Aug. 23, 1966 E. E. CASTOR ETAL 3,268,239

UNDERWATER WELLHEAD ASSEMBLIES

Filed Aug. 19, 1963

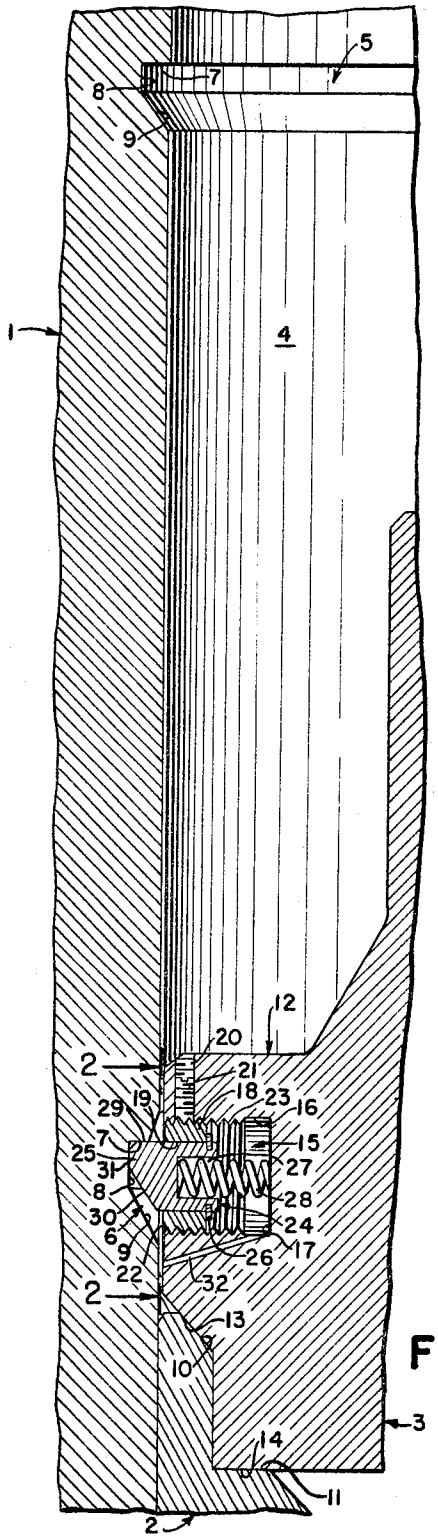


FIG. 1.

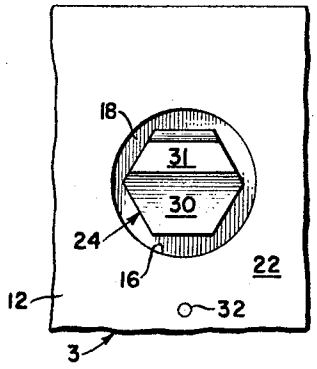


FIG. 2.

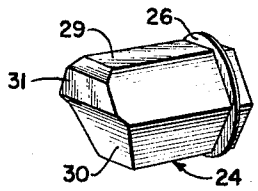


FIG. 3.

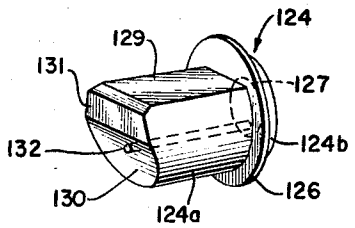


FIG. 4.

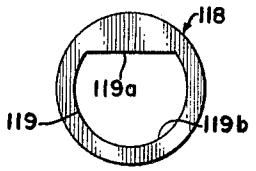


FIG. 5.

INVENTORS
EDWARD E. CASTOR
MICHAEL A. WALKER

BY Arnold, Fogelman & Harris

ATTORNEYS

United States Patent Office 3,268,239
Patented August 23, 1966

3,268,239

UNDERWATER WELLHEAD ASSEMBLIES

Edward E. Castor and Michael A. Walker, Houston, Tex., assignors to Armco Steel Corporation, Middletown, Ohio, a corporation of Ohio

Filed Aug. 19, 1963, Ser. No. 302,973
1 Claim. (Cl. 285—3)

This invention relates to wellhead assemblies and, more particularly, to wellhead assemblies adapted for installation at a remote point under water.

