 21 is a detail section through the meeting ends of two sections of the tension element shown in Figs. 18 and 19, on line 21—21 of Fig. 18.

Fig. 22 is a detail view illustrating a slight modification in the construction of the tension element shown in Figs. 18, 19 and 20.

Fig. 23 is a detail perspective view of a modified form of bridge piece.

Fig. 24 is a view similar to Fig. 2, showing another modified form of clamp, in which a portion of the tension member comprises separate links and other portions thereof comprise portions of the clamping ring segments.

Fig. 25 is a view similar to Fig. 2, showing another modified form of clamp.

Fig. 26 is a section on line 26—26 of Fig. 25.

Fig. 27 is a section similar to Fig. 26, showing another modified form of clamping ring.

Fig. 28 is a horizontal section on line 26—28 of Fig. 27.

Referring to the embodiment of my invention illustrated in Figs. 1 to 6 inclusive, I have shown in Fig. 1, a bell and spigot joint having the repair clamp applied thereto, 1, representing the spigot end of a bell and spigot pipe section, 2, the bell, 3—4 any usual or preferred packing interposed between the spigot and bell when the pipe line is laid, and comprising the usual fibrous material, 3, and solid material, as lead or cement, 4. C represents the adjustable clamping ring as a whole, which is composed of a plurality of short independently movable segments connected only by a tension member, three of such segments being illustrated in Fig. 2, adapted to substantially encircle the spigot member, 1, and to provide a substantially continuous packing recess, to engage a circular packing ring, 5, preferably formed of rubber or rubber composition. Each segment of the ring, C, is provided with a plate member, 6, inclined outwardly from a plane perpendicular to the axis of the ring, and provided adjacent to its inner edge with a recess, 7, forming part of the packing recess of the ring and formed in this instance by a wall, 8, substantially perpendicular to the axis of the ring, and an inclined wall, 9, extending outwardly therefrom and toward the face of the ring. Each segment of the ring may be provided with bolt connecting means located at a distance outwardly from the packing engaging portion, usually in the form of one or more bolt receiving holes, and in this instance I have shown the plate member, 6, provided centrally of the length of the segment with an outwardly extending portion, 10, having a bolt hole, 11, therein, increasing slightly in diameter from the inner face of the plate member, reinforced by a circular web, 12, in the usual manner. The segment is also provided with a curved reinforcing flange, 13, approximately parallel with the axis of the ring and extending rearwardly from the rear face of the perpendicular wall, 6, for a considerable distance. The segment is also provided preferably midway of its length, and in line with the bolt hole, with a radially disposed web, 14, which is conveniently formed integral with the reinforcing flanges, 13 and 12, and is of course an integral part of the plate member. This web, 14, forms in effect a lever arm project- ing centrally from the rear face of the segment in a direction almost at right angles with the plate member, 6, and the outer end of this web, 14, of each segment engages at a point located at a distance longitudinally with respect to the axis.
of the ring from the packing recess a non-elastic tension member, 15, which extends entirely around the ring and holds the outer ends of the web, 14, of all of the segments in the clamping tension member, and forms the only means for connecting the segments when in operative assembled relation. In Figs. 1 to 6, the tension member is shown in the form of a metal band, and preferably composed of two thicknesses of metal, 18, 19', as shown in the drawings, for convenience of the two thin bands will be more flexible than a single thick band, and this is advantageous in placing the ring around the spigot member of the pipe coupling. These bands may be made of rustless steel or other suitable metal not subject to oxidation or corrosion. The tension member is preferably given a polygonal rather than a circular form, especially when it is in the form of a band, and it may, if desired, and preferably, is permanently secured to each of the segments, so as to hold them in assembled relation, provision being made for opening the ring at one or more points temporarily to permit it to be placed around the pipe. In this instance the bands are shown as welded to the ribs, 14, of the several segments, as indicated at 16. For the purpose of detachably connecting the end portions of the bands, and loading the bands, 15, 15', have their end portions bent in opposite directions, as indicated at 17, 17', and engage a clip, 18, compressing oppositely disposed clamping portions, 19, 19', forming a central chamber or recess, 20, to accommodate the bent end portions of the bands, and end recesses, 21, for embracing the bands adjacent to their bent portions, the said clamping members, 19, being united by a short bolt, 22, and nut, 23, as best illustrated in Figs. 3 and 4. By loosening or removing the clip, 18, just described, the ring segments and the tension member can be opened up far enough to permit the clamping ring to be placed around pipe section, 1, when the ends of the band are again united by the clip. The packing ring, 5, is usually molded as a ring and is severed at one point, usually by a diagonal cut, so that it can be placed around the pipe within the packing recess of the clamping ring, and the meeting ends lapped. Variations in the size of the pipe will require, in most instances, the cutting off of a larger or smaller portion from one end of the severed packing ring in order that the ends may meet perfectly around the particular pipe. The packing ring and clamping ring are then rolled along the pipe into engagement with the face of the bell, in the manner shown in Fig. 1, and coupling bolts, 24 are passed through bolt holes in a bull ring, indicated at B in Fig. 1, and hereinafter described, and the tension member, 15, 15', having been assembled, is clamped by the proper operation of the clamp in compressing the rubber ring, 5, to effect a gas tight joint, but where the ring is used with a pipe of such external diameter that these spaces are of very small extent, as an eighth of an inch or less, for example, these spaces do not in any way interfere with the proper operation of the clamp. In some instances these 155

