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(54) **Pipe string tie-back connector.**

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Description

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 production 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 drilling 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.

British Patent 2 094 430 shows a torquing bushing which is threaded to a connector. After the connector has been put into place this bushing is unscrewed and dropped into the wellhead where it is then screwed into another thread.

Also, from the general art of pipe connectors, thread-type connectors are known. Thus, EP—A—0 060 549 describes a pipe connector employing a differential thread system.

Summary of the Invention

In accordance with this invention the above indicated problems in conjunction with a connector as defined in the introductory clause of claim 1 are solved by such a connector as it is defined by claim 1. Preferred embodiments are contained in the dependent claims.

The present invention overcomes the foregoing problems and disadvantages by providing a riser tie-back 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 lockdown 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 lockdown 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 lockdown 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 tie-back 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 lockdown 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 Figure 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 lockdown assembly 46 for the tie-back connector, whereby the housing 40, the guide assembly 44, and the lockdown 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 lockdown 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 lockdown 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 in groove 54a (not shown) into an expanded condition (Figure 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 sholder 30b 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 lockdown 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 lockdown assembly 46 further into the wellhead 26 until the landing body shoulder 52a lands and seats on the casing hanger shoulder 30a (Figure 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 (Figure 2) in the lockdown 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 lockdown 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 30b, there-

by 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.

Claims

1. A pipe-string tie-back connector (8) for interconnecting a riser pipe (12), and a subsea wellhead (10) without rotation of said riser pipe, said connector (8) comprising,

a) a housing (40) connected to said riser pipe,

b) a sleeve for connecting the housing and the wellhead, characterized in that

c) a landing body (52) is connected via a first thread (60) with said sleeve (54), said landing body having means (52a) for seating on a shoulder (30a) in a wellhead element (30),

d) said sleeve (54) is connected via a second thread (58) with said housing (40),

e) said first and said second thread form differential threads,

f) securing means (62) are provided for securing said landing body (52) to said wellhead element (30) and for preventing rotation of said landing body with respect to said wellhead element (30),

g) a locking split ring (56) is arranged with respect to said sleeve (54) in such a way that upon rotation of said sleeve (54) relative to said housing (40) and said landing body (52) said split ring (56) is expanded into a groove in said wellhead element (30) thereby locking the connector to said wellhead and a metal-to-metal seal (66) is established between a lower position (40a) of said housing (40) and another shoulder (30b) of said wellhead element,

h) means (80) for rotating said sleeve (54) relative to said housing (40) are provided.

2. A connector in accordance to claim 1 characterized in that said rotation of said sleeve (54) first secures said landing body (52) to said wellhead element (30) by seating said split ring (56) in said groove in said wellhead element (30) and then effects the metal-to-metal seal (66) between said housing and said wellhead element by pulling said housing towards said landing body.

3. A connector according to claim 1 or claim 2, characterized in that a groove (54a) is provided in said sleeve (54) for carrying the split ring in the unexpanded condition and that said split ring is moved out of that groove by abutment with said landing body (52) and is expanded by said sleeve into locking engagement with said groove in said wellhead element by continued rotation and threading of said sleeve into said landing body.

4. A connector in accordance with one of the preceding claims characterized in that a resilient seal (68) is provided in said housing, preferably on the lower end thereof, for establishing a fluid seal between said wellhead element (30) and said housing (40).

5. A connector in accordance with one of the preceding claims characterized in that a resilient seal (70) is provided on the lower end of the sleeve (54) for fluid sealing between the lower end of said sleeve (54) and said wellhead element (30).

6. A connector in accordance with one of the preceding claims, characterized in that a resilient seal (72) is provided on the upper end portion of said sleeve (54) for trash sealing between the sleeve (54) and the housing (40).

7. A method for connecting a riser pipe to the subsea wellhead without rotation of said riser pipe, using the apparatus in accordance with one of the preceding claims, said method comprising

a) attaching the pipe connector (8) to the riser pipe (12);

b) inserting the lower portion of said connector (8) into the wellhead and seating the landing body (52) on the first shoulder (30a);

c) rotating the sleeve (54) and pulling the housing (40) and the landing body (52) toward each other and expanding said split ring (56) and locking said connector (8) to said wellhead (10); and

d) continuing rotating said sleeve (54) and establishing the metal-to-metal seal (66) between said housing (40) and said second shoulder (30b) on said wellhead element (30).

