Feb. 8, 1966 R. L. GEER ETAL 3,233,666

UNDERWATER WELLHEAD WITH REMOTELY-DETACHABLE FLOW LINE

Filed July 19, 1962 4 Sheets-Sheet 1

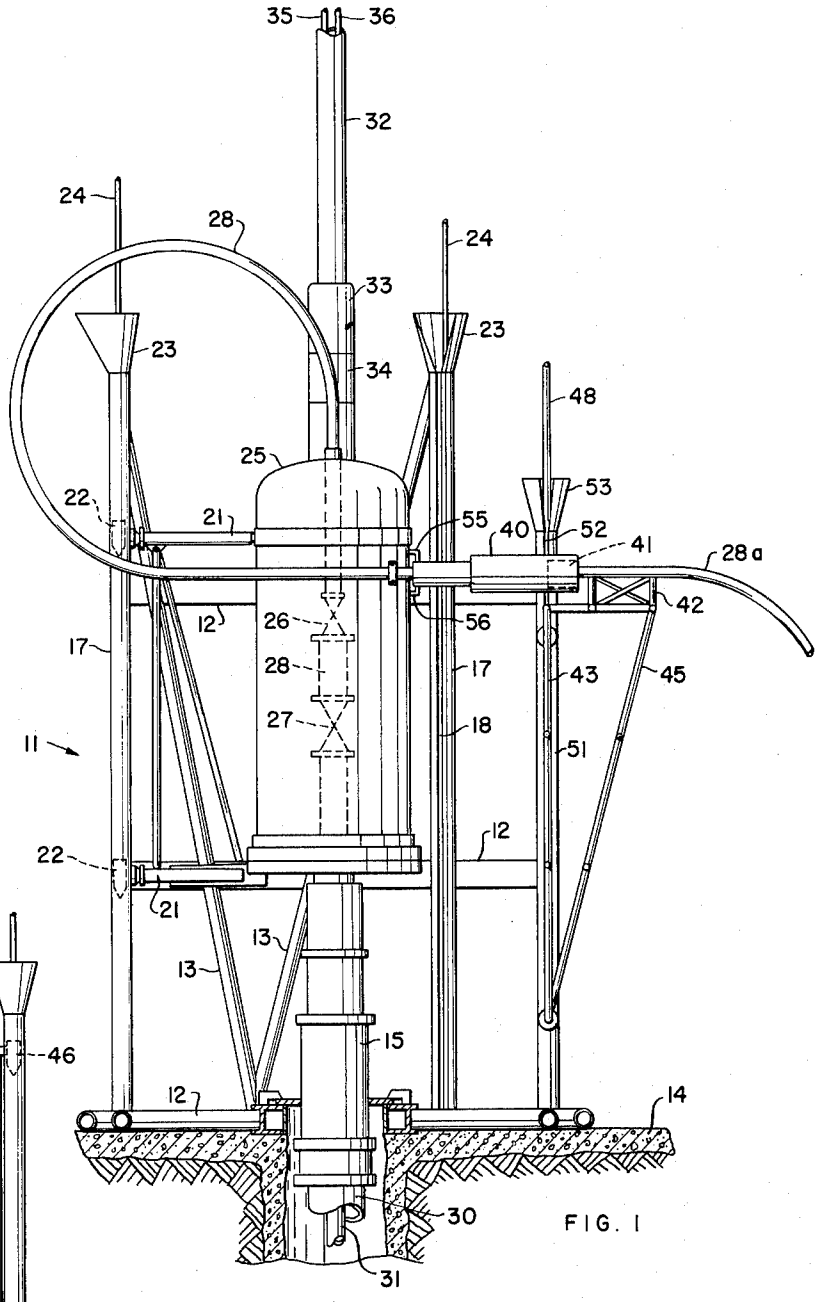

FIG. 1

FIG. 2

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UNDERWATER WELLHEAD WITH REMOTELY-DETACHABLE FLOW LINE

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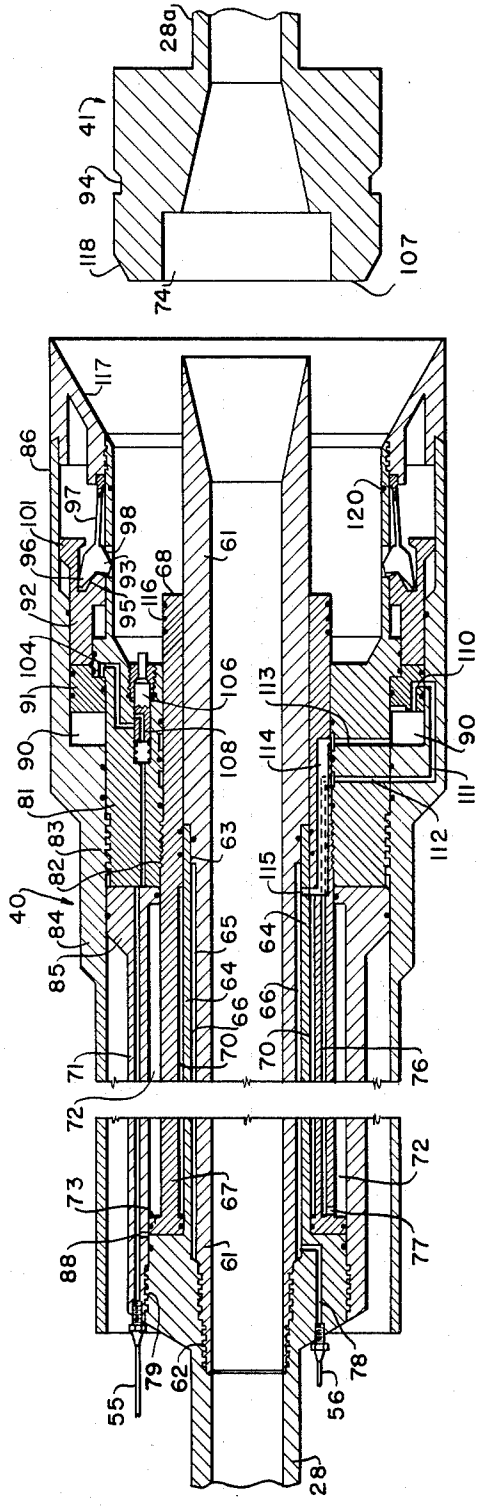