It will be noted by reference to Fig. 1, that as the bolts are tightened, the plate member, 6, of each segment will be drawn in a direction toward the bull ring, and also caused to swing inwardly in the direction of the pipe, 1, since the outer ends of the lever like webs, 14, are prevented from outward movement by the tension member, 15, 15'. In other words, by reason of the assembled, the plate member, 6, of each segment and the outwardly extending lever portion or web, 14, held rigidly against outward movement by the tension member, each segment has a theoretical axis adjacent to the tension member, and which may be indicated for purposes of description by the point, X, in Fig. 1, the flexing of the retaining member in this instance permitting this turning movement. This construction, the outward movement of the segment in position to overlap the adjacent segment, either by spot welding or riveting, or otherwise, if this seems to be desirable, and as is perfectly obvious. In some instances these 155

It will also be noted by reference to Fig. 1, that the load or strain of the bolts, 24, is exerted in a direction parallel to the axis of the ring and substantially perpendicular to the direction in which the strain of the tension member is exerted to resist the outward movement of the engaged portions of the segment, to wit, the ribs, 14, from which it follows that a resultant force greater than either is exerted by the walls of the packing recess of the ring upon the packing ring in any inclined direction, indicated by the dotted line, Y, in Fig. 1, and tending to force the packing directly into the angle formed by the outer face of the pipe member, 1, and the perpendicular face of the bull, 24, and solid packing, 4. The increase in diameter in the bolt holes, 11, will accommodate the slight changes in position between the plate member of each segment and the connected bolt, 24, as the bolts are tightened. It will also be noted that each bolt exerts its strain or stress independently upon one only of the segments and therefore each segment is free to move inwardly independently of the others, thus enabling the ring to fit itself and the packing ring around the pipe and accommodate any differences in the radii of different portions of the exterior surface engaged by the packing. In some instances these 155

It will be understood that the segments are made of such length that the desired range of adjustment may be obtained without at any time bringing the ends of the adjacent segments into direct contact. There will, therefore, always be a gap or space between the adjacent ends of adjacent segments and these spaces will be greater when the ring is applied to a pipe having a larger exterior diameter than they will be when the ring is applied to a pipe of smaller exterior diameter within the range for which the ring is intended. When the ring is applied to a pipe of such external diameter that these spaces are of very small extent, as an eighth of an inch or less, for example, these spaces do not in any way interfere with the proper operation of the clamp in compressing the rubber ring, 5, to effect a gas tight joint, but where the ring is used with a pipe of such external diameter that the gaps or spaces between the segments might otherwise permit a certain amount of cold flowing of the rubber packing, I provide bridging means for engaging the inner faces of the segments within the packing recess to bridge over these gaps. These bridge pieces are preferably 155

in the form of short pieces of sheet metal, one of which is indicated in detail in Fig. 9, the bridge piece being illustrated as a whole at 26, and shown provided with angularly disposed flanges, 27—28, preferably shaped to conform to the contiguous faces of the packing recess and rubber ring. While it is not necessary, the adjacent faces of the segments may be recessed adjacent to each end to accommodate the thickness of the bridge piece and each bridge piece may be secured at one end to one of the segments in position to overlap the adjacent segment, either by spot welding or riveting, or otherwise, if this seems to be desirable, and as is perfectly obvious. In some instances these 155
bridge pieces may be attached to the rubber packing, 5, at the desired intervals around the same, and for example, may be molded therewith, as indicated in Fig. 10, in which case it would be necessary, in placing the rubber ring in position, to see that the bridge pieces were in proper register. To effect gaps between the segments of the ring, which could be readily determined by placing any one of the bridge pieces with its longitudinal center in line with the center of one of the gaps or spaces.

By constructing the clamping ring in the manner previously described, it may be made to operate conform to pipe sections having a wide range of divergence in their external diameters, even as great as three quarters of an inch or more in the larger sizes. These repair clamps are used for the repair of leaky bell and spigot joints occurring in pipe lines which may frequently have been laid many years ago, and where the actual outside diameter of the pipe and bell is frequently unknown until the leaking joint is uncovered, a repair clamp will adapt itself to all ordinary or possible variations in the outside diameter of the pipes for any nominal size and facilitates the repair, and at the same time saves the expense of making the rings in split sizes, avoids delay in keeping the excavation open, which is frequently in the midst of a busy street, and prevents the waste of a valuable product as gas or oil, and possibly injury to adjoining property.