Patentansprüche

1. Rohrstrang-Verbindungseinrichtung (8) zum Verbinden eines Steigrohres (12) mit einem Unterwasser-Förderkopf (10) ohne Rotation dieses Steigrohres, wobei diese Verbindungseinrichtung (8) enthält:

a) ein Gehäuse (40), welches mit diesem Steigrohr verbunden ist,

b) eine Hülse zum Verbinden des Gehäuses und des Förderkopfes, dadurch gekennzeichnet, daß:

c) ein Anschlagkörper (52) über ein erstes Gewinde (60) mit dieser Hülse (54) verbunden ist, wobei dieser Anschlagkörper Einrichtungen (52a) aufweist, um auf einer Schulter (30a) in einem Förderkopf-Element (30) aufzusitzen,

d) in diese Hülse (54) über ein zweites Gewinde (58) mit diesem Gehäuse (40) verbunden ist,

e) dieses erste und dieses zweite Gewinde als unterschiedliche Gewinde geformt sind,

f) Befestigungseinrichtungen (62) vorgesehen sind, um diesen Anschlagkörper (52) mit diesem Förderkopf-Element (30) zu verbinden und um die Rotation dieses Anschlagkörpers in bezug auf dieses Förderkopf-Element (30) zu verhindern,

g) ein geteilter Befestigungsring (56) in bezug zu dieser Hülse (54) in einer solchen Weise angeordnet ist, daß nach der Rotation dieser Hülse (54) relativ zu diesem Gehäuse (40) und diesem Anschlagkörper (52), dieser geteilte Ring (56) in eine Nut in diesem Förderkopf-Element (30) ausgedehnt wird, wobei die Verbindungseinrichtung mit diesem Förderkopf verbunden wird und eine Metall-zu-Metall-Dichtung (66) zwischen einer unteren Position (40a) dieses Gehäuses (40) und

einer weiteren Schulter (30b) dieses Förderkopf-Elementes gebildet wird,

h) Einrichtungen (80) zur Rotation diese Hülse (54) relativ zu diesem Gehäuse (40) vorgesehen sind.

2. Verbindungseinrichtung gemäß Anspruch 1, dadurch gekennzeichnet, daß:

diese Rotation dieser Hülse (54) zuerst diesen Anschlagblock (52) mit diesem Förderkopf-Element (30) verbindet, indem dieser geteilte Ring (56) in diese Nut in dieses Förderkopf-Element (30) gesetzt wird und dann die Metall-zu-Metall-Dichtung (66) zwischen diesem Gehäuse und diesem Förderkopf-Element bewirkt, indem dieses Gehäuse zu diesem Anschlagkörper gezogen wird.

3. Verbindungseinrichtung gemäß Anspruch 1 oder Anspruch 2, dadurch gekennzeichnet, daß:

eine Nut (54a) in dieser Hülse (54) vorgesehen ist, um den geteilten Ring im ungedehnten Zustand zu tragen und daß dieser geteilte Ring aus dieser Nut bewegt wird, durch ein Anstossen an diesen Anschlagkörper (52) und durch diese Hülse in einen verbindenden Eingriff mit dieser Nut in dieses Förderkopf-Element durch fortgesetzte Rotation und Einschrauben dieser Hülse in diesen Anschlagkörper gedehnt wird.

4. Verbindungseinrichtung gemäß mindestens einem der vorgehenden Ansprüche, dadurch gekennzeichnet, daß:

eine elastische Dichtung (68) in diesem Gehäuse vorgesehen ist, und zwar vorzugsweise an dessen unteren Ende, um eine flüssigkeitsdichte Dichtung zwischen diesem Förderkopf-Element (30) und diesem Gehäuse (40) zu bewirken.

5. Verbindungseinrichtung gemäß mindestens einem der vorgehenden Ansprüche, dadurch gekennzeichnet, daß eine elastische Dichtung (70) an dem unteren Ende der Hülse (54) vorgesehen ist, zur flüssigkeitsdichten Abdichtung zwischen dem unteren Ende dieser Hülse (54) und diesem Förderkopf-Element (30).

6. Verbindungseinrichtung gemäß mindestens einem der vorgehenden Ansprüche, dadurch gekennzeichnet, daß eine elastische Dichtung (72) an dem unteren Endteil dieser Hülse (54) zur Abdichtung zwischen dieser Hülse (54) und dem Gehäuse (40) vorgesehen ist.

