March 17, 1970 B. J. WATKINS ET AL 3,500,904

MARINE CONDUCTOR PIPE

Filed Dec. 15, 1967 2 Sheets-Sheet 1

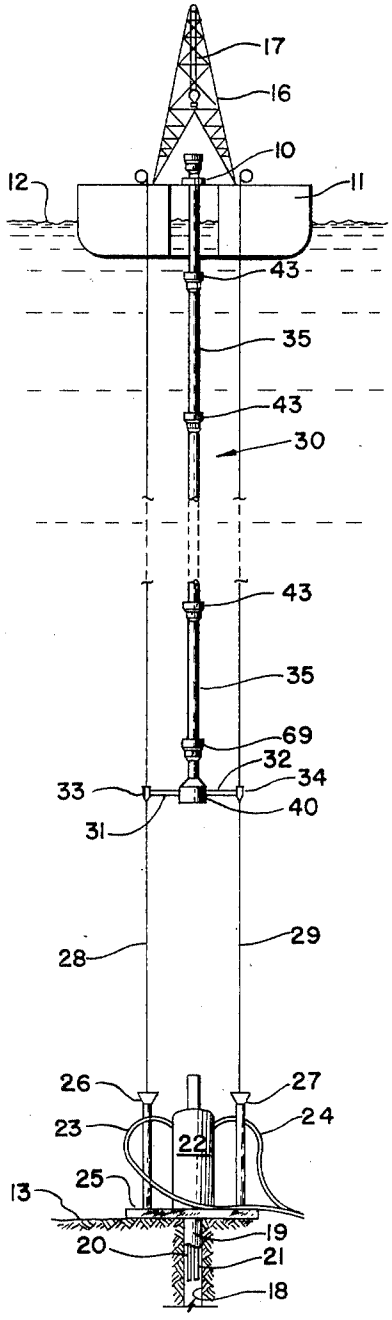


FIG. 1

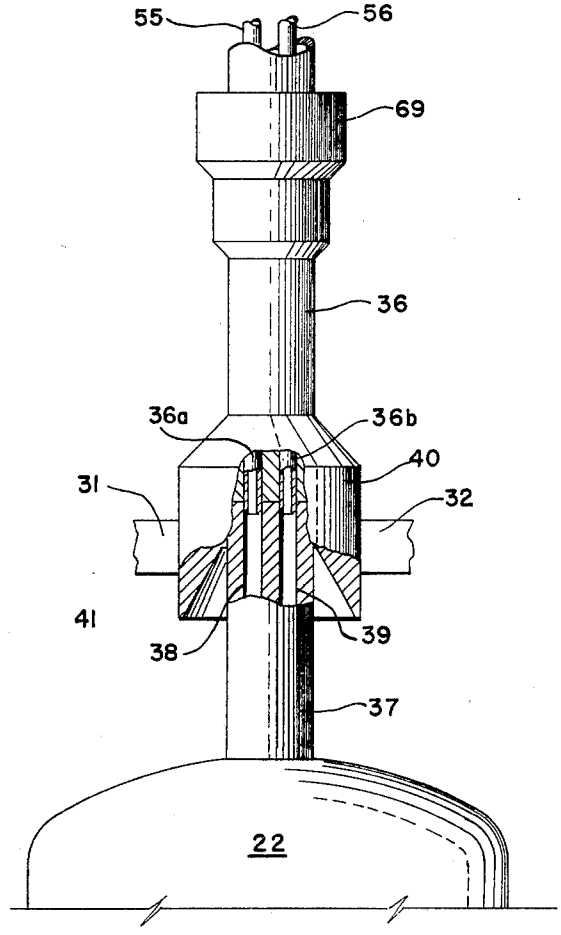


FIG. 2

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MARINE CONDUCTOR PIPE

Filed Dec. 15, 1967 2 Sheets-Sheet 2

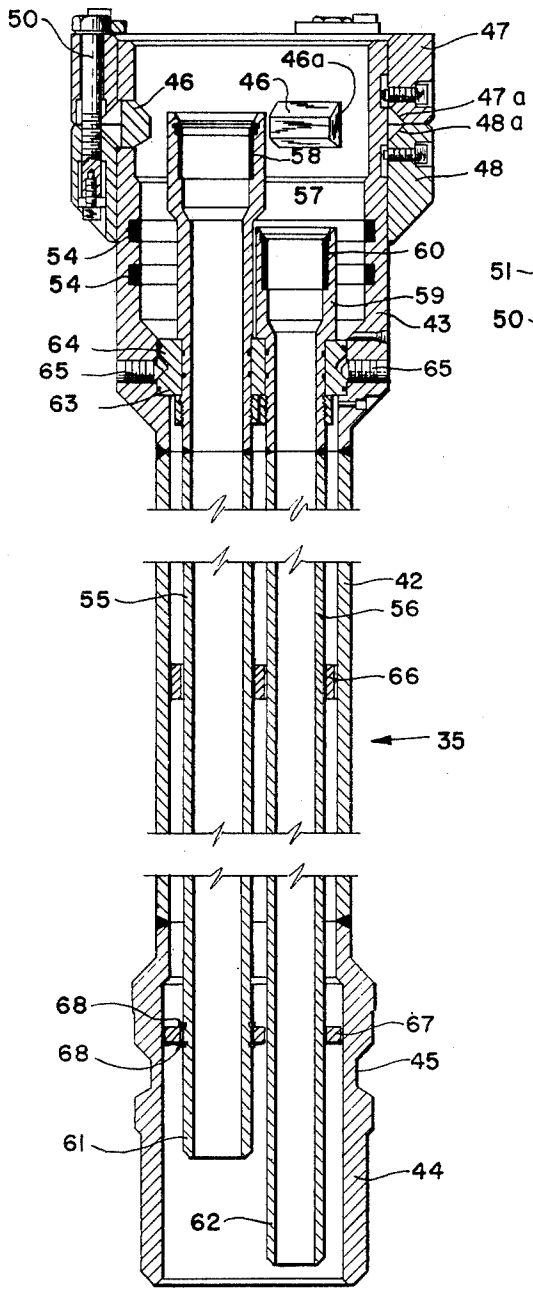


FIG. 3

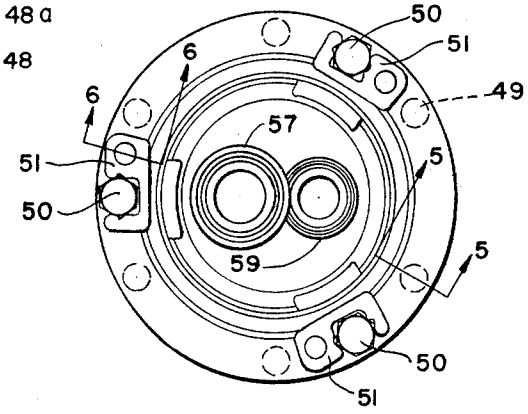


FIG. 4

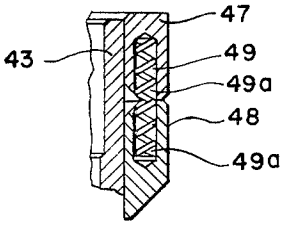


FIG. 5

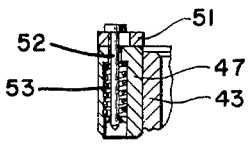


FIG. 6

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3,500,904

MARINE CONDUCTOR PIPE

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Int. Cl. E21b 33/035; F16l 35/00
U.S. Cl. 166—.5 8 Claims

ABSTRACT OF THE DISCLOSURE

A marine conductor pipe for establishing communication with an underwater well wherein the conductor pipe is made up of a plurality of interconnecting pipe lengths each containing tubing string sections that mate when the pipe lengths are connected so that a composite marine conductor pipe is formed having longitudinal tubing strings extending therethrough. The lower end of the conductor is provided with coupling means for connecting the tubing strings to fluid passageways in the wellhead that communicate with the well.