In connection with the adjustable clamping ring having such a wide range of adjustment, it is desirable, and in many cases necessary that the bull ring shall also be adjustable in order to accommodate variations in the size of the bell, although the bull ring does not have to fit the bell as accurately as the clamping ring does. It is extremely important that the inner edge of the flange, 8, of each clamping ring segment shall come as close as possible to the outer face of the spigot portion of the pipe section without touching it in order to prevent cold flowing of the rubber or pinching of the rubber at this point. This of course is not involved in connection with the bull ring. I have, however, shown in Fig. 1, and in detail in Figs. 5 and 6, a bull ring which is likewise adjustable to meet the conditions previously described. The bull ring, B, is also composed of a plurality of segments as shown best in Figs. 5 and 6, although it is not necessary that there be the same number of segments in the bull ring that there are in the clamping ring. As shown in Figs. 5 and 6, the bull ring is composed of a number of segments, 30, each of which is provided with its inner edge with inwardly projecting lugs or flanges, 31, to engage the exterior of the bull, as shown in Fig. 1. The bull ring segments are preferably formed of cast metal and provided with reinforcing flanges, indicated at 32, for securing the desired strength without undue weight. Each segment is provided also with the requisite number of bolt holes to substantially register with the bolt holes in the clamping ring with which the bull ring is to be used, and each segment is provided with end portions, 33-34, which are less in thickness than the other portions of the ring and which overlap the end portions of adjacent segments. In this instance I have shown each segment, 30, provided with a central bolt hole, 35, to receive one of the bolts, 24, and with bolt holes, 36 and 37, in the overlapping portions, 33-34, respectively.

One of these end bolt holes is formed as a slot, in this instance indicated at 36, to accommodate variations in the diameter of the ring. In order to firmly lock the overlapping end portions of the bull ring segments together when in operative position, and at the same time provide for the adjustment of the diameter of the ring, the adjacent faces of said overlapping portions, 33-34, of adjacent segments are serrated, preferably by providing them with interengaging teeth, indicated at 38 in Fig. 6. Any desired number of these teeth may be provided according to the desired range of adjustment. It will be understood that this construction provides for the enlargement of the ring, one tooth of each of the joints between the bull ring segments, and assuming that the ring comprises four segments, and that each segment may be adjusted to the extent of two or more teeth, it will be seen that a very wide range of adjustment is provided, the width of a single tooth at one of such joints only of the ring to the maximum number of teeth permitted at all of the joints. In the form of bull ring illustrated in Figs. 1, 5 and 6, the serrated or toothed overlapping ends of the bull ring segments are drawn into rigid engagement with each other by the through bolts, 24, which in this instance pass through the bolt holes, 36, 37, of the engaged parts, as clearly shown in Figs. 5 and 6. It is obvious, however, that it is not necessary that the through bolts should pass through the overlapping portions of the segments, and that in such case they can be held together in a known manner by the use of short bolts generally termed section bolts, and nuts, in a manner similar to that illustrated in Fig. 21, in which the overlapping portions of a different ring are so connected.

In Fig. 7 I have illustrated a slight modification of the clamping ring segment shown in Figs. 1 and 2, in which the portion of the segment 315 which engages the tension member, here designated as a whole at 154, is recessed to receive the tension member. In this figure the radial lever web, 142, is provided with a recess, 39, to receive the tension member, which is secured therein by 123 welding, indicated at 162. The construction is otherwise exactly as hereinbefore described.

In Fig. 8 I have illustrated a slightly different means for connecting the segments of the clamping ring with the tension member. In this instance the segment, which is formed of malleable cast iron, has its radial lever web, indicated at 14b, provided with an open slot, ingeniously adapted at 40, to receive the tension member, which in this instance is a single band, indicated at 139 15b, and the web, 14b, is provided with a suitable projection, 41, which may be bent downward over the outer edge of the bend to confine it in engagement with the slot, 40.

The constructions illustrated in Figs. 7 and 8 123 are merely illustrative of different ways in which the segments may be permanently united with the tension member.

It will be understood that in forming a clamping ring comprising segments and tension member, in accordance with my invention, the form of the packing engaging recess of the segments and the section of the annular rubber packing may be very widely varied. Thus, in Figs. 11, 12, 13 and 14, I have illustrated the same construction, of ring segments previously described, with variations in the packing engaging portions and the cross section of the packing ring co-operating therewith. As the segments are otherwise constructed exactly as previously described, the parts, 150
exclusive of the packing engaging portions are given the same reference numerals as in Figs. 1 and
5 before it is drawn up by the bolts, the packing recess is formed by the flanges, 8c and 9c, which differ slightly in relative width from those shown in Fig. 1, for example, the outer face of the packing ring, 9c, being of greater width than the face, 8c, of the recess and the inclined face of the rubber packing, which engages the angular face, 9c of the recess being disposed at an angle thereto. The effect of this construction, as illustrated in Fig. 11, is that on the first contact between the ring segments and the packing, the packing is pressed firmly into the angle between the pipe and the face of the bell, and as the rubber becomes distorted it gradually assumes the configuration of the recess.