7. Verfahren zum Verbinden eines Steigrohres mit einem Unterwasser-Förderkopf ohne Rotation dieses Steigrohrs, wobei eine Vorrichtung gemäß mindestens einem der vorgehenden Ansprüche verwendet wird und wobei dieses Verfahren folgende Schritte aufweist:

a) das Befestigen des Rohrverbinders (8) mit einem Steigrohr (12);

b) das Einführen des unteren Teils dieser Verbindungseinrichtung (8) in den Förderkopf und das Aufsetzen des Anschlagkörpers (52) auf der ersten Schulter (30a);

c) das Rotieren der Hülse (54) und Ziehen des Gehäuses (40) und des Anschlagkörpers (52) zueinander und das Ausdehnen dieses geteilten Rings (56) und das Befestigen dieser Verbindungseinrichtung (8) an diesen Förderkopf (10); und

d) das fortgesetzte Rotieren dieser Hülse (54) und das Aufbauen einer Metall-zu-Metall-Dichtung (66) zwischen diesem Gehäuse (40) und dieser zweiten Schulter (30b) auf diesem Förderkopf-Element (30).

Revendications

1. Connecteur de raccordement pour train de tiges (8) pour interconnecteur une colonne montante (12) et une tête de puits sous-marine (10) sans rotation de ladite colonne montante, ledit connecteur (8) comportant,

a) un carter (40) connecté à ladite colonne montante,

b) un manchon pour connecter le carter et la tête de puits, caractérisé

c) en ce qu'un élément annulaire de pose (52) est connecté, par l'intermédiaire d'un premier filetage (60), aux dits manchons (54), ledit élément annulaire de pose présentant des moyens (52a) pour venir de façon étanche sur un épaulement (30a) de l'élément formant tête de puits (30),

d) en ce que ledit manchon (54) est connecté, par l'intermédiaire d'un second filetage (58), au dit carter (40),

e) en ce que ledit premier filetage et ledit second filetage forment des filetages différentiels,

f) en ce que des moyens de fixation (62) sont prévus pour fixer ledit élément annulaire de pose (52) au dit élément formant tête de puits (30) et pour empêcher la rotation du dit élément annulaire de pose par rapport au dit élément formant tête de puits (30),

g) en ce qu'une bague fendue de verrouillage (56) est disposée par rapport au dit manchon (54) de façon que, lors de la rotation du dit manchon (54) par rapport au dit carter (40) et au dit élément annulaire de pose (52), ladite bague fendue (56) se dilate pour venir dans une rainure du dit élément formant tête de puits (30), de sorte que le connecteur se verrouille à ladite tête de puits et qu'il s'établit une étanchéité métal sur métal (66) entre une position inférieure (40a) du dit carter (40) et un autre épaulement (32) du dit élément formant tête de puits.

h) en ce que des moyens (80) sont prévus pour faire tourner ledit manchon (54) par rapport au dit carter (40).

2. Connecteur selon la revendication 1, caractérisé en ce que ladite rotation du dit manchon (54) fixe tout d'abord ledit élément annulaire de pose (52) au dit élément formant tête de puits (30) en provoquant le portage de ladite bague fendue (56) dans ladite rainure du dit élément formant tête de puits (30); puis réalise l'étanchéité métal sur métal (66) entre ledit carter et ledit élément formant tête de puits en tirant ledit carter en direction du dit élément annulaire de pose.

3. Connecteur selon la revendication 1 ou la

revendication 2, caractérisé en ce qu'il est prévu une rainure (54a) dans ledit manchon (54) pour porter la bague fendue dans sa condition non dilatée; et en ce que ladite bague fendue sort de cette rainure en venant en butée contre ledit élément annulaire de pose (52) et se dilate sous l'action du dit manchon pour venir se verrouiller dans ladite rainure du dit élément formant tête du puits du fait de la poursuite de la rotation et du vissage du dit manchon dans ledit élément annulaire de pose.

4. Connecteur selon l'une des revendications précédentes, caractérisé en ce qu'il est prévu une garniture d'étanchéïté élastique (68) dans ledit carter, de préférence à son extrémité inférieure, pour établir une étanchéïté à l'égard du fluide entre ledit élément formant tête de puits (30) et ledit carter (40).

