Description

The present invention relates to an improved pressure monitoring system for subsea wellhead annuli.

Recently the Minerals Management Service has issued new rules and regulations affecting oil and gas operations in the Outer Continental Shelf. (See Federal Register April 1, 1988, pp. 10596 through 10777 and particularly 10730 through 10733). These rules include the requirement that it is necessary in such subsea wellheads to be able to monitor all annuli for pressure.

The disclosure of one prior patent (U. S.-A-4,116,044, suggest the monitoring of a plurality of annuli within a wellhead at an unaccessible location by having pressure sensors extending through the wall of the wellhead to communicate with the annuli therein. These sensors are used to detect packoff leaks by detecting change of pressure under the seal after the area above the seal is pressurized. These sensors are connected to a junction box and to the surface to provide indication of the output of the sensors.

U. S.-A-4,410,186, discloses a combination leakage detection system with a sealant injection system for pressurized flanged joints. The flanges include passages through the ring seal and through the flanges to provide for the detection of leakage and the maintenance of the seal.

U. S.-A-4,458,903, discloses a special tubular member to seal a control passage across a flanged joint. The control passage is stated as being applicable to subsurface safety valves. The tubular seal extends between flanges to provide a sealed continuation of the passage extending through the lower member and the passage extending through the upper flange to a needle control valve on its exterior.

US-A-4,202,410, discloses a seal testing system for a wellhead joint in which test passages extend through the walls of the wellhead to the exterior to provide the indication of the pressure in the annulus to which each passage is connected.

US-A-3,974,690, discloses the sensing of vertical movement of a pressure responsive element to detect the change of pressure in an annulus. This involves lowering a sensing head into the wellhead to sense the position of the movable element and thus determine the pressure to which it has been exposed.

US-A-4116044 discloses a subsea wellhead assembly comprising a wellhead housing having an interior surface, an upper surface and a landing seat at the lower end of the interior surface, a series of hangers landed within the wellhead housing, each of the hangers having an exterior sealing surface, a series of seal assemblies having a seal for sealing between the exterior sealing surface of a hanger and the interior surface of the wellhead housing, the sealing of the seal assemblies providing a plurality of annuli between the hangers and the wellhead housing, a plurality of passages in the wellhead housing each communicating with a respective annulus; and means associated with the passages for isolating the annuli from each other and to prevent flow from one annulus to another; and according to the present invention, such an assembly is characterised in that each passage leads from the upper surface of the wellhead housing, and by means for communicating fluid pressure changes at the upper surface of the wellhead housing to the sea surface.

The invention provides an improved assembly for monitoring the annuli of a subsea wellhead which does not provide a flow path from one annulus to another annulus.

The invention further provides an improved assembly for monitoring the annuli of a subsea wellhead which does not penetrate completely through the wall of the subsea wellhead housing.

Preferably the assembly includes the ability to bleed pressure from the annulus.

Preferably the assembly remains passive during drilling operations and becomes active automatically when the well is put on production.

In the accompanying drawings:

Fig. 1 is a sectional view of a subsea wellhead having the improved annuli monitoring system included therein:

Fig. 2 is a quarter sectional view of the wellhead housing and its passages during drilling;

Fig. 3 is a quarter sectional view of the wellhead housing and spool clamped connection to illustrate the relationship between the individual passages communicating axially through the housing to each other and to the annulus created in the flanged connection and to the single passage through the spool to communicate pressure changes to the surface;

Fig. 4 is a sectional view of a modified form of the present invention taken along line 4-4 in Fig. 7;

Fig. 5 is a detail sectional view of the tube extending between the wellhead housing passage and the spool passage above the housing;

Fig. 6 is a detailed sectional view of one of the orienting pins providing proper connection between the wellhead housing and the spool landed thereon; and

Fig. 7 is a transverse sectional view of the orienting pins and the tubes connecting the passages between the wellhead housing and the spool landed thereon.

Subsea wellhead 10 illustrated in FIGURE 1 is a typical subsea wellhead and includes landing

base 12 positioned on the bottom 11 at the subsea location, guide base 14 having guide posts 16 and cables 18 extending upwardly for the landing of equipment on guide base 14, 30" conductor housing 20 seated within guide base 14 with 30" conductor 22 extending therebelow, an internal landing seat 21 in said conductor housing 20 and 18 3/4" housing 24 having an external shoulder 25 which is landed on said landing seat 21 within 30" conductor housing 20 and has 20" casing 26 extending therebelow. Large diameter hanger 28, i. e., a 13 3/8" hanger, is landed on the lower interior of housing 24 and has 13 3/8" casing 30 connected to its lower end and extending downwardly therefrom into the well bore. Seal assembly 32 is positioned to have its seal 34 in engagement between the exterior of hanger 28 and the interior of housing 24. Second hanger 36, which would be a 9 5/8" hanger, is landed on the interior of hanger 28 and its casing 38 extends downwardly therebelow. Seal assembly 40 is positioned to have its seal 42 in engagement between the exterior of second hanger 36 and the interior of housing 24. Third hanger 44, which would be a 7" hanger, is landed on the interior of second hanger 36 and its casing 46 extends downwardly therebelow. Seal assembly 48 is positioned to have its seal 50 in engagement between the exterior of third hanger 44 and the interior of housing 24.

