

July 9, 1968

H. B. SCHRAMM ET AL
MEANS FOR DRILLING, COMPLETING, PRODUCING
AND TREATING SUBMARINE WELLS

3,391,735

Original Filed Nov. 4, 1957

3 Sheets-Sheet 1

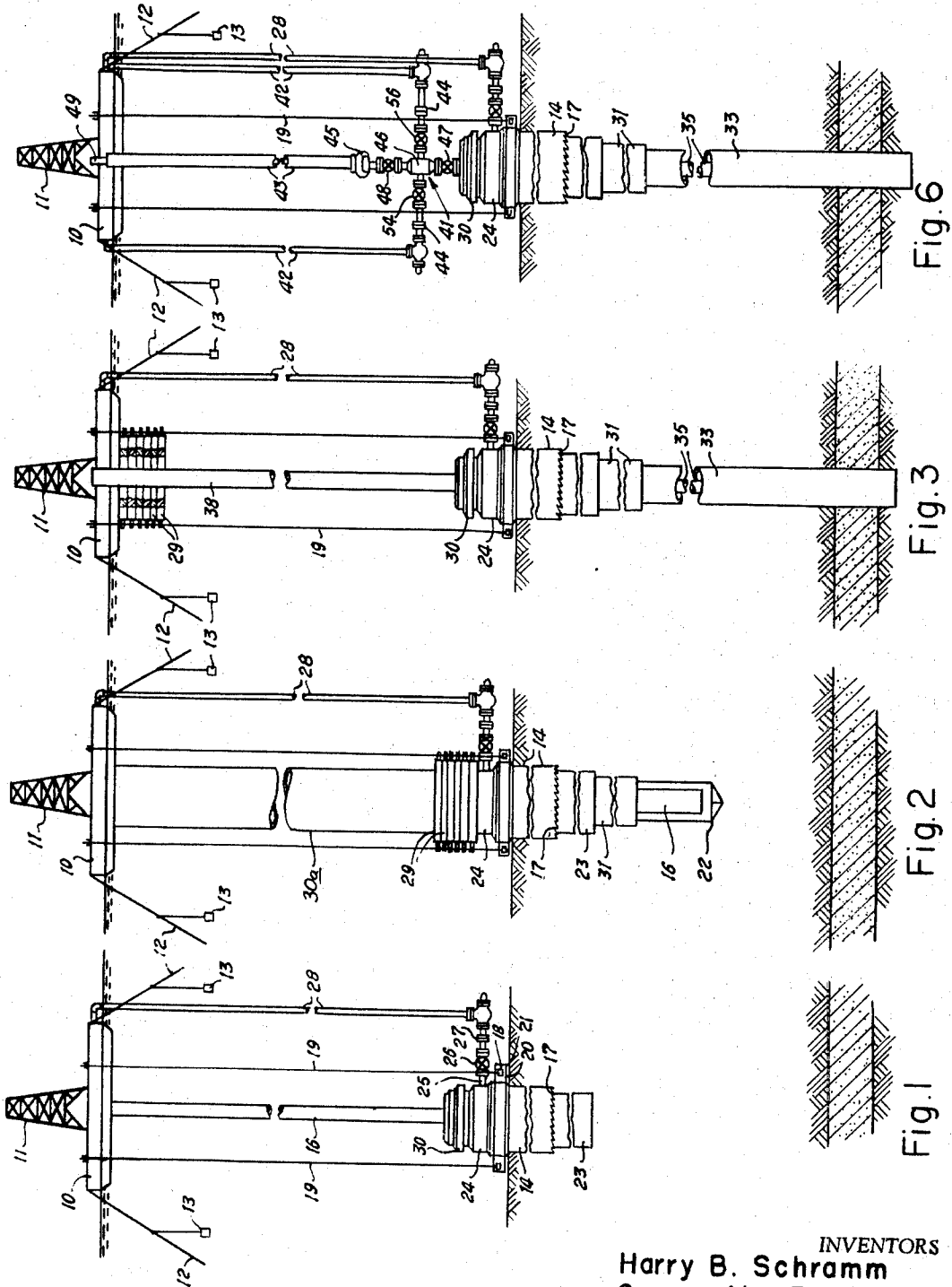


Fig. 1

Fig. 2

Fig. 3

Fig. 6

INVENTORS
Harry B. Schramm
George Max Raulins
John V. Fredd
BY *Res Hastings Ackley*
ATTORNEY

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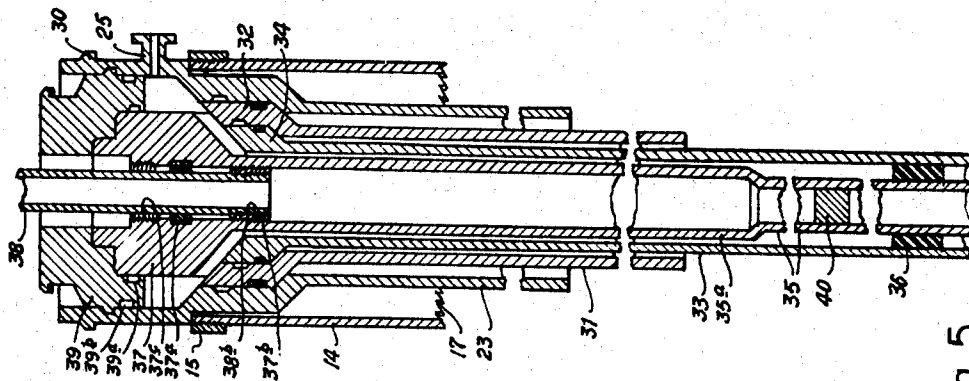