In Fig. 12 the packing engaging portion of each segment is formed by flanges, 5d and 6d, which meet substantially perpendicularly. In this case the packing ring, 5d, is rectangular in cross section, and in this construction the bridge pieces, instead of being made in one piece will consist of separate plates, 27d and 26d, and the plate, 26d, which may be on the continuous annular band, 27d, must obviously be made sufficiently narrow so that its inner edge will not engage the wall, 26d, of the recess when the clamping ring is drawn up.

In some instances the packing recess of the clamping ring may be segmental instead of angular in cross section. Thus in Fig. 13 I have shown the recess as having a concave wall, indicated at 8e, and the outer face of the packing ring, 5e, correspondingly formed. Where this concave form is used, I find it desirable to provide the wall, 8e, about centrally thereof, with an inwardly extending rib or projection, indicated at 8e' in this figure, which comes in contact with the convex outer surface of the packing ring, and forces the latter into firm engagement with the pipe and bell face, and is thereby forced into the convex surface of the packing, and interlocked therewith. This projection or rib may, however, be omitted. Obviously the bridge pieces used with this form of segment, one of which is indicated at 26e, will conform to the bridge pieces shown in the preferred embodiment of my invention.

Fig. 14 illustrates a further modification, in which the packing engaging portion of each segment, instead of being a recess, is a convex wall, indicated at 8f. In this case the packing ring, which is indicated at 5f, will have an exterior concave face substantially conforming to the convex face 8f, and the bridge pieces where used will be of the concavo-convex form, shown at 26f.

It will be understood that where either the concave or convex packing engaging portions are provided on the ring segments, they will have a curvature substantially coaxial with a point in the line of the resultant of force, indicated by the dotted lines, Y' and Y2, in Figs. 13 and 14.

In Figs. 15, 16 and 17, I have illustrated a modified form of clamping ring in which each of the segments is provided at a distance from the plane of the concave or convex packing engaging portion, with a stud or projection, the studs or projections of the several segments being connected by links, and thereby forming the tension member of the ring. In Fig. 15, B', represents the bull ring, which may be constructed as herebefore described, and C' represents the clamping ring, the parts of which are given the same reference numerals as in Figs. 1 and 2, with the addition of 100. The clamping ring, C', is formed of a plurality of segments, each of which comprises the plate member, 106, provided with the packing engaging portions, which in this instance are formed by the inclined walls, 108 and 109, the plate member being provided with an outwardly extending portion, 110, having a bolt hole, 111, therein, as previously described. The outer face of each segment is provided with a horizontally disposed stud, 114, which is conveniently formed in line with the bolt hole, 111, and at the junction of the radial and lateral reinforcing flanges, 113. The outer end of the stud, 114, is located at a considerable distance from the plane of the plate member, 106, and is preferably of cylindrical form, as shown, and provided at its outer end with malleable projections, 114a. The clamping ring is completed by links, 115, preferably formed of malleable cast iron, like the clamping ring segments, one of which links is illustrated in detail in Fig. 17. Each link is preferably bifurcated at one end to provide the parallel arms, 115a, having apertures, 115b, therein, to fit over one of the studs, 114, the other end of the link being provided with an aperture, 115c. The thin end of each link is inserted between the bifurcated portions of the adjacent link, slipped over one of the projections, 114, and secured in position thereon, by bending outwardly the projections, 114a, as clearly shown in Fig. 18. In this manner the studs, 114, of all the segments constituting the ring may be readily connected by the links, 115, these links and the engaged portions of the studs, 114, constituting the tension member of the ring. In practice, the segments and links will be assembled and permanently connected with the exception of a single stud, so that the ring can be placed around the pipe and the last link connection made after the ring is in position.

