

Description

Background

The present invention relates to an improved method of repairing a subsea pipeline which involves pressure forming the end of a section of pipe into an annular connection member so that connection can be made to the pipe. The repair of subsea pipelines has been accomplished by the use of equipment manipulated from the surface and by direct manipulation of divers at the subsea location.

Normally a section of a pipeline is damaged or ruptured and such section is first cut from the pipeline by suitable apparatus at the subsea location. Thereafter it is necessary to prepare the cut ends of the pipeline for attachment to a replacement section of pipe which will be lowered to the subsea location and positioned between the open ends of the pipeline to replace the damaged section.

EP-A-0 146 316 discloses apparatus and method of providing the connection to the end of a subsea pipeline after the damaged section has been removed. Generally, such patent suggests that a tool be positioned within the end of the pipeline and the annular connector be positioned around the end of the pipeline and pressure be supplied to the tool to pressure form the end of the pipeline into tight sealing and gripping engagement with the interior of the connecting tool. Similar types of pressure forming is suggested in US-A-3,432,916, and US-A-4,388,752.

While such methods have been used, some difficulties have been encountered with their use in a subsea location. One difficulty is that it is a problem to mount the forming tool on a suitable frame and move it into the desired position with respect to the end of the pipeline which is to be deformed. A further problem encountered is that most subsea pipelines are at least partially embedded in the earth of the sea floor and the movement of the tool and the surrounding annular connector into position within and surrounding the open end of the pipeline has caused sand and other subsea floor detritus to enter into the interior profile of the annular connector. This presence of sand or other solid materials within the connector profile can prevent the formation of a proper sealing and gripping engagement with the end of the pipeline.

According to one aspect of the present invention there is provided a method of providing a connection element to the end of a damaged subsea pipeline after the removal of the damaged section including the steps of:

positioning an assembly of an internal forming tool, an extending and retracting actuator connect-

ed to said forming tool substantially aligned with the end of the pipeline, and a connection sleeve element on the sea bottom in close relationship to the end of the pipeline,

5 extending said forming tool into the end of said pipeline,

expanding the forming portion of said forming tool into tight engagement with the interior of said pipeline,

10 retracting the forming tool to pull the assembly close to the end of said pipeline, to position the connection sleeve element in surrounding relationship to the pipeline and to provide a shoulder against which a forming sleeve is to abut during forming,

15 expanding the forming portion of said tool into forming engagement with the interior of said pipeline end to firm it radially outward into gripping and sealing engagement with the interior of said connection sleeve element, and characterised by

20 extending said actuator to move said actuator away from the end of the pipeline and from said connection sleeve element,

25 releasing forming pressure from said forming tool, and

thereafter retracting said actuator to remove said forming tool from within the end of said pipeline.

30 According to another aspect of the present invention there is provided an apparatus for securing a connector on the open end of a subsea pipeline comprising:

35 a pressure forming tool having a body, a resilient sleeve carried in surrounding relationship to said body and means for delivering pressure to the interior of said resilient sleeve,

an outer forming sleeve,

an actuator to extend and retract said forming tool with respect to said outer forming sleeve,

40 means releasably connecting the actuator to the outer forming sleeve, and characterised by

45 said actuator being so disposed and arranged that, with said resilient sleeve in its expanded forming position, it can be moved with respect the forming sleeve after forming, which movement of said actuator is responsive to extension of said actuator while said sleeve is still in said expanded forming position.

50 The present method and apparatus may provide an initial pressure rounding of the end of the pipeline.

The present method and apparatus may provide a power swaging of the end of the pipeline to ensure its rounding.

55 The present method and apparatus may allow the pressure and axial thrust load testing thereof prior to the removal of the forming tool.

The invention will be described now by way of

example only, with particular reference to the accompanying drawings. In the drawings:

Figure 1 is an axial sectional view of the improved forming tool and extension and retraction means of the present invention.

Figure 2 is a view of the improved apparatus positioned on the sea floor in alignment with the end of a pipeline which is to be formed into an annular connector.

Figure 3 is a view of the apparatus with the forming tool partially extended toward the end of the pipeline.

Figure 4 is a view of the apparatus with the forming tool positioned within the end of the pipeline but with the annular connecting means being ready for movement into position around the end of the pipeline.