Fig. 5

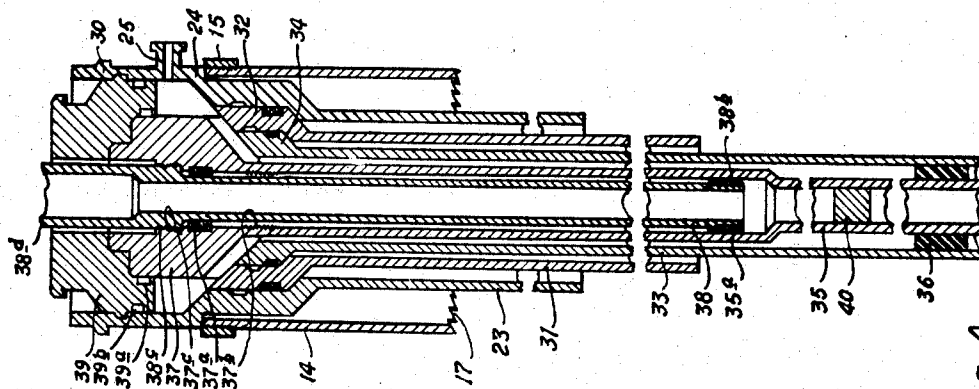


Fig. 4

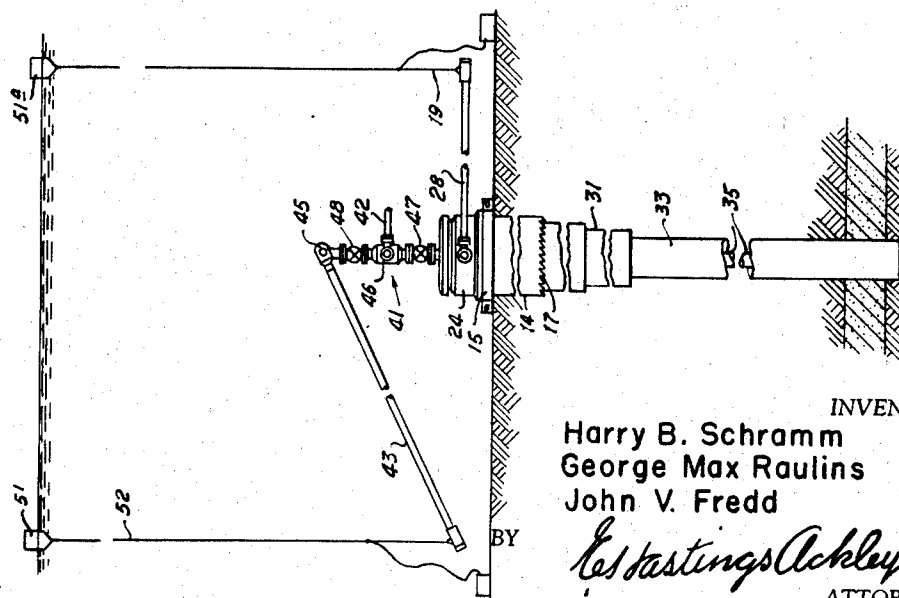


Fig. 7

INVENTORS

Harry B. Schramm
George Max Raulins
John V. Fredd

BY *Estastings Achley*
ATTORNEY

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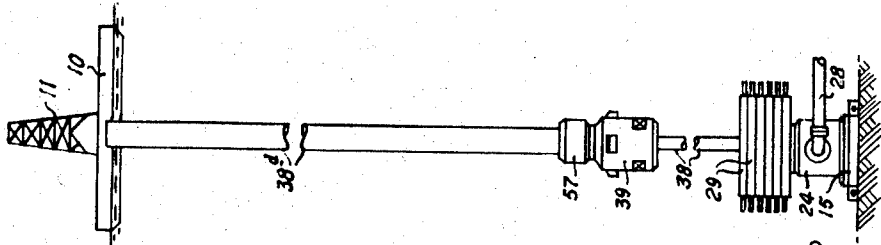


Fig. 12

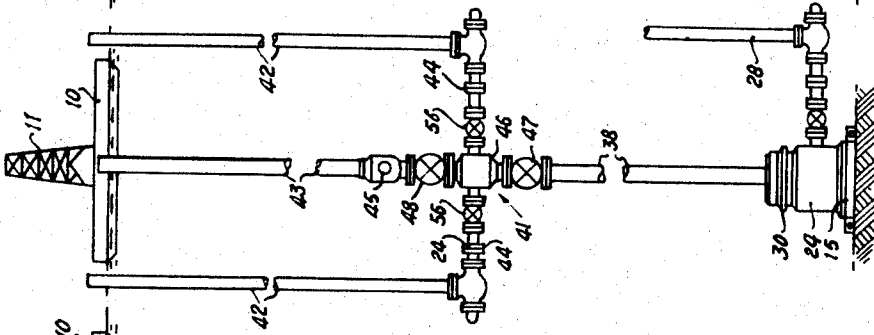


Fig. 11

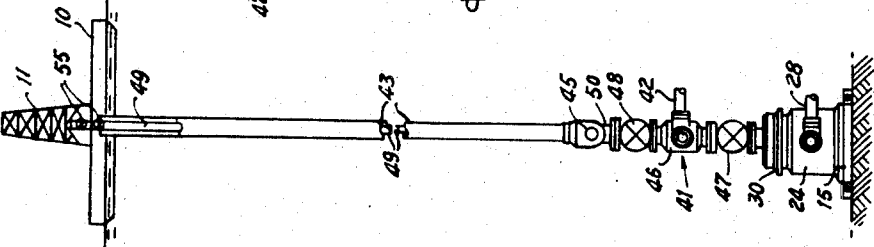


Fig. 10

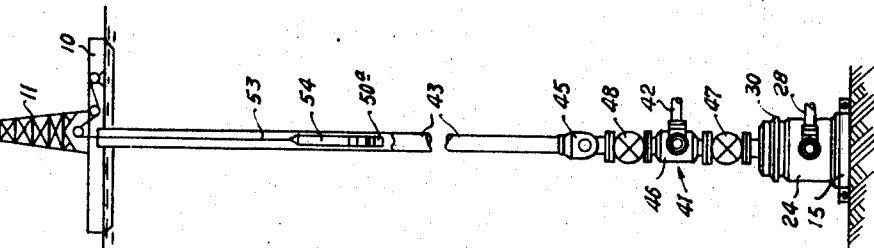


Fig. 9

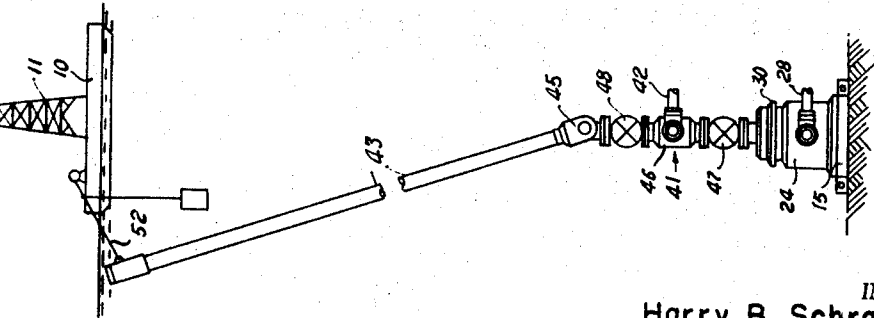


Fig. 8

INVENTORS

Harry B. Schramm
George Max Raulins
John V. Fredd

BY

Res Hastings Ackley

ATTORNEY

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3,391,735

MEANS FOR DRILLING, COMPLETING, PRODUCING AND TREATING SUBMARINE WELLS

Harry B. Schramm, deceased, late of Dallas, Tex., by Josephine Schramm, executrix, Dallas, Tex., and George Max Raulins, Houston, and John V. Fredd, Dallas, Tex., assignors to Otis Engineering Corporation, Dallas, Tex., a corporation of Delaware

