Feb. 22, 1966 R. D. JOHNSTONE ETAL 3,236,301

DRILLING AND PRODUCTION APPARATUS AND METHOD

Filed July 10, 1961

4 Sheets-Sheet 1

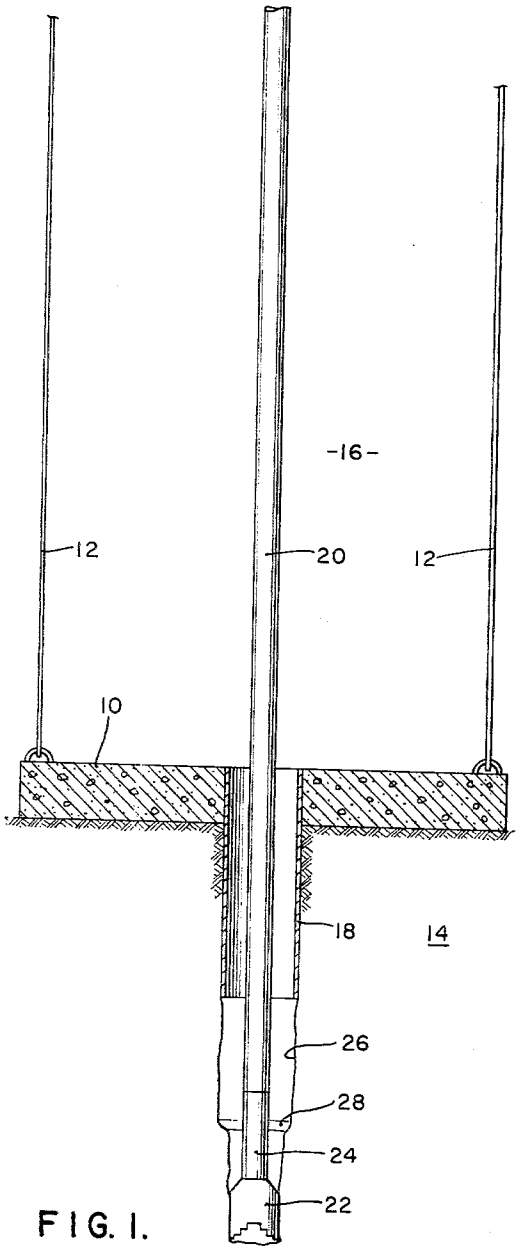

FIG. 1.

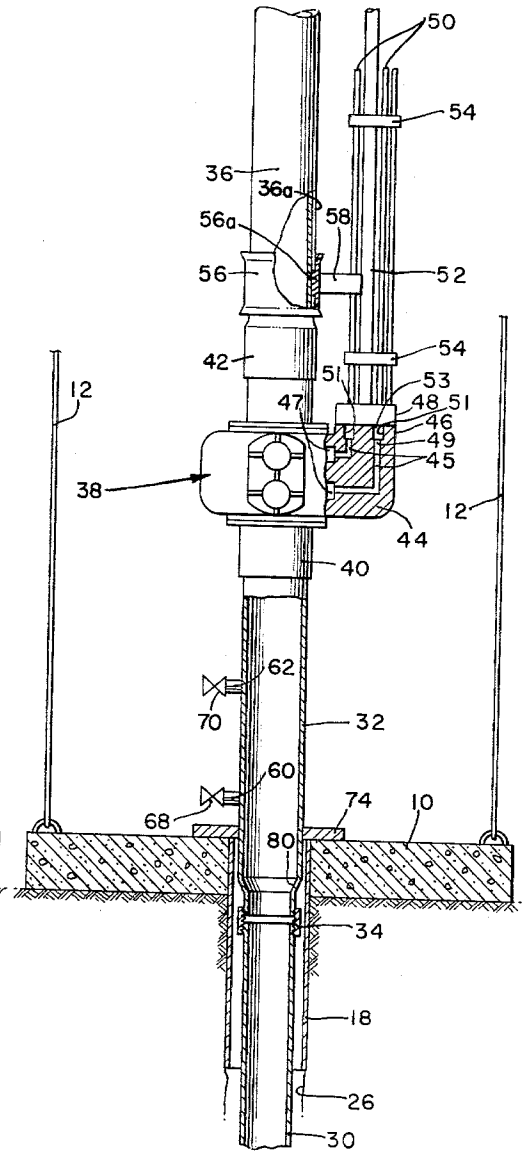

FIG. 2.

