Dec. 31, 1968 L. E. WILLIAMS, JR., ET AL 3,419,071

UNDERWATER WELLHEAD APPARATUS

Original Filed Dec. 18, 1964 Sheet 1 of 3

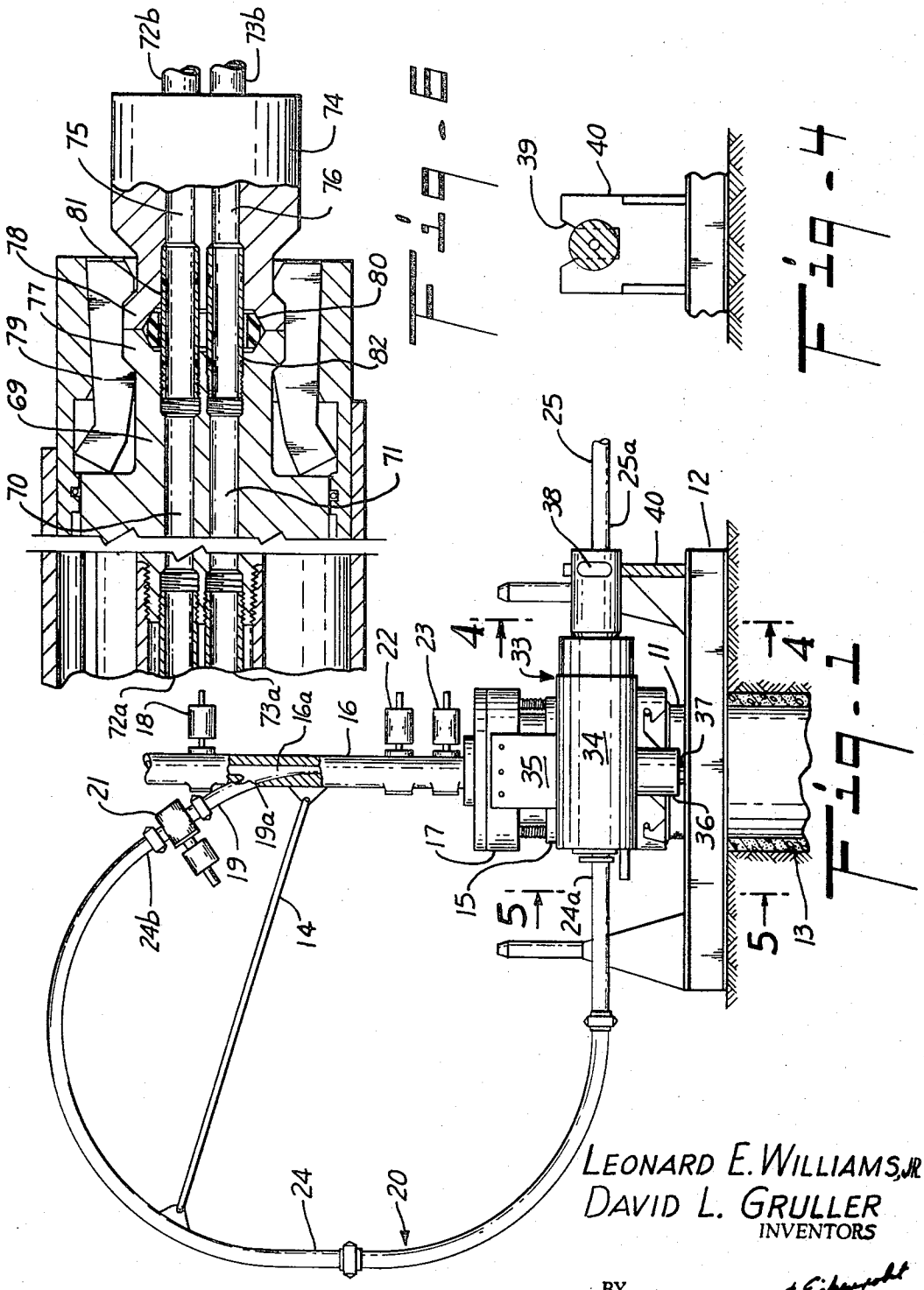


Fig. 1

Fig. 4

Fig. 5

LEONARD E. WILLIAMS, JR.
DAVID L. GRULLER
INVENTORS

BY

Browning, Simms, Hyer & Eichenlaub

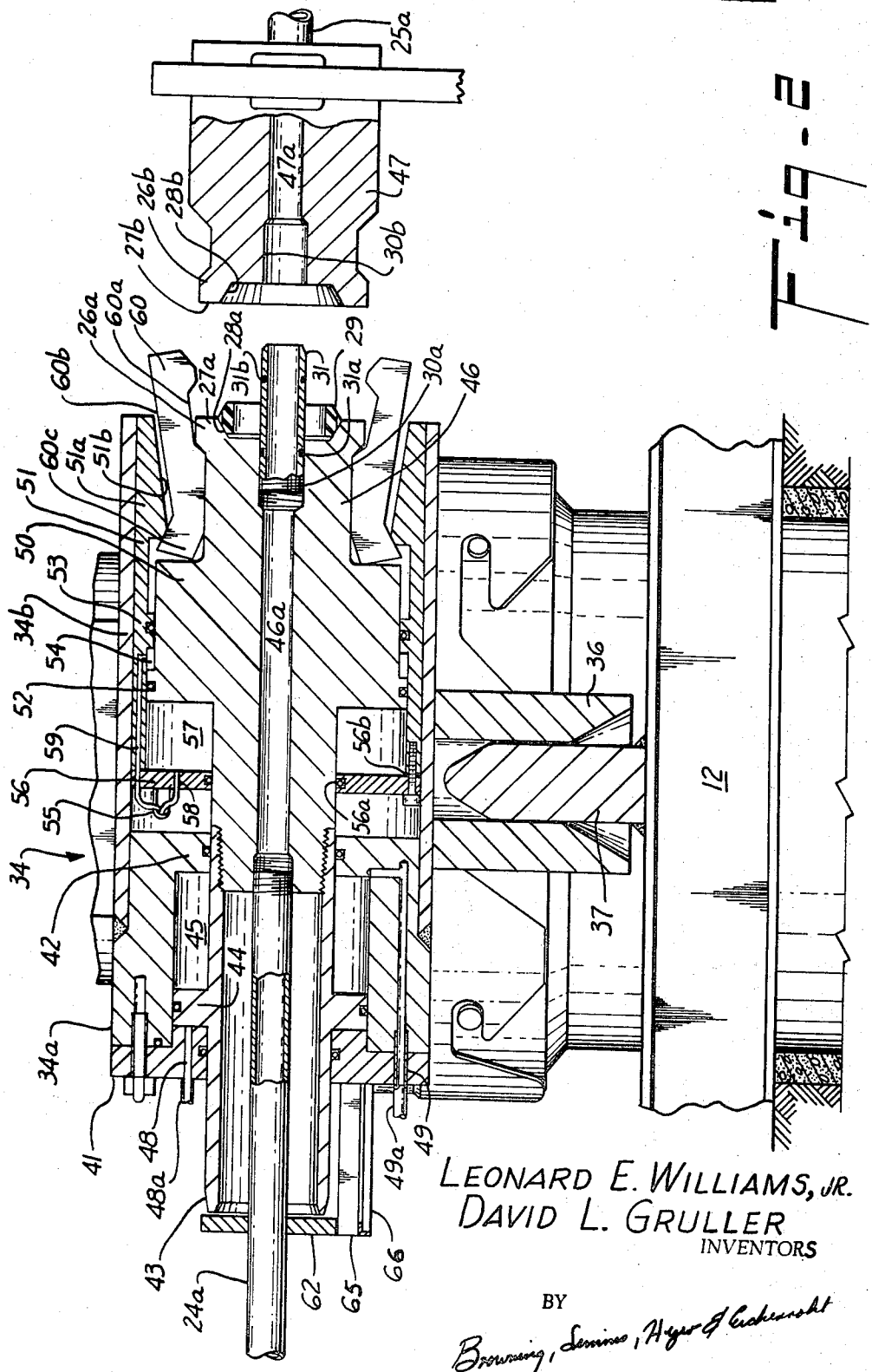
ATTORNEYS

Dec. 31, 1968 L. E. WILLIAMS, JR., ET AL 3,419,071

UNDERWATER WELLHEAD APPARATUS

Original Filed Dec. 18, 1964 Sheet 2 of 3

Fig. 2



LEONARD E. WILLIAMS, JR.
DAVID L. GRULLER
INVENTORS

BY

Browning, Semmes, Hyer & Eichenlaub

ATTORNEYS

Dec. 31, 1968 L. E. WILLIAMS, JR., ET AL 3,419,071

UNDERWATER WELLHEAD APPARATUS

Original Filed Dec. 18, 1964 Sheet 3 of 3

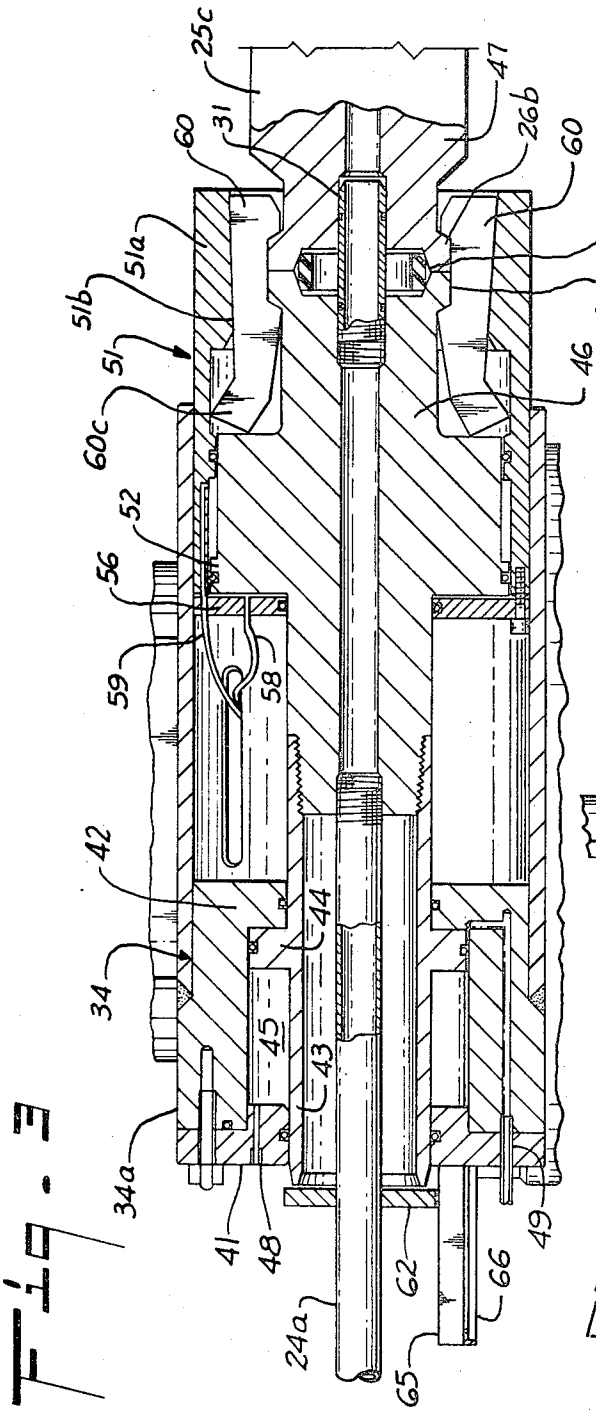


Fig. 3

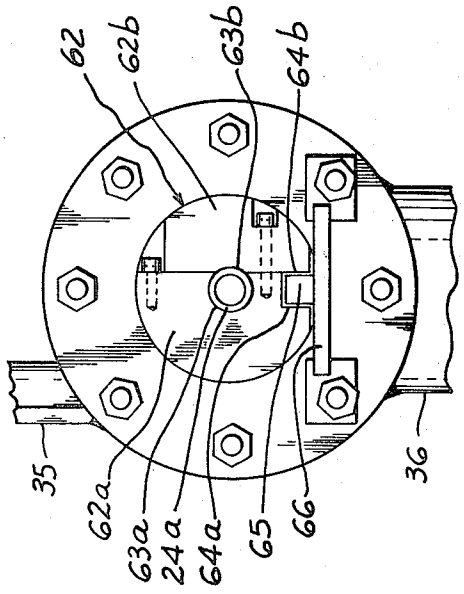


Fig. 5

LEONARD E. WILLIAMS, JR
DAVID L. GRULLER
INVENTORS

BY

Browning, Bushman, Hogan & Eickemeyer

ATTORNEYS

United States Patent Office 3,419,071
Patented Dec. 31, 1968

3,419,071

UNDERWATER WELLHEAD APPARATUS

Leonard E. Williams, Jr., and David L. Gruller, Houston, Tex., assignors to Cameron Iron Works, Inc., Houston, Tex., a corporation of Texas

Continuation of application Ser. No. 419,442, Dec. 18, 1964. This application June 21, 1967, Ser. No. 647,880
22 Claims. (Cl. 166—.6)

ABSTRACT OF THE DISCLOSURE

Remotely operated apparatus for connecting and disconnecting two sections of a flow line for an underwater well. One section of the flow line has one end connected to the wellhead and the other end connected to a piston located in a housing mounted on the wellhead. This section is curved sufficiently to permit the piston to move the end attached to it axially. Located adjacent and in axial