Continuation of application Ser. No. 443,773, Mar. 19, 1965, which is a continuation of application Ser. No. 694,307, Nov. 4, 1957. This application Nov. 21, 1966, Ser. No. 601,276

12 Claims. (Cl. 166—.5)

ABSTRACT OF THE DISCLOSURE

A submarine well installation having a flow conductor extension movable between secured positions telescoped into the well flow conductor and extended therefrom to the surface of the water, and means closing off well pressure and flow to said extension during movement thereof between such positions.

This invention relates to a means for drilling, completing, producing and treating submarine wells. This application is a continuation of our co-pending application, Ser. No. 443,773, filed Mar. 19, 1965, which was a continuation of our earlier application, Ser. No. 694,307, filed Nov. 4, 1957, both now abandoned.

In the drilling of wells in deep waters the problem exists of providing a platform for drilling the well and of establishing a wellhead for producing the well, as well as of conducting remedial or treating operations on the well. In shallow waters, the drilling may be done from a fixed or movable platform, tower or similar structure erected on the floor of the body of water, and the wellhead is generally established at the surface of the water on a permanent platform erected on the floor of the body of water. In waters of depth greater than 100 feet, it is impractical to utilize a drilling platform supported by the floor of the body of water, and it is similarly impractical to provide such a platform to establish the wellhead at the surface of the water. In addition, such a platform for the wellhead and the wellhead itself are subject to damage by heavy seas and by surface shipping.

One object of this invention is to provide a means for drilling and completing a submarine well from a floating drilling barge or vessel anchored at the drilling site, the wellhead of the completed well being located at the floor of the body of water.

Another object of the invention is to provide a means for establishing a connection from the submerged wellhead to the water surface after completion of the well for subsequent reworking or remedial operations.

A further object of the invention is to provide a means for raising the wellhead fittings or Christmas tree from submerged position on the wellhead to the water surface for repair operations or alterations to the Christmas tree.

The invention is therefore directed to a submarine well installation having a flow conductor extension telescoped in the upper end of the well tubing string or flow conductor and extensible to the surface of the water to provide access to the flow conductor in the well from the surface. A closure plug is removably insertable through the extension into the flow conductor to be secured therein below the extension to close off well pressure and flow of fluids to the extension while it is moved between telescoped and extended positions. Seal means seals between the extension and the upper end of the flow conductor in telescoped and extended positions, and means is provided

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for releasably securing the extension to the upper end of the flow conductor in both such positions.

Additional objects and advantages of the invention will readily be apparent from the reading of the following description of the method of the invention and of apparatus for carrying out the same, and reference to the accompanying drawings thereof, wherein:

FIGURE 1 is a schematic view showing a drilling barge anchored in place over a submarine well and showing the conductor pipe set and with the surface pipe with wellhead connections being installed;

FIGURE 2 is a view, similar to FIGURE 1, showing the blowout preventers set in place on the wellhead, the surface pipe and the intermediate casing string set, and the hole being drilled for the production casing string;

FIGURE 3 is a view, similar to FIGURE 2, but showing the production casing string set, the tubing string installed and the telescoping portion thereof retracted or collapsed, and the blowout preventers being removed from the well;

FIGURE 4 is an enlarged schematic sectional view of the well showing the method of installing the tubing and casing strings, and with the tubing extension retracted or collapsed;

FIGURE 5 is a view, similar to FIGURE 4, showing the tubing extension connected in extended position;

FIGURE 6 is a view, similar to FIGURE 3, but showing the tubing control fittings installed on the tubing extension and lowered into place on the wellhead, and a lubricator guide and a lubricator installed on the tubing control fittings extending to the drilling barge;

FIGURE 7 is a view, similar to FIGURE 6, but showing the lubricator removed from the lubricator guide and the lubricator guide and the several flow lines laid down on the bottom of the body of water, the barge having been removed;

FIGURE 8 is a schematic view showing the workover barge in place over the well and lubricator guide being raised to a vertical position by means of the attached cable;

FIGURE 9 is a view, similar to FIGURE 8, showing the shielding plug being removed from the lubricator guide;

FIGURE 10 is a view, similar to FIGURE 9, showing the lubricator installed in the lubricator guide;

FIGURE 11 is a view, similar to FIGURE 9, showing the Christmas tree being raised to the barge;

FIGURE 12 is a view, similar to FIGURE 9, showing the blowout preventers in place on the wellhead and the tubing hold-down being removed from the well.

Referring now to the drawings, particularly to FIGURES 1 through 7, a barge 10 having a drilling tower 11 mounted thereon is shown anchored in place at the well site by means of the cables 12 attached to weights, hooks or anchors (not shown) and provided with suspended stabilizing weights 13 to assist in maintaining the barge in a relatively stationary position.

The drilling operation may be conducted in any manner desirable, such as by cable tool drilling, turbine drilling, rotary drilling, and the like; but it is preferable that the drilling be done using rotary or turbine methods.

A conductor pipe 14 of relatively large diameter is drilled into the earth at the bottom of the body of water, the conductor pipe being provided with a fitting 15 at its upper end (FIGURE 4) for releasably securing thereto the drill pipe 16. The fitting permits the transmittal of the torque necessary for drilling, so that rotation of the drill pipe causes rotation of the conductor pipe. The lower end of the conductor pipe is provided with cutting teeth 17 so that the pipe itself acts as a drill to cut its way into the floor of the body of water or ocean. A drilling fluid

such as water or mud can be pumped downwardly through the drill pipe and the conductor pipe to force the solid matter cut by the conductor pipe outwardly and upwardly around the conductor pipe, if desired. When the conductor pipe has been drilled in to the desired depth, such that the fitting 15 is at or near the level of the ocean floor, cement is pumped downwardly through and upwardly and around the conductor pipe to firmly secure the conductor pipe in the drilled hole.

