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(54) Pipe string tie-back connector.

(57) A pipe connector (8) for establishing a remote connection between a riser pipe (12) and a subsea wellhead (10). The connector comprises a plurality of annular elements (40, 52, 54) interconnected by a differential thread system (58, 60) which facilitates making up and breaking the riser-wellhead connection from a drilling platform or other surface location without rotation of the riser or diver assist. The preferred embodiment also includes a provision for establishing a metal-to-metal seal (66) between the connector and the wellhead, and a guide assembly (16) to assure proper alignment of the connector with the wellhead prior to completing the connection.

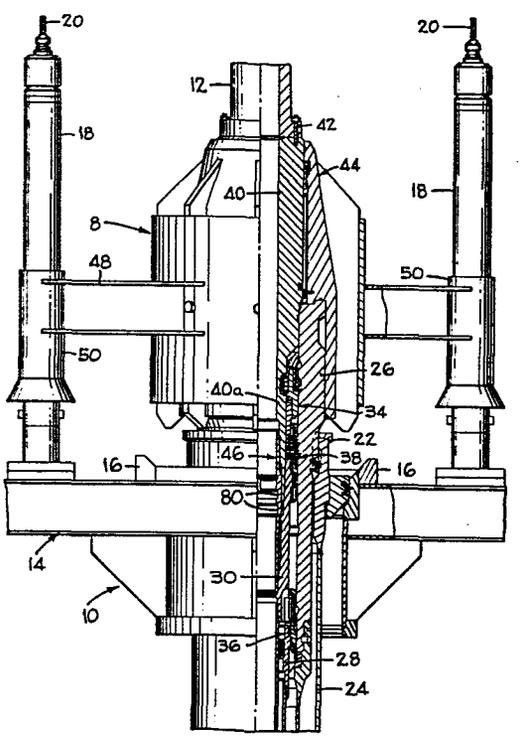

FIG_1

EP 0 109 541 A1

PIPE STRING TIE-BACK CONNECTOR

Field of the Invention

This invention relates to pipe connectors, and more particularly to tie-back connectors for joining a riser pipe string to a casing hanger or other element in a subsea wellhead.

Description of the Prior Art

The product of oil and gas from offshore wells is an established major endeavor of the petroleum industry, and requires techniques and apparatus for connecting strings of pipe to subsea wellheads to provide conduits between the wellheads and the frilling and/or production platforms at the water surface. Whereas divers can be used to make up these connections at relatively shallow depths, their employment is very costly and involves undesirable elements of risk, thereby encouraging the development of remotely operable connector systems that do not require diver assist. The search for and production of oil in deep water, and especially at depths beyond practical diver operations, has increased the need for well equipment that can be installed and operated entirely by remote control from a surface facility, and the prior art reflects considerable development in that area.

One of the prior types of pipe connectors for this purpose comprises a union nut style of threaded

components that requires rotation of a relatively large ring or sleeve element to make up the connection. Not only is it difficult to properly align the riser with the wellhead so that cross-threading will not occur, it also is troublesome to rotate the ring or sleeve without the aid of special equipment and skilled personnel. Another problem with union nut connectors is that their single shoulder is highly loaded when the connection is completed, and this stress results in an undesirably short fatigue life.

Another type of known riser connector employs a turnbuckle-style assembly with right and left hand threads between a rotatable sleeve and the two pipe elements that are to be connected. Although the principle of this connector type is sound, in practice it requires undesirably high torque in order to produce the pre-load required for proper functioning.

In a third category of riser connectors the entire riser must be rotated in order to make up the connection at the wellhead. Not only is it difficult to handle these very heavy, and often quite lengthy and complex, strings of pipe, their rotation can result in fatally galling the metal-to-metal seal that must be employed at the wellhead, thereby requiring disconnection and removal of the riser, replacement of the seal, and another attempt to establish a fluid-tight joint.

Summary of the Invention

The present invention overcomes the foregoing

problems and disadvantages by providing a riser tieback connector with a differential thread system that facilitates landing, locking and sealing the riser to the wellhead without rotation of the riser, and that results in a releasable connection with substantially less stress concentration for a given pre-load than that produced by a union nut type connector. The differential thread system in the connector of the present invention is employed to first lock the connector to the wellhead, and then to draw the connector seal surface axially into fluid-tight metal-to-metal contact with a sealing surface in the wellhead, both events being accomplished without the possibility of galling or otherwise damaging the seal surface such as might occur when they are joined by relative rotation.