Figure 5 is a view of the apparatus with the annular connecting means in position around the end of the pipeline during the forming step.

Figure 6 is a view of the apparatus with the annular connecting means formed on the end of the pipeline and with the forming tool being extended to move the remainder of the apparatus away from the end of the pipeline.

FIGURE 7 is a view of the forming tool apparatus and its extension and retraction means being recovered from sea bottom and with the frame structure being positioned in supporting relationship to the end of the pipeline to assist in the alignment of the pipe section to be connected to the pipeline.

Description of the Preferred Embodiment

As shown in FIGURE 1, forming tool T includes a body 10 with resilient sleeve 12 positioned between shoulder 14 and shoulder 16. Shoulder 14 extends radially outward from the exterior of sleeve 12 in its relaxed position to engage with the end of pipeline P when tool T is within the end of pipeline P in its desired forming position. Annular sleeve S which forms the annular means into which the end of pipeline P is to be formed is secured in position surrounding tool T by collet connector C which is supported from tool T as shown in FIGURE 1. Lifting arm A is secured to flange F and has line L connected thereto which extends to the surface or to buoyancy devices (not shown) to allow the combined structure to have a neutral buoyancy. Tool T is connected to retraction and extension means M by piston rod R which extends through the interior of flange F collet connector C and through annular sleeve S. Base B is secured to sleeve S by straps S1 which are positioned within grooves S2 around the exterior of sleeve S.

Flange F is the connecting element for the assembly of the components of the structure as

shown in FIGURE 1. Retraction and extension means M or actuator M is secured to one side of flange by suitable connecting means such as bolts and rod flange 18 is secured to the end of rod R and is also secured to the inner end of tool body 10. Flange F includes an outer collet flange 20 which is engaged by the collet fingers 22. Collet fingers 22 also engage collet flange 24 on the end of forming sleeve S in the initial assembly of the components used in the method of this invention. Outer rim 26 of flange F provides the support for arm A and also for the actuators 28 which move the camming ring 30 to move the collect fingers 22 into and from engagement with flanges 20 and 24. Collect housing 32 surrounds outer rim 26 and connects between actuators 28 and camming ring 30. Suitable sealing means is provided in the end of collet flange 20 to seal against the end of forming sleeve S when it is engaged by collet connector C. Additionally this abutment of the end of sleeve S with the end of collet flange 20 provides the shoulder or stop 34 to properly position sleeve S with respect to tool T and collet connector C. Hose bundle 36 extends from the surface or suitable control area (not shown) and through protective housing 38 surrounding actuator M. The individual hoses are connected to the elements which they are to pressurize. For example, one hose is connected to the extending side of actuator M and one is connected to the retracting side of actuator M; one hose is connected through tube 39 extending through the interior of actuator M and piston 40 thereof into port 42 in body 10 which communicates pressure to the interior of resilient sleeve 12; one hose is connected to each side of the actuators 28 of the collet connector C; and a hose is connected to each of a plurality of fittings 43 in flange F which communicates through ports 44 with the side of flange F facing tool T and sleeve S. The end of ports 44 includes a suitable jet fitting 46 which direct the flow of flow therefrom into a position between the interior of sleeve S and the exterior of pipeline P. Also, after the forming of the end of pipeline P into the interior of sleeve S, the joint between such members can be tested by pressure supplied through ports 44 and fittings 46.

As shown in FIGURE 2, the damaged section of pipeline P has been removed and the end is exposed by removing the sand and other material of the sea bottom SB. It is recommended that the pipeline should be cut back to a position at which it appears that the pipe is generally round in section. With the pipeline P and sea bottom SB prepared as described and shown, the assembly of the base B, tool T, collet connector C, sleeve S and extending and retracting means M are maneuvered into position with the tool T, which extends partially from sleeve S, aligned with and close to the end of

pipeline P. At this point the tool T is extended to be positioned within the end of pipeline so that its shoulder 14 engages the prepared end of pipeline P. FIGURE 3 represents this movement of tool T toward this position. With tool T positioned within pipeline P, the expandable annulus or sleeve 12 is expanded into tight engagement with the interior of pipeline P. The pressure used for this expansion is substantially less than the pressure used subsequently for the pressure forming of the end of pipeline P into the interior of sleeve S. The pressure is also sufficient to securely retain tool within pipeline P and to reposition the remainder of the assembly into more perfect alignment with pipeline P. Additionally, this pressure is preselected to be sufficient to provide a reforming of the end of pipeline P into a more rounded configuration. The means M is then actuated to retract tool T and the position shown in FIGURE 4 illustrates this retraction prior to the movement of sleeve S into surrounding relationship with the end of pipeline P which is shown in FIGURE 5.