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4 Sheets-Sheet 2

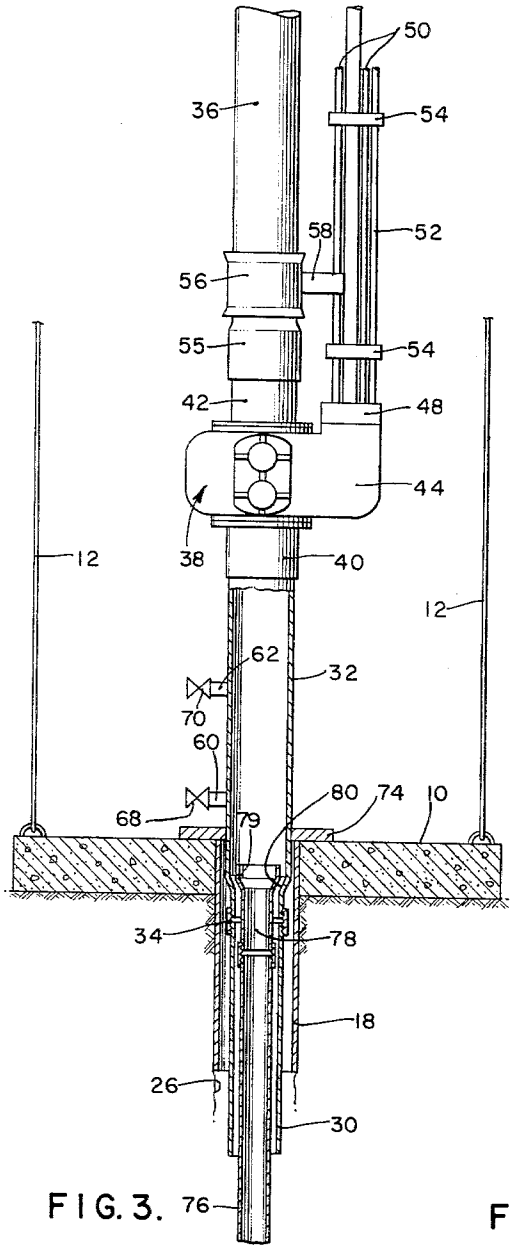

FIG. 3.

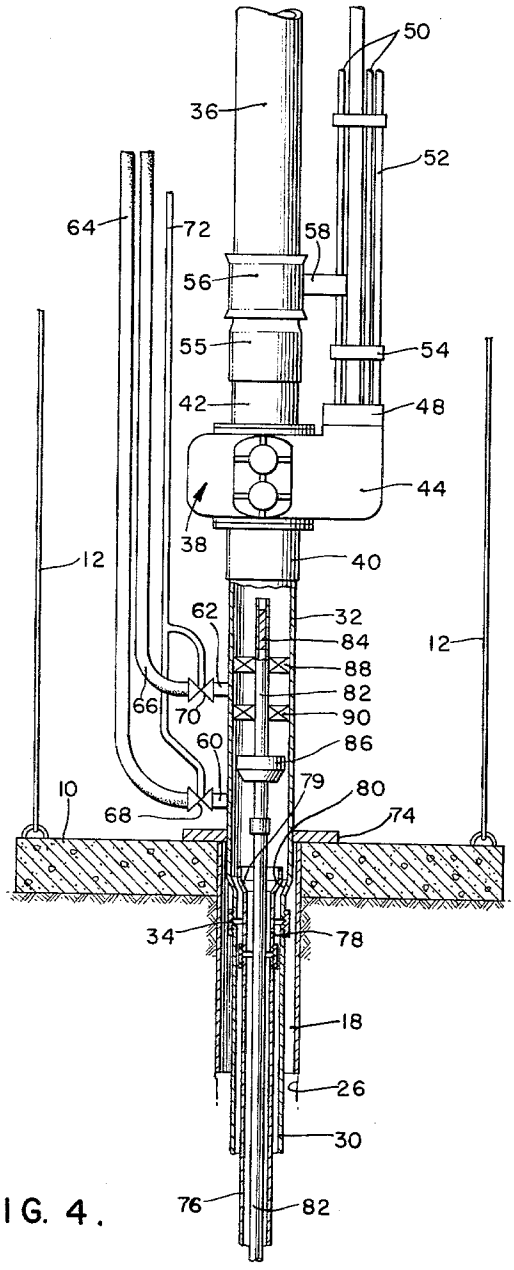

FIG. 4.