The tie-back connector of the present invention includes an annular housing which, in use, is attached to the lower end of the riser, an annular landing body below the housing with a shoulder that seats the connector on a complementary stop shoulder in the wellhead, a rotatable sleeve interconnecting the housing and the landing body by means of a differential thread system, and a lock-down ring that is expanded by the sleeve to lock the connector to the wellhead.

Operational steps involved in using this tie-back connector to interconnect a riser with a wellhead include lowering the riser until the shoulder of the landing body comes to rest on the wellhead stop shoulder, rotating the

connector sleeve to expand the lock-down ring into a mating recess in the wellhead, thus locking the connector to the wellhead, and rotating the connector sleeve further to move the housing axially into metal-to-metal sealed contact with the wellhead. Rotation of the connector sleeve is accomplished by means of a torque tool attached to a drill pipe string that is lowered inside the riser, releasably connected to the sleeve, and then rotated with respect to the connector housing, landing body and lock-down ring.

In its preferred form, the tie-back connector is associated with a guide assembly that is attached to the riser to seat against the wellhead and serve as a centralizer for the connector housing. Trash seals between the guide assembly and the wellhead protect the tie-back connector and other components of the installation from corrosion, a valuable additional feature should it become necessary to disconnect and remove the riser from the wellhead, for example if reinstallation of a subsea blowout preventer is required.

Brief Description of the Drawings

Figure 1 is a side elevation, partially in section, of a subsea wellhead installation and a riser releasably attached thereto by means of a tieback connector according to the present invention.

Figure 2 is a fragmentary view, in side elevation and on an enlarged scale, of the Figure 1 installation, showing in better detail the tie-back connector components.

The Preferred Embodiment

Attention is directed first to Figure 1 which illustrates a riser tie-back connector assembly 8 interconnecting a subsea wellhead assembly 10 and a riser 12. The wellhead assembly comprises a template 14, a guide assembly 16, guide posts 18 secured to the template 14 and anchoring guide cables 20 that extend to the surface drilling platform (not shown), a conductor housing 22 mounted on top of a conductor pipe 24, a wellhead 26 within and supported on the conductor housing 22, a first or outer casing hanger 28 supported in the wellhead 26 near the lower end thereof, and a second or inner casing hanger 30 also supported in the wellhead 26.

The second casing hanger 30 is locked into the wellhead 26 by a lock-down assembly 34, which assembly 34 also is utilized to transfer riser loads through the hanger 30 to the wellhead 26, and packoff assemblies 36, 38 establish a fluid-tight seal between the wellhead 26 and the first casing hanger 28, and between the wellhead 26 and the second casing hanger 30, respectively all in a conventional manner.

The riser tie-back connector assembly 8, which will be described in more detail with reference to Fig. 2, includes an annular housing 40 that is attached at its upper end by bolts 42 to the lower end of the riser 12. In the illustrated embodiment, the housing 40 is surrounded by a guide assembly 44, and the lower portion 40a of the housing 40 functions as an element of a

lock-down assembly 46 for the tie-back connector, whereby the housing 40, the guide assembly 44, and the lock-down assembly 46 together constitute the tie-back connector assembly 8. Mounted on this connector assembly 8 is a guide frame 48 to which are fixed a plurality of guide sleeves 50 (only two shown) for guiding the assembly 8 on its descent from the surface platform to the wellhead assembly 10.

With reference now to Figure 2, the tie-back connector lock-down assembly 46 comprises the lower portion 40a of the housing 40, an annular landing body 52, a rotatable sleeve 54 and a lock-down ring 56. The upper end portion of the sleeve 54 is connected to the housing 40 by threads 58, and the landing body 52 is connected by threads 60 to the lower portion of the sleeve 54. The threads 58, 60 are so related that they constitute a differential thread system, for example by differing in their pitch, whereby rotation of the sleeve 54 with respect to the housing 40 and landing body 52 in one direction tends to pull the housing and landing body towards each other, and rotation in the opposite direction tends to push the housing and landing body apart. The landing body 52 includes an annular shoulder 52a that cooperates with a complementary shoulder 30a on the second or inner casing hanger 30, and the landing body is keyed to the hanger 30 at 62 to prevent rotation of the landing body with respect to the hanger.

The lock-down ring 56, which has a single axial

split and is of resilient construction, is carried on the sleeve 54 surrounding its reduced outside diameter area 54a. The upper end of the area 54a is formed by an annular frusto-conical shoulder 54b which functions to cam the ring 56 outwardly from a retracted condition (not shown) into an expanded condition (Fig. 2) as the sleeve 54 is threaded downwardly with respect to the landing body 52.