FIG. 3

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UNDERWATER WELLHEAD WITH REMOTELY-DETACHABLE FLOW LINE

Filed July 19, 1962 4 Sheets-Sheet 3

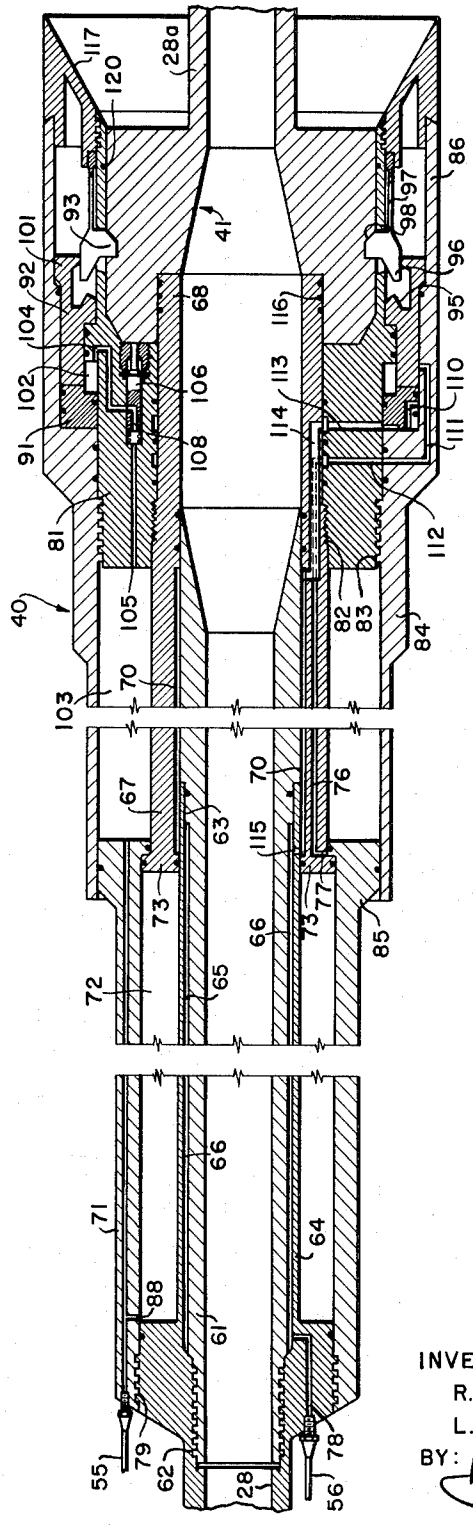

FIG. 4

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UNDERWATER WELLHEAD WITH REMOTELY-DETACHABLE FLOW LINE

Filed July 19, 1962 4 Sheets-Sheet 4

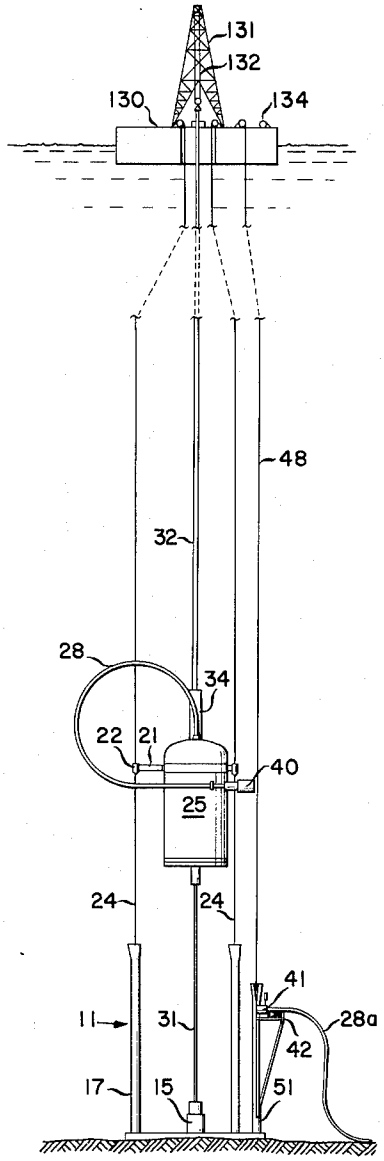

FIG. 5

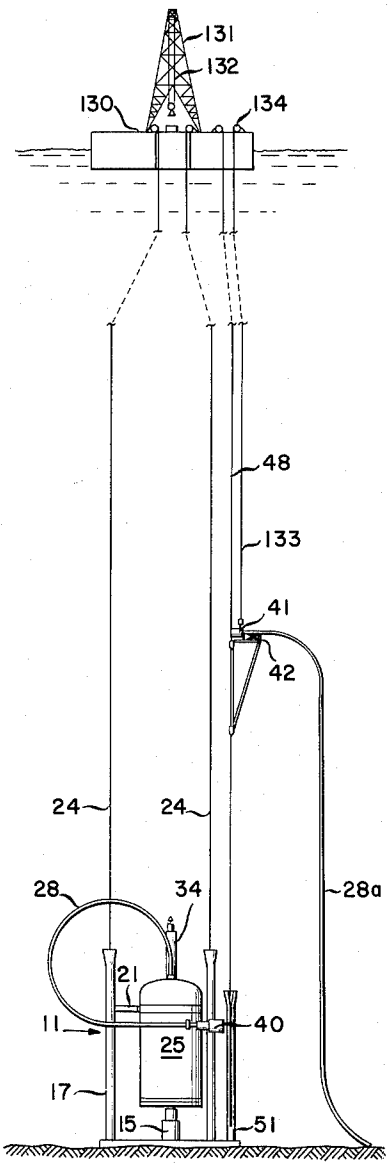

FIG. 6

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United States Patent Office 3,233,666 Patented Feb. 8, 1966

3,233,666

UNDERWATER WELLHEAD WITH REMOTELY-DETACHABLE FLOW LINE

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Filed July 19, 1962, Ser. No. 211,038
7 Claims. (Cl. 166—.5)

This application is a continuation-in-part of copending application, Serial No. 835,930, filed August 25, 1959, now U.S. Patent No. 3,052,299, issued September 4, 1962.

The present apparatus relates to oil well equipment for use at underwater locations and pertains more particularly to an underwater wellhead apparatus with a remotely-detachable flow line which includes a power-actuated and remotely-operable pipeline connector for connecting the wellhead assembly to an underwater pipeline, such as one running along the ocean floor.

The wellhead apparatus of the present invention is adapted to be used to close wellhead assemblies of the type described in copending patent application, Serial No. 834,096, filed August 17, 1959, now Patent No. 3,064,735, issued November 20, 1962. A recent development in the field of oil well drilling is the completion of wells at offshore locations with a wellhead assembly positioned on or close to the ocean floor out of the way of ships which might otherwise damage it in the event of a collision. Equipment positioned on the ocean floor, however, is exposed to conditions such as the corrosive nature of the sea water and the presence of marine life which tends to grow and become encrusted on metallic structures below the surface of the water.

Since it is necessary from time to time to go back into a well wherever it has been completed for servicing or work-over operations, it is desirable to have an underwater wellhead structure of suitable design so that it could be readily removed from the underwater wellhead and raised to the surface. An underwater wellhead structure of this type is shown and described in copending patent application, Serial No. 834,096, filed August 17, 1959.

On removing a wellhead assembly from the top of the well in accordance with present practice, a diver must first be sent to the ocean floor to disconnect the production flow line from the wellhead assembly. Otherwise, the production flow line adjacent the wellhead assembly must be raised to the surface of the water along with the wellhead assembly when the latter is removed from an underwater wellhead and raised to the surface. Divers can be used effectively only at relatively shallow water depths of up to about 150 feet.

It is therefore an object of the present invention to provide an underwater wellhead apparatus which can be readily detached from an underwater wellhead flow line by operators working at a remote location, such as on a barge or other vessel positioned on the surface of the water above the well site.