The retraction of tool T is continued until the retraction of rod R is complete and sleeve S is in position around the end of pipeline P. As set forth above, the tapered surface 23 on the interior leading surface of sleeve S causes a further rounding of the exterior of pipeline P as it is forced into its position.

During retraction of tool T, fluid is jetted through ports in flange F and through the interior of sleeve S and the exterior of the end of pipeline P to scour away debris from the sleeve interior profile and the exterior pipe surface. Thereafter, tool T is actuated to forming pressures and the end of pipeline P is formed radially outwardly into tight gripping and sealing engagement with the profile on the interior of sleeve S. The presence of the compressible material in the grooves of the sleeve internal profile prevents the water from forming a hydraulic lock which would interfere with the proper completion of the forming of the end of pipeline P into the internal profile of sleeve S.

With completion of the forming step, the joint is hydrostatically and axially loaded to prove its integrity. Tool pressure is reduced to a value of approximately 500 psi (3447 KN/m²) above the hydrostatic pressure applied through ports 44. This hydrostatic pressure causes an axial force against shoulder 14. Joint leakage is shown by a reduction of the applied hydrostatic pressure. Joint failure as a result of axial load will be indicated if the pressure to retract actuating means M increases. If there is a failure indicated in the testing the forming step can be repeated. With the completion of the hydrostatic test and the release of collet connector C from engagement with sleeve S, means M is actuated to extend tool T which causes the movement of collet

connector C away from the end of pipeline P and sleeve S to the position shown in FIGURE 6. Thereafter, the venting of pressure from tool T allows disengagement of tool T from the interior of the end of pipeline P. Then means M is actuated to retract tool T from within pipeline P and back to its retracted position as shown in FIGURE 7.

From this it can be seen that the present invention does provide an assurance of full alignment of the forming tool and the connecting sleeve with the end of the pipeline, the at least partial rounding of the end of pipeline P with the initial pressuring of the tool T, the swaging action of the forcing of the connecting sleeve S onto the exterior of pipeline P for final rounding of the pipeline end and the support of the sleeve S and the pipeline end by the base B which is left connected to sleeve S and in supporting relationship thereto. The provision of the internal jetting of fluids through the interior of sleeve S after it is installed on pipeline P will cause the removal of all sand, earth and other materials, which would be detrimental to the forming step, to be removed therefrom.

Claims

1. A method of providing a connection element to the end of a damaged subsea pipeline after the removal of the damaged section including the steps of:

positioning an assembly of an internal forming tool (T), an extending and retracting actuator (M) connected to said forming tool substantially aligned with the end of the pipeline (P), and a connection sleeve element (S) on the sea bottom in close relationship to the end of the pipeline,

extending said forming tool (T) into the end of said pipeline (P),

expanding the forming portion (12) of said forming tool (T) into tight engagement with the interior of said pipeline,

retracting the forming tool (T) to pull the assembly close to the end of said pipeline, to position the connection sleeve element (S) in surrounding relationship to the pipeline and to provide a shoulder against which a forming sleeve is to abut during forming,

expanding the forming portion (12) of said tool (T) into forming engagement with the interior of said pipeline end to firm it radially outward into gripping and sealing engagement with the interior of said connection sleeve element (S), and characterised by

extending said actuator (M) to move said actuator away from the end of the pipeline and from said connection sleeve element (S),

releasing forming pressure from said for-



pipeline P. At this point the tool T is extended to be positioned within the end of pipeline so that its shoulder 14 engages the prepared end of pipeline P. FIGURE 3 represents this movement of tool T toward this position. With tool T positioned within pipeline P, the expandable annulus or sleeve 12 is expanded into tight engagement with the interior of pipeline P. The pressure used for this expansion is substantially less than the pressure used subsequently for the pressure forming of the end of pipeline P into the interior of sleeve S. The pressure is also sufficient to securely retain tool within pipeline P and to reposition the remainder of the assembly into more perfect alignment with pipeline P. Additionally, this pressure is preselected to be sufficient to provide a reforming of the end of pipeline P into a more rounded configuration. The means M is then actuated to retract tool T and the position shown in FIGURE 4 illustrates this retraction prior to the movement of sleeve S into surrounding relationship with the end of pipeline P which is shown in FIGURE 5.

