July 11, 1967 W. J. HAYES ETAL 3,330,340

MARINE CONDUCTOR PIPE ASSEMBLY

Filed Oct. 5, 1964

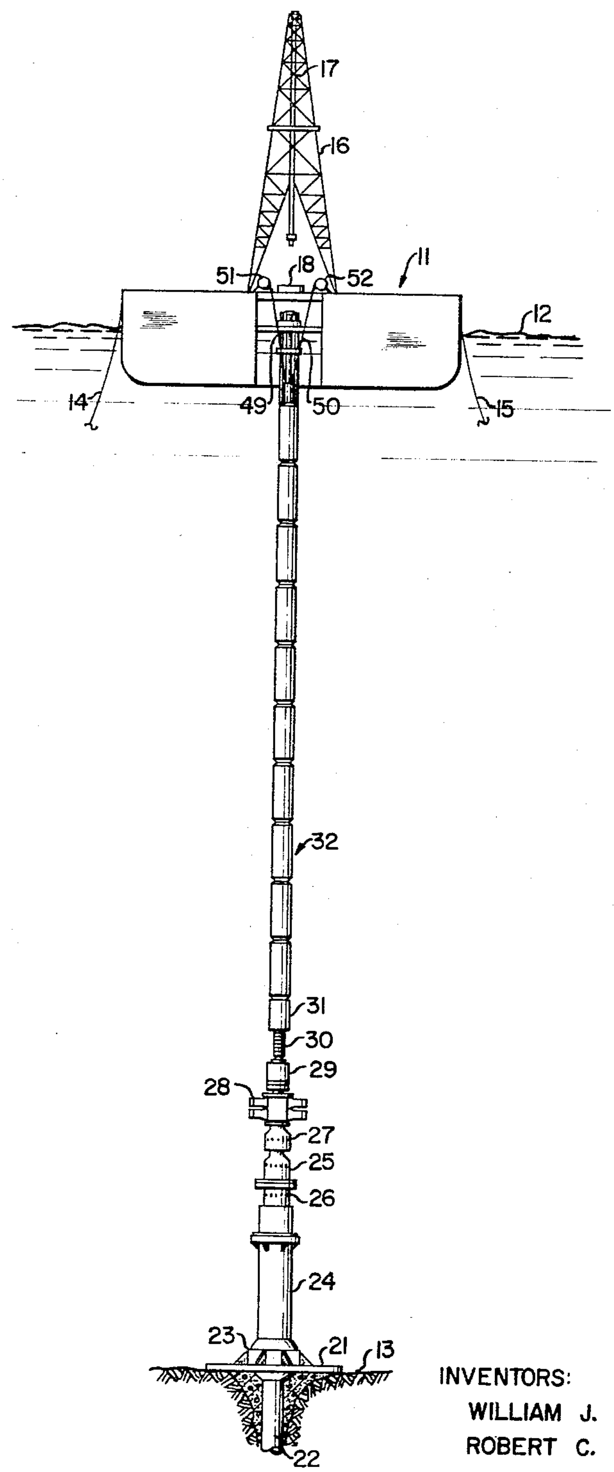

FIG. 1

INVENTORS:
WILLIAM J. HAYES
ROBERT C. VISSER
GLENN D. JOHNSON
BY: A. H. McCarthy
THEIR AGENT

MARINE CONDUCTOR PIPE ASSEMBLY

Filed Oct. 5, 1964

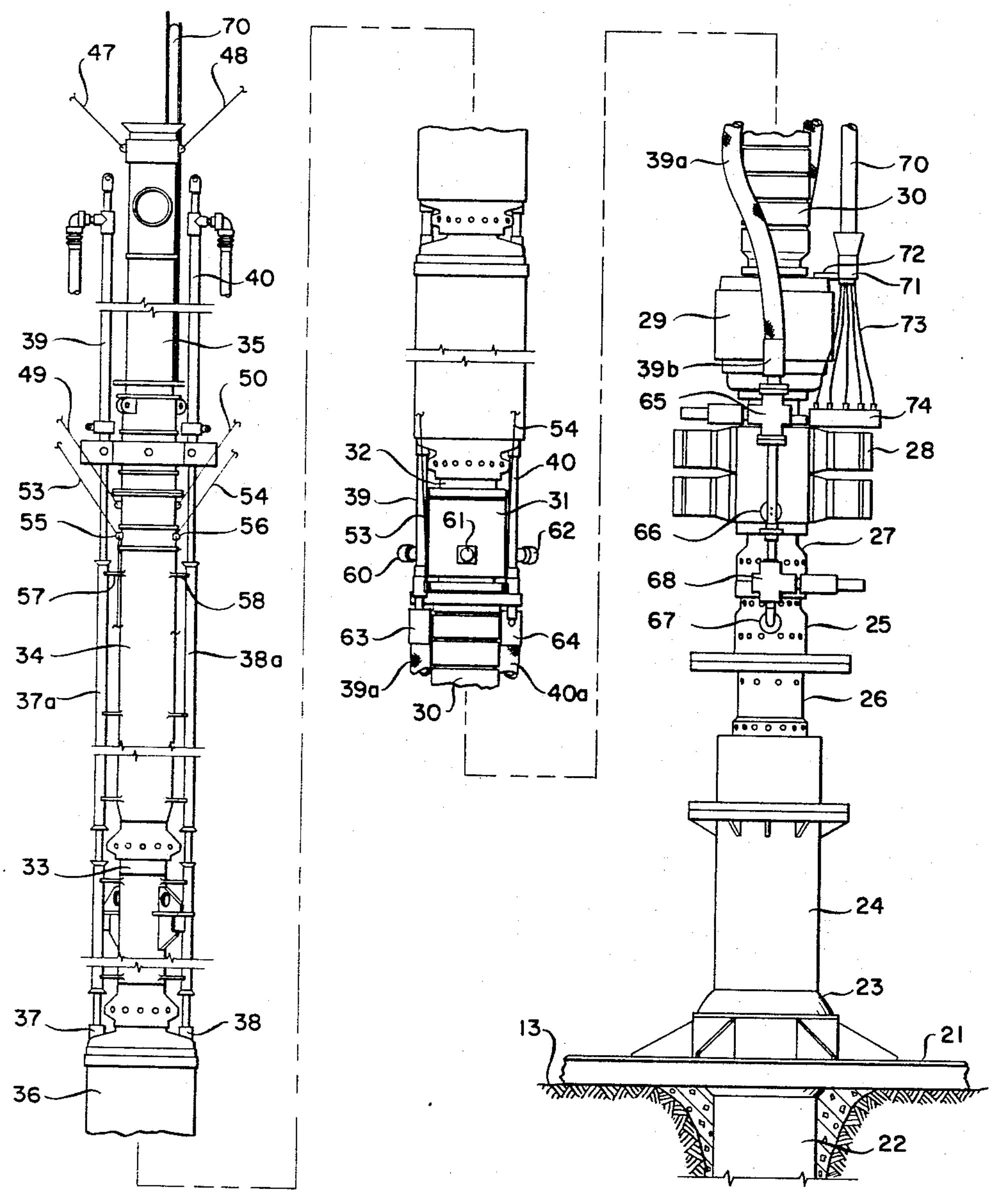

FIG. 2A FIG. 2B FIG. 2C

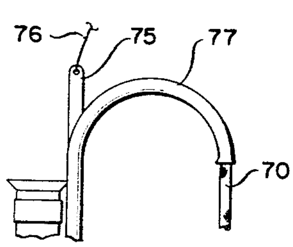

FIG. 3

INVENTORS:
WILLIAM J. HAYES
ROBERT C. VISSER
GLENN D. JOHNSON
BY: J. H. McCarthy
THEIR AGENT

July 11, 1967 W. J. HAYES ETAL 3,330,340