5. Connecteur selon l'une des revendications précédentes, caractérisé en ce qu'il est prévu une garniture d'étanchéïté élastique (70) à l'extrémité inférieure du manchon (50) pour assurer l'étanchéïté à l'égard du fluide entre l'extrémité inférieure du dit manchon (54) et ledit élément formant tête de puits (30).

6. Connecteur selon l'une des revendications précédentes, caractérisé en ce qu'il est prévu une garniture d'étanchéïté élastique (72) sur la portion d'extrémité supérieure du dit manchon (54) pour assurer une étanchéïté grossière entre le manchon (54) et le carter (40).

7. Procédé pour connecter une colonne montante à la tête de puits sous-marine sans faire tourner ladite colonne montante, à l'aide d'un appareillage conforme à l'une des revendications précédentes, ledit procédé comprenant

a) attacher le connecteur pour tiges (8) à la colonne montante (12);

b) introduire la portion inférieure dudit connecteur (8) dans la tête de puits et provoquer le portage de l'élément annulaire de pose (52) sur le premier épaulement (30a);

c) faire tourner le manchon (54) et tirer le carter (40) et l'élément annulaire de pose (52) l'un vers l'autre et dilater ladite bague fendue (56) et verrouiller ledit connecteur (8) à ladite tête de puits (10); et

d) continer à faire tourner ledit manchon (54) et établir une étanchéité métal sur métal (66) entre ledit carter (40) et ledit second épaulement (30b) sur ledit élément formant rête de puits (30).