Historically, oil and gas wells have been drilled from above-ground, dry land locations and the wellheads have accordingly been installed at ground level, so that the various elements of the wellhead could be manipulated conveniently, under direct observation, by the operating personnel. In recent years, however, there has been an increasing amount of offshore drilling, in lakes and in ocean locations, under circumstances such that it is desirable to install the wellhead at the marine floor, drilling of the well and installation of all of the well devices usually being accomplished from a floating vessel.

In the case of a dry-land installation, with the wellhead installed at ground level, internal wellhead members can be landed with relative ease and secured rigidly in place by conventional fastening devices, such as hold-down screws, which are manipulated directly by a workman. However, when the wellhead is to be installed at the marine floor, hundreds or even thousands of feet below the drilling vessel, many operations which are handled with ease on dry land become exceedingly difficult. Particular difficulty is encountered in installing internal wellhead elements such as hanger members, mandrels, seals or pack-off devices, bore protector sleeves, and the like, which not only must be properly landed at a specific point in the wellhead assembly but also must be secured rigidly in place against upward movement. Since diver assistance is frequently not available, and is a costly and undesirable expedient even when available, all of the usual securing devices requiring direct manual manipulation are useless and recourse must be had to automatic, remotely operated devices.

Some prior-art workers have proposed to employ threaded joints for securing certain internal elements in place in underwater wellheads, but it has been found that even the ordinarily simple task of making up a threaded joint becomes impractically difficult when the operation must be carried out from a vessel which is not only floating far above the wellhead but also rising and falling and pitching and rolling, with the constant motion of the water. Other expedients, such as the use of wedging slips, have also proved impractical for various reasons, including the fact that devices so equipped, once installed in the wellhead, frequently cannot be recovered.

A general object of this invention is to provide, in an underwater wellhead assembly, dependable means for securing internal wellhead members in place automatically in response to landing of the internal member.

Another object is to devise an underwater wellhead assembly in which an internal member is secured in place, against upward movement, by shear means which is engaged automatically upon landing of the internal member.

A further object is to provide such an assembly wherein automatic latching of the shear means occurs dependably without regard to rotational orientation of the internal member relative to the wellhead body or member within which it is landed.

Yet another object is to devise dependable shear means, for the aforementioned purposes, which is unusually inexpensive to manufacture and easy to install.

In order that the manner in which these and other objects are attained in accordance with the invention can be understood in detail, reference is had to the accompanying drawings, which form a part of this specification, and wherein:

FIG. 1 is a fragmentary vertical sectional view of a portion of a wellhead assembly constructed in accordance with one embodiment of the invention;

FIG. 2 is a detail elevational view taken on line 2—2, FIG. 1;

FIG. 3 is a perspective view of a shear member employed in the assembly of FIGS. 1 and 2;

FIG. 4 is a perspective view of a modified form of shear member in accordance with the invention; and

FIG. 5 is an elevational view of a supporting and orienting ring useful with the shear member of FIG. 4.

Turning now to the drawings in detail, and first to FIGS. 1–3, it will be seen that this embodiment of the invention comprises an outer wellhead body member indicated generally at **1**, a lower internal wellhead member **2**, and a hanger mandrel **3**. Body member **1** has an upright passage defined by the cylindrical wall **4**, a plurality of transverse annular grooves **5** and **6** opening inwardly into the passage at axially spaced points. Grooves **5** and **6** are identical, each being defined by a flat transverse annular top wall **7**, lying in a plane at right angles to the axis of the passage, a cylindrical wall **8**, and a downwardly and inwardly slanting frusto-conical lower wall **9**.