The lower end of the housing 40 is tapered to cooperate with an annular shoulder 30a on the inside surface of the hanger 30 to establish a metal-to-metal seal at 66 between the housing and hanger. Annular resilient seals 68 just above the metal-to-metal seal 66 provide a fluid-tight barrier between the housing 40 and hanger 30 prior to establishing the metal-to-metal seal 66. The sleeve 54 similarly carries annular resilient seals 70 at its lower end to effect sealing engagement with the hanger 30, and an annular resilient seal 72 at the upper end of the sleeve 54 provides the requisite trash seal between the sleeve and the housing 40.

Operation

With respect to the structures illustrated in the drawings, after the casing hanger 30 has been locked down by means of the lock-down assembly 34 and the packoff assembly 38, the tie-back connector assembly 8 and the riser 12 to which it is attached are lowered to the subsea wellhead assembly 10. The guide assembly 44 contacts and seats on the wellhead 26, thus serving as a centralizer

for the housing 40. A downward force is then applied to the housing 40 through the riser 12, pushing the housing and the tie-back connector lock-down assembly 46 further into the wellhead 26 until the landing body shoulder 52a lands and seats on the casing hanger shoulder 30a (Fig. 2).

A torquing tool (not shown) is then lowered through the riser 12 by means of a drill pipe string (not shown). When the tool arrives at the grooves 80 (Fig. 2) in the lock-down assembly sleeve 54, elements on the tool expand into these grooves and releasably lock the tool to the sleeve. The drill string is then rotated, thereby rotating the running tool and the sleeve 54. As the sleeve 54 rotates it moves downwardly within the landing body 52, thereby expanding the lock-down ring 56 into the mating grooves in the casing hanger 30 and securing the body 52 against upward movement. As rotation of the sleeve 54 is continued the differential threads 58, 60 cause the connector housing 40 to move downward until its lower end comes to rest on the hanger shoulder 30a, thereby establishing a metal-to-metal seal at 66 between the sleeve and the hanger. Accordingly, at this final position three seals exist between the connector assembly and the hanger 30, i.e. the two resilient seals 68 and the metal-to-metal seal 66, thereby assuring the maintenance of pressure integrity between the riser annulus and the exterior of the wellhead installation.

Although the best mode contemplated for carrying out the present invention has been herein shown and

described, it will be apparent that modification and variation may be made without departing from what is regarded to be the subject matter of the invention.

CLAIMS

1. A pipe string tie-back connector for interconnecting a riser pipe and a subsea wellhead without rotation of said riser pipe, said connector comprising:

a) a housing having means for attachment thereof to a riser pipe;

b) a landing body having means for seating the connector against a wellhead element;

c) means for interconnecting the housing and the landing body, said interconnecting means having differential threads engagable with said housing and said landing body; and

d) means for securing the landing body to a wellhead element to prevent rotational and axial movement of said landing body with respect to said wellhead element;

whereby with said connector positioned within a subsea wellhead rotation of said interconnecting means with respect to said housing and said landing body effects locking said connector to said wellhead.

2. A pipe string tie-back connector according to Claim 1 including means to establish a metal-to-metal seal between said connector and a wellhead element.

3. A pipe string tie-back connector according to Claim 2 wherein said metal-to-metal seal is established by rotation of the interconnecting means.

4. A pip string tie-back connector according to Claim 1 wherein said interconnecting means comprises a

sleeve with means for anti-rotational connection thereof to a drill pipe.

5. A pipe string tie-back connector according to Claim 4 wherein said sleeve is rotationally connected to the interior of said housing and said landing body by said differential thread means.

6. A pipe string tie-back connector according to Claim 1 wherein said means for securing said landing body to a wellhead element comprises an expandable lock-down ring.

7. A pipe string tie-back connector according to Claim 6 wherein said lock-down ring is expanded into locking engagement with said wellhead element by rotation of said interconnecting means relative to said landing body.

8. A pipe string tie-back connector according to Claim 1 wherein rotation of said interconnecting means with respect to said housing and said landing body also effects metal-to-metal fluid-tight contact between said connector and said wellhead.

9. A pipe string tie-back connector according to Claim 8 wherein said rotation of said interconnecting means first secures said landing body to said wellhead element and then effects a metal-to-metal seal between said housing and said wellhead element.

