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PATENT SPECIFICATION

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(54) IMPROVEMENTS IN AND RELATING TO PIPE CONNECTORS

(71) We, HUNTING OILFIELD SERVICES (U.K.) LIMITED, a British Company of Blackness Road, Aberdeen, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to improvements in pipe connectors.

According to the present invention there is provided a pipe connector comprising a tubular pin member having a frusto-conical outer peripheral surface, a tubular box member for receiving and engageable with the pin member and having a frusto-conical inner peripheral surface corresponding to the frusto-conical surface of the pin member and which overlies the frusto-conical surface of the pin member when the members are engaged, and annular projection and groove means provided in the frusto-conical surfaces of the pin member and the box member and inter-engageable to axially lock the pin member and the box member together, the projection and groove means comprising annular projections in one of the frusto-conical surfaces and annular grooves in the other of the frusto-conical surfaces the projections having planar crest surfaces, and the projections and grooves being axially spaced apart along the frusto-conical surfaces, extending in radial planes, and being arranged so that, on assembly of the pin member and the box member, initial metal-to-metal contact will be made between the crest surface of a respective one of the projections of one of the frusto-conical surfaces and a part of the other of the frusto-conical surfaces between adjacent grooves, wherein the radial dimensions of the projections and grooves are such that the expansion of the box member and/or contraction of the pin member resulting from forcing the projections into the corresponding grooves during engagement of the members does not

exceed the elastic limit of the material of the box member and/or the pin member.

The present invention will be more fully understood from the following description of an embodiment thereof, given by way of example only, with reference to the accompanying drawings.

In the drawings:

Figure 1 is an axial section through an embodiment of a pipe connector in accordance with the present invention and showing the pin and box members assembled;

Figures 2 and 3 are enlarged sections of the pin and box members of Figure 1 respectively;

Figures 4 and 5 are enlarged sections showing the pin and box members of Figure 1 during assembly and when assembled;

Figure 6 is an axial section through the connector of Figure 1 showing means for applying an axial assembling force thereto; and

Figure 7 is a plan view of the force apply means of Figure 6.

As shown in the drawings, the pipe connector comprises a tubular pin member 1 for connection, e.g. by welding, to the end of a pipe 2, and a tubular box member 3 for connection, e.g. by welding, to the end of a pipe 4 to be connected to pipe 2. The pin and box members are telescopically engageable and have corresponding frusto-conical outer and inner peripheral surfaces 5, 6 respectively which overlie one another when the pin member 1 is fully inserted into the box member 2.

To axially lock the pin member relative to the box member when the members are engaged, the box member has in its frusto-conical surface 6 a plurality of circumferentially extending annular grooves 7a, 7b ... 7g, 7h, each groove extending in a radial plane, having a planar root surface 8a parallel to surface 6, radially extending end surfaces 8b, 8c and being spaced by a surface 10a, 10b ... 10g, 10h from the adjacent groove. The root surfaces 8a lie

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on a frustoconical surface having the same conicity as surface 6. The pin member has axially spaced circumferentially extending annular projections or teeth 11a, 11b ... 11g, 11h corresponding to the grooves 7 and having planar crest surfaces 9a parallel to surface 5 and lying in a frusto-conical surface, and radially extending end surfaces 9b, 9c. The grooves 7 and teeth 11 are relatively dimensioned and shaped to facilitate assembly of the pin and box members, to resist axial forces tending to pull the members apart, and so that there is metal-to-metal contact between the end face 8b of each groove and the corresponding end face 9b of each tooth resisting axial forces tending to pull the members apart when the members are fully engaged. The teeth and grooves may, as shown, extend over substantially the entire extent of the surfaces 5, 6 but may extend over a lesser extent of the surface.

The box member may, as shown, be provided with a radial passage 12 communicating with an axially extending recess 13 intersecting some of the grooves 7 centrally of the groove region. The passage 12 is adapted for connection to a source of liquid, e.g. oil, under pressure, e.g. at about 5000 to 7000 p.s.i. for pin and box members made of high tensile steel.