alignment with the movable end of the first section is one end of the other section of the flow line. Fluid pressure supplied from the surface can act on either side of the piston and move the end of the flow line section attached to it into and out of engagement with the adjacent, axially aligned end of the other section to connect and disconnect the two flow line sections.

This application is a continuation of my earlier application, Ser. No. 419,442, filed Dec. 18, 1964, entitled "Underwater Wellhead Apparatus," and now abandoned.

This invention relates to improved apparatus for remotely connecting and disconnecting two sections of an underwater flow line connected to an underwater wellhead.

It is common practice today when completing underwater wells to locate the wellhead equipment adjacent to the bottom of the water and run one or more flow lines from the wellhead along the bottom to a remotely located production facility. The flow lines are usually connected to the Christmas tree portion of the wellhead during the initial installation. From time to time, it is necessary to remove the Christmas tree to allow certain maintenance operations to be performed in the well. At these times, it is necessary to disconnect the flow lines to allow the tree to be removed, and then reconnect them when the tree is reinstalled on the wellhead.

In many instances the depth of the water above the well is such that a diver cannot safely perform these operations. Therefore, there is a need for remotely operable means for connecting and disconnecting a flow line to and from a Christmas tree located adjacent to the bottom of a body of water. Apparatus for accomplishing this has been provided before; however, this apparatus places a section of increased internal diameter in the flow line since it relies upon a telescoping joint to bridge the space between the ends of the two sections.

Most underwater wells have their wellheads and flow lines arranged to allow well tools to be pumped into and out of the well through the flow line. An enlargement in the passageway through which the well tools pass is undesirable if it permits the fluid pushing the tools through the flow line to bypass the tools at these enlargements, because the tools would stop moving.

Therefore, it is an object of this invention to provide apparatus for remotely connecting and disconnecting two sections of a flow line in such a manner that the flow passage therethrough may be of least substantially uniform diameter.

It is very important to keep the fluid passing through the flow line from escaping into the water. In the prior

apparatus, at least one dynamic or moving seal was used for this purpose. Moving or dynamic seals, i.e., seals that are subjected to a differential pressure while sealing between two members moving relative to each other, usually have a shorter life than do static seals or seals required to hold against pressure differentials only while sealing between members not moving relative to one another. Therefore, it is desirable to have and it is an object of this invention to provide apparatus for remotely connecting and disconnecting sections of an underwater flow line in which the seals may be static.

It is another object of this invention to provide improved apparatus for remotely connecting and disconnecting two sections of a flow line that is reliable and economical to manufacture.