Before the drill pipe 16 is released from the conductor pipe fitting, a guide cable anchor 18 is lowered by means of its attached guide cables 19 around the drill pipe and is secured to the fitting 15 on the conductor pipe. The cable anchor may be installed over the upper end of the drill pipe, or it may be hinged to be lowered over the side of the drilling barge and latched or secured around the drill pipe. The upper ends of the guide cables of the anchor are retained on the barge, the guide cables serving to guide subsequent tools and equipment downwardly to the well. The cable anchor may be secured to an external flange 20 on the conductor pipe fitting by means of spring actuated latches 21 or by any other suitable means.

The drill pipe 16 is releasably connected to the fitting 15 at the upper end of the conductor pipe 14, the connection between the fitting and the drill pipe being of any well known type, such as a low-friction square thread. With such a connection, when the drill pipe is rotated in a direction opposite to that used in drilling, the low-friction threads release to allow removal of the drill pipe. The drill pipe is released or disconnected from the conductor pipe after it is cemented in the drilled hole and the guide cable anchor is secured to the fitting 15.

A drill bit 22 is then installed on the lower end of the drill pipe 16, and the drill pipe is inserted in the conductor pipe and the well hole drilled to the depth desired for the surface casing, a drilling fluid such as water being circulated downwardly through the drill pipe and the drill bit to wash the cuttings upwardly from the drilled hole to the ocean floor.

The drill pipe and drill bit are removed from the well after the hole has been drilled to the desired depth for surface casing, and the surface casing 23 is then lowered into the drilled hole. A casing head fitting or bowl 24 is attached to the upper end of the string of surface casing and is lowered with the surface casing until the casing head is slightly above the upper end of the conductor pipe 14. Before the casing head fitting is permanently installed on the fitting 15 on the conductor pipe, the string of surface casing is cemented in place by pumping cement downwardly through and upwardly around the surface casing. The surface casing string and the casing head fitting 24 are then lowered until the casing head engages the fitting 15 on the conductor pipe. The surface casing is now permanently secured in the well by the cement.

A lateral pipe or casing flow wing 25 leads from the casing head fitting and is provided with a suitable remotely controlled valve 26. A swivel joint 27 is attached to the outer end of the valve, and a casing flow line 28 extends through suitable fittings from the swivel to the barge. The swivel joint may be of any suitable type such that its outer end is freely rotatable relative to its inner end about its longitudinal axis.

Suitable blowout preventers 29 are assembled together on the barge and are lowered into place, being guided by means of the guide cables 19 to the casing head fitting for further drilling. The lowermost blowout preventer includes a latching mechanism, which may be similar to that shown in the patent to H. C. Otis, 2,212,036, issued Aug. 20, 1940, to releasably engage an external annular flange 30 on the casing head fitting. The blowout preventers are of a size to pass the largest drilling bit to be used, and they are of a pressure rating to withstand the highest pressure expected to be encountered in the well. A sufficient number of preventers is used with ram openings to close off around the various sizes of drill pipe and well

pipe to be used and also to completely close off the well bore when no pipe is in said bore. Manifestly, the blowout preventers are remotely controlled, the electrical cables or hydraulic hoses (not shown) for such control extending upwardly to the drilling barge. The blowout preventers may be similar to those of Cameron Iron Works, Inc., shown on p. 1072 of the Composite Catalog of Oil Field and Pipeline Equipment, 1952-53 edition, or of Hydril Corp., shown on p. 2578 of the same publication.

The latching mechanism of the lowermost blowout preventer may be of any well known type and may include a plurality of plungers or latches which are urged by means of springs into engagement with the flange of the casing head fitting 24. The plungers extend resiliently inwardly from the inner surface of a bowl which fits closely and with sealing engagement over the casing head fitting and the plungers are retractable by the application of hydraulic pressure thereto through a suitable control line, or hose. Such plungers or latches may be similar to those shown in the H. C. Otis Patent No. 2,212,036.

A conductor tube 30a (FIGURE 2) extends from the upper blowout preventer to the barge to provide for a return flow of the drilling fluid to be used in further drilling. Such a conductor tube includes sufficient flexible and extensible joint means (not shown) to accommodate vertical and lateral movement of the drilling barge, due to wave action or any looseness in the anchoring means for the barge. The flexible and extensible joint means may be similar to those shown in the J. M. McNeill Patent No. Re 24,083.

Alternatively, a rotating packer or seal member (not shown) may be provided atop the uppermost blowout preventer for sealing around the drill pipe. Such rotating packer seals off the annular space around the drill pipe and within the casing and is provided with a flexible mud return hose leading to the drilling barge. The rotating packer may be similar to that shown in the H. C. Otis Patent No. 2,176,355.

The string of drill pipe 16 is again lowered into and through the open blowout preventers, and drilling is conducted in the conventional manner for the string of intermediate casing 31. With rotary or turbine drilling methods, the drilling fluid is pumped downwardly through the drill pipe and the drill bit and thence upwardly through the drilled hole around the drilling string, through the blowout preventers, and through the mud return conductor tube or hose. Obviously, if the mud return hose is used, the rotating packer atop the blowout preventers is closed to make sealing contact with the drill pipe.

When the drilling has progressed to the depth required for the intermediate casing string, the intermediate casing string 31 is lowered into the drilled hole, a casing hanger 32 (FIGURE 4) being installed atop the upper end of the intermediate casing string to support and lock the intermediate casing string in the casing head fitting 24 of the surface casing. Such a casing hanger may be similar to that shown in our co-pending patent application, Ser. No. 694,204 filed Nov. 4, 1957. Before the casing hanger 32 is completely lowered into and locked in position in the casing head, cement is pumped downwardly through the intermediate casing string 31 and upwardly through the drilled hole, the fluid displaced flowing upwardly through the casing head 24 and thence back to the drilling barge through the mud return conductor or hose. Alternatively, the hanger of our co-pending application, Ser. No. 694,204 may be caused to seal with the casing head 24 above the flow wing 25, whereupon the valve 26 on the flow wing may be opened and the displaced fluid returned through the flow line.

When the cement has been circulated into place, the intermediate casing string is fully lowered and the hanger locked to hold the string in position. The running tool by which the hanger 32 is installed in the casing head, for example, that shown in our co-pending application, Ser.