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DRILLING AND PRODUCTION APPARATUS AND METHOD

Filed July 10, 1961 4 Sheets-Sheet 3

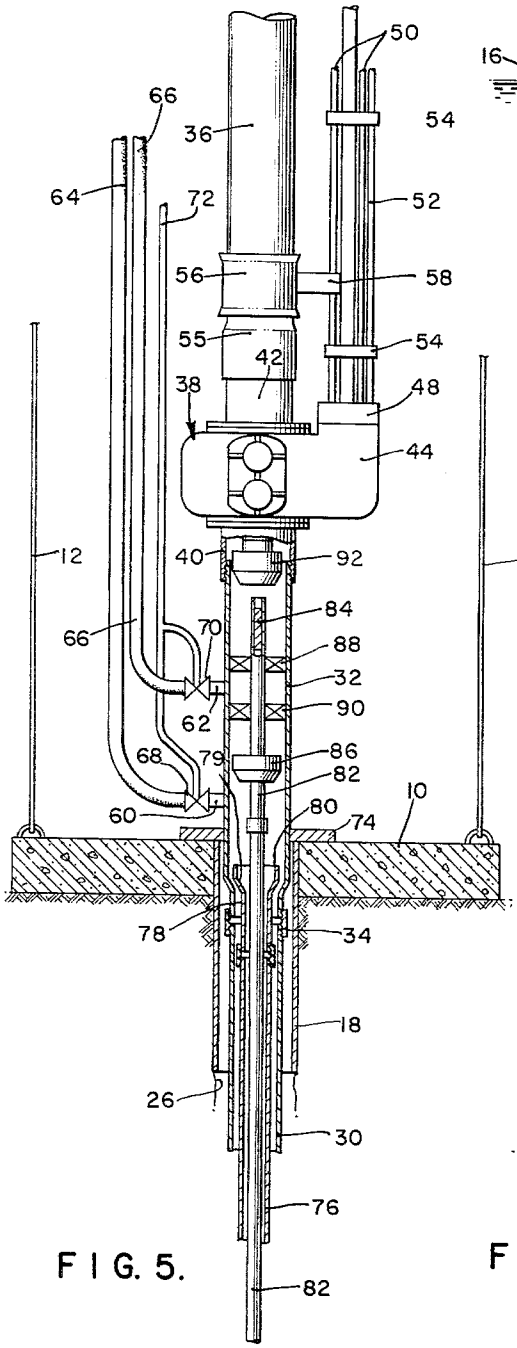

FIG. 5.

