EXTENSIBLE COUPLING FOR WELL PIPES

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Filed Oct. 29, 1964

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EXTENSIBLE COUPLINGS FOR WELLPIPES

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Filed Oct. 29, 1964, Ser. No. 407,468
13 Claims. (Cl. 175—5)

This invention relates to extensible couplings for pipe strings, and more particularly to a form of extensible coupling, commonly referred to as "slack joint," installed in a drill pipe string being operated from afloat-type drilling platforms during drilling of wells in submerged lands.

In drilling wells by the conventional rotary method from a floating drilling platform, the platform will be subjected to vertical movements in response to the passage of waves over the surface of the water body on which it is afloat. This necessarily produces a corresponding up and down movement of the drill pipe string, which is a serious hindrance to maintenance of the drilling operation, since upward movements tend to pull the bit and drill collars off bottom while downward movement may tend to apply undue downward pressure on the drill string and the bit.

Various types of "slack joints" have heretofore been employed to overcome this difficulty by providing an extensible coupling in the drill pipe string which will allow for the vertical movements of the floating platform, while maintaining rotative movement throughout the drill string necessary to turn the drill bit. Such conventional joints employ various forms of splined connections between telescoping members of the coupling to accommodate the longitudinal movement which occurs. However, such conventional couplings are subject to very severe wear and to unbalanced pressure forces such that they must be replaced frequently and may, in some instances, become broken by reason of the extensive wear thereof.

Accordingly, it is a primary object of the present invention to provide an improved form of extensible coupling which overcomes the deficiencies of more conventional couplings.

An important object is to provide a coupling in which the internal and external pressure forces are balanced to permit free relative movement of the coupling members under all conditions.

A further object is to provide a coupling in which the spline connection is enclosed within a body of hydraulic fluid which serves as a lubricant for the spline members and as a pressure transfer medium in connection with the balancing of the pressures across the coupling.

Yet another object is to provide in a coupling of the character described, a spline connection in which the male spline member comprises a plurality of longitudinally aligned cylindrical pins, each of which is enclosed by an anti-friction bearing which engages the walls of the female spline grooves to assure substantially free relative movement of the members.

Still another object of this invention is the provision of a hydraulic fluid-containing chamber enclosing the spline connection, the chamber being defined by upper and lower seal elements arranged between the coupling members above and below the spline connection, one of the seal elements being in the form of an annular piston slidably disposed between the coupling members and exposed to fluid pressure externally of the coupling, whereby to maintain a balancing pressure on the confined hydraulic fluid corresponding to the external fluid pressure.

Other and more specific objects and advantages of this invention will become more readily apparent from the following detailed description which illustrates a useful embodiment in accordance with this invention.

In the drawing:

FIG. 1 is a generally diagrammatic view of a marine drilling operation illustrating an extensible coupling in accordance with this invention, installed in a drill pipe string being operated in a well;

FIG. 2 is a longitudinal quarter sectional view of an extensible coupling in accordance with this invention;

FIG. 3 is a cross-sectional view taken generally along line 3—3 of FIG. 2;

FIG. 4 is a longitudinal cross-sectional view of one of the pin members forming the male spline member of the coupling;

FIG. 5 is a cross-sectional view taken along line 5—5 of FIG. 4; and

FIG. 6 is a fragmentary, quarter sectional view on a larger scale of a portion of the coupling shown in FIG. 2.

Referring first to FIG. 1, there is shown a marine drilling operation in which drilling of a well W is being conducted in a sub-bottom land body L from a drilling vessel V, which is afloat on the surface of the over-lying water body B. Vessel V has a vertical opening O therethrough, from which a conductor pipe P extends into land body L and through which drilling operations are conducted from the vessel, the latter being free to move up and down relative to the upper end of pipe P in response to wave action. A conventional drill pipe string D is shown extending from the vessel through conductor pipe P, into well W and is fitted at its lower end with a drill bit R above which are positioned a plurality of conventional drill collars C. The upper end of the drill pipe string will normally be secured to or suspended from the vessel so as to be subject to the vertical movements of the latter. Interposed in the drilling string immediately above drill collars C, is an extensible coupling or slack joint in accordance with this invention, designated generally by the numeral 10.