In order to monitor the annuli within housing 24, passages 52, 54 and 56 extending downwardly through housing 24 from its upper surface 58 and communicate respectively with annulus 60 below seal 34, with annulus 62 between seal 34 and seal 42 and with annulus 64 between seal 42 and seal 50 as shown in FIGURE 1. Check valves 66, 68 and 70 are located in the upper ends of passages 52, 54 and 56 and are positioned to allow flow upwardly through the passages but to prevent flow downwardly therethrough and thus prevent communication between passages 52, 54 and 56 and annuli 60, 62 and 64.

With spool 72 connected to the upper end of housing 24 outer seal 74 and inner seal 76 are provided to seal between housing 24 and spool 72 and to define annulus 78 into which passages 52, 54 and 56 connect. Passage 80 extends axially through spool 72 and is in communication with annulus 78 at its lower end and provides means for communicating to the surface 82 either directly or through a suitable control line or other means so that there is an indication at the surface of any change in pressure within annulus 78.

During drilling operations blowout preventer 84 or other suitable spool is secured above wellhead housing 24 as shown in FIGURE 2 and no communication is provided therethrough so that the passages 52, 54 and 56 remain passive during the drilling operations.

A modified form of the present invention is shown in FIGURES 4, 5, 6 and 7 with wellhead housing 124 having passages 152, 154 and 156 extending therethrough to communicate with the annuli. The upper ends of passages 152, 154 and 156 terminate at the upper end of wellhead housing 124 and each of such passages is provided with a counter bore, such as 152a shown in FIGURE 5 which receives tube 186. Tube 186 is threaded into counterbore 180a at the lower end of passage 180 in spool 172, extends across annulus 178 and includes seals for sealing against the interior of counterbores 180a and 152a. With each of passages through wellhead housing 124 being in direct communication with one of the passages 180 through spool 172, no check valves are needed to ensure that there is no intercommunication between passages 152, 154 and 156. In this manner communication is established between the annuli and the surface. With this structure flow can be provided from the surface to the individual annuli and each of the annuli is connected so that its pressure can be monitored at the surface. Alternately, check valves could be provided in the counterbores 152a. 154a and 156a which are of the type well known in the art that are sealed until "stung open" by the tube 186. This would prevent intercommunication as noted above, and would allow no pressure to be released from an annulus until the appropriate time.

In the installation of spool 172, some orientation is provided so that the desired communication between the passages in wellhead housing and the passages in spool 172 is established. This is shown in FIGURES 6 and 7 wherein the relative positions of tubes 186 and alignment pins 188 are shown. Alignment pins 188 are held in recesses 190 in the lower end of spool 172 and are adapted to be received within recesses 192 in the upper end of wellhead housing 124 as shown in FIGURE 6. With the pattern of the pins 188 and the tubes 186 as shown in FIGURE 7, there is only one position in which the spool 172 can be landed on wellhead housing 124 and that is with the desired communication established by tubes 186 between the passages 152, 154 and 156 and their mating passages (passage 180 being shown) to the surface 182.

With the improved structure of the present invention, indication is provided of any change in pressure in any of the annuli to comply with the above mentioned regulations and to allow the operator to take steps to control the condition if it needs controlling.

Claims

1. A subsea wellhead assembly comprising a wellhead housing (24,124) having an interior surface, an upper surface (58) and a landing seat at the lower end of the interior surface, a series of hangers (28,36,44) landed within the wellhead housing, each of the hangers having an exterior sealing surface, a series of seal assemblies (32,40,48) having a seal (34,42,50) for sealing between the exterior sealing surface of a hanger and the interior surface of the wellhead housing, the sealing of the seal assemblies providing a plurality of annuli between the hangers and the wellhead housing, a plurality of passages (52,54,56;152,154,156) in the wellhead housing each communicating with a respective annulus; and means (66,68,70;186) associated with the passages for isolating the annuli from each other and to prevent flow from one annulus to another; characterised in that each passage (52,54,56;152,154,156) leads from the upper surface (58) of the wellhead housing (24,124), and by means (80,180) for communicating fluid pressure changes at the upper surface of the wellhead housing to the sea surface.