The operation of the clamping ring in compressing the packing making a tight joint, will be exactly the same as that previously described, except the engagement of the links, 115, with the studs, 114, preventing the outward movement of the studs, 114, when the bolts are tightened, permitting the segments to rock inwardly into proper relation with the spigot member of the joint and compensate for variations in the diameter thereof. It will be understood that the apertures, 115b and 115c, in the links are sufficiently larger than the studs, 114, to form a loose joint and permit the turning movement of each of the segments with respect to the tension member, as previously described. The force of the bolts applied to the packing will be the resultant of the bolt strain exerted in a line parallel to the axis of the ring, and the retaining force of the tension member exerted in a plane perpendicular thereto, the force being applied in the general direction indicated by the dotted line at Y3. The turning moment of the ring segments will in this instance be about a theoretical axis located in each of the studs, 114, and indicated for example approximately at X' in Fig. 16. It will be noted that in this instance the tension member which connects the segments of the clamping ring is comprised in part of portions of the segments that are the studs, and in part by extraneous elements, that is the separate links, 115, the tension member constituting a circular member extending entirely around the ring and around the spigot member of the joint as is the previously described embodiment of my invention.
In Figs. 18 to 21 inclusive, I have illustrated another modification of my invention, in which the tension member comprises a ring separate from the sections of the clamping ring and preferably formed in segments, adjustedly connected together so that the tension member itself can be adjusted if desired, and this embodiment of my invention is found particularly desirable in segments for pipes of very large diameters. In these figures the parts corresponding with those previously described with respect to Figs. 1 and 2, are given the same reference numerals with the addition of 200. In Figs. 18 and 19, B2, represents the bull ring, which may be of the same construction as that previously illustrated and described, and C2, represents the clamping ring, comprising a plurality of segments formed preferably of malleable cast iron, each of which comprises a plate member, 200a, provided with a bolt hole, 200c, so that each segment is acted upon by two bolts, 202, instead of a single bolt, as shown in the forms previously described. One advantage of using more than one bolt in connection with a segment of the clamping ring is that where a single bolt is employed, there is a slight tendency for the segment to twist, as the nut is screwed up, tending to move one end of the segment inwardly and the other outwardly. This tendency is entirely neutralized where two bolts are connected to each segment. The plate member is provided with the packing engaging portion in this instance a recess provided by the walls, 208-209, and the outer face of the segment is strengthened by the radial webs, 214, in line with each bolt hole and by laterally extending webs, 213, which webs practically converge at two points in a radial line with the respective bolt holes to form bearing shoulders, 214a, beyond which project studs, 214b, provided at their outer ends with the malleable projections, 214c.

The tension element in this instance comprises a ring, 215, also preferably formed of cast or malleable cast iron, and constructed in sections, although it is not necessary that there should be as many sections in the tension element as there are in the clamping ring. I prefer to construct the tension ring, 215, with half the number of segments that are used in the clamping ring itself, so that each segment of the ring, 215, engages the shoulders, 214a, of two clamping ring segments. The ring, 215, comprises a flat section provided with a plurality of apertures, 215a, in this instance four in number for each section of the ring, 215, and each section of the ring, 215, is provided adjacent to each of the apertures, 215a, with a horizontally disposed flange, 215b, to engage the shoulder, 214a, of the adjacent section. The studs, 214b, of the segments extend through apertures, 215a, of the ring, 215, and the projections, 214b, thereof are bent outwardly to permanently connect the clamping ring segments with the section of ring, 215, as shown in Fig. 19. Each section of the tension ring, 215, is also provided adjacent to each bolt hole with perpendicular webs, indicated at 215c, on opposite sides of the apertures, 215a, to strengthen the tension element at these points, and the apertures, 215a, increase in diameter from the inner face of the tension ring segment outwardly to allow freedom of movement to accommodate the turning movement of the clamping ring segments. The tension ring sections are provided with overlapping portions, 215d, as shown in Fig. 21, which preferably have their meeting faces provided with teeth, as indicated at 215e, and said overlapping portions are provided with elongated slots, indicated at 215f, to accommodate a short section bolt, 215g, provided with a nut, 215h. This connection is similar to the connection between the ends of the bull ring sections previously described, and permits an adjustment of from one to any desired number of teeth at each joint between the sections of the ring, 215, which joints occur at proper intervals between the radial positions occupied by the through bolts, 224, as clearly indicated in Fig. 18.

By reference to Fig. 19, it will be seen that when the parts of the clamping ring just described are assembled around a spigot member, 201, in conjunction with the packing ring, 205, and the bull ring, B2, and the bolts are tightened, the turning moment of the segments will cause the shoulders, 214a, to bear outwardly against the inner faces of the flanges, 215b, of the tension ring, 215, which of course prevents any movement in this direction. The engagement of the shoulder, 214a, and flange, 215b, forms a sort of knuckle and the engaged surfaces of these parts are conveniently rounded to facilitate the turning movement of the segments, which will occur about a theoretical axis indicated at X2.