The retraction of tool T is continued until the retraction of rod R is complete and sleeve S is in position around the end of pipeline P. As set forth above, the tapered surface 23 on the interior leading surface of sleeve S causes a further rounding of the exterior of pipeline P as it is forced into its position.

During retraction of tool T, fluid is jetted through ports in flange F and through the interior of sleeve S and the exterior of the end of pipeline P to scour away debris from the sleeve interior profile and the exterior pipe surface. Thereafter, tool T is actuated to forming pressures and the end of pipeline P is formed radially outwardly into tight gripping and sealing engagement with the profile on the interior of sleeve S. The presence of the collapsible material in the grooves of the sleeve internal profile prevents the water from forming a hydraulic lock which would interfere with the proper completion of the forming of the end of pipeline P into the internal profile of sleeve S.

With completion of the forming step, the joint is hydrostatically and axially loaded to prove its integrity. Tool pressure is reduced to a value of approximately 500 psi (3447 KN/m²) above the hydrostatic pressure applied through ports 44. This hydrostatic pressure causes an axial force against shoulder 14. Joint leakage is shown by a reduction of the applied hydrostatic pressure. Joint failure as a result of axial load will be indicated if the pressure to retract actuating means M increases. If there is a failure indicated in the testing the forming step can be repeated. With the completion of the hydrostatic test and the release of collet connector C from engagement with sleeve S, means M is actuated to extend tool T which causes the movement of collet

connector C away from the end of pipeline P and sleeve S to the position shown in FIGURE 6. Thereafter, the venting of pressure from tool T allows disengagement of tool T from the interior of the end of pipeline P. Then means M is actuated to retract tool T from within pipeline P and back to its retracted position as shown in FIGURE 7.

From this it can be seen that the present invention does provide an assurance of full alignment of the forming tool and the connecting sleeve with the end of the pipeline, the at least partial rounding of the end of pipeline P with the initial pressuring of the tool T, the swaging action of the forcing of the connecting sleeve S onto the exterior of pipeline P for final rounding of the pipeline end and the support of the sleeve S and the pipeline end by the base B which is left connected to sleeve S and in supporting relationship thereto. The provision of the internal jetting of fluids through the interior of sleeve S after it is installed on pipeline P will cause the removal of all sand, earth and other materials, which would be detrimental to the forming step, to be removed therefrom.

Claims

1. A method of providing a connection element to the end of a damaged subsea pipeline after the removal of the damaged section including the steps of:

positioning an assembly of an internal forming tool (T), an extending and retracting actuator (M) connected to said forming tool substantially aligned with the end of the pipeline (P), and a connection sleeve element (S) on the sea bottom in close relationship to the end of the pipeline,

extending said forming tool (T) into the end of said pipeline (P),

expanding the forming portion (12) of said forming tool (T) into tight engagement with the interior of said pipeline,

retracting the forming tool (T) to pull the assembly close to the end of said pipeline, to position the connection sleeve element (S) in surrounding relationship to the pipeline and to provide a shoulder against which a forming sleeve is to abut during forming,

expanding the forming portion (12) of said tool (T) into forming engagement with the interior of said pipeline end to firm it radially outward into gripping and sealing engagement with the interior of said connection sleeve element (S), and characterised by

extending said actuator (M) to move said actuator away from the end of the pipeline and from said connection sleeve element (S),

releasing forming pressure from said for-



ming tool (T), and

thereafter retracting said actuator (M) to remove said forming tool from within the end of said pipeline (P).