These and other objects, advantages, and features of the invention will be apparent to those skilled in the art from a consideration of this specification and attached drawings.

These objectives are attained, in accordance with this invention, by curving one of the sections of the flow line sufficiently to allow its end that is to be connected to the end of the other section and that is adjacent thereto to be moved relative to the adjacent end of the other section even though its other end is fixed. Apparatus is then provided, which can be remotely operated, to move the movable end toward and away from the adjacent end of the other section to connect and disconnect the ends of the two sections. By connecting the ends of the two sections in this manner, the flow passage through the flow line can be provided with a substantially uniform diameter through the connection since no telescoping sleeve is required to bridge the space therebetween. Further, by moving one or both of the ends of the sections to connect and disconnect the sections, the seals provided to seal between the ends of the two sections are static seals, which are much more reliable than the dynamic seal heretofore relied upon to maintain the fluid in the flow line.

The invention will now be described in detail in connection with the embodiment thereof shown in the attached drawings in which:

FIGURE 1 is a view in elevation of an underwater wellhead and a flow line for connecting the wellhead to a remote production facility (not shown), the flow line comprising two sections, each having one end positioned adjacent the end of the other to allow the two sections to be connected and disconnected by apparatus which moves the adjacent end of one section toward and away from the adjacent end of the other section;

FIGURE 2 is a vertical sectional view through the two adjacent ends of the sections of flow line which are to be connected together and apparatus constructed in accordance with this invention for moving the movable end of one of the sections of flow line toward the adjacent end of the other section so as to connect the two sections;

FIGURE 3 is a view similar to FIGURE 2, but showing the ends of the two sections of flow line connected together by the apparatus of FIGURE 2;

FIGURE 4 is a sectional view taken along line 4—4 of FIGURE 1 showing the apparatus employed to hold the adjacent end of one section of the flow line in position to be connected to the movable end of the other section;

FIGURE 5 is a view taken along line 5—5 of FIGURE 1; and

FIGURE 6 is a partial sectional view of an alternative form of the apparatus for connecting together the ends of sections of two flow lines.

The underwater wellhead assembly shown in FIGURE

1 comprises a base including conductor casing **11**, and a base plate **12** attached to it. The casing is usually jetted into the ground below the water until base plate **12** is in position adjacent the bottom. The conductor casing may then be anchored in position by a cement layer **13** between the conductor casing and the walls of the hole formed when the conductor casing is jetted into place. The base also includes a head assembly **15** mounted on the top of conductor casing **11** to support the various strings of casing in the conventional manner. Christmas tree **16** includes a coupling **17** on its lower end releasably connected to casing head assembly **15**. This coupling can be of any type which allows the tree to be remotely attached and detached from the casing head assembly. One such connection which can be used for this purpose is shown and described in United States Patent No. 3,137,348.

The Christmas tree **16** is provided with a bore **16***a* through which the well fluid passes as it leaves the well. Bore **16***a* is generally vertical to allow vertical access to the well. It is connected to a laterally extending flow wing **19** which connects the bore to a flow line **20** for conducting the well fluid to a remote production facility. Vertical access to the bore **16***a* is controlled by valve **18** and flow through this bore between the well and flow wing **19** is controlled by master valves **22** and **23**.

The bore **19***a* of laterally branching flow wing **19** curves gently upwardly and laterally from and substantially tangent to the axis of bore **16***a*. The flow line **20** also curves gently upwardly and around from the flow wing to form a portion of a loop, this loop and the curved passage in the flow wing combining to guide well tools pumped through the flow line into and out of bore **16***a* of the tree. Wing valve **21** is provided to control the flow through flow wing **19** and to connect the flow wing to flow line **20**.

Flow line **20** is divided into two sections **24** and **25**, respectively. Section **24** has one end **24***b* connected to the flow wing of the tree, whereas section **25** has one end (not shown) located at the remote production facility to which the fluid produced by the well is conducted by the flow line. The opposite ends **24***a* and **25***a*, respectively, of the flow lines **24** and **25** are adapted to be connected together to complete the flow line in the manner to be described.

Section **24** of flow line **20** curves upwardly and around from wing valve **21** with a large radius of curvature until its end **24***a* is substantially horizontal. Thus, it is shaped like a portion of one coil of a coil spring and its end **24***a* can be moved in an axial direction even though its end **24***b* is fixed to wing valve **21** on flow wing **19** of tree **16**. The distance end **24***a* can be moved without exceeding the yield strength of the material from which section **24** is made will depend, of course, upon the yield strength of the material, the radius of curvature of the section, the diameter of the pipe, the opening therethrough, etc. Since this section of the flow line acts as a spring, it can be designed to normally urge end **24***a* to a position spaced from or engaged with end **25***a* of section **25**, as desired. Also, the section can be designed for a minimum of stress in the section when its end is either connected to the end of the other section or at some other position.

A lateral brace **14** extends from tree **16** outwardly at an angle to support section **24**. The brace is pivotally connected to the tree and the flow line to allow some movement of the section. It tends to shorten the length of the section which acts as a spring, however, and therefore can be left off if it interferes with the desired movement of end **24***a*. The brace also serves to relieve the connection between end **24***b* of this section of the flow line and wing valve **21** of some of the stress which would otherwise be imposed on it when the end **24***a* is moved relative to the wellhead. Usually, this is desirable.