The joint is designed to be assembled as follows. Initially the pin member is pushed into the box member until metal-to-metal contact is obtained between parts of the frusto conical surfaces 5, 6. The conicity and the tooth and groove lengths of the pin and box members are arranged so that initial metal-to-metal contact is obtained with between the crest surface of each tooth, e.g. surface 9a of tooth 11g, on the pin abutting that surface, e.g. surface 10g, immediately before the respective groove, e.g. 7g, in which the tooth is to be engaged. Once metal-to-metal contact has been made, an axial force is applied between the pin and box members to progressively bring the members together and engage the teeth in the respective grooves. On application of the axial force, the box member expands and/or the pin member contacts a sufficient amount to allow each tooth e.g. tooth 11g, to slide over the surface, e.g. surface 10g, into the groove, e.g. groove 7g. The tooth and groove depth is arranged so that in so doing, the elastic limit of the material of the pin and box members is not exceeded.

A caliper type jack 14 (Figure 6 and 7) may be used to apply the axial force to the members. The caliper jack consists of an upper plate 15 and a lower plate 16 each of which is split diametrically and hinged at 17 to permit each plate to be engaged around a respective one of the members. A plurality

of hydraulic jacks 18 are arranged to act between the plates, the jacks being angularly spaced apart around the axis of the caliper jack. The plates 15, 16 engage in grooves 19, 20 provided in the pin and box members respectively.

During application of the axial force, it is found advantageous to apply liquid under pressure to the region of overlap between the pin and box members. It is for this reason that the passage 12 and recess 13 are provided. The liquid flows from the passage 12 to the recess 13 and then into those grooves 7 with which the recess communicates. Flow beyond these grooves 7 is initially prevented by the metal-to-metal contact between the teeth 11 and surfaces 10. The pressure of the liquid is set at a level sufficient to aid expansion of the box member and/or contraction of the pin member as the members are brought together under the axial force. It is found that in effect the liquid lubricates the contacting surfaces of the pin and box member which then form a hydrostatic bearing so that metal-to-metal contact is lost. While there is consequently leakage of the liquid, the leakage is not sufficient to render the application of the liquid ineffective. The lubrication of the contacting surfaces of the pin and box member reduces the possibility of damage to the toothed and grooved surfaces of the pin and box member as they are forced together.

In the preferred embodiment of the connector, the tolerances of the surfaces 5, 6 of the pin and box members are minimised and the box is dimensioned so that the pin is a shrink fit in the box with the end faces 8b of the grooves 7 in metal-to-metal contact with the corresponding end faces 9b of the teeth 11 and with radially extending surfaces 24, 25 in abutment. With this arrangement, it is found essential to ensure that no liquid is trapped in any of the grooves 7 when the pin and box members are fully engaged. Should any liquid be trapped, the corresponding tooth will be unable to engage fully in its groove and there will then be a risk of the connector coming apart. To avoid this possibility, the recess 13 is extended to and is in communication with the two grooves 7b and 7g adjacent each end groove 7a and 7h so that the liquid in the grooves 7b to 7g can be drained through the passage 12. Any liquid remaining in the end grooves 7a and 7h can escape around the end of the pin member and box member respectively. Where the pin member is not a shrink fit in the box member, it is merely necessary to ensure that all fluid can be drained from between the overlying surfaces of the pin and box members and the precise extent of the recess is not so critical but clearly it must be sufficient to aid in

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expansion and/or contraction of the box member and pin member respective.