It is also an object of the present invention to provide an underwater wellhead assembly with a remotely detachable flow line extending therefrom in a manner such that after disconnecting the flow line from the wellhead assembly, either the wellhead assembly or the disconnected flow line may be raised independently to the surface of the water without interfering with the other equipment at the wellhead and without the necessity of moving both the flow line and the wellhead assembly.

A further object of the present invention is to provide apparatus for lowering one end of an underwater production flow line down to an underwater wellhead in a manner such that the lowered end of the flow line is

in coaxial register with the cooperating end of the production flow line at a point after it leaves the wellhead assembly.

These and other objects of the present invention will be understood from the following description taken with regard to the drawing, wherein:

FIGURE 1 is a schematic view illustrating a wellhead assembly of the present invention positioned on the ocean floor;

FIGURE 2 is a side view of the pipeline coupling lowering mechanism shown in FIGURE 1; and

FIGURES 3 and 4 are views taken in longitudinal cross-section of a hydraulically-operated pipeline connector or coupling, of the type to be used with the wellhead assembly of FIGURE 1, in its uncoupled and coupled positions, respectively; and,

FIGURES 5 and 6 are diagrammatic views illustrating the method of the present invention.

Referring to FIGURE 1 of the drawing, a wellhead support structure 11 is shown as comprising a series of interconnected girders 12 and cross-bracing members 13. The bottom-most girders 12 may rest on a cement pad 14 which may be poured on the ocean floor in a manner described in copending patent application, Serial No. 830,538, filed July 30, 1959. A casinghead 15 is fixedly secured to the wellhead support structure 11 and is preferably installed therewith at the time the wellhead support structure is positioned over the well to be drilled.

Suitable apparatus is provided for guiding well equipment into place upon the casinghead 15, both during and after drilling operations. In the particular apparatus illustrated in FIGURE 1, the vertical members 17 of the wellhead support structure comprise vertical guide tubes 17 each having a vertical slot 18 cut through the wall thereof. Each piece of equipment to be lowered into place on the well casinghead 15 may be provided with two or more guide arms 21 adapted to extend through the guide slot 18 of two or more guide tubes 17 where they are connected to guide cones 22. The guide cones are of a diameter slightly less than the inner diameter of the guide tubes 17 and preferably have a lower portion that tapers downwardly.

Preferably, each of the guide tubes 17 has a cone-shaped flange 23 attached to its upper end which serves to align the guide cones 22 as they move downwardly into the guide tubes 17. Each of the guide cones 22 is provided with a vertical hole therethrough of a diameter slightly larger than the guiding cables 24 which are secured at their ends to the wellhead support structure within the bottom of the guide tubes 17 and extend upwardly to the surface where they are suspended from a drilling vessel or barge (not shown) from which operations are being carried out.

In FIGURE 1 the guide arms 21 are shown as being connected to a container 25 which may be employed to surround the wellhead assembly or production control unit of the well. For purposes of simplifying the drawing and description thereof, the wellhead assembly of the present invention is shown as comprising a pair of control valves 26 and 27 which are positioned in the production flow line 28 coming from the well. Although the well is illustrated as having a single string of well casing 30 and a single string of production tubing 31 extending downwardly into the well, it is to be understood that the present wellhead apparatus could be employed with wells having multiple strings of casing and tubing.

Normally, the production control unit or wellhead assembly enclosed within the container 25 comprises the necessary piping, valves, chokes, and other equipment normally connected together and mounted on the top of a well, and known as a "Christmas tree," together with

the necessary hydraulic or electrical systems including pumps, reservoirs, motors, and etc., to operate the valves at the head of the well from a remote location. A typical example of a suitable underwater production control unit or wellhead assembly for use at an offshore well location, and the manner in which it is locked to the casinghead 15, is shown and described in copending patent application, Serial No. 834,096, filed August 17, 1959.

The container 25 and the wellhead assembly contained therein is normally lowered into place by means of a string of pipe 32 known as a "running string" which has a running head 33 attached to the lower end thereof which may be connected to the top of container 25 or to its lubricator 34. The lubricator or wellhead closure 34 may be of any desired type suitable for use in offshore underwater wellhead assemblies. A typical lubricator or wellhead closure of this type is shown and described in copending application, Serial No. 830,587, filed July 30, 1959. A wellhead closure of this type permits reentry into the well for well control or work-over purposes. During normal production of a well the running string 32, running head 33 and any pressure tubing strings 35 and 36 which may be contained therein, are disconnected from the wellhead assembly and drawn to the surface. When not in use the guide cables 24 are dropped to the ocean floor where they may later be retrieved by grappling hooks or other suitable means when it is desired to use them again to lower equipment to the wellhead. During work-over or other operations on the well, the running string 32 and the running head 33 may be replaced by a marine conductor pipe string and a landing head or seal (not shown).

The production flow line 28 as it leaves the top of the wellhead assembly or the container 25 is preferably, though not necessarily, curved in an arc of substantial radius so that various tools, instruments, or other devices may be circulated through the production flow line and down into the well. As the flow line 28 passes horizontally by the container 25 it is preferably rigidly fixed thereto as by welding, clamping, bolting, etc.