10. A method for connecting a riser pipe to a subsea wellhead without rotation of said riser pipe, comprising:

a) attaching a pipe connector assembly having a differential thread system to the riser pipe;

b) inserting at least a portion of said connector assembly into the wellhead;

c) rotating at least one internal element of said connector assembly from within said assembly to lock said assembly to said wellhead.

11. A method according to Claim 10 including the additional step of establishing a metal-to-metal seal between said assembly and said wellhead.

12. A method according to Claim 11 wherein said metal-to-metal seal is established by further rotation of said internal element after said assembly has been locked to said wellhead.

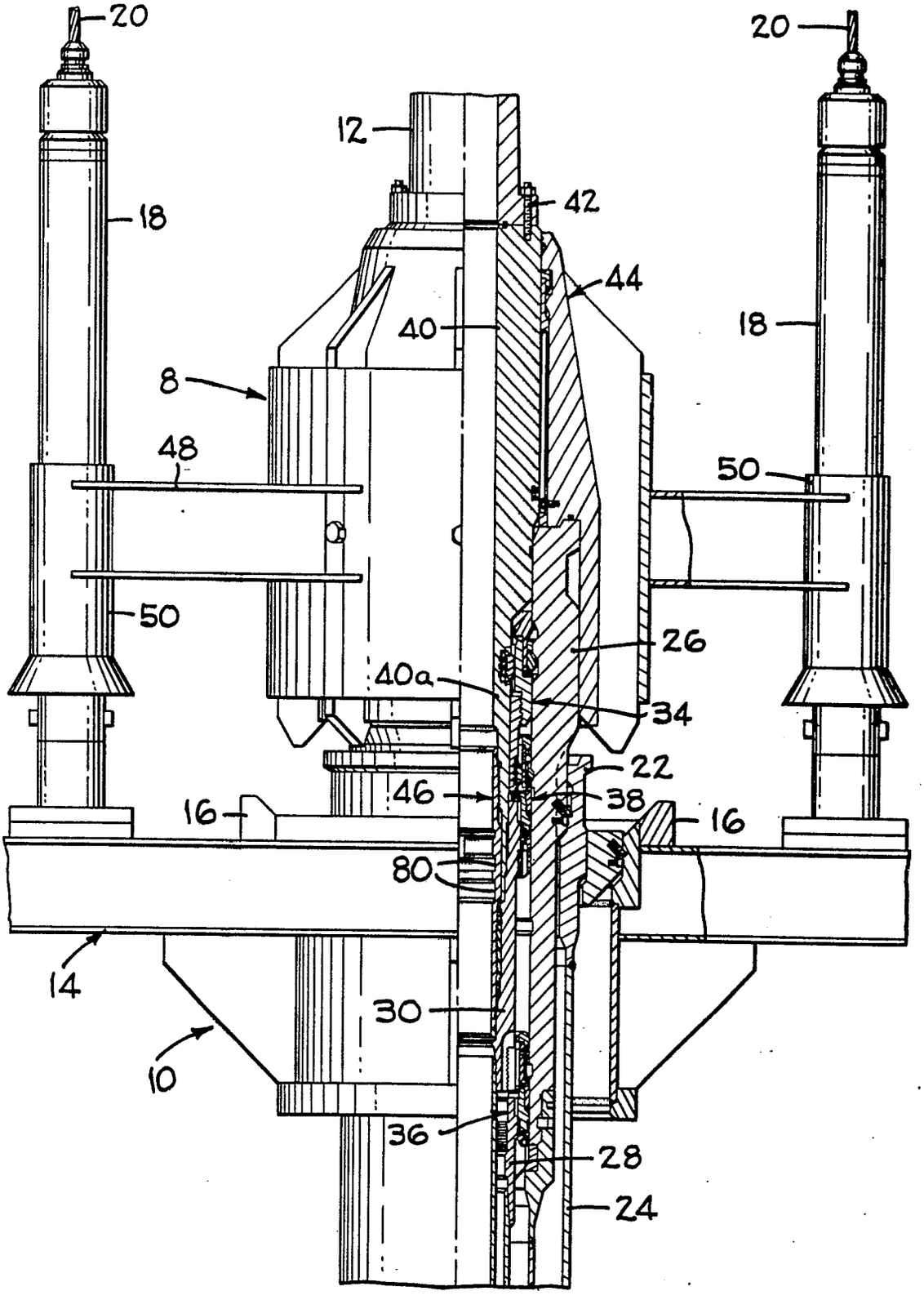