If it is required that the assembled connector be able to be disassembled, the passage 12 and recess 13 can be provided and used for this purpose. Liquid under pressure is then applied to the passage 12 and flows along the recess 13 and circumferentially in the clearances which are left between the end face 9 of each recess and the corresponding end face of each tooth for those grooves 7 which are in communication with the recess 13. The axial extent of penetration of the liquid is initially limited by the metal-to-metal contact between the teeth and grooves at the ends of the recess 13. At the same time an axial disengaging force is applied to the pin and box members, e.g. using the caliper jack 14, so as to maintain metal-to-metal contact between the end face 8b of each groove and the corresponding end face 9b of the tooth. As in the case where liquid under pressure is used in assembling the pin and box members, the liquid acts to expand the box member and/or contract the pin member to free the teeth from the grooves. However in disassembly, the applied axial force maintains the end faces 8b of the grooves in contact with the corresponding end faces 9b of the teeth to prevent substantial leakage of the liquid until the teeth have been disengaged from the grooves and rest on the surfaces 10 between the grooves. Further slight application of axial force will bring the pin member back to a position relative to the box member as shown in Figure 4 corresponding to initial metal-to-metal contact during assembly.

Seals may be provided in one or both of the surfaces 5, 6 of the pin and box members at the ends of these surfaces to assist prevention of leakage of liquid from between the members during assembly and disassembly and in use. If such seals are provided, one or more of the teeth and grooves at the ends of the members may be omitted. However, if the pin and box members are suitably relatively dimensioned, sealing by metal-to-metal contact between the pin and box members may be solely relied on and no other seals provided. As shown an O ring seal 21 is provided in the surface of the pin member adjacent the end tooth 11a to provide additional sealing when the coupling is in use.

Where the box member is dimensioned relative to the pin member to provide a shrink fit with the pin member, the connector will to an extent transmit torque. Should separate torque transmission means be required an inwardly projecting pin may be provided at the inner end of the frusto conical surface of the box member for

engagement in a recess provided in the leading edge of the pin member, the end groove 7a and tooth 11a being omitted.

In a preferred embodiment, the pin and box members are made of high tensile steel and have external and internal diameters of about 28". The conicity of the frusto-conical surfaces is 2°, each tooth has a height of 0.048" and a length of its base of 0.80". Each groove has a depth of 0.044" and a length at the surface of 0.84". Eight teeth and grooves are provided in each frusto-conical surface and are spaced 1.5" apart in the axial direction. The end face 8b of each groove and the corresponding face 9b of each tooth has a taper of 12° to a plane perpendicular to the axis of the pin and box members and the face 8c of each groove and the corresponding face 9c of each tooth has a taper of 60°. The former taper is determined by the tolerances of manufacture and is the angle required to ensure a tight fit between the opposed surfaces 24, 25 as shown, at the inner end of the pin member and the free end of the box member, or at the free end of the pin member and the inner end of the box member, for pile driving.

It will be appreciated that by using a different angle for the conicity of the frusto-conical surfaces of the pin and box members, and different materials for the pin and box members, the foregoing dimensions and numbers of the teeth and grooves may be varied.

It will be further appreciated that while the above described connector has been described in terms of teeth provided on the pin member and grooves provided in the box member, this is exactly equivalent to the provision of grooves in the pin member and teeth in the box member.

There is thus provided a pipe connector which has a simple construction, is easy to assemble and does not rely on relatively movable parts to maintain interengagement between the pin and box members.

The above described pipe connector is particular designed and adapted for use in connecting pipes and other tubular structures for use in the drilling and/or completion of off-shore oil and/or gas wells.

WHAT WE CLAIM IS:—

1. A pipe connector comprising a tubular pin member having a frusto-conical outer peripheral surface, a tubular box member for receiving and engageable with the pin member and having a frusto-conical inner peripheral surface corresponding to the frusto-conical surface of the pin member and which overlies the frusto-conical surface of the pin member when the members are engaged, and annular projection and groove means provided in the frusto-conical surfaces of the pin

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expansion and/or contraction of the box member and pin member respective.