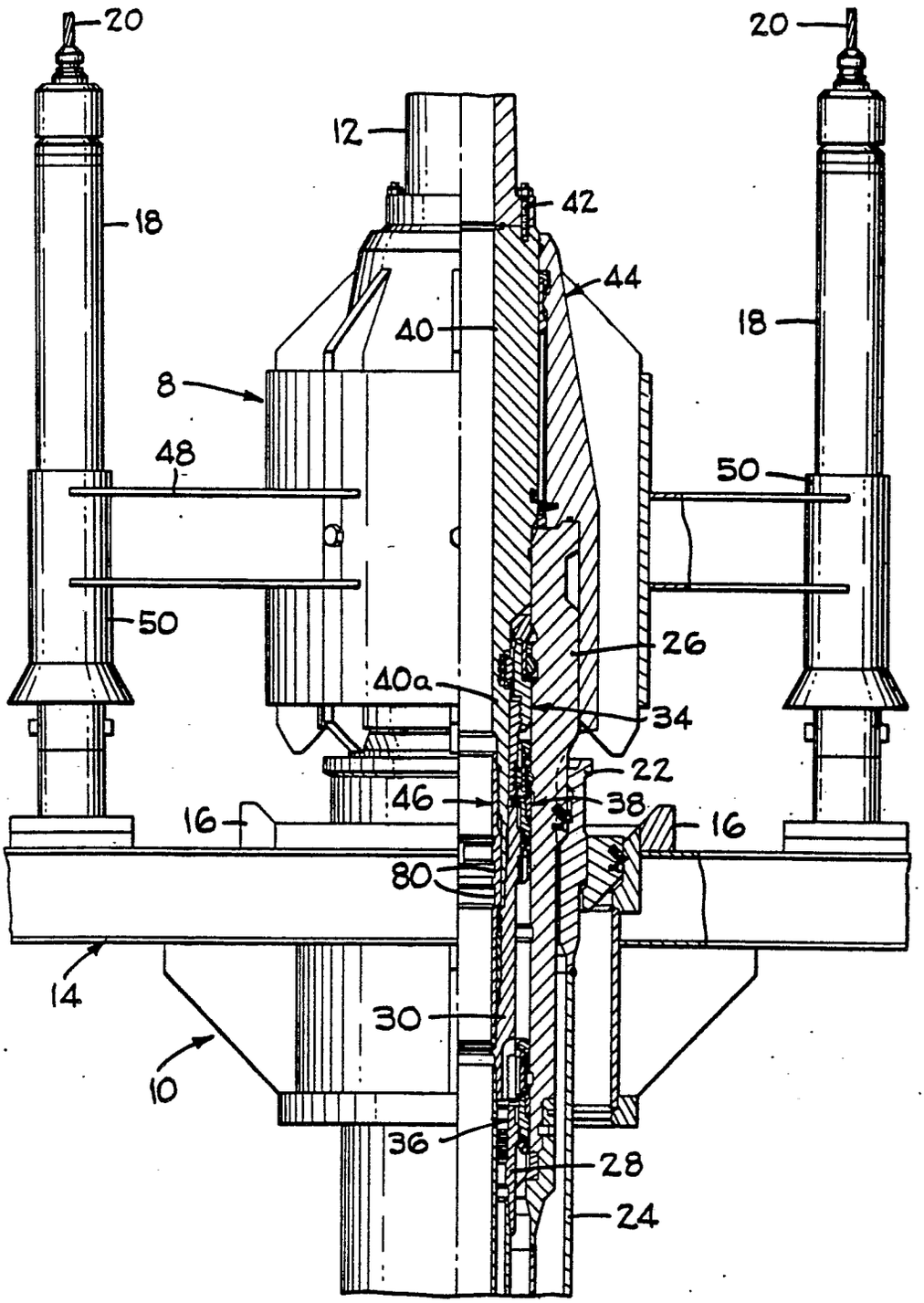
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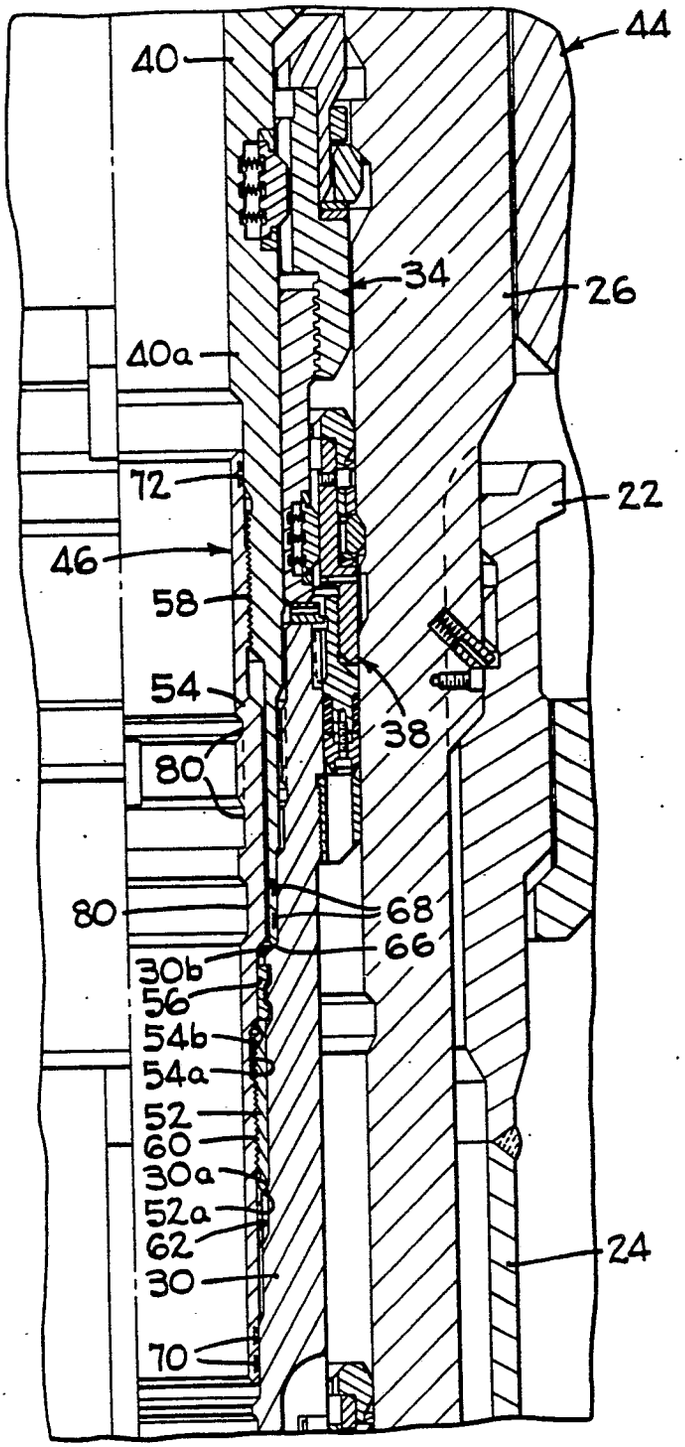
FIG_1

FIG_2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