This case relates to apparatus for conducting completion and maintenance operations on an underwater well wherein the production wellhead assembly is positioned below the surface of a body of water. More particularly the invention relates to a large-diameter pipe, commonly referred to as a marine conductor pipe, which extends between a fixed platform or a floating vessel on or extending above the surface of the water and a production wellhead positioned on or near the floor of the body of water.

BACKGROUND OF THE INVENTION

In the quest to locate new oil deposits an increasing amount of offshore drilling and well completion is being conducted. Although the well casing and interior tubing strings of an offshore well may be extended to the water surface and closed off in a conventional manner such as is used on land wells, this arrangement is subject to damage and presents a navigational hazard for surface vessels. Accordingly, it is becoming increasingly popular to complete an offshore well entirely underwater, preferably with a production wellhead assembly located at or near the floor of a body of water. In order to perform certain completion and work-over operations on the well, it is necessary to establish communication between a surface platform or vessel and the well so that these operations can be performed. This is normally accomplished by extending a large-diameter pipe, commonly known as a marine conductor pipe, from the surface vessel down to the production wellhead. Subsequently, a tubing string is run down the marine conductor pipe and stabbed into a fitting on the production wellhead so that it is placed in communication with a tubing string extending into the well. In the event two or more tubing strings are employed in the well in side-by-side relationship, it thus becomes necessary to run these tubing strings down the marine conductor pipe and align and stab the marine conductor pipe tubing strings into the production wellhead to establish communication with the corresponding strings in the well. However, this is a particularly time-consuming and difficult operation since there is no guarantee that the tubing string or for that matter the marine conductor pipe remain perfectly straight so that aligning and stabbing the tubing strings becomes an especially difficult if not impossible operation. The tubing strings may, for example, become twisted during lowering so that they spiral one about the other.

In addition, time is of the essence in installing a marine conductor pipe since the labor costs, rental of the vessel and down time of the well amount to thousands of dollars a day. Thus, ease of assembly of the conductor pipe and installation are critical factors in performing completion and maintenance operations on an underwater well. The problem is particularly compounded as the water depth increases since the length of the marine conductor pipe accordingly increases thereby compounding the attendant problems of alignment and assembly. With the increased emphasis on drilling in deeper waters, that is, beyond diver depths and up to a thousand feet or more, the need for a marine conductor pipe which is easy and quick to assemble and reliable in operation is a pressing need in the development of underwater wells, particularly those wells in which two or more strings are employed.

SUMMARY OF THE INVENTION

In view of the aforementioned problems, it is a primary object of the present invention to provide a marine conductor pipe apparatus comprised of a plurality of pipe joints or sections which are readily coupled by means of a stab-type connection and which include a plurality of tubing string sections mounted side-by-side; said tubing strings being joined with tubing string sections in an adjacent marine conductor pipe joint when the joints are made up so as to form a composite marine conductor pipe with the pipe strings extending therethrough and said marine conductor pipe having means on the lower end thereof for connecting the pipe to a production wellhead and for securing the tubing strings in fluidtight relationship with passageways formed in the production wellhead which in turn communicate with tubing strings extending into the well casing.

Another object of the invention is to provide an apparatus of the subject type in which the side-by-side tubing string sections in each marine conductor pipe joint may be closely associated by longitudinally offsettting or staggering the tubing string sections each to the other.

Still another object of the invention is to provide the subject apparatus with means for removably latching said tubing string sections in said marine conductor pipe joints so that the tubing string section can be removed for repair or replacement.

These and other objects of this invention will become apparent from a reading of the detailed description of the invention.

In accordance with these objects, the marine conductor pipe according to this invention is made up of a plurality of pipe joints or sections having an outer casing containing tubing string sections mounted side-by-side and secured within the casings. The pipe is made up at a surface vessel or installation by stabbing the joints together in end-to-end relationship. Each joint incorporates stab-type connector means at each end thereof and the tubing strings similarly carry stab-type connector means at each end so that when the joints are made up the tubing strings are also connected in fluidtight relationship to form a composite marine conductor pipe. When the marine conductor pipe is lowered into position by adding successive pipe joints to the top of the marine conductor pipe, the lowermost marine conductor pipe joint, which is provided with coupling means on its lower end, is stabbed onto the top of a production wellhead to secure the tubing strings carried therein in fluid communication with passageways formed in the production wellhead that in turn communicate with tubing strings in the well casing. In addition, the tubing string sections may be axially staggered with respect to each other to permit closer side-by-side spacing of the tubing string sections and further, the sections are preferably removably secured in the casings by releaseable latching means so that the sections may be removed for repair or replacement.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a diagrammatic view taken in longitudinal projection **10** illustrating a floating vessel positioned over a drilling location wherein a production wellhead assembly is positioned on the ocean floor and a marine conductor pipe extends generally between the wellhead assembly and the drilling vessel at the surface, just prior to connecting the marine conductor pipe to the wellhead;

