

PATENT SPECIFICATION

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(54) APPARATUS FOR SEALING EXTERNAL SURFACE OF A TUBULAR MEMBER

(71) We, HYDROTECH INTERNATIONAL INC., of 4800 West 34th Street, Houston, Texas, 77018, United States of America, a Corporation organised and existing under the laws of the States of Delaware, United States of America, 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:—

In several industries, and particularly in the oil and gas industry, it is frequently necessary to tap into a pipe carrying a fluid under pressure. Many devices are available in the art for performing such a "hot" tap. However, all of the known tapping devices are designed to be operated within a pressure-tight riser tube which is welded on to the pipe to be tapped. Conventionally these devices comprise mechanically or hydraulically actuated drills which cut a coupon or disc out of the wall of the pipe being tapped.

In many of these hot tapping situations, such as in the case of a submerged pipe or when dealing with a pipe pressurized with a flammable or explosive fluid, it can be extremely dangerous and/or expensive to weld a riser tube on to the pipe to be tapped.

Another similar pipeline servicing problem arises when it becomes necessary to repair a crack or break in a pressurized pipe or a pipe submerged in water. Conventionally the break is welded closed. Various devices have been developed for use in situations where welding would be hazardous or unduly expensive. However, these devices must be mechanically assembled and sealed about the cracked pipe by one or more experienced workers. The cost of using such devices can be relatively high when the cracked pipe is in a fairly inaccessible location, such as underwater.

An object of this invention is to provide

apparatus for use in closing breaks in pipes or other tubular members and for use with hot tapping devices to avoid the difficulties and disadvantages of the prior art.

In its broadest aspect the invention provides apparatus including a segmented housing adapted for clamping about a tubular member, at least one resilient packer adapted for mounting about the external surface of the tubular member within the housing, and means connected to the housing for applying axial force to the packer thereby axially to compress and sealingly engage the packer with the external surface of the tubular member, said means including at least one fluid pressure-actuated piston.

In certain embodiments of the invention, in particular those intended for hot tapping applications, the apparatus has first and second resilient packers adapted for mounting about the tubular member at longitudinally spaced apart positions within the housing, individual force-applying means, each including at least one fluid pressure-actuated piston, being associated with each packer.

Preferably the force-applying means for the or each packer includes a plurality of longitudinally aligned cylinders in the housing, with a piston slidably positioned in each cylinder and arranged to exert an axial force upon the associated packer.

The or each packer may be formed from a plurality of resilient rings arranged for parallel adjacent mounting about the tubular member or it may be formed from a tubular resilient member which is longitudinally slit in one or more places.

In those embodiments of the invention having a pair of spaced-apart resilient packers, two sets of slips may be mounted in the housing at longitudinally spaced-apart positions, each set being arranged to be moved radially into engagement with the

The left end of housing 60 has a plurality of cylinders 74 formed therein which are coupled together by a manifold (not shown) and arranged to receive a pressure fluid through pressure inlet line 75. A piston 76 is disposed in each of cylinders 74 and is arranged for axial movement in response to a fluid pressure within cylinders 74. Interposed between the right end of pistons 76 and the left end of packer 73 is a second split compression ring 77 arranged to distribute the forces from pistons 76 to packer 73 and to slips 70.

The right one-half of this apparatus (not shown) is constructed as the mirror image of the portion shown in Figure 6, so that housing 60 would additionally have a second group of cylinders 74 at the right end thereof, and similarly be provided with another set of slips, compression rings, and a second packer. The illustrated lower segment of housing 60 is provided with longitudinal seal recesses 78 and 79 extending from packer 73 to the second packer (not shown) and seals 80 and 81 of generally circular cross-section are respectively positioned therein and arranged to effect longitudinal inter-packer closure of housing 60, as described above with reference to Figures 1-3.