MARINE CONDUCTOR PIPE ASSEMBLY

Filed Oct. 5, 1964 3 Sheets-Sheet 3

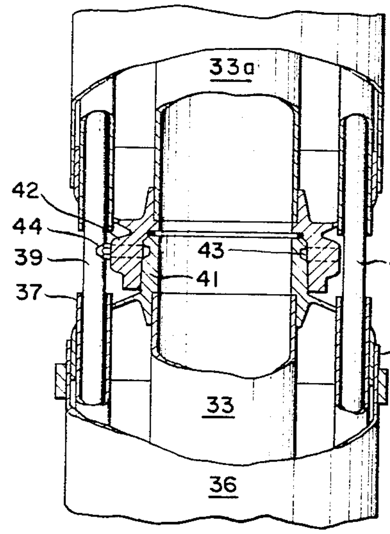

FIG. 4

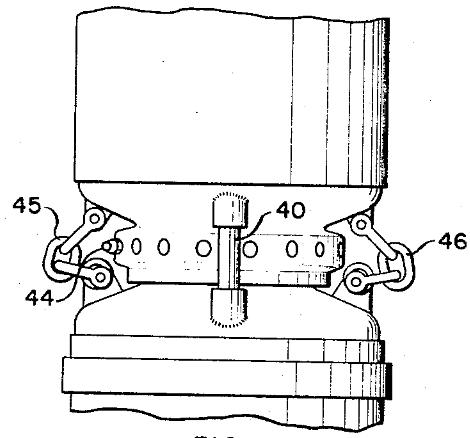

FIG. 5

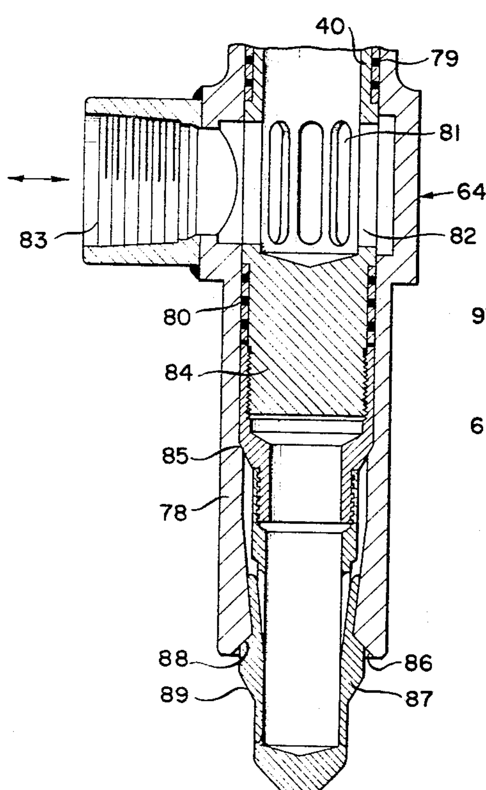

FIG. 6

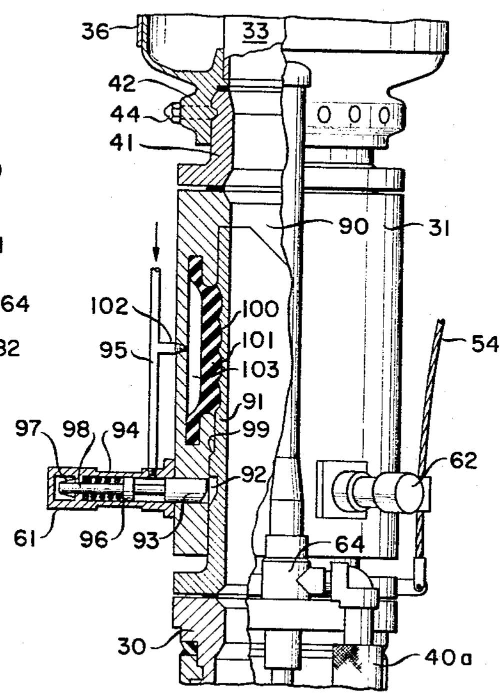

FIG. 7

INVENTORS:
WILLIAM J. HAYES
ROBERT C. VISSER
GLENN D. JOHNSON
BY: A. H. McCarthy
THEIR AGENT

United States Patent Office 3,330,340
Patented July 11, 1967

3,330,340
MARINE CONDUCTOR PIPE ASSEMBLY
William J. Hayes, Torrance, Robert C. Visser, San Dimas, and Glenn D. Johnson, Downey, Calif., assignors to Shell Oil Company, New York, N.Y., a corporation of Delaware
Filed Oct. 5, 1964, Ser. No. 401,488
5 Claims. (Cl. 166—.6)

This invention relates to apparatus for use in drilling, completing and working-over operations in oil and gas wells at offshore locations, and pertains more particularly to apparatus adapted to provide full-flow fluid communication between a vessel at the surface of a body of water and a wellhead assembly positioned on the ocean floor or at a substantial depth below the surface of the water.