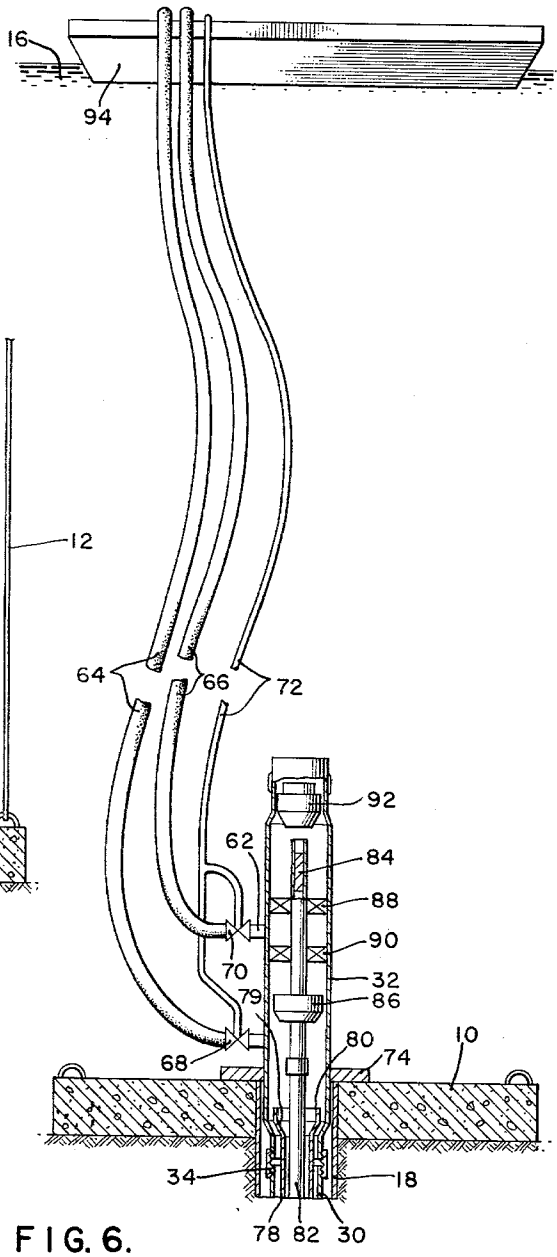

FIG. 6.

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DRILLING AND PRODUCTION APPARATUS AND METHOD

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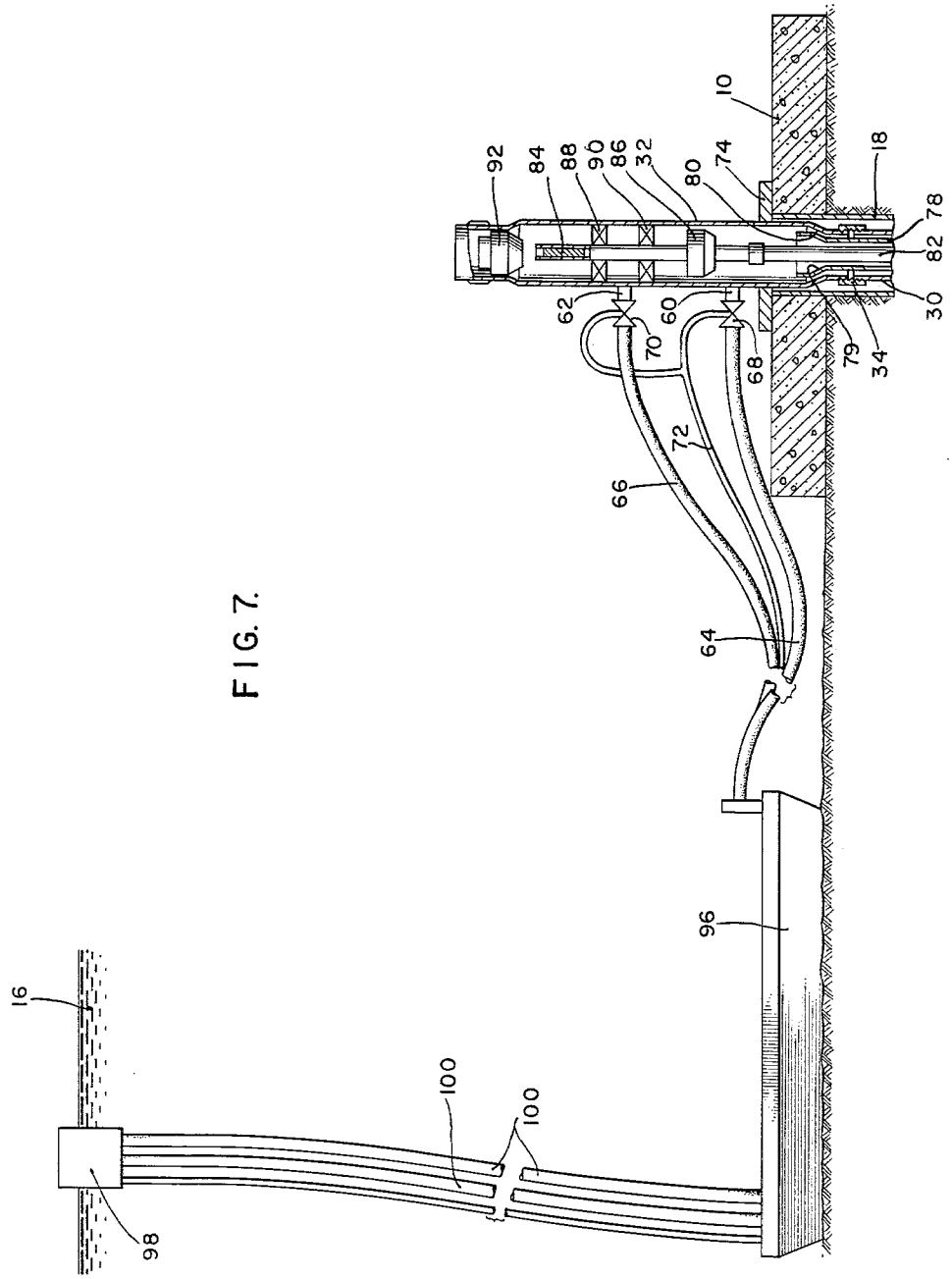