A pipeline coupling or a pipeline connector consisting of a female portion 40 and a male portion 41 is installed in the production flow line 28 at a point close to the wellhead assembly or its container 25. Preferably, the male portion 41 of the coupling is fixedly mounted on a carriage 42 which is, in turn, fixedly secured by means of suitable braces 43, 44 and 45 (FIGURE 2) to one or more guide cones 46 and 47. The guide cones 46 and 47 are slidably mounted on a guide cable 48 which passes downwardly through a vertical guide tube 51 which is similar in design to guide tubes 17 and is provided with a slot 52 therein and a cone-shaped flange 53 on the top thereof. A suitable stop member is provided in the guide tube 50 so as to limit the downward movement of the cones 46 and 47 within the guide tube 51 so that the carriage 42, at the end of its travel, is positioned with the male portion 41 of the coupling on a level with the female portion 40. Instead of employing a stop member within the guide tube 51, the slot 52 therein could be terminated at some point above the bottom of the tube 51 so as to limit the downward travel of the lower guide cone 47.

The precise placement of the slot 52 in the guide tube 51 serves as aligning means between the carrier 42 and the cable 48 to position the male portion 41 of the coupling in substantially coaxial register and spaced relationship with the female portion 40 of the coupling. In some installations it may be found more advantageous to lower the male portion 41 of the coupling on its carriage 42 that is suspended between two parallel guide cables 48 which terminate in two parallel guide tubes 51. The portion 28*a* of the production flow line extending from the male portion 41 of the coupling is preferably flexible, but may also be a preformed rigid section, to facilitate positioning it on the ocean floor and attaching it to the female portion 40 of the coupling. In the event that the well has two or more production flow lines, then the wellhead assembly would be provided with two or more couplings.

The pipeline coupling 40–41 to be used in connecting the underwater pipeline 28*a* to the wellhead assembly may be of any suitable type which is provided with a housing to protect its working parts against corrosion caused by the sea water and the growth of marine organisms. The connector 40–41 is preferably positioned substantially horizontally, i.e., up to about 45 degrees from the horizontal, for ease in making the connection. Additionally, the pipeline connector of the present invention is positioned to one side of the present wellhead assembly so that after the pipeline coupling 40–41 is disconnected, either the male end 41 of the coupling together with its pipeline 28*a*, or the female end 40 together with the wellhead assembly and container 25, can be raised to the surface independently while the other portion of the coupling and its attached equipment remain at the ocean floor or in their original position. The coupling 40–41 is of the power-actuated, remotely-operated type which may be of either the pneumatic, hydraulic, or electrical type with power leads or fluid-pressure operating lines running independently to the surface. However, the coupling 40–41 is preferably of the remotely-controlled, hydraulically-operated pipeline coupling as shown in FIGURES 3 and 4 of the drawing. The female portion 40 of the coupling contains both the sealing and locking mechanism for forming a fluidtight seal with the male portion 41 of the coupling. The female portion of the coupling comprises a central tubular member 61 which forms an extension of the production flow line 28 and is fixedly secured thereto as by threads 62. The outer surface of tubular member 61 is reduced in diameter as at 63 so as to seat the end of a sleeve 64 which extends outwardly from the flow line 28. The outer surface of the tubular member 61 is further reduced in diameter, as at 65, to provide an annular flow passage 66 which is in communication at one end with the pressure fluid conduit 56. The outer surface of the sleeve 64 and the outer surface of the tubular member 61 and its largest diameter are fitted flush so as to serve as a guide tube on which a tubular or sleeve-type piston 67 is slidably mounted. The inner diameter of the piston 67 is enlarged over a portion of the length thereof in order to form an annular fluid passage 70 between the inside of the piston 67 and the outside of the sleeve 64.

The outside wall, forming the chamber in which piston 67 is slidably mounted, is formed by a coaxial sleeve or tubular member 71 which is fixedly secured to the end of the pipe 28 as by threads 79. The inner diameter of the tubular member 71 is increased over a substantial portion of its length to form an annular fluid passageway 72 between the outer wall of the piston 67 and the inner wall of the tubular member 71. The annular fluid passageway or chamber 72 forms the piston chamber in which the head 73 of the piston 67 moves. The length of the chamber 72 determines the length of the stroke of the piston 67. Thus, it is apparent that the length of the chamber 72 must be at least equal to the distance the opposite end 68 of the piston 67 must travel in order to be positioned in fluidtight engagement within a recessed portion 74 of the male portion 41 of the coupling.