This embodiment is also provided with a retaining pin ram cylinder 82 which is connected to the left end of housing 60 and is arranged coaxially with retaining pin 67. Cylinder 82 is of sufficient length to accept pin 67 when it is withdrawn from pads 65 and 66, and is provided with a fluid inlet 83 at the left end thereof. A piston 84 is slidably positioned within cylinder 82 and is connected to the left end of pin 67 and arranged for movement therewith. In operation the apparatus is clamped about pipe 61 and cylinder 82 is pressurized to insert pin 67 into pads 65 and 66. A pressurized fluid is then inserted into cylinders 74 through line 75. This pressure causes rightward movement of pistons 76 and ring 77, engaging packer 73 and slips 70 with the outer surface of pipe 61.

When provided with a hydraulic clamping ram such as ram 51 illustrated in Figure 3, this embodiment of the apparatus may be clamped, retained and engaged about pipe 61 entirely hydraulically, and therefore lends itself for use where a completely remotely controlled operation is desired. Although not illustrated or described as a part of the other embodiments of the apparatus of this invention, cylinder 82 and piston 84 illustrated in Figure 6 could be used with any of the embodiments of this apparatus, if desired, to achieve a totally remotely operated capability.

Referring to Figure 7, the left one-half of another embodiment of the apparatus of

this invention is illustrated which is similar in construction to that shown in Figures 1-3 and described above. In this embodiment the left end of a housing 90 is provided with an inwardly facing frusto-conical tapered seat 91 containing mating slips 92, and the inward portion of housing 90 is provided with a packer 93 arranged for sealing engagement with a pipe 94 inserted therein. However, instead of the generally centrally disposed cylinders 39 of the Figures 1-3 embodiment arranged to thrust the packer outwardly towards the tapered seat and slips to actuate the latter, this embodiment utilizes slidable or "floating" cylinder and piston assemblies disposed between the slips 92 and the packer 93.

Thus a plurality of axially slidable cylinders 95 are provided adjacent the right end of slips 92 and are arranged to open towards packer 93. A piston 96 is slidably positioned in each of cylinders 95, and the force of rightward movement of pistons 96 is distributed to packer 93 through a split compression ring 97. Means for injecting a pressure fluid into cylinders 95 is provided in the form of pressure inlet lines 98. A clearance slot 99 is provided in housing 90 adjacent to each of lines 98 so that cylinders 95 will be free for limited axial movement during the setting operation.

In operation, this apparatus is clamped and retained about pipe 94 by means (not shown) similar to that described above with respect to previously described embodiments. A pressurized fluid is then injected into cylinders 95 through lines 98, causing leftward movement of cylinders 95 and engagement of slips 92, and simultaneous rightward movement of pistons 96 and engagement of packer 93. Although not illustrated, the other one-half of this apparatus is a mirror image of the portion illustrated and is similarly actuated to engagement with pipe 94.

Yet another embodiment of this invention, particularly suitable for use in sealing a crack or other opening in a tubular member, is illustrated in Figures 8 and 9. In this embodiment a segmented housing 100 is similarly provided with hinge eyes 101 and 102, hinge pin 103, closure pads 104 and 105, retaining pin 106, arm 107, pivots 108 and 109, and hydraulic ram 110, all of which provide means for closing upper segment 111 and lower segment 112 of housing 100 about pipe 113, as described above with reference to previous embodiments.

As best seen in Figure 8, a generally tubular packing 114 is confined about the pipe 113 within housing 100 and is arranged to be readily deformed into sealing engagement with pipe 113. Packing 114 may be arranged in one of the forms illustrated in

Figures 4 and 5, and described above, or may assume any similar tubular shape.

A generally cylindrical compression ring 115 is slidably positioned within housing 100 adjacent the right end of packing 114 and is arranged to transmit an axial force to packing 114. Ring 115 is formed in two semi-cylindrical mating halves so that it may be conveniently opened and fitted over pipe 113 when the apparatus is installed. Each half of ring 115 is provided with a radially directed threaded hole 116, arranged to receive a retainer screw as described below.

The right end of housing 100 has a plurality of longitudinally aligned cylinders 117 provided therein, the right end of each of cylinders 117 being closed by a threaded plug 118. An axial opening 119 through each plug 118 communicates with cylinders 117. Means for introducing a pressure fluid into cylinders 117 is provided in the form of rigid manifolds 120 connected to plugs 118 and by an interconnecting flexible manifold 121.