No. 694,204, is then removed upwardly from the well, the blowout preventers being closed as necessary to prevent the intrusion of sea water.

Drilling is conducted in the same manner for additional smaller intermediate casing strings and/or for the string of production casing 33. The smaller strings of intermediate and/or production casing are suspended and secured in position in the well by hangers 34 similar to that shown in our said co-pending application, Ser. No. 694,204, the hangers for each of the smaller casing strings being locked in and to the hanger for the next larger casing string. The succeeding strings of casing are cemented in place in the same manner as that described with the intermediate casing string.

The tubing string 35 for the well is provided with an enlarged upper portion 35a and is installed in substantially the conventional manner. That is, a packer 36 to seal between the lower part of the tubing 35 and the production casing 33 is first installed in the casing and the tubing is then lowered into the well and installed in the packer, the upper end of the tubing being supported in place by means of a tubing hanger 37 such as that shown in our co-pending application, Ser. No. 694,203, filed Nov. 4, 1957. The tubing hanger 37 is supported by its engagement with the upwardly facing shoulder provided by the upper ends 24a of the fitting 24, 32a of the casing hanger 32 and 34a of the casing hanger 34.

The upper end of the tubing string is provided with a telescoping tubing extension 38 which may be similar to that shown in our co-pending application Ser. No. 694,203. The tubing extension is of a length such that, when extended, it reaches to the drilling barge; but it is capable of being collapsed or retracted into the upper part of the tubing string. Sealing means 37a are provided in the tubing hanger to seal between the tubing extension 38 and the tubing string so that no leakage will occur therebetween when the extension is extended or collapsed. The extension is provided with threads 38b and 38c on its lower and upper ends, respectively, for engagement with the corresponding threads 37b and 37c in the hanger to secure the extension in the extended and in the telescoped or collapsed positions, the thread 38b projecting outwardly of the outer surface of the extension 38 and the thread 37b extending inwardly of the inner surface of the extension hanger.

A hold-down 39 for the tubing hanger retains the tubing hanger in position in the well, and is provided with the sealing means 39a and 39b to seal with the tubing hanger 37 and the casing head fitting 24, respectively. The hold-down is releasably attached to a hold-down running tool (not shown), and the running tool is attached to the upper end of the telescoping tubing extension. The tubing extension is then collapsed or telescoped into the upper part of the tubing, the hold-down being lowered with the extension into position on the wellhead. Manifestly, as the tubing extension is lowered into the tubing string, additional tubing extension sections 38d are attached to extend the tubing string to the drilling barge. The hold-down running tool is operated to install the hold-down in position in the casing head to secure the tubing hanger in place. A plug 40 of any well known type may be lowered into and installed in the tubing string at a point below the tubing extension as a safety precaution prior to the removal of the blowout preventers.

The blowout preventers may be removed after the tubing string has been installed in the well without danger of a blowout, even if the production casing has been perforated. Accordingly, the blowout preventers are released from the casing head by the proper application of pressure through the control line (not shown) and are removed upwardly from the well and from the upper end of the tubing string extending above the production casing 33.

With the blowout preventers removed, the hold-down running tool is released from the hold-down, the tubing

extension 38 is raised to the drilling barge, and the additional tubing sections 38d previously installed atop the extension and the running tool are removed.

The tubing flow control valve means or Christmas tree 41 is assembled on the barge and is installed on the upper end of the tubing extension the tubing flow wings 42 and a lubricator guide or tubular member 43 being attached to the Christmas tree fittings. The valves of the Christmas tree are remotely operated in a manner similar to the valve of the casing flow wing 25 and the tubing flow wings are provided with swivels 44 similar to the swivel 27 on the casing flow wing so that the flow lines may be swung from a vertical position extending from the tree 41 to the barge to a more or less horizontal position lying along the ocean floor.

The lubricator guide 43 extends upwardly from the center of the Christmas tree and is provided with a swivel 45 so that it, too, may be lowered from a vertical position to a position along the ocean floor. The lubricator guide has a provision for installing therein a lubricator or imperforate pipe 49 when the guide is in a vertical position, in order to establish a fluid connection from the barge to the tubing of the well when the Christmas tree is in position on the well. The lubricator guide and the lubricator may be similar to those shown in our co-pending application, Ser. No. 694,190.

The Christmas tree, instead of being equipped with a conventional cross fitting for the lateral tubing flow wings, is provided with a swivel type cross fitting 46 whereby the tubing extension to which it is attached may be rotated without rotating the tubing flow wings 42. Thus any rotational movement of the tubing extension in extending or retracting said extension may be accomplished without rotation of the flow wings.

The Christmas tree includes, below the cross fitting 46, a lower valve 47 by which the well may be completely closed in; and an upper valve 48 above the cross fitting provides a closure from the well to the lubricator guide. The control lines or hoses of the remotely controlled lower valve 47 are of a length sufficient to allow for the necessary rotation of the tubing extension and the lower valve relative to the flow wings 42 without fouling or parting the control lines.

The tubing extension with the attached Christmas tree is then lowered into place, the flow wings 42 and the lubricator guide 43 being provided with sufficient sections of pipe to extend to the barge as the Christmas tree is lowered. The control lines for the various valves are paid out with the pipe sections, and the control lines may be clamped to the flow lines and the lubricator guide as appropriate in order to prevent their being fouled with projections or obstructions. As the Christmas tree is lowered into place, the locking mechanism of the tubing extension engages the tubing hanger to lock the extension in the retracted or collapsed position. The Christmas tree, being attached to the tubing extension, is thus secured in place on the well head. The operation of the locking mechanism of the tubing extension is more fully described and shown in our co-pending application, Ser. No. 694,203.

With the lubricator guide in the vertical position, the lubricator 49 is installed therein (or the lubricator may be installed in the lubricator guide swivel while the Christmas tree is at the barge, the sections of the lubricator and the lubricator guide being attached as the Christmas tree is lowered to the well head). The lubricator 49 is provided with low-friction threads on its lower end to freely engage corresponding threads in the lower part 50 of the swivel 45 of the lubricator guide 43, and a seal means (not shown) on the lubricator 49 seals with the lower part of the swivel. The tubing plug 40 previously installed is then removed through the lubricator by means of a flexible line using standard flexible line methods, and the well is completed and brought in.