Extending through the tubular member 71 which forms the cylinder wall for pistonhead 73 is a fluid passageway 75 in communication between the pressure fluid line 55 at one end of the apparatus and the space outside the other end of the tubular member. Extending through a substantial length of the piston wall 67 is a fluid passageway 76 which is in communication through a port 77, just below the head 73 of the piston 67, with the annular fluid chamber 72. The annular flow passage 66 is in communication through conduit 78 with the pressure fluid line 56 at the end of the coupling.

A collar 81 forming a tandem piston head with piston head 73, is fixedly secured, as by threads 82, on the outside of the piston 67 just below the tubular member 71, or at a distance from the head 73 of the piston 67 equal to or slightly greater than the stroke of the piston. Fixedly secured to the outside surface of the annular collar or tandem piston 81 is a cylindrical housing 84 which is also in sliding fluidtight engagement with the end 85 of the tubular member 71. Preferably, the end 85 of the tubular member 71 is enlarged in diameter for design purposes so that a collar 81 of substantial thickness may be employed in order to increase the effective area against which pressure fluid acts, as well as to accommodate the necessary valve and conduit arrangement for unlatching the present coupling.

The piston head 73 moves within a chamber formed by the annular sleeve 64 and the tubular member 71. While it is possible to consider the enlarged end 85 of the tubular member 71 to be a piston moving within the chamber formed by the cylindrical housing 84 on the outside and the piston 67 on the inside, for purposes of clarification the enlarged end 85 of the tubular member 71 will be considered hereinbelow as the stationary end of a piston chamber since the tubular member is fixedly secured at 72 to the flow line 23. Thus, the collar 81 will be considered to be a tandem piston fixedly secured to and movable with piston 67, with the outside wall of piston 67 and the inside wall of housing 84 forming the piston chamber into which a pressure fluid is applied to move the piston 67, collar 81 and housing 84 axially along the central tubular member 61. A port 83 in the tubular member 71 is in communication between the fluid passage 75 therethrough and the space outside thereof at the end of chamber 72, whereby a pressure fluid may be applied to the outer face of the piston 73 for driving it to the right.

The extending portion 86 of a cylindrical housing 84 is enlarged in diameter providing a wall of substantial thickness for containing the locking mechanism of the present coupling. A portion of the wall of the end 86 of the cylindrical housing 84 is recessed to form a piston chamber 90 in which an annular piston 91 is slidably mounted. The piston 91 is fixedly secured to and slidable with a locking piston 92 which may be either in ring form or may comprise a plurality of individual locking elements adapted to engage a plurality of locking dogs 93 which are adapted to be seated in a locking groove 94 formed on the outer surface of the male portion of the coupling, as illustrated in FIGURE 4. The locking piston 92 is provided with a downwardly sloping surface 95 adapted to engage upwardly sloping surfaces 96 of the dogs 93 for raising the dogs 93 into the wall of the cylindrical housing 86 so that the female portion 41 of the coupling can be withdrawn.

The locking dogs or latching members 93 are spring-loaded in any suitable manner, as by being provided with spring-like arms 97 which allow the dogs 93 to extend normally through slots 98. A locking head 101 is carried at the end of the locking piston 92 for locking the dogs 93 in place in the annular groove 94 of the male portion 41 of the coupling, as shown in FIGURE 4.

In the locked position shown in FIGURE 4 of the drawing, a chamber 102 is formed in back of piston 91 between the outer surface of the collar 81 and the inner surface of the locking piston 92. At the same time another chamber 103 is formed between the collar 81 and the enlarged end 85 of the tubular member 71 and between the cylindrical housing 84 and the piston 67. In the locked position the chambers 102 and 103 are in communication through fluid passageways 104 and 105 and through passageway 108 of a spring-loaded valve 106 which has been forced inwardly by the face 107 of the male portion 41 of the coupling to be positioned, as shown in FIGURE 4, so that the passageways 104 and 105 are in communication through 108.

The piston 91 is provided with a flow passageway 110 while the cylindrical housing 84 is provided with passageway 111 and the collar 81 is provided with passageway 112. These flow passageways 110, 111 and 112 form a continuous flow passage so that in the unlatched position the chamber 90 formed on one side of the annular piston 91 is in communication through flow passageways 110, 111, 112, 76 and 77 with the annular fluid chamber 72. The chamber 90 is also in communication through a passageway 113 through the collar 81, through passageway 114 in the piston 67 and through port 115 in the annular sleeve 64 so as to communicate through annular flow passage 66 and conduit 78 with the fluid pressure line 56. The annular fluid passageway 70 between the piston 67 and the sleeve 64 is in communication at all times through port 115 with the annular flow passageway 66 and thence through conduit 78 with the pressure fluid conduit 56. The outer surface of the piston 67 near the end 68 thereof is provided with suitable sealing means, such for example as O-ring seals or rings of packing, which act as a primary seal between the male and female portions of the coupling. The inner surface of the cylindrical housing 84, or the outer surface of the male coupling 41, is provided with a seal 120 which closes the space between the housing 84 and the male portion 41 of the coupling in a fluidtight manner. The ends of the female 40 and the male 41 portions of the coupling are bevelled, as at 117 and 118, respectively, to aid in aligning the two portions of the coupling when the female portion is forced toward the male portion.

