

Nov. 6, 1962

J. A. HAEBER

3,062,288

UNDERWATER DUAL TUBING WELL COMPLETION

Filed July 30, 1959

4 Sheets-Sheet 1

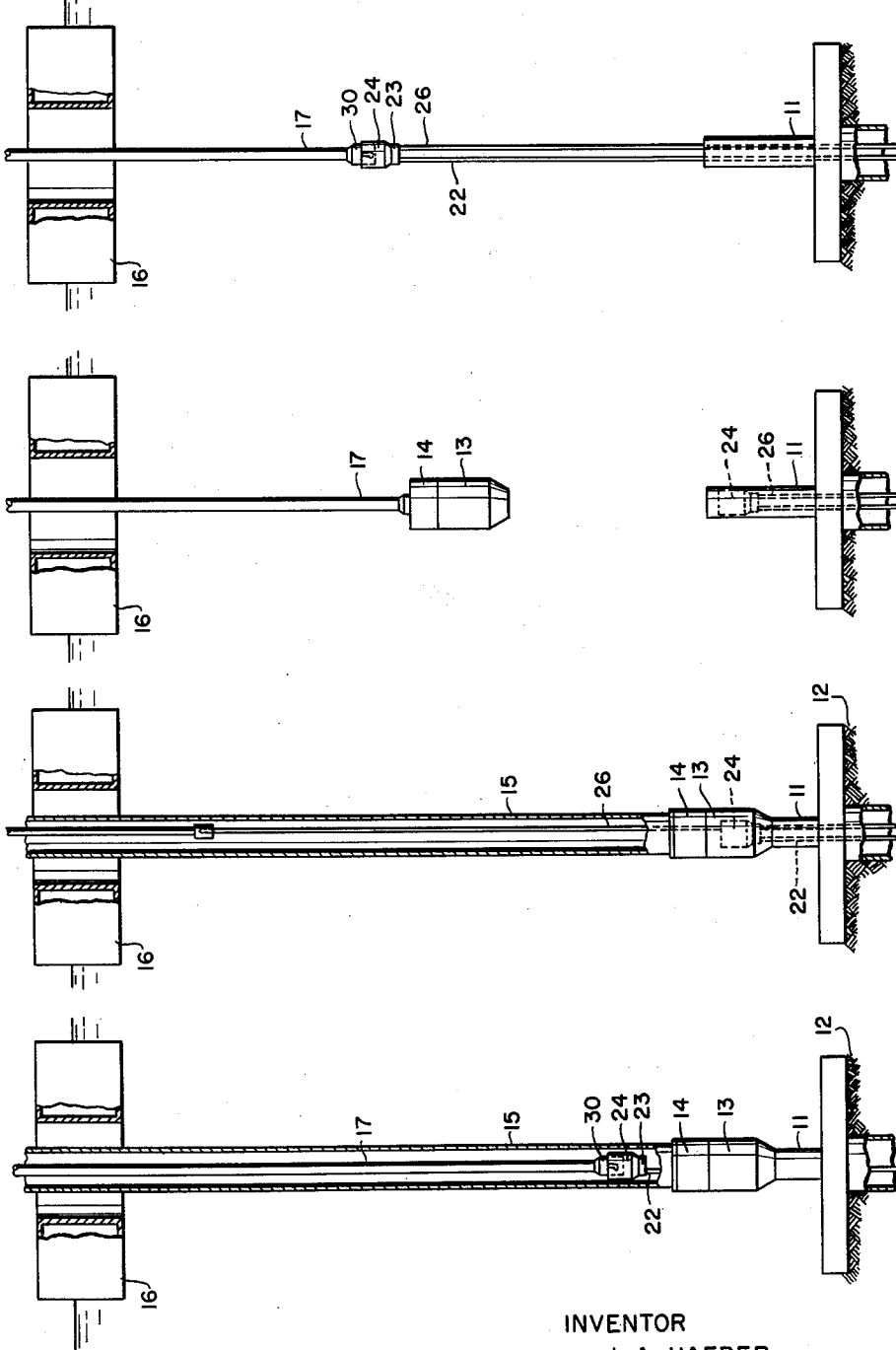


FIG. 4

FIG. 3

FIG. 2

FIG. 1

INVENTOR  
J. A. HAEBER

BY: *J. H. McCarthy*  
HIS AGENT

Nov. 6, 1962