In an attempt to locate new oil fields, an increasing amount of well drilling has been conducted at offshore locations, such for example, as off the coast of Louisiana, Texas and California. As a general rule, the strings of casing in a well, together with the tubing string or strings, extend to a point about the surface of the water where they are closed in a conventional manner that is used on land wells, with a conventional wellhead assembly being attached to the top of the casing. Recently, methods and apparatus have been developed for drilling and completing wells wherein both the well casinghead, and subsequently the wellhead assembly and casing closure device, are located underwater at a depth sufficient to allow ships to pass over them. Preferably, the casinghead and wellhead closure assemblies are located close to the ocean floor. In order to install well drilling equipment underwater at depths greater than the shallow depth at which a diver can easily operate, it has been necessary to design entirely new equipment for this purpose.

Wells drilled in deep water are generally drilled from vessels of varying designs commonly known as drilling barges, vessels or platforms. Deep water wells are generally drilled by one of two methods. In one method the string of drill pipe extends downwardly from the drilling vessel to the drilling wellhead assembly, on the ocean floor, which is closed at the top by a circulation head with a flexible hose running from the circulation head back to the surface and to the drilling vessel so that drilling fluid may be circulated down the drill pipe, through the drill bit, and thence upwardly along the outside of the drill pipe, out the circulation head and up the flexible hose to the vessel again. In a second method, a large-diameter pipe known as a marine conductor pipe is put together and arranged to extend from the drilling wellhead assembly near the ocean floor to the vessel on the surface of the water. In the latter method, the drill pipe rotates within the conductor pipe with drilling fluid being circulated down through the drill pipe, through the bit at the bottom thereof, up the outside of the drill pipe and thence upwardly through the annular space between the conductor pipe and the drill pipe, returning to the barge in the conventional way. The present invention is concerned with apparatus to be used in the second method described hereinabove.

One of the problems in drilling underwater wells from floating vessels is that of providing suitable means for suspending and/or supporting a large-diameter marine conductor pipe and auxiliary smaller-diameter equipment or well-control pipes in the water beneath the drilling vessel while the lower ends thereof are secured to a wellhead assembly positioned near the ocean floor. A further problem is encountered at times when drilling at offshore locations due to the possibility of a violent storm which necessitates moving the drilling vessel away from the well being drilled or having it moved away by abnormal

wind and wave action. In the cases where the vessel has to be moved or is liable to be moved, it is necessary to quickly disconnect the marine conductor and auxiliary lines from the drilling well head assembly near the ocean floor and withdraw them to the vessel prior to the vessel moving off location.

It is therefore a primary object of the present invention to provide a marine conductor pipe assembly which can be quickly disconnected from a wellhead drilling assembly at the ocean floor while control of the well being drilled is maintained by suitable blow-out equipment left on the ocean floor.

A further object of the present invention is to provide a marine conductor pipe assembly of rugged design which can be built in sections small enough to be handled easily on a drilling vessel while being provided with means for connecting the various sections together easily and quickly.

Another object of the present invention is to provide a sectionalized marine conductor pipe assembly wherein all of the sections are substantially and individually buoyant so that the major portion of all of the marine conductor pipe is substantially self-supporting within a body of water.

Still another object of the present invention is to provide a sectionalized buoyant marine conductor pipe assembly provided with means for accommodating one or more smaller-diameter well control or equipment control pipelines which are protected by the conductor pipe assembly while extending from the vessel down to the equipment at the ocean floor.

A further object of the present invention is to provide means on the sectionalized marine conductor pipe assembly whereby smaller-diameter auxiliary pipes extending from the vessel to the drilling equipment at the ocean floor may be readily removed or replaced in case of emergency or damage without pulling the marine conductor pipe assembly back to the vessel.