FIGURE 2 is an enlarged detail view taken in longitudinal projection in partial cross section showing the upper portion of the production wellhead assembly and the marine conductor pipe connected thereto for illustrative purposes, two internal tubing strings have been shown;

FIGURE 3 is a longitudinal cross-section taken through one length or joint of the marine conductor pipe;

FIGURE 4 is a plan view of the upper end of the marine conductor pipe joint shown in FIGURE 3;

FIGURE 5 is a partial cross-section taken along the line **5—5** of FIGURE 4; and,

FIGURE 6 is a partial cross-section taken along the line **6—6** of FIGURE 5.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGURE 1 of the drawing, a floating (or bottom supported) vessel **11** of a type suitable for performing completion and work-over operations on an underwater well is illustrated floating on the surface of body of water **12** while positioned over a preselected well location by suitable vessel positioning means well known in the art or by means of anchor lines (not shown) extending to the floor **13** of the body of water. The drilling vessel **11** is equipped with a suitable derrick **16** containing a power-operated hoist or fall line system **17** for lowering a marine conductor pipe in a manner to be described later. The vessel **11** is also provided with suitable auxiliary equipment for performing completion or maintenance operations on the well once the marine conductor pipe is in place. Such operations include, for example, pumping a well tool or instrument into and out of a well or other operations as described in U.S. Patents 3,052,302; 3,090,440 and 3,268,006.

As shown in FIGURE 1 a well **18** has been drilled into formation underlying the floor **13** of the body of water and is provided with a production wellhead assembly **22** positioned on the floor **13** in communication with the well. The well is cased in a conventional manner by means of a casing **19** and is further provided, for example, with dual tubing strings **20** and **21** extending into the well **18** through the casing **19**. The drilling of the well **18** and the installation of the production wellhead **22** may be accomplished by suitable operations well known in the art which do not form a part of this invention. Running from the production wellhead and adapted to lie along the floor of a body of water are, for example, two flowlines **23** and **24** which serve to handle the offtake of oil and/or gas produced from the well **18**. These flowlines may extend to a suitable underwater collecting facility or directly to storage facilities located on shore.

The underwater production wellhead assembly includes a base member **25** provided with suitable guide posts or columns **26** and **27** having attached guidelines **28** and **29**, respectively, extending upwardly to the vessel **11** at the water surface. A marine conductor pipe, indicated generally by the numeral **30**, is shown in FIGURE being lowered down the guidelines **28** and **29** by means of radially-extending guide arms **31** and **32** which are attached to the lower end of the marine conductor pipe. The guide arms **31** and **32** include a guideline receiving portion **33** and **34**, respectively, which surround the guidelines and are freely movable therealong.

It will be noted at this point that the marine conductor pipe **30** is comprised of a plurality of pipe lengths or

joints **35** which are joined end-to-end to form the marine conductor pipe **30**. Located on the vessel is a rotary table, **10** or other suitable pipe-holding device which is employed when lowering the marine conductor pipe. As shown, the rotary table **10** is used to temporarily hold the marine conductor pipe while an additional pipe joint or line **35** is added onto the upper end of the string. After the length is added, the assembled marine conductor pipe is lowered by means of the fall line system **17** and the newly-added pipe is then held by the rotary table. Thus, successive lengths are added to the marine conductor pipe until the lower end reaches the production wellhead assembly **22** where it is connected in a manner to be described.