Remotely operable means connect and disconnect the two sections **24** and **25** of flow line by moving the movable end **24***a* of section **24** toward and away from the adjacent end **25***a* of the other section **25** of the flow line. In the embodiment illustrated, the connector, generally indicated by the number **33**, includes cylindrical housing **34**, made up of two annular members **34***a* and **34***b*, which in this embodiment are welded together as shown. The housing is attached to mounting plate **35**, as by welding, and plate **35**, is bolted to the removable portion of coupling **17** (FIGURE 1), which, as explained above, is used to releasably attach tree **16** to the casing head of the wellhead assembly. Thus, when the tree is removed from the well, housing **34** and the components mounted therein will be removed with it. As shown in FIGURE 2, the lower end of the housing **34** is attached to tubular member **36** which engages pin **37** attached to base plate **12** to help guide the housing into proper alignment with the section **25** of the flow line when the tree is installed on the wellhead.

Member **34***a* of housing **34** has end plate **41** attached to one end and an integrally attached inwardly extending flange **42** on the other end. Both end plate **41** and flange **42** are provided with openings through which sleeve **43** extends. An outwardly extending annular flange **44** is located between end plate **41** and flange **42** and integrally connected to sleeve **43**. Seals, such as the O-ring type shown in the drawings, are located between sleeve **43** and end plate **41** and flange **42**, and between annular flange **44** and housing section **34***a*. With this arrangement, flange **44** constitutes an annular piston slidably mounted within annular pressure cylinder **45** formed by the members described above.

Threadedly connected to both end **24***a* of section **24** of the flow line and sleeve **43** is connector body **46**. End **25***a* of section **25**, in turn, is connected to hub **47**. With sleeve **43** connected to body **46**, movement of piston **44** in cylinder **45** will, in turn, cause movement of the body either toward or away from hub **47**. Fluid pressure is applied alternately to opposite sides of piston **44** to cause such movement, through openings **48** and **49** and fluid pressure hoses **48***a* and **49***a*. The source of fluid pressure supplied through hoses **48***a* and **49***a* is usually located at the surface of the water, thus allowing the movement of piston **44** to be controlled remotely.

As best seen in FIGURES 2 and 3 of the drawings, both body **46** and hub **47** are provided with annular flanges **26***a* and **26***b*, respectively, to provide opposing end faces, **27***a* and **27***b*. These end faces engage and limit the distance piston **44** can move the body toward the hub. The body and hub are also provided with tapered bores **28***a* and **28***b* adjacent to the end faces, which wedge against seal ring **29** when the end faces are in engagement to provide a seal between the hub and the body. The body and hub are provided with longitudinal passageways **46***a* and **47***a* which preferably have the same diameter as the flow passage through the flow line. To connect these passageways and to maintain the same diameter flow passage therebetween, passageways **46***a* and **47***a* are provided with sections of increased diameter **30***a* and **30***b*, respectively, to allow seal sub **31**, having a passageway equal in diameter to the passageway through the flow line, to extend into bores **30***a* and **30***b*. Seals **31***a* and **31***b*, carried by the seal sub, sealingly engage the bores.

In the embodiment shown, the seal sub is threadedly connected to body **46** so that the sub will be carried with the body as it moves away from and into engagement with hub **47**. There is no pressure across seal **31***b* as it moves into sealing engagement with bore **30***b* in the hub. This allows both seals to be designed as stationary or static seals.

To allow end **25***a* of flow line section **25** to be moved to the surface for repair or replacement and then repositioned for connection to the section of flow line connected to the tree, hub **47** is provided with milled flats **38** to engage slot **39** in bracket **40**, as shown in FIGURES 1 and 4. The bracket is attached to base plate **12** to maintain end **25***a* of section **25** of the flow line fixed relative to the wellhead and in proper alignment with end **24***a* of the other flow line section for connection thereto.

In FIGURE 2, the two sections of flow line are disconnected, with movable end 24*a* of section 24 and body 46 spaced from and in axial alignment with hub 47 and end 25*a* of section 25 of the flow line. To connect the two sections, fluid pressure is supplied to annular cylinder 45 through opening 48 to move piston 44 toward hub 47, thus moving end 24*a* of flow line section 24 and body 46 axially toward hub 47 until end faces 27*a* and 27*b* engage, as shown in FIGURE 3. Concomitantly, seal sub 31 enters bore 30*b* of hub 47 and seal ring 29 is compressed by tapered bores 28*a* and 28*b*.

To move body 46 out of engagement with hub 47 and disconnect the two sections of flow line 20, pressure is supplied through opening 49 which exerts a force on the other side of piston 44 and moves body 46 and movable end 24*a* of flow line section 24 axially away from end 25*a*. Thus, body 46 is movable between a first position in engagement with hub 47 to connect the two sections of flow line and a second position out of engagement with and spaced from the hub to disconnect the two sections of flow line.

With fluid pressure held in cylinder 45, body 46 and hub 47 are held in engagement and the two flow line sections are connected. Usually, it is undesirable to maintain the fluid pressure for a long period of time. Therefore, means are provided for mechanically holding the two sections connected together independently of this fluid pressure. In the embodiment illustrated, body 46 has integrally connected thereto an outwardly extending flange 50, which extends only part way toward cylindrical portion 34*b* of housing 34. Located between flange 50 and cylindrical member 34*b* is tubular locking ring 51. Flange 50 and locking ring 51 have oppositely extending annular portions 52 and 53 which combine to provide pressure cylinder 54. O-rings are appropriately located in each portion, in the manner shown in the drawings, to retain pressure in the cylinder.