If the well has previously been perforated, it is neces-

sary only to bring the well in in the customary manner, such as by swabbing, the swabbing operations being conducted through the lubricator. If the well has not been perforated, a customary gun perforator (not shown) is lowered through the lubricator and the tubing by means of a flexible line, and the production casing string 33 is perforated at the appropriate level. The well is then brought in in the usual manner.

With the well brought in, the remotely controlled upper valve 48 above the cross of the Christmas tree is closed and the lubricator is unthreaded from and removed from the lubricator guide. A shielding plug 50a (FIGURE 9) is lowered by means of a flexible line and installed in the lubricator guide 43 below the swivel, in order to protect the sealing surfaces and threads in which the lower end of the lubricator seals and locks. With the lubricator removed and the plug installed, the upper end of the lubricator guide is swung downwardly, the guide pivoting at the swivel, until the lubricator guide rests along the ocean floor. A buoy 51 is preferably attached by a cable 52 to the end of the lubricator guide so that the well can be easily relocated and the lubricator guide raised at a future time.

The flow lines from the casing wing and from the tubing wings are similarly laid down onto the ocean floor, sufficient lengths of pipe being added to said flow lines to extend to a tank platform or to any other desired point. Obviously, the several flow lines may be equipped with suitable flexible or articulated sections to provide the flexibility necessary to conform to the ocean floor.

The control lines for the valves of the well may be extended with the flow lines to the tank platform or to some other remote location, or they may be extended to a buoy such as that for the lubricator guide so that the valves at the well head may be operated from the water surface.

The cables 19 of the cable guide may be attached to a buoy 51a at the surface, or they may be attached to the lubricator guide before lowering the guide so that the cables may be subsequently retrieved.

As an alternative, the lowermost valve or fitting incorporated in the Christmas tree may be provided with a swiveled connection (not shown) for attaching the tree to the upper end of the tubing extension so the tubing extension may be rotated relative to the Christmas tree. In such an alternative installation, a conventional cross is used in the Christmas tree; and it is unnecessary to provide surplus control line for the tubing valves below the cross, as the valves do not rotate relative to the flow wings and flow lines.

With such an installation, the tubing extension is rotated as necessary for release from its extended or retracted position in the tubing hanger 37 by means of a rotator bar (not shown) inserted through the lubricator guide and the swivel to engage in the upper end of the tubing extension.

Referring now particularly to FIGURES 8 through 12 of the drawings, when it is desired to conduct workover or remedial operations on the submarine well, a barge carrying the necessary workover equipment is maneuvered into place and anchored in position. The free end of the lubricator guide 43 is raised by means of the attached buoyed cable 52 until the guide is in a vertical position, and the shielding plug 50a is removed from the lower part of the lubricator guide swivel by means of a flexible line 53 and a customary retrieving tool 54.

The lubricator 49 is installed in the lubricator guide and suitable valves 55 are installed atop the lubricator, so that the pressure within the well may be completely controlled and so that the desired operations may be conducted on the well. With the lubricator valves closed, the upper and lower valves 48 and 47 of the Christmas tree may be opened by means of the remote control operating mechanism, any pressure exerted within the well

being retained by the lubricator 49 and the lubricator valves 55.

With the tubing valves opened, any of the operations customarily performed on wells through the tubing can be conducted through the lubricator and the tubing. Obviously, the valves 56 of the flow wings 42 can be closed by means of the remote control apparatus to shut the well in and facilitate the lowering of the various well tools into the well. The operations can be carried on by means of a flexible line operating mechanism or any other suitable means.

When the remedial operations are completed, the upper valve 48 of the Christmas tree is closed and the lubricator is removed from the lubricator guide. The shielding plug 50a is reinstalled in the lower part 50 of the swivel of the lubricator guide, and the lubricator guide is then lowered by means of the cable attached thereto until the guide lies along the ocean floor. The flow line valves of the well are reopened by means of the remote control apparatus to again allow the well to flow.

If it is necessary to remove the Christmas tree for repairs or alterations, the well is shut in, the lubricator is reinstalled in the lubricator guide and the flow lines from the tubing flow wings 42 are elevated by means of the swivels 44 to the barge (FIGURE 4).

The plug 40 is then lowered into the tubing 35 through the lubricator and is reinstalled in the tubing below the lower end of the telescoping tubing extension. The lubricator is then removed from the lubricator guide, and the telescoping extension is released for upward movement in the manner previously described. The Christmas tree and the telescoping extension are raised to the barge, sections of the pipes making up the flow lines and the lubricator guide being removed as desired to facilitate handling. The telescoping extension is preferably raised to the fully extended position, the extension locking in extended position. With the Christmas tree at the barge, any desired repairs or modifications can be made to the elements of the tree, including the remotely controlled valves and the several swivels.

When the repairs to the tree have been completed, the telescoping extension is released from its upper locked position and the extension and the Christmas tree are lowered into position on the wellhead, the necessary sections of pipe being added to the lubricator guide and to the flow lines. The telescoping extension is then again locked in its retracted or collapsed position, the Christmas tree thus being secured in position on the wellhead. The tubing plug 40 is removed, the flow lines and the lubricator guide are again laid down to positions along the ocean floor, and the well is again opened for flow.

When it is necessary to remove the tubing from the well, the lubricator is installed in the lubricator guide, and a perforation is made in any well known manner through the tubing wall above the lower packer 36. Weighted drilling mud is circulated into the well through the tubing and into the annular space surrounding the tubing within the production casing 33. If desired, a circulating valve (not shown) allowing downward flow therethrough, but preventing upward flow, may be installed in the tubing to complete the protection against blowouts while the well is being loaded with weighted fluid. The telescoping extension 38 is extended and the Christmas tree is removed, whereupon the necessary blow-out preventers are installed over the telescoping extension and are lowered into and locked in place on the casing head (FIGURE 12).

A suitable pulling tool 57 for the tubing hold-down 39 is installed on the upper end of the telescoping tubing extension, and the extension is retracted or collapsed into the tubing to engage the pulling tool with the hold-down. The hold-down is then removed by an upward pull exerted through the telescoping tubing extension and the pulling tool. The removal of the tubing hold-down is

more fully described in our co-pending application, Ser. No. 694,203.

When the telescoping tubing extension is fully extended, an upward pull on the extension causes the tubing hanger and the tubing to be elevated in the well; whereupon the tubing can be removed from the well. The removal of the tubing hanger is likewise more fully described in our co-pending application, Ser. No. 694,203.