A piston 122 is slidably positioned within each of cylinders 117 and is arranged to contact compression ring 115 and to thereby impart an axial force to packing 114. Prior to installation of this apparatus, pistons 122 and compression ring 115 are retained to the right and away from packing 114 by screws 123 which are inserted through openings 124 in housing 100 into threaded holes 116 in ring 115.

In operation, the apparatus of Figures 8-9 is initially opened using hydraulic ram 110 and is positioned about pipe 113. Ram 110 is then actuated to close the apparatus about pipe 113 and retaining pin 106 is inserted into closure pads 104 and 105. After removing screws 123, a pressurized fluid is transmitted to cylinders 117 through manifolds 120 and 121, causing leftward engaging movement of pistons 122 and ring 115. This movement axially compresses packing 114, causing it to deform radially inward into sealing engagement with pipe 113.

If a permanent installation is desired when installing any of the foregoing devices, a hardenable fluid such as an epoxy resin may be used as the piston pressurizing fluid.

WHAT WE CLAIM IS:—

1. Apparatus for sealing a portion of the external surface of a tubular member, comprising a segmented housing adapted for clamping about a tubular member; at least one resilient packer adapted for mounting about the external surface of said tubular member within said housing; and means connected to said housing for applying axial force to said packer thereby axially to compress and sealingly engage said

packer with said external surface of said tubular member, said means including at least one fluid pressure-actuated piston.

2. Apparatus according to claim 1, having first and second resilient packers adapted for mounting about said tubular member at longitudinally spaced apart positions within said housing, and individual means, each including at least one fluid pressure-actuated piston, for applying axial force to the respective packers.

3. Apparatus according to claim 1 or 2, wherein the or each said means for applying axial force to a packer includes a plurality of cylinders in said housing, said cylinders being longitudinally aligned with and circumferentially spaced apart within said housing and each having a piston movable therein to exert an axial force upon the associated packer.

4. Apparatus according to claim 3, including means for distributing pressurized fluid amongst said cylinders for activating said pistons.

5. Apparatus according to claim 2, or either of claims 3 and 4 when dependent on claim 2, including two sets of slips respectively mounted in said housing at longitudinally spaced points, each set being arranged to be moved radially into engagement with said tubular member upon actuation thereof by an individual one of said force-applying means.

6. Apparatus according to claim 5, wherein the force-applying means associated with a set of slips and a packer is disposed between such set of slips and the packer and is arranged to exert axial separating forces upon the associated packer and set of slips.

7. Apparatus according to claim 6, including means for applying substantially equal fluid pressures to each of said force-applying means.

8. Apparatus according to claim 2 or any claim dependent thereon, including longitudinal seal means extending between said packers at the adjacent surfaces of said segments of said housing in the closed position thereof.

9. Apparatus according to any one of claims 1 to 8, including means for hydraulically closing said segmented housing about said tubular member.

10. Apparatus according to claim 9, wherein said segmented housing is formed of a plurality of partial cylindrical segments longitudinally pivotally interconnected and arranged to be laterally opened to receive said tubular member.

11. Apparatus according to claim 10, including mating closure pads extending from the segments of said housing which are arranged for lateral opening and a retainer pin arranged to be inserted through

Figures 4 and 5, and described above, or may assume any similar tubular shape.

A generally cylindrical compression ring 115 is slidably positioned within housing 100 adjacent the right end of packing 114 and is arranged to transmit an axial force to packing 114. Ring 115 is formed in two semi-cylindrical mating halves so that it may be conveniently opened and fitted over pipe 113 when the apparatus is installed. Each half of ring 115 is provided with a radially directed threaded hole 116, arranged to receive a retainer screw as described below.

The right end of housing 100 has a plurality of longitudinally aligned cylinders 117 provided therein, the right end of each of cylinders 117 being closed by a threaded plug 118. An axial opening 119 through each plug 118 communicates with cylinders 117. Means for introducing a pressure fluid into cylinders 117 is provided in the form of rigid manifolds 120 connected to plugs 118 and by an interconnecting flexible manifold 121.