The details of internal member **2** are not material in this embodiment, save that member **2** must be rigidly supported by member **1** against downward movement, and must present at least one transverse upwardly directed shoulder on which the hanger mandrel **3** can seat. In this embodiment, member **2** has a downwardly and inwardly slanting frusto-conical end face **10** and a transverse annular shoulder **11** located below and inwardly of face **10**. Typically, member **2** can be a seal ring of the type described and claimed in copending application Serial Number 302,994, filed concurrently herewith by Edward E. Castor, Claude R. Neilon, Michael A. Walker and William W. Word, Jr.

Mandrel **3** comprises a cylindrical body portion **12** dimensioned to fill the passage defined by wall **4**, body portion **12** having a downwardly and inwardly slanting shoulder **13** and a transverse annular shoulder **14**, shoulders **13** and **14** facing downwardly and being dimensioned and located to come into face-to-face engagement with end face **10** and shoulder **11**, respectively, so that mandrel **3** is supported on member **2** against downward movement.

Above shoulder **13**, body portion **12** of the mandrel is provided with a plurality of outwardly opening, radially disposed, cylindrical recesses, one of which is indicated generally at **15**. Recesses **15** are so located with respect to shoulder **13** that, when mandrel **3** is landed on member **2**, the recesses all open toward groove **6**. The outer end portion of the cylindrical wall **16** of each recess **15** is threaded, as shown in FIG. 1, and the inner end of the recess is defined by a flat wall **17**. The threaded portion of cylindrical wall **16** receives an externally threaded ring **18** having a centrally disposed opening **19** which is of hexagonal transverse cross section. Body portion **12** is provided with a small internally threaded bore **20** which opens through the threaded portion of wall **16** and receives a set screw **21**. Screw **21** serves to fix ring **18** in a given rotational position such that the outer face **22** of the ring is spaced slightly inwardly from the circumferential wall of body portion **12** and one flat surface of hexagonal opening **19** is horizontal and faces downwardly when the mandrel is positioned as shown. The inner

face 23 of ring 18 is spaced outwardly from inner end wall 17 of recess 15.

Ring 18 slidably supports a shear member 24 which is fashioned from hexagonal stock of such cross-sectional dimension as to fill opening 19. Member 24 is substantially longer than the axial dimension of ring 18, so that a tip portion 25 of the shear member can project outwardly beyond face 22 by a distance slightly greater than the depth of groove 6. Member 24 is provided with an outwardly opening transverse annular groove which retains a snap ring 26, the snap ring projecting transversely from member 24 so as to constitute a stop for engagement with face 23. Snap ring 26 is so located on member 24 that, taking into consideration the location of face 23 and the distance between snap ring 26 and the free end of the tip portion 25, the latter can fully enter groove 6, as shown in FIG. 1, when the snap ring engages face 23.

The inner end portion of member 24 is provided with a recess 27, and a helical compressions pring 28 is disposed with one end engaged in recess 27 and the other engaged with the wall 17. Hence, spring 28 biases shear member 24 outwardly, resiliently urging snap ring 26 against face 23.

Since member 24 fits snugly within hexagonal opening 19, member 24 is positively restrained against rotation, and one flat face 29 thereof is maintained horizontal, facing upwardly. Recess 15 is so located, and elements 18 and 24 so dimensioned, that, when mandrel 3 is fully seated on member 2 in the fashion shown in FIG. 1, member 24 is free to enter groove 6, with face 29 engaged beneath the wall 7.

At its free end, tip portion 25 has a downwardly and inwardly slanting, downwardly directed cam face 30 which extends from the vertical end face 31 to a point which is substantially aligned with the circumferential surface of portion 12 when snap ring 26 is engaged with face 23. Typically, face 30 may be disposed at an angle of 45° with the horizontal, while the lower walls 9 of grooves 5 and 6 are disposed at an angle of 60° with the horizontal.