The pipe joints **35** may vary in length but are typically in the order of 40 feet long to permit ease of assembly and disassembly. At the lower end of the marine conductor pipe **30** is a short pipe section or "sub" **36** which is shown in greater detail in FIGURE 2.

Referring now to FIGURE 2, the lower end of the marine conductor pipe **30** is illustrated in its final position connected to the production wellhead assembly **22**. The production wellhead assembly **22** includes at its upper end a short connector pipe **37** of the type shown in U.S. Patent No. 3,102,591 having a pair of passageways **38** and **39** formed therein and which communicate through suitable passages (not shown) formed in the production wellhead assembly **22** with the tubing strings **20** and **21** located in the well **18**. At the lower end of the sub **36** is an enlarged female connector end **40** adapted to receive the connector pipe **37** on the production wellhead assembly **22**. This female connector **40** is commonly known in the art as a wellhead connector and may be of any type, e.g., as shown in U.S. Patent 3,163,224. The female connector end **40** is formed with a flared mouth portion **41** which serves to axially align the female connector end **40** with the connector pipe **37**. The female wellhead connector **40** and the connector pipe **37** may also be provided with orienting means to assure accurate rotary alignment between the two parts of this function may be performed solely by the cooperation of the guide arms **31** and **32**, guidelines **28** and **29**, and the guide posts **26** and **27**. In any event the orienting means must include one portion carried by the production wellhead assembly and one portion carried by the conductor pipe and may be of the type, for example, as described in U.S. patent to Haeber 3,189,098.

FIGURE 5 is a cross-sectional view illustrating one of the pipe joints **35** that make up the marine conductor pipe. The joint **35** includes an outer tubular casing **42** terminating in a female connector housing **43** at the upper end thereof and a male connector housing **44** at the lower end. The upper end of sub **36** is also provided with a female connector housing **69** which is identical to the female connector housing **43** of the joint **35**. The pipe joints are arranged during assembly so that the male connector housing **44** of one pipe joint mates with a female housing connector of an adjacent joint. The male connector housing includes an annular recess or groove **45** formed about its outer periphery for receiving locking dogs **46** carried by the female connector housing **43**. The dogs **46** are received in apertures or recesses **46***a* formed in the wall of the female housing **43** and are adapted to be horizontally displaced. Suitable actuating means for extending the dogs **46** into locking engagement with the groove or recess **45** of another pipe joint are carried on the outer periphery of the female connector housing **43**. These means comprise an upper ring **47** and a lower ring **48** adapted to permit limited longitudinal sliding movement along the housing. The rings are normally biased apart by means of compression coil springs **49** carried in recesses **49***a* formed in the rings **47** and **48** (see FIGURES 4 and 5). A plurality of circumferentially-spaced actuating means in the form of bolts **50** extend through the ring **47** and threadably engage the ring **48** so that axial rotation of the bolts **50** serves to

move the rings toward each other or away from each other depending on the direction the bolts are turned. Each ring is cut away or relieved in the vicinity of the locking dogs **46** to form a cam surface **47***a* on ring **47** and a cam surface **48***a* on ring **48** so that when the rings are in the expanded condition, that is, when they are separated, the dogs **46** may be retracted to permit entry into housing **43** of a male connector housing **44** from an adjacent pipe joint. After the male connector housing **44** is inserted in the female connector housing **43**, the actuating bolts **50** are rotated to bring the rings **47** and **48** together as shown in FIGURE 3 so that cam surfaces **47***a* and **48***a* force the locking dogs **46** inwardly into the annular recess **45** formed in the male connector housing **44** of the adjacent pipe joint.

Suitable locking means may be carried by the upper end of the female connector housing for preventing the actuating bolts **50** from inadvertently turning. These means may take any suitable form, for example, a locking plate **51** adapted to engage the head of the actuating bolts **50** to prevent rotation thereof as shown in FIGURE 4. The plates **51** may be carried by a shaft **52** which is biased by spring **53** to force the plate **51** into contact with the head of the actuating bolt **50** (see FIGURE 6). Thus, when it is desired to turn the actuating bolt **50**, the locking plate **51** is lifted against the action of spring **53** and rotated out of alignment with the head of the actuating bolt so that the bolt may then be turned. Subsequently, the ring **51** is returned to the position shown in FIGURE 4 to thus lock the actuating bolt. In addition, suitable elastomeric sealing rings **54** may be carried on the internal wall of the female connector housing **43** to assure a fluidtight seal between the connector pipe joints thereby preventing the ingress of sea water into the casing **42**.