2. A subsea wellhead assembly according to claim 1, wherein each passage (52,54,56;152,154,156) extends axially through the wellhead housing (24,124) and then radially inwardly into communication with a respective annulus.

3. A subsea wellhead assembly according to claim 1 or claim 2, wherein the seal assemblies (32,40,48) define a first annulus below the lowest seal assembly and the interior of the housing and a second annulus between the seal assemblies, and one of the passages (52,54,56;152,154,156) communicates with the first annulus and another of the passages communicates with the second annulus.

4. A subsea wellhead assembly according to claim 1 or claim 2, wherein there are three seal assemblies (32,40,48) including a lower seal assembly, an intermediate seal assembly and an upper seal assembly, the seal assemblies defining a lower annulus below the lower seal assembly, an intermediate annulus between the lower seal assembly and the intermediate seal assembly and an upper annulus between the intermediate seal assembly and the upper seal assembly, three passages (52,54,56;152,154,156) extend through the housing including a first passage, a second passage and a third passage, and the first passage communicates with the first annulus, the second passage communicates with the second annulus and the third passage communicates with the third annulus.

5. A subsea wellhead assembly according to any one of the preceding claims, wherein the passage isolating means includes a check valve (66,68,70) in each of the passages (52,54,56) to prevent flow between the annuli.

6. A subsea wellhead assembly according to any one of claims 1 to 4, wherein the passage isolating means includes a structure (172) secured to the upper end of the wellhead housing (124) and having a passage (180) extending axially therethrough for each of the passages (152,154,156) through the wellhead housing, and means (186) extending between the upper end of the wellhead housing and the structure to provide a seal communication between the passages in the wellhead housing and the passages in the structure.

7. A subsea wellhead assembly according to claim 6, including orienting means (188) provided between the structure (172) and the wellhead housing (124) to connect the communication sealing means (186) between the passages (152,154,156) in the housing and the structure.

8. A subsea wellhead assembly according to any one of the preceding claims, wherein the housing (24,124) and the hangers (28,36,44) each include a tubular member (26,30,38,46) extending downwardly therefrom.

9. A subsea wellhead assembly according to any one of the preceding claims, including a base (14) positioned at the subsea location, and a conductor housing (20) supported in the base and having an internal landing seat (21), the wellhead housing (24,124) being positioned within the conductor housing and having an external seat (25) which is landed in engagement with the conductor housing internal landing seat.

Patentansprüche

1. Unterwasser-Bohrlochkopf-Konstruktion, bestehend aus einem Bohrlochkopfgehäuse (24, 124) mit einer Innenfläche, einer oberen Fläche (58) und einer Setzschulter am unteren Ende der Innenfläche, einer Reihe von Aufhängungen (28, 36, 44), die innerhalb des Bohr-

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lochkopfgehäuses aufgesetzt haben, wobei jede der Aufhängungen eine äußere Dichtungsfläche, eine Reihe von Dichtungseinrichtungen (32, 40, 48) mit einer Dichtung (34, 42, 50) zum Abdichten zwischen der äußeren Dichtungsfläche einer Aufhängung und der Innenfläche des Bohrlochkopfgehäuses aufweist, und das Abdichten der Dichtungseinrichtungen eine Vielzahl von Ringräumen zwischen den Aufhängungen und dem Bohrklochkopfgehäuse schafft; einer Vielzahl von Durchlässen (52, 54, 56; 152, 154, 156) im Bohrlochkopfgehäuse, von denen jeder mit einem entsprechenden Ringraum verbunden ist; und Einrichtungen (66, 68, 70; 186) zur Abtrennung der Ringräume voneinander und zur Verhinderung des Fließens von einem Ringraum zum anderen, die den Durchlässen zugeordnet sind, **dadurch gekennzeichnet**, daß jeder Durchlaß (52, 54, 56; 152, 154, 156) von der oberen Fläche (58) des Bohrlochkopfgehäuses (24, 124) wegführt, und dadurch, daß eine Einrichtung (80, 180) zur Übertragung von an der oberen Fläche des Bohrlochkopfgehäuses auftretenden Druckänderungen des Fluides zur Wasseroberfläche hin vorhanden ist.

2. Unterwasser-Bohrlochkopf-Konstruktion nach Anspruch 1, **dadurch gekennzeichnet**, daß jeder Durchlaß (52, 54, 56; 152, 154, 156) axial durch das Bohrlochkopfgehäuse (24, 124) und dann radial einwärts zwecks Verbindung mit einem entsprechenden Ringraum führt.