Attached to the end of locking ring 51, as by means of a plurality of cap screws, is annular member 56 which carries a seal 56*a* engageable with the outer surface of the body 46. This combines with locking ring 51 and the annular member to provide annular cylindrical chamber 57. Gasket 56*b* is located between annular member 56 and locking ring 51 to retain pressure in the chamber. Opening 58 is provided through annular member 56 and opening 59 extends through annular member 56 and a portion of locking ring 51 to supply fluid pressure to pressure chambers 57 and 54. Slot 55 in the housing allows these openings to be connected to pressure sources external to the housing.

Thus, by selectively applying pressure either through opening 58 or opening 59, locking ring 51 can be moved axially with respect to body 46. The locking ring functions to move locking dogs 60, a plurality of which are spaced circumferentially around body 46, into and out of engagement with the opposite sides of flanges 26*a* and 26*b*, in the manner shown in FIGURE 3. To so move the dogs, the locking ring is provided with cam 51*a* having a sloping cam surface 51*b* which engages the sloping surface 60*b* on locking dogs 60 and holds them in position for notch 60*a* to hold end faces 27*a* and 27*b* in engagement. The dogs are moved into holding position by applying fluid pressure to chamber 54. The taper of cam surface 51*b* is such that outward force exerted thereon by the dogs will not cause locking ring 51 to move. Therefore, once the locking ring is in position holding the dogs in engagement with the ends of the two sections, the pressure in chambers 54 and 45 can be released.

To release the latch dogs, pressure is applied through opening 58 into pressure chamber 57 to move locking ring 51 axially back into housing 34. This causes cam 51*a* to engage the upwardly inclined end portions 60*c* on latch dogs 60 and pivot them out of latching engagement with respect to flanges 26*a* and 26*b*, as shown in FIGURE 2. With the body and hub thus released, pressure may be applied through opening 49 against piston 44 to move end 24*a* of section 24 of flow line 20 and body 46 axially out of engagement with hub 47, thereby disconnecting the two sections of flow line.

To reduce the stress imposed on the threaded connection between body 46 and flow line end portion 24*a*, guide means are provided to maintain the end of flow line section 24 in axial alignment with the body as they move toward and away from the hub. As best shown in FIGURE 5, clamp members 62*a* and 62*b* of clamp 62 are bolted together around end 24*a* adjacent the end of sleeve 43. The clamp members are provided with circular grooves 63*a* and 63*b* to receive the flow line. Both are also provided with adjacent notches 64*a* and 64*b* which form a rectangular groove to receive rectangular guide bar 65. The bar guides the clamp members and thereby the end of the flow line section along a path in axial alignment with the path of the body. Since the shape of flow line section 24 will cause end 24*a* to tend to move downwardly as it moves away from the other flow line section, a guide bar need only be positioned along the bottom of the clamp members. The guide bore is supported by bracket 66 attached to end plate 41 on housing 34.

The connector can be modified to accommodate a plurality of flow lines. In FIGURE 6, the connector is shown modified to simultaneously connect and disconnect the ends of two flow lines. Body 69 has two longitudinal passageways 70 and 71, which are threadedly connected to end portions 72*a* and 73*a* of section of the two flow lines. These flow line sections could be connected to the Christmas tree in the manner described in connection with section 24 of flow line 20 of FIGURE 1, or they could extend to a remote production facility. In either event, they should be provided with sufficient curvature to allow their ends to move axially relative to the adjacent ends 72*b* and 73*b* of the two sections of flow line with which they combine to provide two continuous conduits for well fluids from the well to a remote production facility.

End portions 72*b* and 73*b* are connected to longitudinal passageways 75 and 76 in hub 74, which are aligned with passageways 70 and 71 of the body 69. Preferably, these passageways are the same diameter as the flow passages through the flow line sections. The body is moved into and out of engagement with the hub in the same manner as described above. They are provided with flanges 77 and 78 which provide end faces to stop the axial movement of body 69 toward hub 74 and to provide outwardly extending protrusions for engagement by the notch in latch dogs 79, which, like latch dogs 60 in the embodiment above, releasably hold the two end faces in engagement. Further, the body and hub are provided with tapered bores for sealingly engaging seal ring 80 when the end faces are in engagement.

To provide fluid communication between each of the passageways in the body with one of the passageways in the hub and to isolate the fluid flowing between each pair of passageways, each passageway has a section of increased diameter adjacent its end to receive one end of seal subs 81 and 82. Each seal sub is preferably attached to either the body or the hub to keep it from falling when the body and the hub move apart to disconnect the ends of the flow line sections. In the embodiment shown, the seal subs are attached to body 69. Each seal sub is provided with seals to engage the enlarged bores adjacent the ends of the passageways in which they are located to prevent fluid communication between the flow lines.

Preferably, the flow passages through the seal subs and the passageways through the body and hub have the same diameter as the flow passages through the flow lines they connect. This avoids creating any enlargement in the diameter of the flow passages through the flow lines, which is one of the objects of this invention. There is, of course, a section of slightly enlarged diameter in the flow passages between the ends of the seal subs and the ends of the portions of enlarged diameter in the passageways through the body and hub. This length of this section, however, may be made as short as desired.