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

FIGURE 1 is a diagrammatic view taken in longitudinal projection illustrating a floating drilling vessel positioned at the surface of the ocean with an underwater wellhead assembly positioned on the ocean floor;

FIGURES 2A, 2B and 2C are longitudinal views adapted to be arranged end-to-end to show enlarged detail sections of the marine conductor pipe assembly of the present invention as it is positioned on a wellhead at the ocean floor;

FIGURE 3 is a view in enlarged detail illustrating the upper end of the marine conductor pipe of FIGURE 2A as well as the upper end of a bundle of hydraulic control cables positioned alongside the marine conductor pipe;

FIGURE 4 is a longitudinal view taken in partial cross section illustrating interconnecting ends of two sections of the marine conductor pipe of the present invention together with smaller-diameter auxiliary pipes arranged in guide tubes on either side of the marine conductor pipe;

FIGURE 5 is a partial longitudinal view taken at 90° to the view shown in FIGURE 4 so as to illustrate auxiliary connections between two sections of the marine conductor pipe assembly;

FIGURE 6 is an enlarged cross-sectional longitudinal view showing in enlarged detail the manner in which an auxiliary smaller-diameter pipeline is coupled to a drilling wellhead assembly in communication with a suitable conduit thereto; and,

FIGURE 7 is a longitudinal view taken in partial cross section of a sealing and connector unit between the marine conductor pipe assembly and the drilling wellhead assembly.

Referring to FIGURE 1 of the drawing, a drilling vessel, barge or platform is generally represented by numeral **11**. The drilling vessel is of any suitable type preferably, as illustrated, floating at the surface of a body of water **12** and being substantially fixedly positioned over a preselected drilling location by suitable barge-positioning means or by being anchored to the ocean floor **13** by suitable anchors (not shown) connected to the anchor lines **14** and **15**. Equipment of this type may be used when carrying on well drilling operations in water depths varying from about 100 to 1500 feet or more. The drilling vessel is equipped with a suitable derrick **16** as well as other auxiliary equipment needed during the drilling of a well such as a hoist system **17**, rotary table **18**, etc. The derrick **16** may be positioned over a drilling slot or well which extends vertically through the vessel in a conventional manner. When using the equipment of the present invention, the slot of the vessel may be centrally located or extend in from one edge. However, drilling operations may be carried out over the deck of the vessel which is cantilevered out over one end. Additionally, it is to be understood that the equipment of the present invention may be also used when drilling a well from any suitable operational base positioned above the surface of the water, such for example, as from a drilling barge having legs extending to the ocean floor or from a platform permanently positioned on the ocean floor.

A typical underwater wellhead structure is illustrated in FIGURES 1 and 2C as comprising a base member **21** which is positioned on the ocean floor **13** and is fixedly secured to a conductor pipe or a large-diameter well casing **22** by means of a ball-and-socket joint **23**. During drilling operations a drilling wellhead assembly is removably secured to the top of a foundation pile **24** which in turn is secured to the top of the ball-and-socket joint **23**. In the wellhead structure illustrated, the drilling wellhead is secured to the top of a two-piece casinghead **25–26** which in turn is mounted at the top of the foundation pile **24**. The combined casing **22**, foundation pile **24** and casinghead **25–26**, form a continuous tubular member or pipe extending up from the ocean floor through which drilling operations are conducted.

The drilling wellhead assembly illustrated includes a detachable wellhead connector or drilling bonnet **27** of any type well known to the art. Fixedly secured above the wellhead connector **27** is a ram-type blowout preventer unit **28**, a bag-type blowout preventer unit **29**, a flexible joint **30**, a remotely-operable quick-disconnect coupling and sealing apparatus **31**, and a sectionalized marine conductor pipe assembly **32** (FIGURE 1) extending to the vessel **11** at the surface.

As shown in FIGURE 2A, the marine conductor pipe assembly consists of a marine conductor pipe **33** having an enlarged telescoping section **34** into which the upper end section **35** of the marine conductor pipe is arranged for sliding vertical movement, thus compensating for rise and fall of the vessel with wave action or tides. Most or all of the marine conductor pipe sections below the telescoping joint **34** are provided with buoyancy tanks **36** of sufficient capacity to float or nearly float the individual sections of the conductor pipe. As shown in FIGURE 4, the buoyancy tanks **36** surround the marine conductor pipe **33** in a fluidtight manner. Extending longitudinally through each of the buoyancy tanks **36** in a direction parallel to the marine conductor pipe **33** are one or more guide sleeves **37** in which small-diameter pipe strings **39** and **40** can be contained and be freely insertable therethrough. Any suitable type of couplings may be employed to connect two sections of marine conductor pipe **33** and **33***a* together. For example, in the form illustrated in FIGURE 4, one section of marine conductor pipe **33** is provided with the male section **41** of a stab-type fitting having conical recesses **43** formed therein for receiving

the locking bolts **44** carried by the female section **42** of the coupling. It is apparent that the bolts **44** are of a form that may be turned by a diver with a wrench or by an underwater robot. If desired, as shown in FIGURE 5, auxiliary safety means may be provided by means of chains **45** and **46** which can hold the sections of marine conductor pipe together after the bolts of the coupling have been unscrewed.