The blowout preventers are opened and closed around the various pipes and equipment as they pass through the preventers and as the tubing is removed from the well to prevent any pressure in the well from blowing from the upper end of the well. When the tubing has been removed from the well, the blowout preventers are operated to completely close in the well.

The tubing is reinstalled in the manner previously described, the guide cables attached to the cable anchor being utilized to guide the lower end of the tubing into the well.

With the tubing removed, any other necessary operations, such as the removal of the lower packer 36 or drilling to a greater depth, can be conducted on the well.

Obviously, if desired, the tubing could be removed from the well without filling or loading the well with mud or a weighted fluid, the blowout preventers being closed around the tubing as it is lifted from the well. Such a method of removing tubing under pressure is shown in the H. C. Otis Patent No. Re. 19,498.

It will now be seen that a new and improved method has been shown and described for drilling, completing, producing and treating a submarine well in deep water such as an ocean or sea.

It will be seen that a method is provided for drilling a submarine well from a floating barge or vessel and for installing the necessary casing string in said well. It will be seen that, after the surface pipe or casing has been set in place, all subsequent operations are conducted with complete protection against blowouts. It will be seen that the wellhead of the well is located on the ocean floor where it is safe against damage by seas or shipping.

It will be seen that a method is provided for installing a tubing string in the well and for sealing and locking the tubing string in the well. It will be seen that a method is provided for installing a tubing flow control valve means or a Christmas tree on the well for controlling the flow through the tubing.

It will also be seen that a method is provided for establishing a fluid connection from the Christmas tree to the barge when the Christmas tree is installed on the well.

It will further be seen that a method is provided to lower the various flow lines and control lines to the ocean floor and for controlling from the water surface the flow through the flow lines.

It will be seen that a method is provided for re-establishing a fluid connection between the water surface and the tubing of the well so that all the operations which are customarily performed through the tubing of a well may be performed on the well.

It will be seen that a method is provided for removing the Christmas tree for repairs or alterations and for re-installing the tree on the well.

It will additionally be seen that a method is provided for removing the tubing from the well and for re-installing the same in the well.

It will also be seen that a new and improved means for drilling and completing a well from a floating vessel has been illustrated and described which includes a Christmas tree which is mounted on a telescoping tubing extension 38 of a well, whereby the Christmas tree may be brought to the surface for remedial operations.

It will be further seen that the Christmas tree is provided with a lubricator guide 43 pivotally connected to the Christmas tree, whereby the lubricator guide may be lowered to a position adjacent the floor of the body of water beneath which the well is located and thus requires no fixed platform, the lubricator guide being pivotable

to a vertical position wherein its upper end extends above the water when it is desired to treat the well.

It will also be seen that the flow wings 42 of the Christmas tree are pivotally or rotatably connected to the tree whereby the flow wings may be positioned parallel to the flow of the body of water during normal flow operation of the well. It will be seen that the new method of drilling and completing a well beneath a body of water, including drilling a plurality of successively smaller well bores into a formation below a body of water, installing a conduit in each well bore prior to drilling the next smaller well bore therethrough, removably positioning blow-out preventers on the upper end of the first conduit installed in the largest well bore whereby the drilling of the other successively smaller well bores is accomplished by a drill pipe extending through the blow-out preventers, installing a tubing string in the smallest conduit, said tubing string having a telescoping section extendable to the surface of the water above the well, connecting a control means to the upper end of the telescoping section while said upper end is located above the upper surface of the body of water, and moving the telescoping section to its telescope retracted position to position control means in the water adjacent the floor of the body of water.

The foregoing description of the invention is explanatory only, and changes in the details of the method described and construction illustrated may be made by those skilled in the art, within the scope of the appended claims, without departing from the spirit of the invention.

What is claimed and desired to be secured by Letters Patent is:

1. Means for carrying out operations such as completing and producing a well having a well flow conductor pipe, said means including: an extension pipe telescopically disposed in said conductor pipe and movable longitudinally therein so as to be retracted therein and extensible therefrom a substantial distance to a point remote from the upper end of the conductor to provide an extension of the conductor from the upper end thereof to such remote point; means sealing between said conductor and said extension when said extension is extended and retracted; flow closure means releasably securable in said well flow conductor pipe below the lower end of said extension pipe when said extension is in retracted position within said conductor pipe for closing off flow from said conductor pipe to said extension pipe, whereby said extension pipe is movable longitudinally with respect to said conductor pipe between extended and retracted positions with the well fluid pressure closed off from access thereto during such movement; means on the upper end of said conductor and means on the upper end of said extension engageable with each other for releasably securing said extension in telescoped position in said conductor; means on the lower end of said extension and means on the upper end of said conductor engageable with each other for releasably securing said extension in extended position; and flow control valve means on the upper end of said extension for controlling flow there-through, said valve means being disposed adjacent the upper end of said conductor when said extension is retracted and being spaced a substantial distance from said conductor when said extension is extended.

2. Means for carrying out operations such as completing and producing a well having a well conductor therein of the character set forth in claim 1, and including: guide means on the upper end of said extension adapted to receive a lubricator pipe to be connected to said extension to form an upward continuation of said extension communicating with said extension pipe and said conductor.

3. Means for carrying out operations such as completing and producing a well having a flow conductor pipe of the character set forth in claim 1, and including: stop means on the lower end of said extension limiting its upward travel.

4. Means for carrying out operations such as completing and producing a well having a well flow conductor

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pipe, said means including: an extension pipe telescopically disposed in said conductor pipe and movable longitudinally therein so as to be retracted therein and extendible therefrom a substantial distance to a point remote from the upper end of the conductor to provide an extension of the conductor from the upper end thereof to such remote point; means sealing between said conductor and said extension when said extension is extended and retracted; flow closure means releasably securable in said conductor pipe at a point therein spaced below the lower end of said extension pipe when said extension pipe is telescoped in said conductor pipe, said flow closure means closing off flow through said conductor pipe to said extension pipe while said extension pipe is being moved between extended and retracted positions, whereby said extension pipe is movable between said extended and retracted positions in the absence of application of well fluid pressure thereto during such movement; flow control valve means on the upper end of said extension for controlling flow therethrough, said valve means being spaced a substantial distance from the upper end of said conductor when said extension is extended and being disposed adjacent the upper end of said conductor when said extension is retracted; means on said extension and means on the upper end of said conductor engageable with each other for releasably securing said extension in extended position; and means on said extension and means on the upper end of said conductor engageable with each other for releasably securing said extension in retracted position.