From the foregoing, it will be seen that this invention is one well adapted to attain all of the ends and objects hereinabove set forth, together with other advantages which are obvious and which are inherent in the apparatus and structure.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the claims.

As many embodiments may be made of the invention without departing from the scope thereof, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

The invention having been described, what is claimed is:

1. Apparatus for use with an underwater wellhead, comprising a flow line for conducting fluid from the wellhead and having first and second sections, said first section having one end connected to the wellhead and said second section having one end remote therefrom, each section having another end adjacent to another end of the other section, one of said sections being curved sufficiently to allow its adjacent end to move toward and away from the adjacent end of the other of said sections, and remotely controlled means for so moving the adjacent end of the curved section to selectively connect and disconnect the adjacent ends of the two sections of flow line, said means comprising a housing fixed relative to the adjacent end of said other of said sections and fluid pressure means for moving the adjacent end of the curved section toward and away from the adjacent end of said other of said sections.

2. The apparatus as defined in claim 1 further provided with releasable locking means for holding the adjacent ends of the two sections of flow line in connected relationship independently of said remotely controlled moving means.

3. Apparatus for use with an underwater well comprising, a wellhead for controlling the flow of fluid from the well, a flow line for carrying fluid from the wellhead, said flow line comprising first and second sections, the first section being curved sufficiently between its connection at one end to the wellhead and its other end to permit said other end to be moved relative to such wellhead, the second section having one end adjacent to and in axial alignment with the movable end of the first section, and remotely operable means mounted on the wellhead for moving the movable end of the first section axially toward and away from the adjacent end of the second section to selectively connect and disconnect the first and second sections of the flow line.

4. Apparatus for use with an underwater well comprising, a wellhead for controlling the flow of fluid from the well, a flow line divided into two sections, a first section having one end connected to the wellhead and a second section having one end remote therefrom, the other ends of the two sections being adjacent to each other, one section of said flow line being curved sufficiently to allow its adjacent end to be moved toward and away from the adjacent end of the other section, means carried by the adjacent ends for sealingly engaging one another, and remotely operable means including a housing fixed relative to the wellhead and the adjacent end of the other flow line section of fluid pressure means for moving the movable end toward the adjacent end of the other section to move the sealing means into engagement with one another and for moving the movable end away from the adjacent end to move the sealing means out of engagement with one another.

5. Apparatus for use with an underwater wellhead, comprising a flow line for carrying fluid to and from the wellhead, said flow line comprising first and second sections, the first section being curved sufficiently to allow one end thereof to be moved axially while its other end is connected to the wellhead, the second section having one end positioned adjacent to and in axial alignment with the movable end of the first section, and remotely operable connector means for moving the movable end of the first section into engagement with the adjacent end of the second section, the connector means comprising a housing fixed relative to the end of the second section and having a pressure chamber therein, a piston located in the chamber and operatively connected to the movable end of the first section, and means for alternately applying fluid pressure to each side of the piston to selectively move the movable end of the first section axially into and out of engagement with the adjacent fixed end of the second section.

6. Apparatus for use with an underwater wellhead, comprising a flow line connector, means for mounting the connector adjacent the underwater wellhead, a flow line having a flow passage therethrough for carrying fluid to and from the wellhead, said flow line comprising first and second sections, the first section having one end connected to the wellhead and one end attached to the connector, said first section being curved sufficiently to allow its end attached to the connector to be moved axially while its other end is fixed to the wellhead, the second section having one end positioned adjacent to and in axial alignment with the end of the first section attached to the connector, the connector comprising a housing providing a cylindrical pressure chamber, a piston reciprocally mounted in the pressure chamber, means operatively connected to the movable end of the first section of the flow line, means for alternately supplying pressure against each side of the piston to move the piston in the housing and thereby selectively move the movable end of the first section of the flow line into and out of engagement with the end of the second section of the flow line, and seal means carried by one of the adjacent ends to provide a seal between the two sections when their adjacent ends are in engagement.

7. The apparatus of claim 6 in which the movable end of the first section and said end of the second section have opposed end faces and bores of increased diameter adjacent their end faces to provide sealing surfaces, and in which said seal means comprises a tubular member having a bore substantially equal in diameter to the flow passage through the flow line connected to one of the sections in axial alignment with the flow line, said member extending beyond the end face of the end to which it is attached to enter the enlarged bore of the other end and provide a continuous passageway of substantially constant inside diameter between the ends of the sections of flow line when the end faces thereof are in engagement, and a seal located between the member and the sealing surface of the bore into which the member is moved by the connector.

8. A remotely operated connector for connecting and disconnecting the adjacent ends of two sections of flow line wherein, one of said ends is in movable axial relation to the other, comprising a hollow housing having an annular pressure chamber, an annular piston reciprocally mounted in the pressure chamber, means operatively connecting the piston to the movable end of one section of flow line to move with the piston, a connector body connected to said movable end for movement therewith and having a passageway therethrough in fluid communication with said one section of flow line, a hub member connected to the adjacent end of the other section of flow line and having a passageway therethrough in fluid communication with such flow line section, means for mounting the hub member to the housing with the passageways of the hub member and body in axial alignment, and means for supplying fluid pressure alternately to each side of the piston to move the body into and out of engagement with the hub to connect and disconnect the two sections of flow line.

9. The connector of claim 8 further provided with releasable locking means for holding the adjacent ends of the two sections of flow line in connected relationship independently of said piston means.