As best seen in FIGS. 2 to 6, inclusive, extensible coupling 10 comprises a tubular outer member 11 and a tubular inner member 12 telescopically received in the bore 11a of the outer member. The upper or outer end of inner member 12 is enlarged somewhat in external diameter to form a socket portion 13 defining downwardly facing annular shoulder 14 engageable by the upper end of outer member 11 to limit relative longitudinal movement of the members toward each other. Socket portion 14 is internally threaded at 15 to receive the lower end of the next adjacent section of drill pipe P. The lower end of outer member 11 is internally threaded at 16 to receive a double-ended externally threaded bushing 17 by which the outer coupling member is connected to the box portion 18 of the subadjacent drill collar C.
The exterior of inner member 12 is provided with a plurality of angularly spaced elongate grooves 20 which extend longitudinally of the coupling member for a length sufficient to accommodate to the designed "stroke", or relative longitudinal movement of the coupling members. In the illustrative embodiment three grooves 20, which comprise three closely spaced parallel grooves, are shown spaced on 120° centers. It will be understood, however, that a greater or lesser number of such spline grooves may be provided. At least one obviously must be used, but the larger number is employed to better balance the forces to which the coupling will be subjected. Ordinarily the length of groove 11 will be made to correspond substantially to the anticipated extent of the rise and fall of the vessel due to wave action to which it will be subjected. Each of the grooves 20 is generally rectangular in cross-section and terminates in upper and lower ends 21 and 22, respectively, which, as will appear, form stops for limiting longitudinal travel between the coupling members. In most cases, however, shoulder 14 will serve as the upper stop for limiting relative inward travel of the members. Bronze or other type wear rings 23-23 are disposed in the exterior of inner member 12 immediately above and below end walls 21, 22, respectively, and grooves 24-24 to project slightly therefrom in order to slantly engage the wall of bore 11c of the outer member.

Each of the male spline members which cooperate with the corresponding female spline grooves 20, comprises a plurality of closely spaced longitudinally aligned pins 25, each having an externally threaded head 26 adapted to be screwed into suitable tapped radial openings 27 provided through the wall of outer member 11. Each of the pins 25 includes a cylindrical shank 28, smaller in cross-sectional diameter than head 26, which projects from outer member 11 into the related groove 20. The exterior of shank 28 forms the inner race for an anti-friction bearing, such as the roller bearing 29, which is, in turn, enclosed by a collar 30 defining the outer race for the bearing. A retainer ring 31 is suitably mounted over the end of shank 28 to retain the bearing in place on the shank. The outer diameter of collar 30 is dimensioned to provide a snug rolling fit between pins 25 and the side walls of grooves 20, so as to permit relatively friction-free movement of one coupling member with respect to the other. It will be evident that pins 25 cooperate with grooves 20 to constrain movement between the coupling members to relative longitudinal movement but preventing relative rotation between the coupling members.

The lowermost one of the series of pins forming the male spline member is designated by the numeral 32 and is provided with a shank 33 having a larger cross-section than shanks 28, the external diameter of shank 33 being substantially equal to the external diameter of bearing collars 30, so as to have a moderately close sliding fit in groove 20.

With the arrangement of pins 25 and 32, as described above, it will be seen that the "stroke" or longitudinal travel between the coupling members will be limited at one end by engagement of pin 32 with lower end wall 22 and at the other end by engagement of the uppermost pin 25 with upper end wall 21 or, as noted previously, by engagement of the upper end of outer member 11 with shoulder 14. The number of pins 25 and 32 forming the male spline members may, of course, be varied, depending upon the loads likely to be encountered in a particular case, the number illustrated being exemplary only. Each of the pins 25 and 32 is provided with an annular packing 34, such as a O-ring, to seal between the pin and the opening 27 in which it is installed.

By reason of their threaded connection into outer coupling member 10, pins 25 may be readily replaced when worn or broken. To prevent their becoming loosened or unscrewed due to vibration and the like to which the coupling is subjected during use, the pins are held in place by a series of metal bands 35 which are flush-seated in annular grooves 36 of suitable depth cut in the outer surface of outer member 11 and in kerfs 37 provided in the outer ends of pins 25. The ends of each band are welded together at 38. When necessary to replace pins 25, the weld is cut or broken and band 35 removed.