Carried within each joint **35** and including therewith are two or more small-diameter tubing string segments **55** and **56** positioned side-by-side. Since the tubing string segments are slightly shorter than the casing **42** they are protected from damage during handling and assembly on the vassel **11**. The upper end of the tubing string segment **55** is provided with a female stab-type connector portion **57** having an internal diameter approximately equal to the external diameter of a mating end of a tubing string section of an adjacent pipe point. Carried internally of the connector portion **57** is a cylindrical sealing member **58** of plastic, rubber or other suitable material. The upper end of the tubing string segment **56** is similarly formed with a female stab-type connector **59** having a cylindrical sealing member **60** for connecting with a tubing string section of an adjacent pipe joint. The lower end of the pipe string sections **55** and **56** form male stab-type connectors **61** and **62**, respectively, for mating with the female portions of tubing string sections in an adjacent pipe joint.

As shown, the tubing strings **55** and **56** are axially staggered with respect to each other so that the female mating portions **57** and **59** will clear each other and allow minimum spacing between the tubing strings. However, such an arrangement is not essential to the subject invention and if desired the tubing strings may be positioned side-by-side with no axial offset without departing from the scope of the invention. In addition, it is to be noted that the tubing strings are preferably removably secured to the outer casing of the pipe joint in order to permit replacement or repair of a tubing string segment. Suitable apertured locating plates **66** and **67** may be employed at spaced intervals along the tubing strings **55** and **56** to locate and maintain the spacing between the tubing strings. Snap rings **68**, as shown at the intersection of tubing string **55** and the locating plate **67**, serve to releasably secure the locating plate to the tubing string **55**. Other means for spacing the tubing strings may also be used, for example, the strings may be fitted with spiders which contact the interior of the casing **42**. As shown in FIGURE 3, the tubing strings may have a ring **63** or any suitable member attached thereto which is formed with an annular groove **64** about the outer periphery for receiving set screws **45** threadably carried in the female connector housing **43**. Thus, it will be seen that the set screws **65** when threaded inwardly as shown in FIGURE 3 serve to fixedly secure and lock the tubing strings **55** and **56** in place within the interior of the tubing string **35**. If it is desired to replace a tubing string, e.g., to repair it or change the size, set screws **65** are released and the entire assembly of tubing strings **55** and **56** and locating plates **66** and **67** are removed. Thereafter, the tubing strings can be diassembled from the locating plates by releasing snap rings **68**. It will be apparent, however, to one skilled in the art that other means may be employed for removably securing the tubing strings or if desired they may be fixedly secured.

Although each pipe joint and tubing string segment has been disclosed with a female upper end and a male lower end, it will be readily apparent that any of the ends may be reversed so long as consistently done throughout the length of the marine conductor pipe or, if desired, the pipe joints may be inverted during assembly.