In Fig. 22 I have illustrated a slight modification of these parts drawn to an enlarged scale, in which the parts corresponding with those just described are given the same reference characters with the addition of 100. In this instance the stud, indicated at 314b, is provided with the malleable projections, 314c, disposed laterally with respect to each other, so that they may be bent outwardly and laterally into contact with a U-shaped boss, 315x, on the outer face of the tension ring, 315, the outer edges of this boss being curved substantially concentrically with the theoretical axis of the turning moment of the clamping ring segments indicated at X3, in Fig. 22. The object of this construction is to insure the freedom of this turning moment and the necessary relative movement between the tension ring, 315, and the shoulders, 314a, of the clamping ring segments at all times even if the malleable projections, 314c, should be bent over into very firm engagement with the outer face of the tension ring, which in this instance would be the curved outer faces of the bosses, 315x. It will be understood that where the separation between the ends of the clamping ring segments is sufficient to require it, bridge pieces will be inserted as previously described in Fig. 19. I have shown a modified form of bridge piece, which is illustrated in detail in Fig. 23, and which is so constructed that it will maintain itself in position with respect to the clamping ring segments. This bridge piece, indicated as a whole at 226, is provided with the integral flanges, 227 and 228, and is made preferably of sheet metal as previously described, and preferably of spring material. The flange, 227, is extended over a considerable distance and bent over upon itself as shown in Figs. 19 and 23, to provide a spring clamping portion, 229, which can be made to engage the outer face of the flange, 227, of a clamping ring segment, adjacent to the end of the segment, where the plate member is of reduced width, thus holding the bridge piece within the packing recess of the clamping ring in a position to extend over the gap or space between the adjacent ends of the segments thereof, and facilitating the assembly of the repair clamp around the joint to
be repaired. It will be clearly seen by reference to Fig. 19, that when the bolts, 224, connecting the clamping ring segments with the bull ring are tightened, the portions of the clamping ring segments containing the packing recess will be forced inwardly to compress the packing ring, 205, and will compensate for any variations in the exterior diameter of the spigot member, 201. If such variation is sufficiently great to require it, the tension ring, 215, can be adjusted to increase or decrease the diameter of the tension ring or member, but it will be understood that in all the positions to which the tension ring may be adjusted, this ring is nonrigid and provides an engagement with the shoulders, 214c, of the clamping ring segments prevents any outward movement thereof.

In Fig. 24 I have illustrated another modified form of the clamping ring, in which the tension element is constituted in part by portions of the clamping ring segments, and in part by extraneous links, operatively connected therewith, so as to entirely encircle the pipe. The parts illustrated in this figure which correspond with those in Figs. 1 and 2 are given the same reference characters as in those figures, and the parts corresponding with those shown in Figs. 1 and 2, are given the same reference numerals with the addition of 500. Each segment in this instance is provided with a plate member, 506, having an outwardly extending portion, 510, provided with bolt hole, 511, and also provided on the outer side of the bolt hole with a tension shoulder, 514a, from which projects a segment stud, 514b, provided with malleable projections, 514c. The packing recess is in this instance of a concave form and constituted by the flanges, 509 and 508, and the segment is suitably reinforced in this instance by a radial web, 514, which extends from the flange, 508, to an annular flange, 515, coincident with the resultant of force. In this embodiment in which the clamping ring as a whole is indicated at C5, the tension element engages the shoulders, 514a, of each clamping ring segment and has its ends connected by a clip, 518, 800. In these figures, the clamping ring comprises a plurality of ring segments each having 120a in this instance the ten 90 plate member, 606, provided with bolt holes, 611, so that two bolts are directly connected with each segment, although this is not essential. On its outer face each segment is provided with radial reinforcing webs, 414, in line with the bolt holes, which webs are connected in this instance by a lateral reinforcing web, 415c, which forms a part of the tension element of the clamping ring. At the intersection of the flanges, 414 and 415a, of each segment is provided a link securing means, which in this instance is in the form of a socket recess, 415b, to receive an enlarged head, 415c, on a connecting link, 415, which extends from the socket recess, 415b, adjacent to one end of each segment to the corresponding recess in the adjacent segment, as clearly illustrated in Fig. 24.

In assembling the parts of the clamping ring shown in this figure, they may be connected by the means, 415, which not only connect the segments, but also form with the webs, 415b, a circular ring, the width of which is equal to the outside diameter of the spigot member, 501, while the forces of the bolt load will be transmitted as a resultant of forces approximately along the dotted line, 115, indicated at Y3, which very nearly coincides with the plane of the plate member, 506, so that the resultant of force will be transmitted to the packing ring in a direct manner through the clamping ring segments and with comparatively little change in the position of the clamping ring segments with respect to the bolts.

In Figs. 27 and 28 I have illustrated another modification of my invention in which the axis of the turning moment of each clamping ring segment intersects the axis of the through bolt connected therewith. The parts of the construction illustrated in these two figures which correspond with those shown in Figs. 1 and 2 are given the same reference numerals with the addition of 600. In these figures, the clamping ring comprises a plurality of ring segments each having a plate member, 606, provided with flanges, 608-609, the inner faces of which form the packing recess, in this instance of concave form, 614a, cross section to engage the convex face of a packing ring, 605. The central portions of the plate member, 606, are extended outwardly and provided with a pair of rounded shoulders or bearing portions, 614a, the portions of the plate member between which are cut away as indicated at 614b to permit the passage of the bolt, 624, therethrough. The tension element is in this instance in the form of a ring, 615, provided with bolt holes, 615a, to permit the passage of the through bolts, 624, therethrough, and said ring is provided on opposite sides of the bolt holes therein with bearing portions, 615b, for engaging the rounded

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with a bull ring, B6, in Fig. 27, and it will be seen that the axis of the turning moment of the ring sections indicated at X6, will practically intersect the axis of the adjacent through bolt, 824, so that the line, Y6, indicating a resultant of forces acting on the packing will be exerted substantially in line with the plate member, 606, of each clamping ring segment. At the same time the portions of the ring packing recess are adjustable to accommodate variations in the diameter of the spigot member, 601, with which the ring may be used with very slight changes in the angular relation between the clamping ring segments and the through bolts.