3. Unterwasser-Bohrlochkopf-Konstruktion nach Anspruch 1 oder 2, **dadurch gekennzeichnet**, daß die Dichtungseinrichtungen (32, 40, 48) einen ersten Ringraum unterhalb der untersten Dichtungseinrichtung und dem Inneren des Gehäuses und einen zweiten Ringraum zwischen den Dichtungseinrichtungen bilden, und einer der Durchlässe (52, 54, 56; 152, 154, 156) mit dem ersten Ringraum und ein anderer der Durchlässe mit dem zweiten Ringraum verbunden ist.

4. Unterwasser-Bohrlochkopf-Konstruktion nach Anspruch 1 oder 2, **dadurch gekennzeichnet**, daß drei Dichtungseinrichtungen (32, 40, 48), welche eine untere Dichtungseinrichtung, eine mittlere Dichtungseinrichtung und eine obere Dichtungseinrichtung umfassen, vorhanden sind, und die Dichtungseinrichtungen einen unteren Ringraum unterhalb der unteren Dichtungseinrichtung, einen mittleren Ringraum zwischen der unteren Dichtungseinrichtung und der mittleren Dichtungseinrichtung und einen oberen Ringraum zwischen der mittleren Dichtungseinrichtung und der oberen Dichtungseinrichtung bilden, daß sich drei Durchlässe (52, 54, 56; 152, 154, 156) durch das Gehäuse erstrecken, die einen ersten Durchlaß, einen zweiten Durchlaß und einen dritten Durchlaß umfassen, wobei der erste Durchlaß mit dem ersten Ringraum, der zweite Durchlaß mit dem zweiten Ringraum und der dritte Durchlaß mit dem dritten Ringraum verbunden ist.

5. Unterwasser-Bohrlochkopf-Konstruktion nach jedem der vorhergehenden Ansprüche, **dadurch gekennzeichnet**, daß die den Durchlaß abtrennende Einrichtung ein Rückschlagventil (66, 68, 70) in jedem der Durchlässe (52, 54, 56) enthält, um den Fluß zwischen den Ringräumen zu verhindern.

6. Unterwasser-Bohrlochkopf-Konstruktion nach einem der Ansprüche 1 bis 4, **dadurch gekennzeichnet**, daß die den Durchlaß abtrennende Einrichtung eine Baueinheit (172) enthält, die am oberen Ende des Bohrlochkopfgehäuses (124) befestigt ist, und einen Durchlaß (180), welcher axial durch diese führt, für jeden der Durchlässe (152, 154, 156) durch das Bohrlochkopfgehäuse aufweist, sowie eine Einrichtung (186) besitzt, die sich zwischen dem oberen Ende des Bohrlochkopfgehäuses und der Baueinheit befindet, um eine Dichtverbindung zwischen den Durchlässen im Bohrlochkopfgehäuse und den Durchlässen in der Baueinheit zu bilden.

7. Unterwasser-Bohrlochkopf-Konstruktion nach Anspruch 6, **dadurch gekennzeichnet**, daß sie eine Ausrichtungseinrichtung (188) enthält, die zwischen der Baueinheit (172) und dem Bohrlochkopfgehäuse (124) vorgesehen ist, um die Einrichtung (186) zur Dichtverbindung mit den Durchlässen (152, 154, 156) im Gehäuse und in der Baueinheit zu verbinden.

8. Unterwasser-Bohrlochkopf-Konstruktion nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet**, daß sowohl das Gehäuse (24, 124) als auch die Aufhängungen (28, 36, 44) jeweils ein rohrförmiges Teil (26, 30, 38, 46) enthalten, welches sich von diesen nach unten erstreckt.

9. Unterwasser-Bohrlochkopf-Konstruktion nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet**, daß es aus einem Tragteil (14), welches unter Wasser angeordnet ist, und einem Führungsgehäuse (20), welches in dem Tragteil abgestützt ist und eine

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innere Setzschulter (21) aufweist, besteht, wobei das Bohrlochkopfgehäuse (24, 124) innerhalb des Führungsgehäuses angeordnet ist und eine äußere Setzschulter (25) aufweist, welche unter Belastung der inneren Setzschulter im Führungsgehäuse aufsitzt.