If it is required that the assembled connector be able to be disassembled, the passage 12 and recess 13 can be provided and used for this purpose. Liquid under pressure is then applied to the passage 12 and flows along the recess 13 and circumferentially in the clearances which are left between the end face 9 of each recess and the corresponding end face of each tooth for those grooves 7 which are in communication with the recess 13. The axial extent of penetration of the liquid is initially limited by the metal-to-metal contact between the teeth and grooves at the ends of the recess 13. At the same time an axial disengaging force is applied to the pin and box members, e.g. using the caliper jack 14, so as to maintain metal-to-metal contact between the end face 8b of each groove and the corresponding end face 9b of the tooth. As in the case where liquid under pressure is used in assembling the pin and box members, the liquid acts to expand the box member and/or contract the pin member to free the teeth from the grooves. However in disassembly, the applied axial force maintains the end faces 8b of the grooves in contact with the corresponding end faces 9b of the teeth to prevent substantial leakage of the liquid until the teeth have been disengaged from the grooves and rest on the surfaces 10 between the grooves. Further slight application of axial force will bring the pin member back to a position relative to the box member as shown in Figure 4 corresponding to initial metal-to-metal contact during assembly.

Seals may be provided in one or both of the surfaces 5, 6 of the pin and box members at the ends of these surfaces to assist prevention of leakage of liquid from between the members during assembly and disassembly and in use. If such seals are provided, one or more of the teeth and grooves at the ends of the members may be omitted. However, if the pin and box members are suitably relatively dimensioned, sealing by metal-to-metal contact between the pin and box members may be solely relied on and no other seals provided. As shown an O ring seal 21 is provided in the surface of the pin member adjacent the end tooth 11a to provide additional sealing when the coupling is in use.

Where the box member is dimensioned relative to the pin member to provide a shrink fit with the pin member, the connector will to an extent transmit torque. Should separate torque transmission means be required an inwardly projecting pin may be provided at the inner end of the frusto conical surface of the box member for

engagement in a recess provided in the leading edge of the pin member, the end groove 7a and tooth 11a being omitted.

In a preferred embodiment, the pin and box members are made of high tensile steel and have external and internal diameters of about 28". The conicity of the frusto-conical surfaces is 2°, each tooth has a height of 0.048" and a length of its base of 0.80". Each groove has a depth of 0.044" and a length at the surface of 0.84". Eight teeth and grooves are provided in each frusto-conical surface and are spaced 1.5" apart in the axial direction. The end face 8b of each groove and the corresponding face 9b of each tooth has a taper of 12° to a plane perpendicular to the axis of the pin and box members and the face 8c of each groove and the corresponding face 9c of each tooth has a taper of 60°. The former taper is determined by the tolerances of manufacture and is the angle required to ensure a tight fit between the opposed surfaces 24, 25 as shown, at the inner end of the pin member and the free end of the box member, or at the free end of the pin member and the inner end of the box member, for pile driving.

It will be appreciated that by using a different angle for the conicity of the frusto-conical surfaces of the pin and box members, and different materials for the pin and box members, the foregoing dimensions and numbers of the teeth and grooves may be varied.

It will be further appreciated that while the above described connector has been described in terms of teeth provided on the pin member and grooves provided in the box member, this is exactly equivalent to the provision of grooves in the pin member and teeth in the box member.

There is thus provided a pipe connector which has a simple construction, is easy to assemble and does not rely on relatively movable parts to maintain interengagement between the pin and box members.

The above described pipe connector is particular designed and adapted for use in connecting pipes and other tubular structures for use in the drilling and/or completion of off-shore oil and/or gas wells.