2. A method according to claim 1, wherein said connection sleeve element (S) is releasably connected to said forming tool (T) and said actuator (M) and including the steps of
 - moving said connection sleeve element (S) into surrounding relationship around the end of said pipeline (P) in said second retracting step, and
 - releasing the connection to said connection sleeve element (S) after said forming step.
3. A method according to claim 2, including the step of
 - flushing the interior of said connection sleeve element (3) during and after its positioning in surrounding relationship to said pipeline end.
4. A method according to claim 1 wherein,
 - sufficient pressure is applied in said initial expanding step to provide a rounding of the end of the pipeline (P).
5. A method according to claim 2 wherein the step of retracting to position said connection sleeve element (S) in surrounding relationship to the end of the pipeline is done with sufficient force so that out-of-round portions of said pipeline (P) end are swaged by the sleeve element (S) into a round shape.
6. A method according to claim 1 including the step of
 - exerting testing pressure against the end of the pipeline (P) and the connection sleeve element (S) while said forming tool (T) is in its expanded condition after said forming step to test the effectiveness of the sealing engagement of the pipeline end within said connection sleeve element.
7. An apparatus for securing a connector on the open end of a subsea pipeline comprising:
 - a pressure forming tool (T) having a body (10), a resilient sleeve (12) carried in surrounding relationship to said body and means for delivering pressure to the interior of said resilient sleeve,
 - an outer forming sleeve (S),
 - an actuator (M) to extend and retract said forming tool with respect to said outer forming sleeve,
 - means (C) releasably connecting the ac-

tuator (M) to the outer forming sleeve (S), and characterised by

said actuator (M) being so disposed and arranged that, with said resilient sleeve (12) in its expanded forming position, it can be moved with respect to the forming sleeve (S) after forming, which movement of said actuator is responsive to extension of said actuator while said sleeve is still in said expanded forming position.

8. An apparatus according to claim 7, including a base (B) connected to said sleeve (S) in supporting relationship thereto.
9. An apparatus according to claim 8 including
 - a support flange having a collet flange (20), and means connecting said actuator (M) to said support flange, and wherein
 - said means (C) is a collet connector (C) engaging said collet flange (20) on said support flange and a collet flange on said forming sleeve (S) to secure said forming sleeve in abutment to said support flange.
10. Apparatus according to any one of claims 7 to 9 including means (44) associated with said forming tool (T) for introducing fluid jets into the interior of said forming sleeve (S) as and after it is positioned in surrounding relationship to the pipeline which is to be formed therein.
11. An apparatus according to any one of claims 7 to 10 wherein
 - said forming sleeve has an interior profile into which the subsea pipeline is to be pressure formed and an exterior collet flange.
12. An apparatus according to claim 11 wherein said releasable connecting means between said actuator and said outer forming sleeve is a collet connector (C).
13. An apparatus according to claim 7 including
 - a support flange mounted within said collet connector (C), and
 - means for securing said actuator (M) to said support flange,
 - said actuator having a connecting rod (R) extending slidably through said support flange and being secured to said forming tool (T).
14. An apparatus according to claim 10 wherein said means (44) comprise ports extending through said support flange and being directed toward the interior of said forming sleeve (S) which is engaged by said collet connector (C)



so that fluids ejected through said ports (44) will flush sediment and other bottom solids from the interior of said forming sleeve.