5. Apparatus for performing operations such as completing and producing a well located beneath a body of water and having a flow conductor therein terminating beneath the surface of the water, said apparatus including: a tubular extension conductor telescopically disposed in the upper end of said flow conductor; flow control valve means on the upper end of said extension conductor controlling flow from the flow conductor through said extension conductor and outwardly through the upper end thereof and movable with said extension conductor, said extension conductor being slidable upwardly with respect to said flow conductor to a position wherein the flow control valve means is positioned above the surface of the water and retractable to a position wherein said valve means is disposed beneath the surface of the water adjacent the upper end of said flow conductor; flow closure means insertable through said extension pipe and releasably securable in said conductor pipe at a point therein spaced below the lower end of said extension pipe when said extension pipe is telescoped in said conductor pipe, said flow closure means closing off flow through said conductor pipe to said extension pipe while said extension pipe is being moved between extended and retracted position, whereby said extension pipe is movable between said extended and retracted positions in the absence of well fluid pressure acting thereon during such movement; means operatively associated with the upper end of said flow conductor and engageable with said extension conductor for releasably securing said extension conductor in retracted and extended positions; and sealing means on said extension conductor and said flow conductor sealing therebetween to direct well fluid from said flow conductor to said extension conductor.

6. Apparatus for performing operations such as completing and producing a well located beneath a body of water and having a flow conductor therein terminating beneath the surface of the water, said apparatus including: a tubular extension telescopically disposed in the upper end of said conductor and slidable longitudinally therein between an extended position and a retracted position; plug means insertable through said extension into said conductor and securable in said conductor for releasably closing the bore of said conductor at a point therein spaced below the inner end of said extension when said extension is telescoped into said conductor to a re-

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tracted position therein to prevent flow from said conductor to said extension, whereby said extension is movable longitudinally relative to said conductor between retracted and extended positions without well fluid pressure from said conductor acting on said extension during such movement; flow control valve means on the upper end of said extension for controlling flow of fluid through said extension and movable with said extension, said flow control valve means being disposed above the surface of the water when said extension member is extended and being disposed below the surface of the water adjacent the upper end of the conductor when the extension is in retracted position; means operatively connected with the upper end of said conductor and engageable with said extension for releasably securing said extension in retracted and extended positions; and sealing means on said extension and said conductor sealing therebetween to direct well fluids from the conductor to the extension.

7. Apparatus of the character set forth in claim 6 and a tubular conductor connectable at one end with said valve means to provide a passage therefrom to the surface of the water when said extension is telescoped into said conductor and said valve means is adjacent the upper end of said conductor and below the surface of the water.

8. Apparatus of the character set forth in claim 7 and including: tubular guide means swingably connected at one end with said flow control valve means and movable to a position with respect to said valve means for guiding said tubular conductor member into position for connection with said valve means.

9. Apparatus for drilling and completing a well in a formation beneath a body of water including: casing means extending from the surface of the earth to the producing formation in the earth therebelow; a tubing string within the casing; means sealingly connecting the upper end of said casing with said tubing string; a telescoping section slidable in the upper end of said tubing string of a length sufficient to extend from the upper end of said tubing string to a point above the surface of the water when in extended position; means sealing between said tubing string and said telescoping section to direct flow of fluids from said tubing string through said telescoping section; means on the upper end of said tubing string and means on said telescoping section engageable with each other for securing said telescoping section in extended position and in telescoped position; and flow closure means insertable through said telescoping section into said tubing string and releasably securable in said tubing string spaced below the inner end of said telescoping section when said section is telescoped into said tubing string for preventing flow of fluids from said tubing string to said telescoping section, whereby said telescoping section is movable between extended and retracted positions relative to said tubing string without the application of well fluid pressure thereto during such movement.

10. Apparatus for performing operations such as completing and producing a submarine well, said apparatus including: a tubular flow conductor position in the well and having its upper end secured in sealing position within said well near the bottom of the body of water in which the well is located; an elongate tubular extension member telescopically disposed in the upper portion of said conductor and slidable therein so as to be extendible from the upper end of said conductor to an extended position with its upper end above the surface of the water and retractable into said conductor to a position in which the upper end of said extension is disposed adjacent the upper end of said conductor; closure means insertable through said extension member into said flow conductor and removably securable therein for closing the bore of said tubular flow conductor at a point below the lower end of the extension member when said extension member is telescoped in retracted position in said conductor to prevent flow of fluids from said well through said con-

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ductor to said extension member, whereby said extension member is movable longitudinally between extended and telescoped positions relative to said conductor free of application of well fluid pressure to said extension member during such movement; means on said extension and said tubular conductor sealing therebetween when said extension is telescoped into said conductor and when said extension is extended therefrom; and means on the upper end of said tubular conductor and on said extension member for restraining said extension member in each of said positions with respect to said tubular flow conductor.

11. Apparatus for performing operations such as completing and producing a submarine well of the character set forth in claim 15, wherein said means for restraining said extension member in each of said positions with respect to said tubular flow conductor includes: means on said tubular conductor and said extension member operable from a remote point at the surface of the water for releasably securing said extension member in each of said positions relative to said tubular conductor.

12. Apparatus for performing operations such as completing and producing a submarine well, said apparatus including: a tubular flow conductor positioned in the well and having its upper end secured in sealing position within said well near the bottom floor of the body of water in which the well is located; an elongate tubular extension member telescopically disposed in the upper portion of said conductor and slidable therein so as to be extensible from the upper end of said conductor to an extended position with its upper end above the surface of the water and retractable into said conductor to a position in which the upper end of said extension is disposed adjacent the upper end of said conductor; closure means insertable

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through said extension member into said conductor and releasably securable in said flow conductor for closing the bore of said conductor at a point therein spaced below the lowermost end of the extension member when said extension member is telescoped into said conductor for preventing flow of fluids from said well through said conductor to said extension member, whereby said extension member is movable between extended and telescoped positions relative to said conductor free of application of well fluid pressures to said extension member during such movement; means on said extension member and said tubular conductor sealing therebetween when said extension member is telescoped into said conductor and when said extension member is extended therefrom; means on the upper end of said tubular member and on the lower end of said extension member for latching said tubular extension in fully extended position; and means on the upper end of said tubular member and on the upper end of said extension member for latching said extension in said fully telescoped position relative to the tubular conductor.

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JAMES A. LEPPINK, *Primary Examiner.*