10. Apparatus for use with an underwater wellhead, comprising a flow line having a flow passage and first and second sections, the flow line being arranged with one end of the first section adapted for connecting to a wellhead, one end of the second section remote therefrom, and the other ends of the two sections adjacent each other and in axial alignment, one of said sections having sufficient curvature to allow its adjacent end to be moved axially toward and away from the other adjacent end, a body member attached to the movable adjacent end and a hub member attached to the other adjacent end, said body and hub members having passageways therethrough in axial alignment with the flow passages in the adjacent ends of the flow line, and means including a housing for mounting on an underwater wellhead and fluid pressure means for moving the body member axially into and out of engagement with the hub member to connect and disconnect the two sections of flow line.

11. The apparatus as defined in claim 10 further provided with means for holding the body member and hub member in engagement, said means comprising outwardly extending adjacent flanges on the two members, a plurality of latch dogs carried by one of the members for pivotal movement into and out of engagement with the two flanges when the two members are in engagement, an actuating sleeve for pivoting the dogs into and out of engagement with the flanges and for holding the dogs in either position, and fluid operated means for moving said actuating sleeve.

12. The apparatus of claim 10 in which the passageway through one of the members is provided with a bore of increased diameter adjacent the other member, and the apparatus is further provided with a seal member having an opening therethrough and carried by and fixed relative to the other member for extending into the enlarged bore section of the adjacent passageway when the two members are moved into engagement to provide a fluid conduit through which fluid can flow between the passageways, and seal means for sealing between the seal member and the members.

13. The apparatus as defined in claim 12 further provided with an annular seal ring encircling the seal member and located between the body member and the hub member to be compressed therebetween when the two members are moved into engagement to provide another seal for retaining fluid carried by the flow line.

14. Wellhead apparatus, comprising a Christmas tree having a bore therethrough, a first flow line section connected at one end to the tree for communication with the bore and means for supporting the other end of the first flow line section from the tree for axial movement relatively to said tree toward a position for connection with the oppositely facing end of a second flow line section, said first flow line section flexing between its end to permit it to be so moved.

15. Wellhead apparatus of the character defined in claim 14, wherein said first flow line section has a constant inner diameter from one end to the other.

16. Wellhead apparatus of the character defined in claim 14, further comprising a base upon which the tree is adapted to be mounted, and means on the tree cooperable with means on the base for guiding said other end of the first flow line section into a position for axial alignment with said end of the second flow line section as the tree is mounted on the base.

17. Wellhead apparatus, comprising a Christmas tree having a bore therethrough, a first flow line section connected at one end to the tree for communication with the bore, a cylinder, means for supporting the cylinder near the other end of the first flow line section, and a piston connected to the first flow line section and sealably slidable within the cylinder for moving said other end toward a position for connection with an oppositely facing end of a second flow line section, said first flow line section flexing intermediate its ends to permit said other end to be so moved.

18. Wellhead apparatus of the character defined in claim 17, wherein said first flow line section has a constant inner diameter from one end to the other.

19. Wellhead apparatus, comprising a base having a bore therethrough, a Christmas tree having a bore therethrough and adapted to be mounted on the base with their bores aligned, a first flow line section connected at one end to the tree for communication with the bore therethrough, a cylinder supported by the tree against axial movement and surrounding the first flow line section near its other end, means on the cylinder and base engageable with one another, during mounting of the tree on the base, to guide the cylinder into a position for axially aligning said other end with an oppositely facing end of a second flow line section, and a piston on the first flow line section and sealably slidable within the cylinder for moving said other end toward a position for connection with oppositely facing end of the second flow line section, said first flow line section flexing between its ends to permit said other end to be so moved.

20. Wellhead apparatus of the character defined in claim 19, wherein said first flow line section has a constant inner diameter from one end to the other.

21. For use with underwater wellhead apparatus including a Christmas tree having an outlet adapted to be connected with a flow line section having one end near the tree; apparatus comprising another flow line section having means on one end for connection to said outlet and means on the other end for connection to said one end of the first-mentioned section, the distance along the length of said other flow line section and between the ends thereof being fixed, said other flow line section being sufficiently curved intermediate said ends so that flexure thereof permits said other end to be moved toward and away from said one end of the first-mentioned flow line section when the means on said one end of the other flow line section is connected to said outlet, and remotely controllable means on said other flow line section for so moving said other end thereof toward said one end of the first-mentioned flow line section in order to connect them together, said moving means having means thereon for mounting it on said wellhead apparatus.

22. Apparatus of the character defined in claim 21, wherein said moving means includes a cylinder and a piston sealably reciprocal within the cylinder and fixedly secured to the other flow line section near its other end, and said mounting means comprises means on said cylinder for fixing it against movement toward and away from said one end of the first-mentioned flow line section.

References Cited

UNITED STATES PATENTS

3,064,735	11/1962	Bauer et al.	166—.6
3,052,299	9/1962	Geer et al.	
3,111,692	11/1963	Cox.	
3,189,098	6/1965	Haeber.	
3,220,477	11/1965	Jones.	
3,233,667	2/1966	Van Winkle.	
3,260,270	7/1966	Watkins et al.	
3,298,092	1/1967	Dozier et al.	166—.6 X
3,307,627	3/1967	Shatto	166—.6

CHARLES E. O'CONNELL, *Primary Examiner.*

R. E. FAVREAU, *Assistant Examiner.*