Revendications

1. Agencement de tête de puits sous-marin comprenant une cage de tête de puits (24, 124) ayant une face intérieure, une face supérieure (58) et un siège de réception à l'extrêmité inférieure de la face intérieure, une série de crochets (28, 36, 44) réceptionnés à l'intérieur de la cage de la tête de puits, chacun des crochets ayant une face d'étanchéité extérieure, une série d'assemblages étanches (32, 40, 48) ayant un joint étanche (34, 42, 50) pour assurer l'étanchéité entre la face d'étanchéité extérieure d'un crochet et la face intérieure de la cage de la tête de puits, le scellement des assemblages étanches assurant une pluralité de chambres annulaires entre les crochets et la cage de la tête de puits, une pluralité de passages (52, 54, 56 ; 152, 154, 156) dans la cage de la tête de puits, chacun communiquant avec une chambre annulaire respective ; et des moyens (66, 68, 70 ; 186) associés aux passages pour isoler les chambres annulaires entre elles et empêcher l'écoulement d'une chambre annulaire à l'autre ; caractérisé en ce que chaque passage (52, 54, 56 ; 152, 154, 156) part de la face supérieure (58) de la cage de la tête de puits (24, 124) et par des moyens (80, 180) pour communiquer les variations de pression hydraulique se produisant dans la face supérieure de la cage de la tête de puits, à la surface de la mer.

2. Agencement de tête de puits sous-marin selon la revendication 1, dans lequel chaque passage (52, 54, 56 ; 152, 154, 156) se prolonge axialement à travers la cage de la tête de puits (24, 124) puis radialement vers l'intérieur de façon à communiquer avec une chambre annulaire respective.

3. Agencement de tête de puits sous-marin selon la revendication 1 ou la revendication 2, dans lequel les assemblages étanches (32, 40, 48) définissent une première chambre annulaire au-dessous de l'assemblage étanche le plus bas et de l'intérieur de la cage et une seconde chambre annulaire entre les assemblages étanches, l'un des passages (52, 54, 56 ; 152, 154, 156) communiquant avec la première chambre annulaire et l'autre passage communiquant avec la seconde chambre annulaire.

4. Agencement de tête de puits sous-marin selon la revendication 1 ou la revendication 2, dans lequel il y a trois assemblages étanches (32, 40, 48) comprenant un assemblage étanche inférieur, un assemblage étanche intermédiaire et un assemblage étanche supérieur, les assemblages étanches définissant une chambre annulaire inférieure au-dessous de l'assemblage étanche inférieur, une chambre annulaire intermédiaire entre l'assemblage étanche inférieure et l'assemblage étanche intermédiaire et une chambre annulaire supérieure entre l'assemblage étanche intermédiaire et l'assemblage étanche supérieur, trois, passages (52, 54, 56 ; 152, 154, 156) s'étendant à travers la cage comprenant un premier passage, un second passageet un troisième, passage ; le premier passage communiquant avec la première chambre annulaire, le second passage communiquant avec la seconde chambre annulaire et le troisième passage communiquant avec la troisième chambre annulaire.

5. Agencement de tête de puits sous-marin selon l'une quelconque des revendications précédentes, dans lequel le moyen d'isolation des passages comprend un clapet de retenue (66, 68, 70) dans chacun des passages (52, 54, 56) pour empêcher l'écoulement entre les chambres annulaires.

6. Agencement de tête de puits sous-marin selon l'une quelconque des revendications 1 à 4, dans lequel le moyen d'isolation des passages comprend une structure (172) fixée à l'extrêmité supérieure de la cage de la tête de puits (124) et ayant un passage (180) se prolongeant axialement à travers celle-ci pour chacun des passages (152, 154, 156) traversant la cap de la tête de puits, et un moyen (186) s'étendant entre l'extrémité supérieure de la cage de la tête de puits et la structure pour assurer une communication étanche entre les passages dans la cage de la tête de puits et les passages dans la structure.

7. Agencement de tête de puits sous-marin selon la revendication 6, comprenant un moyen d'orientation (188) disposé entre la structure (172) et la cage de la tête de puits (124) pour raccorder le moyen d' étanchéification des communications (186) entre les passages (152, 154, 156) dans la cage et la structure.

8. Agencement de tête de puits sous-marin selon l'une quelconque des revendications précéden-

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tes, dans lequel la cap (24, 124) et les crochets (28, 36, 44) comprennent tous un élément tubulaire (26, 30, 38, 46) s'étendant vers le bas depuis ceux-ci.

9. Agencement de tête de puits sou-marin selon l'une quelconque des revendications précédentes, comprenant un support (14) positionné dans l'emplacement sous-marin et une cage de conducteur (20) supportée par le support et ayant un siège de réception interne (21), la cage de la tête de puits (24, 124) étant positionnée à l'intérieur de la cage du conducteur et ayant un siège externe (25) qui est réceptionné engagé avec le siège de réception interne de la cage du conducteur.

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