The marine conductor pipe **30** is made up and connected to the production wellhead assembly **22** as follows. The wellhead connector **40** and short sub **36** which form the lowermost end of the marine conductor pipe are guided by means of guide arms **31** and **32** down the guidelines **28** and **29** as successive pipe joints **35** are added at the vessel **11**. As each joint is added the entire assembly is lowered by means of the hoist or fall line system **17** in the derrick **16** a distance equal to the length of the newly-added pipe joint. The assembly is then held by slips (not shown) in the rotary table **10** or other suitable pipe holding means while the next pipe joint is added. It will be apparent that each pipe joint **35** is assembled to the next successive pipe joint by stabbing the male connector housing **44** into a mating female connector housing **43**. This action simultaneously affects connection of the tubing string segments **55** and **56** by stabbing the male ends **61** and **62** into the female ends **57** and **59**, respectively. After the pipe joints are mated, the actuating bolts **50** are rotated to draw the locking rings **47** and **48** together. As the rings **47** and **48** come together, cam surfaces **47***a* and **48***a* engage the dogs **46** and drive them inwardly into groove **45** to thereby lock the pipe joints together. Thus, it will be seen that as the pipe joints are assembled a composite marine conductor pipe is formed having two or more continuous tubing strings extending therethrough. When the marine conductor pipe is finally assembled and lowered onto the production wellhead assembly **22**, the female wellhead connector **40** at the lower end of the sub **36** is stabbed and latches onto the connector pipe **37** carried by the production wellhead assembly **22** as shown in FIGURE 2. The tubing string segments **36***a* and **36***b* carried in the sub **36** mate with and stab into the passageways **38** and **39** formed in connector pipe **37** which, as described above, communicate with the tubing strings **20** and **21** extending into the well **18**. Thus assembled, the tubing strings of marine conductor pipe **30** provide two or more passageways from the vessel **11** to the well **18** suitable for pumping workover tools into and out of the well or for other operations. It will be seen that once the completion or workover operations are finished, the marine conductor pipe can be removed to the surface and disassembled by reversing the assembly procedure described above.

We claim as our invention:

1. An apparatus for conducting well completion and maintenance operations on an underwater well, said apparatus comprising:

an underwater production wellhead assembly positioned adjacent said well and having vertical fluid passageway means extending therethrough in communication with said well;

a marine conductor pipe extending substantially vertically between said wellhead assembly and the water surface;

a surface vessel positionable above said wellhead assembly;

support means carried by said vessel for contacting and supporting the upper end of said conductor pipe;

said marine conductor pipe being formed of a plurality of pipe joints, each joint comprising:

a large diameter tubular casing;

small diameter tubing string means carried within said casing and extending longitudinally therethrough;

first stab-type connector means carried by the ends of said casing for connecting said joints in end-to-end relationship whereby said casings define a sealed periphery along the length of the marine conductor pipe;

second stab-type connector means carried by the ends of said tubing string means for connecting the tubular string means in each casing in fluidtight end-to-end relationship within the sealed periphery defined by said casings when said joints are connected; and

coupling means carried by the lower end of said marine conductor pipe for securing said tubing string means to said wellhead in fluid communication with the fluid passageway means in said wellhead.

2. An apparatus as defined in claim **1** wherein said passageway means comprise two or more adjacent passageways and said adjacent tubing string means comprise two or more tubing strings, each in alignment with one of said passageways.

3. An apparatus as defined in claim **2** wherein said tubing strings are axially displaced one to the other.

4. An apparatus as defined in claim **3** including:

horizontally extendible locking means carried by one end of said casing;

recess means formed in the other end of said casing for receiving cooperating locking means; and

actuating means carried by said one end for extending said locking means into engagement with said recess means,

whereby said one end of a casing of one joint is connectible to said other end of a shell of another joint for assembling said joints in end-to-end relationship.

5. In a marine conductor pipe extending between a vessel positioned on the surface of a body of water and a production wellhead on the floor of said body of water, said wellhead having two or more fluid passageways extending vertically therethrough in communication with the well, said marine conductor pipe comprising:

a plurality of pipe joints connected in end-to-end relationship, each joint comprising:

a large diameter tubular casing;

tubing string means carried within said casing and extending longitudinally substantially the length thereof;

first stab-type connector means carried by the ends of said casing for connecting said casings in end-to-end relationship;

second stab-type connector means carried by the ends of said tubing string means for connecting the tubing string means carried in each casing in fluidtight end-to-end relationship; and

coupling means carried by the lower end of said marine conductor pipe for securing said tubing string means to said wellhead in fluid communication with the fluid passageway means in said wellhead.

6. An apparatus as defined in claim **5** wherein said tubing string means comprise two or more side-by-side tubing strings each of which is in communication with corresponding fluid passageways in said wellhead.

7. An apparatus as defined in claim **6** wherein the tubing strings carried in each of said pipe joints are axially staggered one to the other.

8. An apparatus as defined in claim **7** including:

latching means carried by said casing and adapted to engage said tubing strings for removably securing said tubing strings in said casing.

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