The threaded connection between ring 18 and the wall 16 of recess 15 provides a substantial seal, and since shear member 25 fits snugly within opening 19, little opportunity is provided for fluid flow around the shear member and its supporting means. In this regard, it will be understood that, as the mandrel 12 is lowered through the surrounding liquid present during installation of the wellhead, a very substantial fluid pressure differential can develop across the shear member, and the shear member therefore might be forced hydraulically inwardly to a fully retracted position. To eliminate this possibility, a duct 32 is provided, extending from the circumferential surface of portion 12 inwardly and opening into recess 15 behind ring 18. Since duct 32 allows entry of the surrounding fluid into the recess and behind the shear member, no effective pressure differential can develope across the shear member, and spring 28 is therefore continually effective to bias the shear member to its outwardly projecting position.

When mandrel 3 is to be installed, the mandrel is connected to a handling joint (not shown) in any suitable fashion, and the joint is manipulated from the drilling vessel to lower the mandrel. For this purpose, the handling string and mandrel can be guided by any suitable guide means, as disclosed for example in U.S. Patent 2,808,229, issued October 1, 1957, to Robert F. Bauer et al. so that the mandrel properly enters the passage defined by wall 4. It will be understood that, above member 2, the passage through body member 1 has no portion with a diameter smaller than that of the cylindrical wall 4 so that, once the mandrel has entered the passage, there is no impediment to downward movement of the mandrel until the mandrel lands on member 2. Since, for each shear member 24, spring 28 is effective to urge the shear member outwardly until snap ring 26 engages face 23, all of the shear members project outwardly from portion 12 as the mandrel enters the passage of the body member. At its upper end, the passage wall is provided with a downwardly and inwardly tapering mouth portion (not shown) so that, as the mandrel descends into the passage, all of the shear members 24 are cammed inwardly, their tip faces 31 then riding along the cylindrical wall 4. As the mandrel descends past groove 5, the shear members 24 first snap outwardly into the groove and are then cammed inwardly again to their fully retracted positions, as the juncture between faces 30 and 31 passes over lower wall 9 of the groove. Accordingly, groove 5, and any similar grooves located above groove 6, represents no impediment to dowaward movement of the mandrel.

When the mandrel has descended far enough to cause shoulders 13 and 14 to seat on face 10 and shoulder 11, respectively, all of the shear members 24 are then free to snap outwardly into groove 6, assuming the position shown in FIG. 1. Accordingly, the mandrel is now fixed against downward movement, by engagement with fixed member 2, and against upward movement, by engagement of surfaces 29 of shear members 24 beneath wall 7. Since groove 6 and its wall 7 extend in a complete circle, it will be clear that proper automatic engagement of the shear members in groove 6 is achieved regardless of the rotational orientation of the mandrel within the body member.

From the foregoing, it will be understood that ring 18, held in fixed position by screw 21, constitutes means for both supporting shear member 24 for sliding radial movement relative to the mandrel and restraining the shear member against rotational movement. Thus, throughout the landing operation, the cam faces 30 are kept downwardly directed, so that the operator is assured that the shear members will be cammed freely out of engagement with such upper grooves as groove 6 as the mandrel descends within body member 1. Should it be necessary to recover mandrel 3 after the same has been landed, a handling string can be attached thereto and sufficient upward strain applied to rupture shear members 24, freeing the mandrel for upward withdrawal.

Since the shear members 24 are fabricated by simple metalworking operations from standard bar stock of hexagonal cross section, and since the forming and threading of recess 15 and the production of threaded ring 18 are simple operations, the latch mechanism is particularly inexpensive from the manufacturing standpoint. The assembly of shear member 24 and ring 18 is also particularly easy to install, since the hexagonal shear member, extending through opening 19, serves as a means for rotating ring 18 to make up the threaded connection between the ring and the wall of the recess. Provision of duct 32 in the body of the mandrel, rather than in member 24 or ring 18, also leads to economy, since it is necessary to drill the duct only once for each recess of the mandrel, rather than once for each shear member, it being understood that the mandrel or other internal wellhead element can be reused with new shear members.