Patentansprüche

1. Verfahren zum Anbringen eines Verbindungselementes an dem Ende einer beschädigten Unterwasser-Pipeline nach dem Entfernen des beschädigten Abschnitts mit folgenden Schritten:
Positionieren einer Anordnung aus einem Innenformwerkzeug (T), einem Ausfahr- und Rückziehbetätigungsorgan (M), das mit dem Formwerkzeug verbunden und im wesentlichen auf das Ende der Pipeline (P) ausgerichtet ist, und einem Verbindungshülselement (S) an dem Meeresboden in dichter Nähe zu dem Ende der Pipeline, Ausfahren des Formwerkzeugs (T) in das Ende der Pipeline (P), Expandieren des Formabschnitts (12) des Formwerkzeugs (T) in dichte Anlage an das Innere der Pipeline,
Zurückziehen des Formwerkzeugs (T), um die Anordnung dicht zu dem Ende der Pipeline zu ziehen, das Verbindungshülselement (S) in eine umgebende Lage zu der Pipeline zu positionieren und um eine Schuler bereitzustellen, an der eine Formhülse während des Formvorgangs anliegt,
Expandieren des Formabschnitts (12) des Werkzeugs (T) in Verformungseingriff mit dem Inneren des Pipelineendes, um dieses radial nach außen in Klemm- und Dichtungsanlage an das Innere des Verbindungshülselementes (S) zu bringen,
gekennzeichnet durch folgende Schritte:
Ausfahren des Betätigungsorgans (M), um das Betätigungsorgan weg von dem Ende der Pipeline und von dem Verbindungshülselement (S) zu bewegen,
Abstellen des Formdrucks des Formwerkzeugs (T) und
danach Zurückziehen des Betätigungsorgans (M), um das Formwerkzeug aus dem Ende der Pipeline (P) zu entfernen.
2. Verfahren nach Anspruch 1, wobei das Verbindungshülselement (S) lösbar mit dem Formwerkzeug (T) und dem Betätigungsorgan (M) verbunden ist, und mit den Schritten des Bewegens des Verbindungshülselementes (S) in eine umgebende Relation um das Ende der Pipeline (P) in dem zweiten Rückziehschritt und Freigeben der Verbindung mit dem Verbindungshülselement (S) nach dem Verformungsschritt.
3. Verfahren nach Anspruch 2, mit dem Schritt des Spülens des Inneren des Verbindungshülselementes (3) während und nach seinem Positionieren in die umgebende Relation zu dem Pipelineende.
4. Verfahren nach Anspruch 1, wobei ein ausreichender Druck in dem anfänglichen Expandierungsschritt aufgebracht wird, um eine Rundung des Endes der Pipeline (P) hervorzurufen.
5. Verfahren nach Anspruch 2, wobei der Schritt des Zurückziehens zum Positionieren des Verbindungshülselementes (S) in eine umgebende Relation zu dem Ende der Pipeline mit einer ausreichenden Kraft erfolgt, so daß unrunde Abschnitte des Pipelineendes von dem Hülselement (S) in eine runde Form gezwängt werden.
6. Verfahren nach Anspruch 1, mit dem Schritt des Aufbringens eines Testdrucks gegen das Ende der Pipeline (P) und das Verbindungshülselement (S), während das Formwerkzeug (T) sich nach dem Verformungsschritt in dem aufgeweiteten Zustand befindet, um die Wirksamkeit des Dichtungseingriffs des Pipelineendes in das Verbindungshülselement zu überprüfen.
7. Vorrichtung zum Befestigen eines Verbindungsteils an dem offenen Ende einer Unterwasser-Pipeline mit
einem Preßformungswerkzeug (T) mit einem Hauptteil (10), einer elastischen Hülse (12), die um das Hauptteils herum gehalten ist, und einer Einrichtung zur Zufuhr von Druck zu dem Inneren der elastischen Hülse,
einer äußeren Formhülse (S),
einem Betätigungsorgan (M), welches das Formwerkzeug gegenüber der äußeren Formhülse ausfährt und zurückzieht,
eine Einrichtung (C), die das Betätigungsorgan (M) lösbar mit der äußeren Formhülse (S) verbindet,
dadurch gekennzeichnet, daß das Betätigungsorgan (M) so angeordnet ist, daß es in der aufgeweiteten Verformungsposition der elastischen Hülse (12) nach dem Formen gegenüber der Formhülse (S) bewegt werden kann, wobei die Bewegung des Betätigungsorgans durch dessen Ausfahren erfolgt, während die Hülse noch in der aufgeweiteten Verformungsposition ist.
8. Vorrichtung nach Anspruch 7, mit einer Basis (B), die mit der Hülse (S) in einer abstützen-



den Relation zu dieser verbunden ist.