FIG. 7.

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United States Patent Office 3,236,301 Patented Feb. 22, 1966

3,236,301

DRILLING AND PRODUCTION APPARATUS AND METHOD

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Filed July 10, 1961, Ser. No. 122,918
7 Claims. (Cl. 166—.5)

The present invention relates to the drilling and production of petroleum from a formation underlying a body of water and more particularly relates to apparatus for drilling and subsequently producing petroleum from a formation underlying a relatively deep body of water.

When drilling into and producing from a formation containing oil and gas under high pressure, blowout prevention equipment is conventionally used in the drilling operation; and a flanged well head assembly with a Christmas tree thereon is normally utilized to control the production of oil and gas from the well during its period of natural flow. In offshore operations, the drilling and production apparatus including the drilling head and the blowout prevention equipment has normally been installed on a marine platform located on the surface of the water over the well bore. Marine production equipment using a platform constitutes an obstacle to navigation and appearance and is limited to relatively shallow water usage. The prior art production apparatus assembly includes, generally a casing which is normally cemented into the well, a casing spool, a tubing head, a casing head, and the various Christmas tree components including, a master valve, one or more wing valves, and such flow constricting devices as may be required in a particular well.

Recently the drilling and production apparatus has been mounted on the ocean floor in relatively shallow water accessible to divers. Conventional equipment used in such shallow water operations, is, however, unsuitable for the production of oil wells in deeper water due to the need for extensive diving operations needed to assemble and locate the various well head components. Such shallow water equipment requiring the use of divers would be extremely difficult to install in deeper water since diver work time is greatly reduced at greater depths. Fluid controlled well head equipment, such as the conventional blowout prevention equipment, necessarily involves the use of fluid hose connections to the well head equipment, e.g., the blowout preventer, which hoses frequently are in need of repair or must be replaced which must normally be done when the well head is located on the ocean floor, through the use of divers. Where the well head equipment is located in deeper water the replacement or repair of these hoses presents a significant problem due to the reduction in diver work time at greater depths.

It is therefore an object of our present invention to provide a novel form of well head equipment for producing petroleum from wells underlying relatively deep bodies of water.

It is also an object of our present invention to provide a combination drilling and production head which can be installed remotely at an underwater formation from the surface of the body of water.

It is a further object of our present invention to provide a drilling head for drilling a well bore into a formation underlying a body of water whereby the drilling head and control lines can be replaced without utilizing a diver.

Other objects and a more complete understanding of our present invention may be realized by reference to the following specification and claims, when taken in conjunction with the accompanying drawings, in which:

FIG. 1 is an elevational view partially in section, showing the manner in which the drilling of the well bore is started and the drilling base is lowered to the formation;

FIG. 2 is an elevational view partially in section, showing an assembled surface casing, production head, blowout prevention equipment and a casing riser, positioned in the well bore at the drilling base;

FIG. 3 shows in elevational partial section, the water string landed in the drilling apparatus of FIG. 2;

FIG. 4 is an elevational view in partial section showing the manner in which the tubing string is hung within the well head equipment;

FIG. 5 is an elevational view in partial section showing the manner in which the well head is sealed off preparatory to removal of the riser pipe and blowout prevention equipment;

FIG. 6 is an elevational view in partial section showing a production barge and the well head during production after the casing riser and blowout prevention equipment has been removed from the well head;

FIG. 7 is an elevational view partially in section showing a modified production arrangement.