A connection is made between the male and female portions of the coupling shown in FIGURE 3 by applying a pressure fluid from any suitable source through conduit 55. The pressure fluid passes through fluid passageway 75 and port 83 to exert pressure against pistons 81 and 73, respectively, moving them to the right together with the cylindrical housing 84 and the locking dogs 93. As the cylindrical housing 84 approaches the male portion 41 of the coupling, tapered faces 117 and 118 of the female and male portions of the coupling align the two portions so that the end 68 of the piston 67, containing the sealing rings 116, moves into and is seated within the recessed opening 74 of the male portion 41 of the coupling. The end 68 of the piston 67 continues to slide into the recessed portion 74 until the face 107 of the male portion 41 of the coupling forces the fluid transfer valve 106 to the left, aligning the conduit 108 therein with conduits 104 and 105. At this time, the locking or latching dogs 93 are positioned over slots 98 so they may enter the annular groove 94 in the outer surface of the male portion of the coupling. With the valve 106 in the position shown in FIGURE 4 of the drawing, the continued application of a pressure fluid through conduits 55 and 75 and into chamber 103 causes pressure to be exerted through conduits 105, 108 and 104 and into chamber 102 where pressure is applied to the right side of the piston 91 causing locking piston 92 to move to the left so that the locking head 101 of the locking piston bears against the top of the locking dog 93, thus anchoring it in place.

During the sealing and locking operations of the coupling described above, fluid in the annular chamber 72 is exhausted through port 77, passageways 76, 112, 111, 110 and into chamber 90 and thence through passageways 113 and 114, port 115 and passageways 66, 78 and 56 to the hydraulic fluid reservoir (not shown).

To disengage the coupling shown in FIGURE 4, pressure fluid is applied through conduit 56, 78 and 66 and thence through port 115 and passageways 70, 114 and 113 to exert a pressure on the left side of piston 91, thus forcing it to the right. As the locking piston 92 is forced to the right, the locking head 101 is removed from the top of the locking dog 93 and the downwardly sloping face 95 of the locking piston 92 engages the upwardly sloping face 96 of the locking dog 93 to raise the spring-loaded locking dog 93 into its retracted position, as shown in FIGURE 3 of the drawing. As the piston 91 reaches the end of its travel to the right, the conduit 110 therein is brought into communication with the conduit 111 of

the cylindrical housing so that pressure fluid from the chamber 90 flows through passageways 110, 111, 112, 76 and port 77 to exert a pressure on the underside of the piston head 73, thus causing it to move to the left. As the piston 91 moved to the right in FIGURE 4 to unlock the dogs 93, fluid in the chamber 102 is exhausted through fluid passageways 104, 108 and 105 into the chamber 103 and thence through passageway 75 and conduit 55 to the hydraulic fluid reservoir (not shown). At the same time, fluid in the chamber 72 to the left of the piston 73 is exhausted through port 88 and conduit 55 to the reservoir. In operation, pressure fluid may be supplied to unlock the coupling of the present invention in a manner described in copending patent application, Serial No. 830,587, filed July 30, 1959, wherein a pair of tubing strings 35 and 36 (FIGURE 1) are inserted through a running string or marine conductor 32 to supply pressure fluid selectively to conduits 55 and 56 leading to the coupling.

As mentioned hereinabove, the arrangement of the apparatus of the present invention is such that either the male end 41 of the coupling together with its pipeline 28*a*, or the female end 40 together with the production wellhead assembly and container 25, can be raised to a vessel to the surface of a body of water independently while the other portion of the coupling end and the attached equipment remain on the ocean floor or underwater in their original position. The raising and/or lowering of equipment may be done by use of the running string 32 in any suitable manner, as by the two separate operations illustrated in FIGURES 5 and 6. In FIGURE 5, a production wellhead assembly and container 25 is shown as being raised or lowered, together with the female portion 40 of the pipeline connector, at the lower end of a running string 32 from a drilling vessel or platform 130, preferably of the floating type, is provided with a derrick 131 having suitable hoist means 132 for raising or lowering equipment from the vessel to the ocean floor. The guide lines 24 and 48 are extended between the wellhead support structure 11 and the vessel 130 in a manner described in copending patent application, Serial No. 830,538 filed July 30, 1959. The production wellhead assembly and container 25 are provided with the guide arms 21 and guide cones 22 by which the container of the well assembly 25 is guided along the guide lines 24 until the lower end of the wellhead assembly and container 25 registers with and seats on the wellhead 15. At this time the female section 40 of the coupling is in register with the male section 41 which, together with its carrier 42 and pipeline 28*a*, remain in a stationary position at the wellhead support structure 11. Subsequently, the male and female portions of the coupling are connected so that the flowline 28*a* and the portion of the flowline 28 carried by the removable wellhead are connected together in fluidtight arrangement.