A piston 122 is slidably positioned within each of cylinders 117 and is arranged to contact compression ring 115 and to thereby impart an axial force to packing 114. Prior to installation of this apparatus, pistons 122 and compression ring 115 are retained to the right and away from packing 114 by screws 123 which are inserted through openings 124 in housing 100 into threaded holes 116 in ring 115.

In operation, the apparatus of Figures 8-9 is initially opened using hydraulic ram 110 and is positioned about pipe 113. Ram 110 is then actuated to close the apparatus about pipe 113 and retaining pin 106 is inserted into closure pads 104 and 105. After removing screws 123, a pressurized fluid is transmitted to cylinders 117 through manifolds 120 and 121, causing leftward engaging movement of pistons 122 and ring 115. This movement axially compresses packing 114, causing it to deform radially inward into sealing engagement with pipe 113.

If a permanent installation is desired when installing any of the foregoing devices, a hardenable fluid such as an epoxy resin may be used as the piston pressurizing fluid.

WHAT WE CLAIM IS:—

1. Apparatus for sealing a portion of the external surface of a tubular member, comprising a segmented housing adapted for clamping about a tubular member; at least one resilient packer adapted for mounting about the external surface of said tubular member within said housing; and means connected to said housing for applying axial force to said packer thereby axially to compress and sealingly engage said

packer with said external surface of said tubular member, said means including at least one fluid pressure-actuated piston.

2. Apparatus according to claim 1, having first and second resilient packers adapted for mounting about said tubular member at longitudinally spaced apart positions within said housing, and individual means, each including at least one fluid pressure-actuated piston, for applying axial force to the respective packers.

3. Apparatus according to claim 1 or 2, wherein the or each said means for applying axial force to a packer includes a plurality of cylinders in said housing, said cylinders being longitudinally aligned with and circumferentially spaced apart within said housing and each having a piston movable therein to exert an axial force upon the associated packer.

4. Apparatus according to claim 3, including means for distributing pressurized fluid amongst said cylinders for activating said pistons.

5. Apparatus according to claim 2, or either of claims 3 and 4 when dependent on claim 2, including two sets of slips respectively mounted in said housing at longitudinally spaced points, each set being arranged to be moved radially into engagement with said tubular member upon actuation thereof by an individual one of said force-applying means.

6. Apparatus according to claim 5, wherein the force-applying means associated with a set of slips and a packer is disposed between such set of slips and the packer and is arranged to exert axial separating forces upon the associated packer and set of slips.

7. Apparatus according to claim 6, including means for applying substantially equal fluid pressures to each of said force-applying means.

8. Apparatus according to claim 2 or any claim dependent thereon, including longitudinal seal means extending between said packers at the adjacent surfaces of said segments of said housing in the closed position thereof.

9. Apparatus according to any one of claims 1 to 8, including means for hydraulically closing said segmented housing about said tubular member.

10. Apparatus according to claim 9, wherein said segmented housing is formed of a plurality of partial cylindrical segments longitudinally pivotally interconnected and arranged to be laterally opened to receive said tubular member.

11. Apparatus according to claim 10, including mating closure pads extending from the segments of said housing which are arranged for lateral opening and a retainer pin arranged to be inserted through



said closure pads to secure said housing about said tubular member.

12. Apparatus according to claim 11, including means for hydraulically inserting said retainer pin into said closure pads.

13. Apparatus according to claim 2 or any claim dependent thereon, wherein said housing is provided with an opening between said first and second packers to allow access to said tubular member when said housing is in the closed position.

14. Apparatus for sealing a portion of the external surface of a tubular member, substantially as described with reference to and as shown in Figures 1 to 3 of the accompanying drawings.

15. Apparatus for sealing a portion of the external surface of a tubular member, substantially as described with reference to and as shown in Figure 6 of the accompanying drawings.

16. Apparatus for sealing a portion of the external surface of a tubular member, substantially as described with reference to and as shown in Figure 7 of the accompanying drawings.

17. Apparatus for sealing a portion of the external surface of a tubular member, substantially as described with reference to and as shown in Figures 8 and 9 of the accompanying drawings.

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