9. Vorrichtung nach Anspruch 8, mit einem Stützflansch mit einem Hülsenflansch (20) und einer Einrichtung, die das Betätigungsorgan (M) mit dem Stützflansch verbindet, wobei die Einrichtung (C) ein Hülsenverbindungsglied (C) ist, welches an dem Hülsenflansch (20) an dem Stützflansch und einem Hülsenflansch an der Formhülse (S) angreift, um die Formhülse in Anlage an dem Stützflansch zu befestigen. 5
10. Vorrichtung nach jedem der Ansprüche 7 bis 9, mit einer Einrichtung (44), die mit dem Formwerkzeug (T) verbunden ist, um Fluidstrahlen in das Innere der Formhülse (S) einzuführen, wenn und nachdem diese in umgebende Relation zu der darin zu verformenden Pipeline positioniert ist. 10
11. Vorrichtung nach jedem der Ansprüche 7 bis 10, wobei die Formhülse ein Innenprofil, in das die Untersee-Pipeline zu preßformen ist, und einen äußeren Hülsenflansch hat. 15
12. Vorrichtung nach Anspruch 11, wobei die lösbare Verbindungsseinrichtung zwischen dem Betätigungsorgan und der äußeren Formhülse ein Hülsenverbindungsglied (C) ist. 20
13. Vorrichtung nach Anspruch 7, mit einem Halteflansch, der in dem Hülsenverbindungsglied (C) befestigt ist, und einer Einrichtung zum Befestigen des Betätigungsorgans (M) an dem Halteflansch, wobei das Betätigungsorgan eine Verbindungsstange (R) hat, die verschieblich durch den Halteflansch ausfahrbar und an dem Formwerkzeug (T) befestigt ist. 25
14. Vorrichtung nach Anspruch 10, wobei die Einrichtung (44) Öffnungen aufweist, die sich durch den Halteflansch erstrecken und in das Innere der Formhülse (S) gerichtet sind, die in Eingriff mit dem Hülsenverbindungsglied (C) steht, so daß durch diese Öffnungen (44) ausgestoßene Fluide Ablagerungen und andere Bodenfeststoffe von dem Inneren der Formhülse wegspülen. 30

Revendications

1. Procédé pour former un élément de raccordement sur l'extrémité d'une conduite sous-marine endommagée après l'élimination du tronçon endommagé, qui comprend les phases consistant à : 35
positionner sur le fond océanique à proximité de l'extrémité de la conduite un ensemble

composé d'un outil de mise en forme intérieur (T), d'un actionneur d'extension et de retrait (M) relié audit outil de mise en forme et sensiblement aligné sur l'extrémité de la conduite, et d'un élément manchon de raccordement (S),

mettre ledit outil de mise en forme (T) en extension pour l'engager dans l'extrémité de ladite conduite (P),

dilater la partie de mise en forme (12) dudit outil de mise en forme (T) pour l'appliquer étroitement contre la surface intérieure de ladite conduite,

rétracter l'outil de mise en forme (T) afin d'attirer l'ensemble contre l'extrémité de ladite conduite, de placer l'élément manchon de raccordement (S) autour de la conduite, et de former un épaulement contre lequel un manchon de mise en forme devra buter pendant la mise en forme, 20

dilater la partie de mise en forme (12) dudit outil (T) pour qu'elle attaque la surface intérieure de ladite conduite pour la mise en forme, afin de la presser radialement vers l'extérieur, et de la mettre en prise d'assemblage mécanique et de joint étanche avec la surface intérieure dudit élément manchon de raccordement (S), et caractérisé par les phases consistant à 25

mettre ledit actionneur (M) en extension pour éloigner ledit actionneur de l'extrémité de la conduite et dudit élément manchon de raccordement (S),

relâcher la pression de mise en forme dudit outil de mise en forme (T) et, 35

rétracter ensuite ledit actionneur (M) pour retirer ledit outil de mise en forme de l'intérieur de l'extrémité de ladite conduite (P).

2. Procédé selon la revendication 1, dans lequel ledit élément manchon de raccordement (S) est relié audit outil de mise en forme (T) et audit actionneur (M) par une liaison démontable, et comprenant les phases consistant à : 40

placer l'élément manchon de raccordement (S) en position autour de l'extrémité de ladite conduite (P) dans ladite seconde phase de retrait, et 45

démonter la liaison avec ledit élément manchon de raccordement (S) après ladite phase de mise en forme. 50

3. Procédé selon la revendication 2, comprenant les phases consistant à : 55

balayer l'intérieur dudit élément manchon de raccordement (3) pendant et après son positionnement autour de ladite extrémité de ladite conduite.