In all the embodiments of my invention herein shown and described, it will be noted that the clamping ring segments are connected with each other only through their connection with the tension element or member, which extends entirely around the ring and pipe, engaging portions of the segments at a distance from a plane passing through the packing recess perpendicular to the axis of the ring and, holding the engaged portion of the clamping ring segments against radial movement oppositely in a direction perpendicular to the bolt strain, so that the portions of each ring segment is given an independent turning moment to accommodate not only variations in the external diameters of the particular pipe sections with which the ring is used, but also to accommodate variations in the outer surface of the pipe itself, such as variations from a perfectly true circle, or variations in the thickness of the pipe wall at particular points around the same. The strain of the through bolts is exerted in lines parallel with the axis of the ring and pipe, while the strain of the tension member is exerted in a plane perpendicular thereto, and the resultant force greater than either of these stresses is transmitted directly to the packing, and in an inclined direction toward the angle formed at the intersections of the exterior of the pipe and the face of the bell and its solid packing, and resulting in all cases in the forming of a tight joint between the packing and said intersecting faces.

What I claim and desire to secure by Letters Patent is:

1. A self adjusting clamping ring comprising a plurality of segments, each provided with a packing engaging portion, bolt receiving portions located at a greater distance from the axis of the ring than the packing engaging portion, a substantially circular tension element connected with each of said segments, at points at a distance longitudinally with respect to the axis of the ring from the plane of the packing engaging portions, for holding the segments at said points against outward movement, each segment having a turning moment with respect to said tension element permitting the packing engaging portions thereof to move inwardly toward the axis of the ring.

2. A self adjusting clamping ring comprising a plurality of segments each provided with a plate member disposed at an angle to the axis of the ring, and having at its inner edge packing engaging portions, said plate member being provided with bolt receiving means, said ring segments being provided with tension shoulders disposed substantially parallel to the axis of the ring, and extending rearwardly of the packing engaging portion of the ring, and an annular tension band extending around and engaging the tension shoulders of all the segments, and permanently connected therewith and holding the tension means in ring formation, said tension band being provided with meeting ends, and detachable means for connecting said meeting ends to facilitate placing it and said tension segments around the pipe.

3. A self adjusting clamping ring comprising a plurality of segments each provided with a plate member disposed at an angle to the axis of the ring, and having at its inner edge packing engaging portions, said plate member being provided with bolt receiving means, said ring segments being provided with tension shoulders disposed substantially parallel to the axis of the ring, and located on the outer side of the bolt circle of the ring and at a distance longitudinally with respect to the axis of the ring from the plane of the packing engaging portions of the ring, and an annular tension element extending around the ring and engaging said shoulders, to hold them against outward movement, each segment having a turning moment with respect to said tension element.

4. A self adjusting clamping ring comprising a plurality of segments each provided with a plate member disposed at an angle to the axis of the ring, and having at its inner edge packing engaging portions, said plate member being provided with bolt receiving means, said ring segments being provided with tension shoulders disposed substantially parallel to the axis of the ring, and located on the outer side of the bolt receiving portions of the plate member, and an annular tension element having portions for engaging said shoulders of all of the segments, and bolt apertures adjacent thereto, each segment having a turning moment with respect to said tension element on an axis substantially in line with the axis of the adjacent bolt aperture in said tension element.

5. A self adjusting clamping ring comprising a plurality of independently movable segments provided with packing engaging portions, bolt receiving portions, and greater distance from the axis of the ring than the packing engaging portions, a tension element connecting the tension shoulders of said segments, said tension element extending across the spaces between the ends of adjacent segments and engaging the packing engaging portions thereof.

6. A self-adjusting clamping ring comprising a plurality of independently movable segments provided with packing engaging portions adjacent to their inner edges, and provided with means for securing clamping bolts thereto at points located at a distance outwardly from said packing engaging portions, portions extending rearwardly of the packing engaging portions and means engaging said rearwardly extending portions for holding said segments in ring formation, said means adapted to react against the force of said clamping bolt to produce an inwardly turning movement of each of said segments.