WHAT WE CLAIM IS:—

1. A pipe connector comprising a tubular pin member having a frusto-conical outer peripheral surface, a tubular box member for receiving and engageable with the pin member and having a frusto-conical inner peripheral surface corresponding to the frusto-conical surface of the pin member and which overlies the frusto-conical surface of the pin member when the members are engaged, and annular projection and groove means provided in the frusto-conical surfaces of the pin

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5 member and the box member and inter-engageable to axially lock the pin member and the box member together, the projection and groove means comprising
10 annular projections in one of the frusto-conical surfaces and annular grooves in the other of the frusto-conical surfaces the projections having planar crest surfaces, and the projections and grooves being
15 axially spaced apart along the frusto-conical surfaces, extending in radial planes, and being arranged so that, on assembly of the pin member and the box member, initial metal-to-metal contact will be made
20 between the crest surface of a respective one of the projections of one of the frusto-conical surfaces and a part of the other of the frusto-conical surfaces between adjacent grooves, wherein the radial dimensions of the projections and grooves are such that the expansion of the box member and/or contraction of the pin member resulting from forcing the projections into the corresponding grooves during engagement of the members does not exceed the elastic limit of the material of the box member and/or the pin member.

2. A pipe connector as claimed in claim 1, wherein the planar crest surfaces of the projections lie on a common frusto-conical surface which has the same conicity as the said one frusto-conical surface.

3. A pipe connector as claimed in either claim 1 or claim 2, wherein the grooves have planar root surfaces which lie on a common frusto-conical surface having the same conicity as the said other frusto-conical surface.

4. A pipe connector as claimed in any one of the preceding claims, wherein the angle of conicity of the said frusto-conical surfaces of the members is of the order of 2° .

5. A pipe connector as claimed in any one of the preceding claims, wherein the pin member is a force fit in the box member when fully engaged therewith.

6. A pipe connector as claimed in any one of the preceding claims, wherein the box member is provided with a radial passage for connection to a supply of fluid under pressure, the passage communicating with an axially extending groove in the frusto-conical surface of the box member and extending centrally of the region provided with the projection and groove means of the assembled pin and box members, for communicating fluid under pressure to the projection and groove means for causing expansion of the box member and/or contraction of the pin member for assisting

in the assembly and/or disassembly of the connector.

7. A pipe connector as claimed in claim 6, wherein the box member is provided with the annular grooves and the axially extending groove extends axially to communicate with that annular groove adjacent the end groove at each end of the groove means.

8. A pipe connector as claimed in either claim 6 or claim 7, wherein the pin and box members are adapted for connection to means external thereto for applying an axial force thereto for assisting in assembly or disassembly of the connector.

9. A pipe connector as claimed in any one of the preceding claims, wherein each groove is defined by a pair of spaced radially extending end surfaces inter-connected by a root surface extending parallel to the other frusto-conical surface, and each projection in said one frusto-conical surface is defined by a pair of spaced radially extending end surfaces corresponding to said end surfaces of the corresponding groove and inter-connected by a crest surface extending parallel to the one frusto-conical surface.

10. A pipe connector as claimed in claim 9, wherein the radially extending end surfaces of the grooves are equally spaced apart and the radially extending end surfaces of the projections are equally spaced apart.

11. A pipe connector as claimed in either claim 9 or claim 10, comprising a pair of radially extending faces provided one on the pin member and one on the box member for abutment when the members are engaged and arranged relative to the projections and grooves such that one of said end surfaces of each projection is maintained in metal-to-metal contact with the corresponding end surface of the corresponding groove by abutment between said radially extending faces for transmission of axial forces between said members.

12. A pipe connector as claimed in claim 11, wherein a clearance is provided between the other end surfaces of the projection and groove means when inter-engaged.

13. A pipe connector as claimed in either claim 11 or claim 12, wherein the one radially extending end surface of each projection and the corresponding end surface of each groove is inclined at an angle of the order of 13° to a plane perpendicular to the axis of the connector.

14. A pipe connector as claimed in any one of claims 11 to 13, wherein the other end surfaces of the projections and grooves



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are inclined at an angle of the order of 60° to said plane.

15. A pipe connector substantially as herein described with reference to the accompanying drawings.

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