With reference to the drawings, generally, the well head of our present invention is shown in FIGS. 2 through 5, with a sequential showing of how our well head may be installed at the ocean floor. Briefly described, our invention provides an apparatus which can be remotely installed on the ocean floor and portions thereof raised to the drilling vessel for repairs, replacements or other purposes by the provision of a modified blowout preventer housing **38** having a shoulder **44** formed thereon which houses a removable control block **48** through which the blowout prevention control hoses **50** are attached to the blowout preventer, thus enabling the control block **48** with the control hoses **50** to be raised to the drilling vessel (not shown), with the help of a guide arm **58** and sleeve **56** slidably attached to the casing riser **36**. The completion of the well and installation of the production equipment may be accomplished remotely through underwater production apparatus for example, the specially designed drilling and production mandrel **32**, the production aspect of which is more fully defined and described in a copending application, Serial No. 100,411, filed April 3, 1961, for "Submarine Drilling and Production Head and Method of Installing Same," in the name of Charles E. Wakefield, Jr.

Referring now, more particularly to the drawings, FIG. 1 shows a concrete drilling base **10** lowered from a floating vessel (not shown) on lowering cables **12** to the formation **14** beneath the body of water **16**. The drilling base **10** has a conductor pipe **18** extending there through. Drill pipe **20** has a drill bit **22** and a drilling collar **24** attached to the lower end thereof. The base **10** with pipe **18** may be installed at the formation by first extending the lower end of the drill pipe through the landing base and pipe **18** while the landing base is suspended over the formation so that the drill string may be operated therethrough from the floating vessel to cut the well bore **26** in the formation. The drill base **10** may then be lowered to the formation with the pipe extending into the well bore **26**. A hole opener **28** is used to enlarge the well bore **26** for conductor pipe **18**.

After the well bore has been deepened sufficiently to receive the surface casing **30**, the surface casing **30** is connected to the well mandrel **32** by any suitable means, e.g., a threaded coupling joint **34**, and the casing riser **36** and blowout prevention equipment **38** connected to the well mandrel **32** and the assemblage lowered from the

floating vessel as shown in FIG. 2, into the drilling base **10** at the formation **14** on the riser pipe **36** over the drill pipe **20** which may be left in the well bore temporarily to provide guidance between the floating vessel and the drilling base for the well head assemblage. The well mandrel **32** is similar to the production mandrel more fully described in the aforementioned copending application Serial No. 100,411, used to connect the blowout preventer **38** to mandrel **32**. This safety joint is preferably a straight pull safety joint for releasing the well mandrel **32** from the safety joint **40** and may employ a latch operated by a cable (not shown)—for example, the right hand torque releasing safety joint found on page 4557 of the 1958–59 Composite Catalog of Oil Field and Pipeline Equipment, published by World Oil. A similar safety joint **42** may be provided at the connection between the blowout preventer **38** and the casing riser **36** so that the casing riser can be remotely released above the blowout preventer.

The blowout preventer housing **38** has a shoulder portion **44** formed thereon. This housing has a manifold section **46** with passageways **45** extending internally therethrough and through the shoulder portion **44** as shown in FIG. 2. The passageways preferably extend at one end **47** to the conventional blowout preventer actuating mechanisms which are within the blowout preventer housing **38** to there effect control fluid comunication between the hoses **50** and the blowout preventer. The other end **49** of the passageways **45** form receptacles **51** to receive control hose terminals **53** which may have sealing rings thereon (not shown). The control block **48** houses the control hose terminals **53** which protrude from the lower side thereof to connect with the passageways or receptacles **51** in the manifold section **46**. The control block **48** has passageways through which the control hose terminals pass and receive the fluid control hoses **50** from the floating vessel. Of course, the connections between the block **48** and the manifold section **46** may be effected by receptacles in the block and terminals protruding from the manifold section **46**.