As shown in FIGURE 2A, the upper end of the telescoping pipe section **35** may be secured to the drilling vessel **11** in any suitable manner, as by cables **47** and **48**. The upper end of the marine conductor pipe assembly below the upper telescoping section **35** is supported from the vessel by means of cables **49** and **50** which extend to any suitable type of constant tension hoist means **51** and **52** which are mounted on the vessel **11**. If desired, additional cables **53** and **54** may be provided which are temporarily connected to the marine conductor pipe assembly at **55** and **56** and which run downwardly along the outside of the entire marine conductor pipe assembly and are anchored to the drilling wellhead assembly below the disconnect coupling **31**, as shown in FIGURE 7. These cables **53** and **54** serve as guide means in the event that the marine conductor pipe assembly has been removed from the drilling wellhead assembly and it is desired to run it down into place again on the top of the drilling wellhead assembly. Since it is cumbersome to provide the telescoping section **34** of the marine conductor pipe assembly with a buoyancy tank, guide sleeves **37***a* and **38***a* are secured outside the telescoping pipe section **34** by means of lateral supports **57** and **58**. These guide sleeves **37***a* and **38***a* are in axial alignment with each of the guide sleeves **37** and **38** passing down through the buoyancy tanks **36** of the marine conductor pipe assembly, thus serving as guides for small-diameter auxiliary pipes **39** and **40**, which in this case may be choke and kill lines.

The coupling and sealing apparatus **31** (FIGURE 2B) between the lower end of the marine conductor pipe **32** and the upper end of the flexible joint **30** is provided with suitable remotely actuatable latches **60, 61** and **62** which are normally disengaged or in an inoperative position while drilling so that the marine conductor pipe above the flexible joint **30** can be pulled away and disconnected from the drilling wellhead assembly in an emergency. Since the marine conductor pipe is disconnected at this point, the auxiliary lines **39** and **40** are also provided with readily disconnectible couplings **63** and **64** so that they may be readily disconnected adjacent the coupling device **31**. In the event that a flexible joint is employed in the drilling wellhead assembly, it is necessary that the portions of the auxiliary conduits **39***a* and **40***a* opposite the flexible joint **30** be also flexible in order to prevent rupturing the lines. Thus, the conduits **39***a* and **40***a* may be made of flexible hose of any suitable type. Below the flexible joint **30** (FIGURE 2C) the flexible conduit **39***a* becomes a rigid conduit **39***b* again which is preferably provided with a valve **65** which may be remotely operated either electrically or hydraulically or may be operated by means of an underwater robot. In the event that the conduit **39***b* is merely to be used as a choke or kill line for the drilling wellhead assembly, it terminates by entering the blowout preventer **28** at flange **66** at a point below the lower set of rams of the blowout preventer. If in addition the conduit **39***b* is to be used as a cement by-pass line so as to allow cement return from the well to by-pass strings of casing already seated in the casinghead **25**, the conduit **39***b* terminates at flange **67** and is provided with a valve **68** which is adapted to be operated in a manner similar to valve **65**.

It is to be understood that all of the various components of the wellhead drilling assembly may be remotely actuatable, as by being operated by hydraulic pressure lines extending from the vessel at the surface. In the arrangement shown in FIGURE 2C, hydraulic hoses extend downwardly from the vessel in the form of a bundle of hoses **70** which terminate at a hose clamp **71** which is secured by an arm **72** to the top of the blowout preventer **29** or the bottom of the flexible joint **30**. The individual hydraulic conduit or hoses **73** extend downwardly to a central distribution panel **74** from which point they may run to the various hydraulically-actuatable components of the drilling wellhead assembly. This bundle of hydraulic pressure hoses runs up alongside the entire marine conductor pipe assembly and is secured to a support arm **75** (FIGURE 3) which in turn is supported from the vessel by means of a cable or suspension line **76**. The upper end of the bundle of hoses or hydraulic conduit **70** may pass through a curved protective pipe **77** before they bend up again to the vessel.