FIG. 4 illustrates another form of shear member useful in the assembly of FIG. 1 in accordance with the invention. Here, member 124 is machined from cylindrical stock and includes a main body portion 124*a*, a rear body portion 124*b*, and an intermediate transverse annular outwardly projecting flange 126. Main body portion 124*a* is cylindrical, but cut away axially to provide a flat face 129, and is also cut away at its tip, opposite face 129, to provide the slanting cam face 131. The free tip of body portion 124*a* terminates in flat, transverse end face 131. Rear portion 124*b* is cylindrical and of smaller diameter than flange 126, a rearwardly opening central recess 127 being provided to accommodate one end of the biasing spring 128, FIG. 1.

Shear member 124 is employed in conjunction with the exteriorly threaded ring 118, illustrated in FIG. 5. The inner periphery 119 of ring 118 has the same con-

figuration as the transverse cross section of body portion **124***a* of the shear member, including a straight edge portion **119***a* and a circular portion **119***b*, and is dimensioned to slidably receive body portion **124***a* to support the shear member for axial movement and to restrain the same against rotation.

In this embodiment, duct **132** extends axially through the shear member **124**, eliminating the need for duct **32**, FIG. 1. It will be understood that the combination of member **124** and ring **118** is employed in mandrel **3**, FIG. 1, for example, in the same general manner hereinbefore described.

Though specific embodiments of the invention have been shown and described as illustrative of the invention, it will be understood by those skilled in the art that various changes and modifications can be made therein without departing from the scope of the invention as defined in the appended claim.

What is claimed is:

In an underwater wellhead assembly, the combination of

a wellhead member having an upright passage therethrough,

said member having a transverse annular internal groove,

the wellhead assembly including means presenting a transverse upwardly directed shoulder in said passage below said groove;

an internal wellhead member dimensioned for downward insertion into said passage and having

downwardly directed shoulder means disposed to engage said upwardly directed shoulder to support said internal wellhead member in said passage, and

an outwardly opening cylindrical recess spaced axially from said downwardly directed shoulder means by a distance such that said recess opens toward said groove when said shoulder means engages said shoulder, said recess being threaded;

an exteriorly threaded ring disposed in the outer end portion of said recess and extending thereacross, the threads of said ring being engaged with the threads of said recess;

a shear member comprising a body portion and a tip portion,

said tip portion having a cam face slanting from said body portion longitudinally and toward the central axis of said shear member,

said shear member having a longitudinally extending flat surface;

said ring slidably embracing said shear member and lying in a plane transverse thereto,

the inner periphery of said ring including a flat portion engaging said flat surface of said shear member to prevent rotation of said shear member relative to said ring,

said ring being so oriented relative to said internal wellhead member that said cam face is directed downwardly;

resilient means engaged between said shear member and the inner end of said recess and biasing said shear member outwardly; and

laterally projecting stop means fixed to said shear member at a point on the side of said ring which is inwardly of said recess,

the biasing action of said resilient means causing said stop means to engage said ring and so position said shear member that said tip portion projects outwardly beyond the mouth of said recess for latching engagement in said groove,

said shear member being provided with a longitudinal bore communicating between the exterior of said tip portion and the interior of said recess inwardly of said ring whereby, when said internal wellhead member is lowered through surrounding liquid, the liquid can enter said recess behind said shear member to eliminate any fluid pressure differential across said shear member which would tend to oppose the biasing action of said resilient means.

References Cited by the Examiner

UNITED STATES PATENTS

2,104,180	1/1938	Barker	285—141
2,138,342	11/1938	Dickerson	279—4
2,337,221	12/1943	Allen	285—142
3,086,590	4/1963	Jackson.	
3,171,674	3/1965	Bickel	285—133 X

FOREIGN PATENTS

860,914	2/1961	Great Britain.

CARL W. TOMLIN, *Primary Examiner.*

S. R. MILLER, R. GIANGIORGI, *Assistant Examiners.*