In FIGURE 6 the operation of installing a new flowline 28*a* is illustrated, it be assumed that the flowline 28*a* is being installed for the first time or is being installed to replace a ruptured flowline which was previously removed by the reverse operations to be described hereinbelow. The carriage 42 having the male portion 41 of the coupling fixedly secured thereto is lowered along the guide line or lines 48. The carriage 42 may be lowered into place by means of a running string, such as described with regard to FIGURE 5, or by means of a wire line 133 which is run down from a suitable winch 134 on the vessel and may be readily disconnected or sheared from the carriage 42 when the carriage 42 is in place on the wellhead support structure, as shown in FIGURE 5. Thus, when the carriage 42 in its new pipeline section 28*a* have been lowered into place, the male portion 41 of the pipeline coupling is in register with the female portion 40 carried by the production wellhead assembly and container 25 which is already locked in the top of the wellhead 15. The two portions of the coupling 40 and 41 would then be connected together.

We claim as our invention:

1. A method of installing production equipment at an underwater wellhead positioned in open water near the ocean floor and exposed to ocean currents, said method comprising

(a) guiding a production wellhead assembly down through a body of water into register with an underwater wellhead, said wellhead assembly having an end of a production fluid flowline extending therefrom at said underwater location,

(b) seating said production wellhead assembly on and securing it to said underwater wellhead,

(c) remotely guiding, from above the surface of the water, the end of an underwater production flowline down through said body of water and into register with the end of the production flowline extending from said production wellhead assembly and along the ocean floor, and

(d) connecting the registering ends of said production flowlines in a fluidtight manner one with the other.

2. A method of installing production equipment at an underwater wellhead positioned in open water near the ocean floor and exposed to ocean currents, said method comprising

(a) establishing a first guide connection between said wellhead and the space above the surface of a body of water along which equipment may be guided to said wellhead,

(b) guiding a production wellhead assembly down through a body of water along said first guide connection into register with said underwater wellhead, said wellhead assembly having an end of a production fluid flowline extending therefrom at said underwater location,

(c) seating said production wellhead assembly on and remotely securing it to said underwater wellhead,

(d) establishing a second guide connection between said wellhead and the space above the surface of the body of water along which equipment may be guided to said wellhead,

(e) remotely guiding from above the surface of the water the end of an underwater production flowline down said second guide connection through said body of water and into register with the end of the production flowline extending from said production wellhead assembly and along the ocean floor, and

(f) connecting the registering ends of said production flowlines in a fluidtight-manner one with the other.

3. The method of claim 2 in which ends of the production flowlines are connected together by extending one flowline end axially in telescoping fluidtight engagement with the other flowline end.

4. The method of removing a production wellhead assembly from an underwater well and from a production flowline positioned in open water near and lying along the ocean floor and exposed to ocean currents, said method comprising

(a) establishing guide connection means between the production wellhead assembly positioned near the ocean floor and a vessel on the surface of a body of water,

(b) disconnecting the production flowline lying along the ocean floor from the production wellhead assembly,

(c) detaching the production wellhead assembly from said wellhead, and

(d) raising said production wellhead assembly as a unit through said open water along said guide connection means to said vessel.

5. The method of claim 4 wherein said step of raising said production wellhead assembly is carried out while maintaining said disconnected production flowline in fixed relationship to the wellhead.

6. The method of installing a production flowline on an underwater installation wherein the flowline is positioned in open water and is lying along the ocean floor and exposed to ocean currents, said method comprising

(a) establishing guide means between the underwater installation and a vessel on the surface of a body of water,

(b) lowering the end of a production flowline to extend from the wellhead and along the ocean floor, from the vessel down through the water to said underwater installation,

(c) guiding said end along said guide means to a point substantially laterally-disposed from a connection point of said underwater installation, and

(d) connecting the end of said production flowline in fluidtight engagement with said underwater installation.

7. The method of changing a ruptured production flowline running along the ocean floor from a production wellhead assembly of an underwater wellhead, said flowline being positioned in open water and lying along tthe ocean floor and exposed to ocean currents, said method comprising

(a) establishing guide connection means between the underwater wellhead and a vessel on the surface of a body of water,

(b) disconnecting the ruptured production flowline from said production wellhead assembly,

(c) raising the disconnected end of said production flowline to the vessel on the surface of the water,

(d) lowering the end of a new production flowline extending from the wellhead and along the ocean floor, from the vessel down through the water along said guide connection means to said wellhead assembly and guiding said end into substantial register with a connection point of said wellhead assembly, and

(e) connecting the end of said new production flowline in fluidtight engagement with said production wellhead assembly.

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