7. A self-adjusting clamping ring comprising a plurality of independently movable segments provided with packing engaging portions adjacent to their inner edges, and provided with means for securing clamping bolts thereto at...
points located at a distance outwardly from said packing engaging portions, and means engaging said segments at points removed longitudinally with respect to the axis of the ring from said packing engaging portions, for holding said segments adapted to receive a clamping bolt located at a greater distance from the axis of the ring than the packing engaging portion, and a portion extending rearwardly from the packing engaging portion of each segment, and tension means engaging said rearwardly extending portions for holding said segments in ring formation, said segments adapted under pressure from said clamping bolts to react against said tension means to force said packing engaging portion in a direction toward the axis of the ring.

8. A self-adjusting packing ring comprising a plurality of segments, each provided with a packing engaging portion and having a portion adapted to receive a clamping bolt located at a greater distance from the axis of the ring than the packing engaging portion, and a portion extending rearwardly from the packing engaging portion of each segment, and tension means engaging said rearwardly extending portions for holding said segments in ring formation, said segments adapted under pressure from said clamping bolts to react against said tension means to force said packing engaging portion in a direction toward the axis of the ring, said tension element being sectional to facilitate the placing of the ring around a pipe section.

10. A self-adjusting packing ring comprising a plurality of segments, each provided with a packing engaging portion and having a portion adapted to receive a clamping bolt located at a greater distance from the axis of the ring than the packing engaging portion, and a portion extending rearwardly from the packing engaging portion of each segment, a substantially circular tension element being formed of segments having overlapping portions, and bolts for holding said interengaging serrated portions rigidly in adjusted relation.

12. A self-adjusting packing ring comprising a plurality of segments, each provided with a packing engaging portion, and having a portion adapted to receive a clamping bolt located at a greater distance from the axis of the ring than the packing engaging portion, and a tension shoulder extending in a direction parallel with the axis of the ring rearwardly from the packing engaging portion of each segment and having portions engaging the tension shoulder of each ring segment, and holding said shoulder against outward movement, while permitting the independent inward movement of the packing engaging portions of each segment, under the action of bolt strain applied to said bolt receiving portions thereof.

13. A self-adjusting clamping ring comprising a plurality of independently movable segments provided with packing engaging portions, bolt receiving portions located at a greater distance from the axis of the ring than the packing engaging portions and tension shoulders extending in a direction parallel with the axis of the ring rearwardly from the packing engaging portions, and provided with attaching studs, a substantially circular tension member having apertures to engage said studs of all the sections and means for securing said studs in engagement with said apertures.

14. A self-adjusting clamping ring comprising a plurality of independently movable segments, provided with packing engaging portions, bolt receiving portions located at a greater distance from the axis of the ring than the packing engaging portion and tension shoulders substantially in the same radial plane with the bolt receiving portions of the ring, and located at a distance longitudinally with respect to the axis of the ring from the packing engaging portions, and provided with attaching studs, a substantially circular tension member having bearings and apertures to engage the attaching studs carried by said shoulders, and means adapted to permanently secure said studs in engagement with said apertures.

15. A self-adjusting packing ring comprising a plurality of segments, provided with packing engaging portions, bolt receiving portions located at a greater distance from the axis of the ring than the packing engaging portions, and tension shoulders substantially in the same radial plane with the bolt receiving portions of the ring, and a substantially circular tension member having portions engaging the tension shoulders of each ring segment and holding said shoulders against outward movement, while permitting the independent inward movement of the packing engaging portions of each segment, under the action of bolt strain applied to said bolt receiving portions thereof, said tension ring being formed of segments having overlapping ends provided with transversely serrated interengaging faces, bolts for clamping said faces rigidly in their adjusted position, said tension ring having bearing and engaging said shoulders and apertures to engage said studs, and bendable attaching projections on said studs for permanently securing said tension ring and segments together.

16. A repair clamp comprising a self-adjusting
clamping ring consisting of a plurality of separate segments, each provided with a packing engaging portion and having a bolt receiving portion located at a greater distance from the axis of the ring than the packing engaging portion of each segment, an adjustable bolt ring having bolt receiving portions, bolts passing through the bolt receiving portions of said segments and said ring for clamping the two together, a portion extending rearwardly from the packing engaging portion of each segment, a tension element engaging said rearwardly extending portion of each segment to hold them against outward movement, while permitting the inward movement of the packing engaging portions of each segment under strain applied to the bolt receiving portions thereof, said tension element being adjustable to vary the diameter thereof.

17. A self-adjusting clamping ring comprising a plurality of independently movable segments provided with packing engaging portions, and having a portion adapted to receive a clamping bolt located at a greater distance from the axis of the ring than the packing engaging portion, and a portion extending rearwardly of the packing engaging portions of each segment, a tension element connecting said rearwardly extending portions for holding them against outward movement while permitting the independent inward movement of the packing engaging portions of each segment with respect to said tension element, and sheet metal bridge pieces extending across the spaces between the ends of adjacent segments, said bridge pieces having yielding clamping means engaging adjacent portions of the segments to hold said bridge pieces in position with respect to the segments.

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