A packing, such as a conventional O-ring, is suitably mounted between the splines and are shown spaced above the upper ends of grooves 20, preferably above upper wear ring 23, to form an upper fluid-tight seal between the coupling members. The external diameter of inner coupling member 12 has a reduced diameter portion 41 extending downwardly from a point just below lower wear ring 23 to form a somewhat widened annular space 42 between the coupling members and defining a downwardly facing annular shoulder 43 at the upper end of space 41. A small annular piston 44 is slidably disposed about reduced diameter portion 41 in space 42 and has limited longitudinal travel therein, shoulder 43 forming an upper stop therefor and a snap ring 45 mounted to project from the exterior of reduced diameter portion 41 at a point a short distance below shoulder 43 forming a lower stop for piston 44. Snap ring 45 is held against downward dislodgment by means of a locking collar 46 which is pinned to inner members 11, 22, being mounted in corresponding grooves 24-24 to project slightly therefrom in order to slantly engage the wall of bore 11c of the outer member.

A plurality of ports 49 are provided through the wall of outer coupling member 11 providing fluid pressure communication between the exterior of outer coupling member and space 42 below piston 44. A lip-type annular seal 50 is mounted between the inner and outer coupling members at a point below ports 49, to seal off the annular space between the coupling members below ports 49. As illustrated, seal 50 is secured to a metal support ring 51 which is clamped between the upper end of bushing 17 and a shoulder 52 formed in the bore wall of the outer coupling member. The free end of lip seal 50 fits tightly against the exterior of a reduced diameter extension 53 of inner coupling member 11. It is free to move upwards and downwards through the bore of lip seal 50 while the latter maintains fluid-tight sealing engagement therearound.

The portion of the annular space between the inner and outer coupling members and extending between upper seal 40 and piston seal 44 defines a chamber 54 adapted to contain a body of hydraulic fluid F, such as conventional lubricating oil or grease, which will be confined between the upper and lower seals. Spaced filler openings 55-55 are provided through the wall of outer coupling member 11 to permit introduction of fluid F into chamber 54. Screw plugs 56-56 serve to close openings 55-55 after chamber 54 has been filled with liquid F. The latter has a dual function. It serves as a lubricant to reduce wear of the spline connection between the coupling members and as a pressure balancing medium to equalize the pressure between the interior of chamber 54 and the piston seal 44. By providing the chamber 54 filled with liquid F, the interior of chamber 54 and the piston seal 44 are maintained at substantially equal pressure, providing sealing engagement therebetween in all positions of the coupling. Pressures in the two chambers will be substantially equal and may be varied and controlled by adjustment of the fluid level in the pressure chambers.
tials which could be damaging to the tool and would interfere with the free movement of the coupling members.

In operation of the device, coupling 10 will be installed in the drill string, as illustrated in FIG. 1, and will form a part thereof when not in use. The vertical movements of the floating vessel occasioned by the passage of waves thereunder will produce corresponding extension and retraction of the coupling members.

When lowering the pipe string into the well, the weight of the bit and drill collars will extend the coupling, bringing the cylindrical shanks 33 of pins 32 into engagement with lower end walls 22 of grooves 20. Since this load will be carried by shanks 33 of pins 32, the provision of the enlarged diameter for shanks 33 will provide the necessary strength to support the load of this portion of the drill string. The same situation will, of course, occur when the drill string is pulled from the well, the load of the drill collars and bit hanging on end walls 22 by engagement therewith of shanks 33.

In addition to the pressure equalizing function of ports 46 and piston 44 acting on the body of hydraulic fluid F, it will be evident that both the interior and outer coupling members will have pressure-effective areas at their opposite ends which are substantially equal, thereby providing for a fully pressure-balanced structure both internally and externally and permitting free movement between the coupling members in response to the vertical movements of the vessel to which the drill pipe string is secured.

It will be understood that various changes and modifications may be made in the details of the illustrative embodiment within the scope of the appended claims but without departing from the spirit of the invention.