4. Procédé selon la revendication 1, dans lequel une pression suffisante est appliquée dans ladite phase initiale de dilatation pour assurer l'arrondissement de l'extrémité de la conduite (P).

5. Procédé selon la revendication 2, dans lequel la phase de retrait servant à positionner ledit élément manchon de raccordement (S) en position autour de l'extrémité de la conduite est exécutée avec une force suffisante pour que les parties non circulaires de ladite extrémité de la conduite (P) soient calibrées à une forme ronde par l'élément manchon (S).

6. Procédé selon la revendication 1, comprenant les phases consistant à exercer une pression de contrôle contre l'extrémité de la conduite (P) et l'élément manchon de raccordement (S) pendant que ledit outil de formage (T) est dans son état dilaté après ladite phase de formage, pour contrôler l'efficacité du contact d'étanchéité de l'extrémité de la conduite à l'intérieur dudit élément manchon de raccordement.

7. Appareil servant à fixer un connecteur sur l'extrémité ouverte d'une conduite sous-marine, qui comprend :

un outil de mise en forme à la pression (T) avant un corps (10), un manchon élastique (12) porté dans une position qui entoure ledit corps et des moyens servant à introduire une pression dans le volume intérieur dudit manchon élastique,

un manchon de mise en forme extérieur (S),

un actionneur (M) destiné à mettre ledit outil de mise en forme en extension et à le rétracter par rapport audit manchon de mise en forme extérieur,

des moyens (C) qui relient l'actionneur (M) audit manchon de mise en forme extérieur (S) par une liaison démontable, et caractérisé en ce que

ledit actionneur (M) est disposé et agencé de telle manière que, lorsque ledit manchon élastique (12) est dans sa position dilatée de mise en forme, il puisse être déplacé par rapport au manchon de mise en forme (S) après la mise en forme, ce mouvement dudit actionneur répondant à la mise en extension dudit actionneur pendant que ledit manchon est encore dans ladite position dilatée de mise en forme.

8. Appareil selon la revendication 7, comprenant une base (B) reliée audit manchon (S) et qui

supporte ce dernier.

9. Appareil selon la revendication 8, comprenant une bride support possédant un rebord de serrage (20), et des moyens servant à relier ledit actionneur (M) à ladite bride support, et dans lequel

lesdits moyens (C) sont un connecteur à pince (C) qui attaque ledit rebord de serrage (20) prévu sur ladite bride support et un rebord de serrage prévu sur ledit manchon de mise en forme (S) afin de fixer ledit manchon de mise en forme en butée contre ladite bride support.

10. Appareil selon une quelconque des revendications 7 à 9, comprenant des moyens (44) associés audit outil de mise en forme (T) pour introduire des jets de fluide dans le volume intérieur dudit manchon de mise en forme (S) pendant qu'on le positionne autour de ladite conduite qu'il s'agit de mettre en forme dans ce manchon et après qu'il a été placé autour de la conduite.

11. Appareil selon une quelconque des revendications 7 à 10, dans lequel

ledit manchon de mise en forme présente un profil intérieur dans lequel la conduite sous-marine doit être mise en forme par pression, et un rebord de serrage extérieur.

12. Appareil selon la revendication 11, dans lequel lesdits moyens de liaison démontables prévus entre ledit actionneur et ledit manchon de mise en forme extérieur sont constitués par un connecteur à pince (C).

13. Appareil selon la revendication 7, comprenant une bride support montée à l'intérieur dudit connecteur à pince (C), et

des moyens servant à fixer ledit actionneur (M) à ladite bride support,

ledit actionneur possédant une tige de liaison (R) qui traverse à coulissement ladite bride support et est fixée audit outil de mise en forme (T).

14. Appareil selon la revendication 10, dans lequel lesdits moyens (44) comprennent des orifices qui traversent ladite bride support et qui sont dirigés vers l'intérieur dudit manchon de mise en forme (S) qui est attaqué par ledit connecteur à pince (C) de telle manière que les fluides éjectés à travers lesdits orifices (44) balayent les sédiments et autres solides du fond et les expulsent de l'intérieur dudit manchon de mise en forme.