The control block **48** is removable from the manifold section **46** and has a hoisting member **52** attached thereto and extending to the floating vessel for raising and lowering the control block **48** onto the manifold section **46** of the blowout preventer shoulder portion **44**. The hoisting member **52** preferably is a rigid steel member such as a rod or a tubular member. Spacer disc **54** is provided to evenly distribute the control hoses about the hoisting member **52** and prevent entanglements and damage to the hoses. An orientation sleeve **56** having an orientation lug **56***a* therein is slidably disposed in orientation cam **36***a* on the casing riser **36** and rigidly attached to the hoisting member **52** by a rod or tubular member **58** to aid in guiding the control block **48** as it is lowered and raised to and from the blowout preventer manifold section **46**.

A casing outlet **60** and a tubing outlet **62**, more fully shown in the above-mentioned copending application, are connected respectively to the casing flow line **64** and the tubing flow line **66**. Fluid operated valves **68** and **70** control flow between the tubing and casing outlets and the tubing and casing flow lines respectively, and are controlled through fluid control house **72** which extends to the floating vessel. The tubing and casing valves **68** and **70** are normally closed. A plate or landing flange **74** fastened to the well mandrel serves as a well mandrel landing base and supports the production head within the drilling base until the surface casing and production head are cemented together into the formation.

After the surface pipe, production pipe, blowout preventer, and casing riser are concentrically assembled and lowered to the ocean bottom, drilling tools are operated through the assemblage to deepen the well sufficiently to receive a water string.

As shown in FIG. 3, the water string is next lowered into the well bore through the riser pipe and the well mandrel on the drilling string with an appropriate release tool (not shown) onto a suitable casing hanger, e.g., a shoulder **80** provided in the lower end of the well head **32**, or a modified Burns fluted holddown liner hanger attached to the long end of the well head **32** which hanger would have the surface casing **30** coupled thereto. The water string **76** is supported on the hanger, e.g., shoulder **80**, by a water string landing mandrel **78** coupled to the upper end of the water string **76**, which mandrel has a shoulder **79** which seats on shoulder **80** of the hanger.

The tubing **82** with a tubing plug **84** is then lowered into the well through the water string and hung within the well head on a tubing hanger **86** as more fully described in our above-mentioned copending application. Packer cups **88** and **90** seal around the tubing above and below the tubing outlet **62** to restrict the tubing flow through the tubing outlet and tubing flow line **66**, as shown in FIG. 4. A well head plug **92** is fastened into the upper end of the well head **32**, as shown in FIG. 5, to serve as a secondary seal behind the packer cup **88** and as a safety device against the possibility of blowing the tubing out of the hole.

After the drilling operation is completed and the well brought into production, the casing riser and blowout prevention equipment may be raised to the floating vessel by releasing the safety joint **40** as previously described leaving the well mandrel in flow operating position as shown in FIG. 6. The flow lines and flow control lines **64**, **66**, and **72**, may be run from the well head to a production barge **94**. As shown in FIG. 7, a production tank **96** may be submerged and production therefrom pumped to a tanker loading buoy **98** or directly to a tanker (not shown) through tanker loading lines **100**. In operations near the shore, flow lines **64** and **66** may be run along the ocean floor **14** to a production control facility on shore. In such case one of the lowering lines **12** may be used to locate the well with a buoy.

Thus with the present apparatus a drilling and production mandrel may be lowered together as a unit and in effect the drilling mandrel serves as a production head since the drilling tools may be operated therethrough. Thus the blowout preventers referred to herein may be latched to a well head which may be either a drilling head, a production head, or a combination drilling and production head. During the drilling operation the blowout preventers which are normally open and only closed when there is an unbalanced pressure condition in the well, may be remotely controlled from the drilling vessel through fluid control lines **50** which may be repaired or replaced by raising the control block **48** to the drilling vessel by retracting the hoisting cable **52** and the blowout preventer control hoses either repaired or replaced as required. Thus it is not necessary to send a diver down to the well head to repair the fluid control hoses at the blowout preventer connections where they most often fail.

The type of blowout prevention equipment, which is conventional equipment, contemplated for use in the present invention employs 3 gates, which are: (1) complete shutoff gate; (2) a gate for shutting off only around the drill pipe; and (3) a hydril or bag type blowout preventer on top of the above-mentioned blowout preventer. After the drilling is accomplished to the desired depth, the well may be completed and brought into production by lowering the production string through the casing riser and blowout preventer into the well mandrel and mounting the production string within the well mandrel as is set forth in the aforementioned copending application drawn to a production head per se and the method for installing such production head.