One form of a quick disconnect coupling for use at the lower end of the auxiliary lines **39** and **40** (FIGURE 2B) is shown in FIGURE 6 as comprising a housing **78** in which auxiliary pipe **40** can be stabbed. The pipe **48** is provided with seals **79** and **80** above and below discharge ports **81** in the side wall of the pipe and annular passage **82** is provided in the housing **78** and around the ports **81** with a discharge of fluid passing port **83** and thence downwardly to the flexible line **40***a* (FIGURE 2B). The lower end of the pipe **40** (FIGURE 6) is closed by a plug **84** adapted to seat on shoulder **85** within the housing **78**. A second shoulder **86** is provided on the lower end of the housing **78** and is adapted to be engaged by spring-type latching fingers **87**. The upper beveled surface **88** of the latching finger **87** is flatter than the beveled surface **89** thereof thus allowing the latching device to be stabbed and locked in place with only a 500 pound pressure while, say, a 2000 pound pull is needed to pull it out of its latched position.

Referring to FIGURE 7 of the drawing, one form of a coupling and sealing apparatus **31** is illustrated as comprising a body member **31** having a vertical axial bore **90** of a size sufficient to receive therein an upwardly-extending tubular mandrel which is fixedly secured to the upper end of the flexible joint **30** in the marine conductor pipe assembly. It is to be understood that the mandrel **91** may be bolted at its lower end to the upper end of the flexible joint **30** while the upper end of the coupling housing **31** is bolted to the lower end of the section of the coupling **41**. For ease of illustration the connecting bolts have been omitted. The outer surface of the mandrel **91** is provided with a latching groove or a series of latching recesses **92** adapted to receive the latching members **93** of the several latches carried by the coupling housing **31**.

One form of latch is shown in FIGURE 7 as being spring actuated by a compression spring **94** which normally urges the latch **93** into the groove **92**. A hydraulic line **95** is provided whereby a hydraulic fluid may be pumped into the latch device **61** to act against the piston **96** therein and move the latch member **93** out of the groove **92** into an inoperative position. Suitable retractable locking dogs **97** are carried on the shaft **98** and arranged to move outwardly and prevent the latch member **93** from being re-engaged in the groove **92** by the compression spring **94**. Thus, once the latch member **93** has been disengaged from the groove **92** it can not re-engage the groove **92** until the apparatus has been returned to the surface and reset in a latching position.

The outer surface of the mandrel **91** is also preferably provided with a seating shoulder **99** on which a cooperating seating surface carried by the coupling housing **31** can land. Additionally, the outer surface of the mandrel **91** is also preferably provided with a series of grooves **100** into which an expandible hydraulically-actuatable annular sealing member **101**, which is carried by the coupling housing **31**, may be expanded. As shown in FIGURE 7, the hydraulic line **95** which actuates the latch **61** to retract its latch member **93** is preferably provided with a side outlet **102** which passes through the outer wall of the coupling housing **31** and is in communication with a chamber **103** in back of the sealing member **101**. Thus, as hydraulic pressure is applied to line **95** from a control panel on the vessel **11** of the surface, the sealing member **101** is expanded inwardly and contracts around the grooved section of the mandrel **91** to form a fluidtight seal therearound and to provide a predetermined pull-off resistance of say 5000 pounds, that is, the force that is necessary to lift the coupling housing **31** off the mandrel **91** when the seal **101** is being actuated thereagainst. Simultaneously with the actuation of the seal **101** against the mandrel **91**, the latches are energized so that their latch members **93** are retracted from the latching groove **92**. If desired, individual actuating hydraulic pressure lines may be used.

Drilling operations are then carried out in the underwater well with the coupling and sealing apparatus **31** arranged in this manner, that is, with the seal activated and the latches retracted so that in an emergency the marine conductor pipe assembly can be readily pulled off the mandrel **91** at the top of the drilling wellhead assembly even though the hydraulic pressure line is plugged so that the seal cannot be de-activated. By employing this arrangement there is no danger of the latching mechanism **61**, **62** and **63** sticking or freezing in the latching groove **92** for any of several reasons. In the event that a well is being drilled for several weeks, say in Alaskan waters, there is always a possibility of the hydraulic lines **95** becoming plugged, frozen or damaged so that the latch member **93** could not be retracted if locking dog **97** were not provided on the latch device **61** to hold the latch in its inactive position, as illustrated. In the event that the marine conductor pipe assembly is removed from the underwater drilling wellhead assembly in an emergency, the guide lines **54** (FIGURE 7) which pass through guide blocks **103** in a slidingly engageable manner, may be utilized to align the coupling housing **31** at the lower end of the marine conductor pipe assembly with the mandrel **91** carried at the top of the drilling wellhead assembly.