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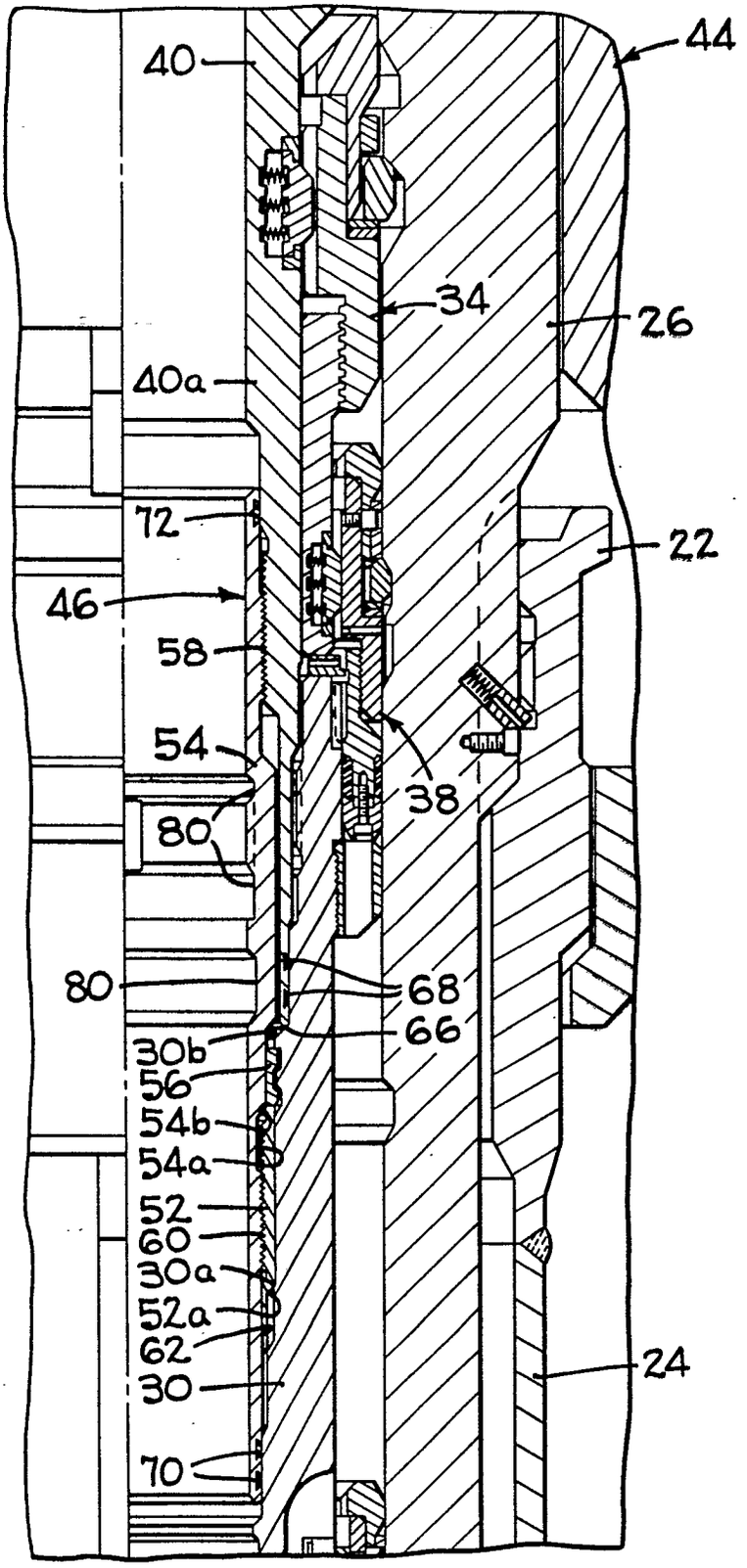
FIG_1

FIG_2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EUROPEAN SEARCH REPORT

Application number

EP 83 11 0271

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
Y	GB-A-2 094 430 (VETCO) * Whole document *	1,4,9-12	E 21 B 33/038
Y	EP-A-0 060 549 (FMC CORP.) * Page 5, line 30 - page 7, line 29; page 10, lines 29-38 *	1-3,5,8,10-12	
A	US-A-3 521 909 (BROWN) * Whole document *	1	
A	US-A-3 986 729 (TAYLOR) * Column 5, line 37 - column 6, line 22; figures 1,2 *	6	TECHNICAL FIELDS SEARCHED (Int. Cl. ³)
A	US-A-3 489 213 (HUTCHISON) * Column 3, lines 40-68; figures 2,3 *	6,7	E 21 B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	18-01-1984	PAUCNIK B.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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