Although the present invention has been described in its preferred form with a certain degree of particularity, it should be understood that this disclosure has been made

only by way of example and that numerous changes in the details of the method and in the combination and arrangements of parts may be made without departing from the spirit and scope of the invention as herein claimed.

We claim:

1. An underwater drilling and production head apparatus for controlling well pressure and the flow of fluids from a well drilled from a floating vessel into a formation underlying a body of water through fluid control hoses, and wherein a landing base having an aperture therein, and a well head are positioned at the well opening, comprising in combination:

(a) casing riser

(b) blowout preventer operatively connected to said riser, said blowout preventer having a housing and fluid operated control means,

(c) connecting means operatively connecting said well head to said blowout preventer, said connecting means having means therein for remotely disconnecting said blowout preventer,

(d) disconnectable means associated with said blowout preventer housing for coupling said control hoses to said housing, and

(e) guide means cooperating with said riser for connecting said central hoses to said blowout preventer housing.

2. An underwater drilling and production head apparatus for controlling well pressure and the flow of fluids from a well drilled from a floating vessel into a formation underlying a body of water through fluid control hoses, and wherein a landing base having an aperture therein, and a well head are positioned at the well opening, comprising in combination:

(a) a casing riser

(b) a blowout preventer operatively connected to said riser, said blowout preventer having a shouldered housing and fluid operated control means, said shouldered portion of said housing having control fluid passageways therein,

(c) a safety joint operatively connecting said well head to said blowout preventer, said joint having means therein for remotely disconnecting said joint,

(d) a removable control block so arranged and constructed as to receive the terminals of said control hoses, and

(e) guide means associated with said control block and cooperating with said riser for remotely connecting said fluid control hoses to said blowout preventer through said passageways.

3. The apparatus of claim 2 wherein said control block has a hoisting member attached thereto for raising said block to said drilling vessel.

4. An underwater drilling and production head apparatus for controlling well pressure and the flow of fluids from a well drilled from a floating vessel into a formation underlying a body of water through fluid control hoses, and wherein a landing base having an aperture therein, and a well head are positioned at the well opening, comprising in combination:

(a) a casing riser

(b) a blowout preventer operatively connected to said riser, said blowout preventer having a shouldered housing and fluid operated control means, said shouldered portion of said housing having control fluid passageways therein,

(c) a safety joint operatively connecting said well head to said blowout preventer, said joint having means therein for remotely disconnecting said joint,

(d) a removable control block so arranged and constructed as to receive the terminals of said control hoses, said control block having a hoisting member attached thereto for raising said block to said drilling vessel,

(e) means associated with said control block for remotely connecting said fluid control hoses to said blowout preventer through said passageways,

(f) a tubular guide member slideably disposed over said casing riser, and

(g) means for connecting said tubular guide member to said control block hoisting member.

5. The apparatus of claim 4 including orientation means for remotely guiding said control block from said vessel onto said shouldered portion proximate said well opening to effect fluid connection between said control hoses and said passageways.

6. The apparatus of claim 4 including an orientation cam associated with said casing riser and an orientation lug in said tubular guide member adapted to engage said cam as said control block is lowered from said vessel to said shouldered portion proximate said well opening to remotely effect fluid connection between said control hoses and said passageways.

7. An underwater drilling and production head apparatus for controlling well pressure and the flow of fluids from a well drilled from a floating vessel into a formation underlying a body of water through fluid control hoses, and wherein a landing base having an aperture therein, and a well head are positioned at the well opening, comprising in combination:

(a) a casing riser

(b) a blowout preventer operatively connected to said riser, said blowout preventer having a shouldered housing and fluid operated control means, said shouldered portion of said housing having control fluid passageways therein, said passageways forming terminal receptacles,

(c) a removable control block having control hose terminals extending therefrom and adapted to sealingly engage said receptacles thereby establishing a fluid communication between said control hoses and said blowout preventer control means, and

(d) guide means cooperating with said riser for raising and lowering said block between said vessel and said blowout preventer.

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