Prior to withdrawing the marine pipe conductor assembly of the present invention from a drilling wellhead assembly, the auxiliary pipes **39** and **40** are withdrawn upwardly to the barge. It may be seen that by utilizing the apparatus of the present invention any of the auxiliary small-diameter pipes **39** and **40** which become plugged or otherwise damaged may be readily withdrawn to the vessel and a new one installed in place of it by forcing it down through the guide sleeves **37** and **38** (FIGURE 4).

We claim as our invention:

1. Apparatus for drilling, completing and working over an underwater well, said appaartus comprising
  operational platform means positioned above the surface of a body of water,
  a well base positioned below the surface of the water and including substantially vertical well base pipe means having a lower portion thereof fixedly anchored to the formation below said body of water and a portion extending upwardly above said formation,
  marine conductor means connectible at its lower end to the upper end of said well base pipe means with the upper end of said conductor means extending above the surface of the water in the vicinity of said operational platform means,
  buoyancy tank means secured to said marine conductor means below the surface of the water and having sufficient buoyancy to support a major portion of the weight of said marine conductor means, and
  open-ended sleeve means extending through said buoyancy tank means parallel to said marine conductor means for passing auxiliary pipe means through said buoyancy tank means,
  said marine conductor means including a large-diameter marine conductor pipe and a drilling wellhead assembly secured to the lower end thereof,

said drilling wellhead assembly comprising blowout preventer means fixedly secured to a wellhead connector means,

a disconnect coupling above said blowout preventor means which are adapted to be detachably secured to the lower end of said marine conductor pipe,

auxiliary conduit disconnect coupling means carried on the outside of said drilling wellhead assembly and in communication with the interior thereof, and

auxiliary conduit means extending through said sleeve means of said buoyancy tank means, said auxiliary conduit means being connected at the lower end to said auxiliary conduit disconnect coupling means.

2. The apparatus of claim **1** wherein said auxiliary conduit means comprise individual choke and kill pipelines and wherein said choke and kill line disconnect coupling means comprise individual stab-type couplings at the bottom of said choke and kill pipelines.

3. The apparatus of claim **1** wherein said marine conductor pipe includes a tubular mandrel extendible within said disconnect coupling above said blowout preventer means, said disconnect coupling including

a housing having a vertical bore therethrough of a diameter greater than said tubular mandrel at the lower end of said conductor pipe,

an annular resilient sealing member positioned in said bore for surrounding the tubular mandrel of said conductor pipe, and

port means through the wall of said housing at a point adjacent said sealing member for applying pressure fluid between said housing and said sealing member to force said sealing member inwardly.

4. The apparatus of claim **3** wherein said housing of said disconnect coupling is provided with laterally-movable latch means adapted to engage the outer suface of the tubular mandrel of said marine conductor pipe to prevent relative axial movement of said mandrel with respect to said housing, hydraulic operator means in engagement with said latch means for moving said latch means to an inoperative position out of engagement with said mandrel, and lock means operatively engageable with said latch means for holding said latch means in an inoperative position.

5. The apparatus of claim **4** including pressure-fluid manifold means interconnecting the pressure fluid port means through the housing wall to said sealing member with said hydraulic operator to said latch means of said disconnect coupling whereby upon application of fluid under pressure to said manifold means the sealing member is sealed as the coupling is disconnected.

References Cited

UNITED STATES PATENTS

2,476,309	7/1949	Lang	175—8
2,699,321	1/1955	Nelson	175—8
3,017,934	1/1962	Rhodes et al.	175—7
3,189,098	6/1965	Haeber	166—.6
3,202,217	8/1965	Watts et al.	166—.6

FOREIGN PATENTS

874,178	8/1961	Great Britain.

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

R. E. FAVREAU, *Assistant Examiner.*