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

1. An extensible coupling from a floating vessel, having its upper end connected to the vessel,
(a) a rotary drill pipe string having its upper end connected to the vessel,
(b) a drill bit carried by the lower end of said drill pipe string for drilling in submated land, and
(c) an extensible coupling mounted between sections of said pipe string to accommodate vertical movements of the vessel relative to the land while maintaining said drilling bit in rotary drilling contact with said land, said coupling comprising:
(d) telescopically engaged inner and outer tubular members,
(e) spline means forming a non-rotating longitudinally slidable connection between said members, and including means limiting relative longitudinal movement of the members,
(f) longitudinally spaced seal means arranged between said members on opposite sides of said spline means to define a fluid-confining chamber therebetween,
(g) a body of hydraulic fluid confined within said chamber,
(h) one of said seal means comprising an annular piston longitudinally slidable disposed between said members,
(i) an additional seal means arranged between said members in spaced relation to said piston, and
(j) port means in said outer member providing fluid communication between the exterior thereof and the interior thereof of said piston and said additional seal means.

2. An extensible coupling for pipe strings according to claim 1 wherein said spline means comprises,
(a) longitudinally extending groove means in the exterior of said inner coupling member, and
(b) pin means mounted on said outer coupling member and having a portion projecting radially into said groove means.

3. An extensible coupling for pipe strings according to claim 2 wherein said projecting portion of the pin means carries anti-friction bearing elements.

4. An extensible coupling according to claim 2 wherein said limiting means comprises walls defining the opposite ends of said groove means.

5. An extensible coupling for pipe strings, comprising,
(a) telescopically engaged inner and outer tubular members,
(b) means carried by the outer ends of the members for connecting them to adjacent sections of a pipe string,
(c) spline means on the members forming a non-rotating longitudinally slidable connection between said members and including means limiting relative longitudinal movement of the members,
(d) longitudinally spaced annular seal means arranged between said members on opposite sides of said spline means to define a fluid-confining chamber therebetween,
(e) a body of hydraulic fluid confined within said chamber,
(f) one of said seal means comprising an annular piston longitudinally slidable disposed between said members,
(g) an additional seal means arranged between said members in spaced relation to said piston, and
(h) port means in said outer member providing pressure fluid communication between the exterior thereof of said piston and said additional seal means.

6. An extensible coupling for pipe strings, comprising,
(a) telescopically engaged inner and outer tubular members,
(b) means carried by the outer ends of the members for connecting the members to adjacent sections of a pipe string,
(c) a plurality of equiangularly spaced elongating longitudinally extending grooves generally rectangular in cross-section in the exterior of said inner member,
(d) said grooves terminating in opposite end walls forming longitudinally spaced stops in said grooves,
(e) a plurality of longitudinally aligned pins extending from said outer member and having cylindrical end portions projecting into said grooves to constrain movement between said members to relative longitudinal movement limited by said stops,
(f) upper and lower seal means arranged between said members above and below the ends of said groove means to form fluid-tight seals between said members and defining a fluid-confining chamber therebetween,
(g) a body of hydraulic fluid confined within said chamber,
(h) said lower seal means comprising an annular piston longitudinally slidable disposed between said members,
(i) port means in said outer member providing fluid communication between the exterior thereof and the interior thereof below said piston, and
(j) an additional seal means arranged between said members below said port means.

7. An extensible coupling according to claim 6 wherein said pin means carry roller bearing elements engageable with the side walls of said groove means.

8. An extensible coupling for pipe strings according to claim 6 having wear rings arranged between said members above and below the ends of said grooves.

9. An extensible coupling for pipe strings according to claim 6 wherein said additional seal means comprises a lip-type seal having a flexible annular lip having slidable sealing engagement with said inner member.

10. An extensible coupling for pipe strings according to claim 6 wherein said hydraulic fluid is a lubricant.

11. An extensible coupling for pipe strings according to claim 6 wherein said inner member carries an external shoulder means adjacent its upper end abuttable by
the upper end of said outer member to limit longitudinal
travel of the members toward each other.

12. An extensible coupling for pipe strings according
to claim 6 wherein each of said pins except the lower-
most one carries roller bearings about their respective
cylindrical portions engageable with the side walls of the
grooves.

13. An extensible coupling for pipe strings according
to claim 12 wherein the cross-sectional area of the cylin-
drical portion of said lowermost one of said pins is greater
than that of the others of said pins.

References Cited by the Examiner

UNITED STATES PATENTS

2,284,199 5/1942 Gruener .................. 64—23
2,606,003 8/1952 McNell .................. 175—7
2,645,459 7/1953 Sutliff .................. 175—297
2,995,908 8/1961 Mazziotti et al. ........... 64—23
3,025,916 5/1962 Frick .................. 175—7
3,211,224 10/1965 Lacy .................. 166—5

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