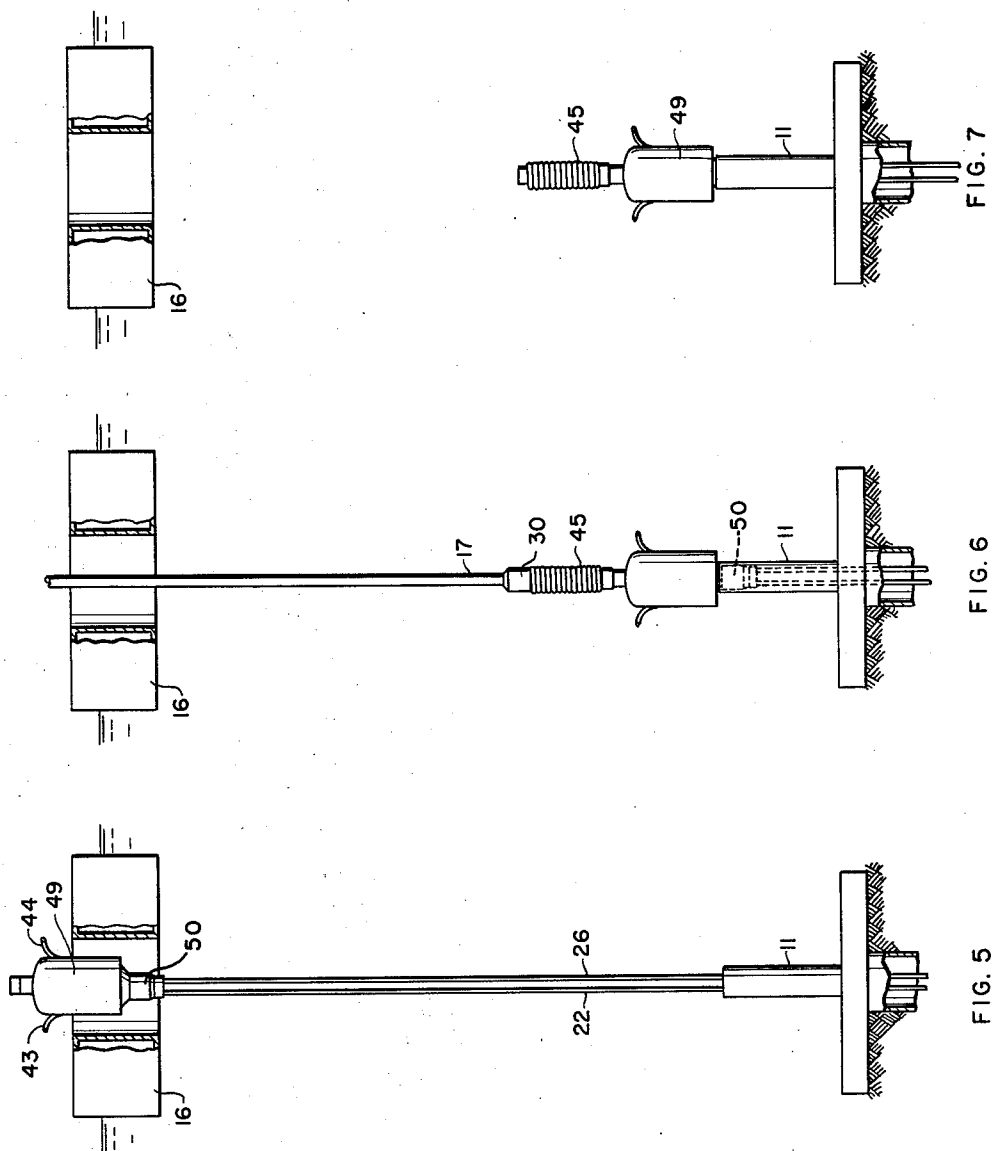
J. A. HAEBER

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INVENTOR:  
J. A. HAEBER

BY: *J. H. McCarthy*  
HIS AGENT

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4 Sheets-Sheet 3

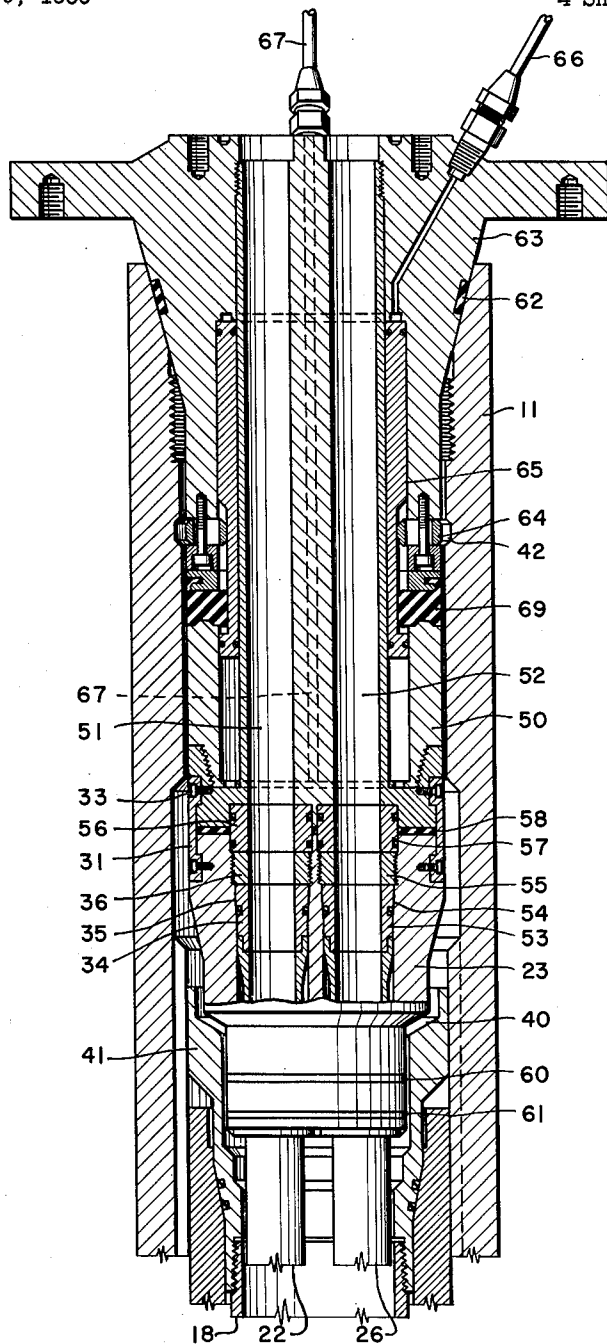


FIG. 9

INVENTOR:

J. A. HAEBER

BY:

*J. H. McCarty*

HIS AGENT

Nov. 6, 1962

J. A. HAEBER

3,062,288

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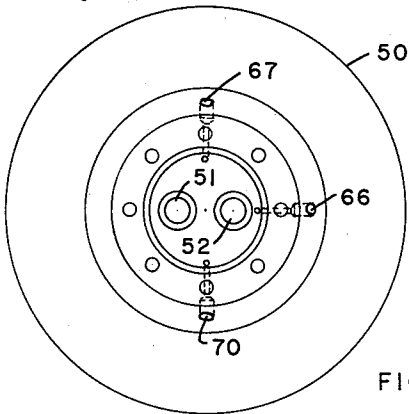


FIG. 11

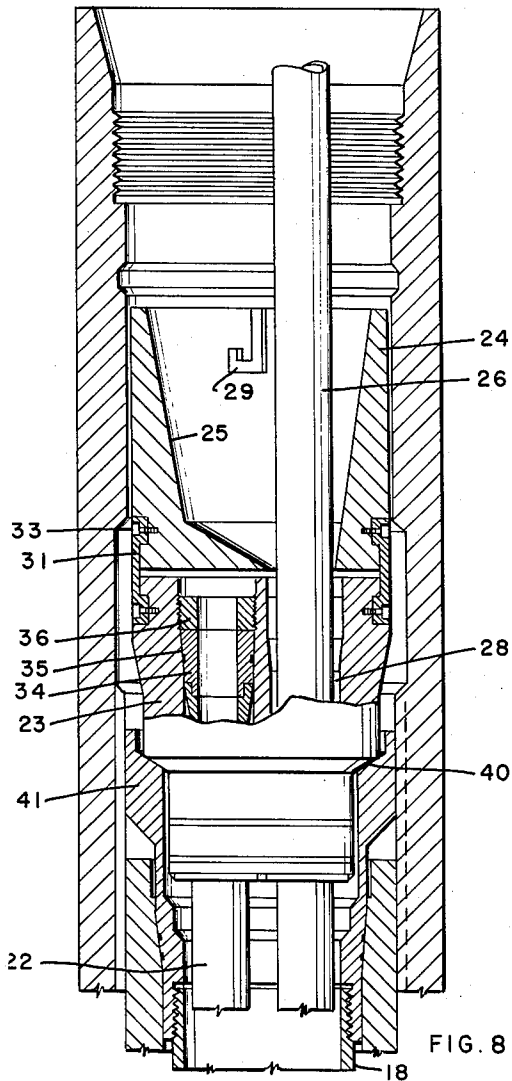


FIG. 8

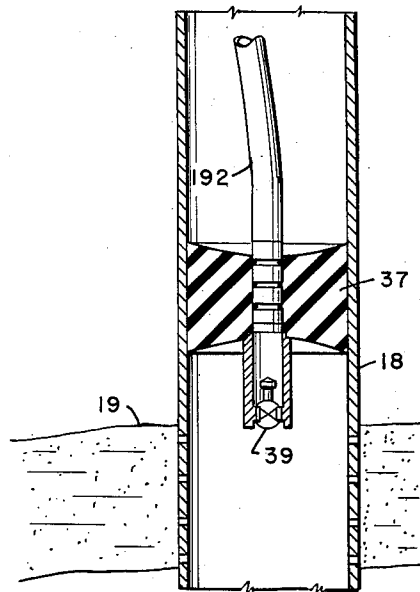
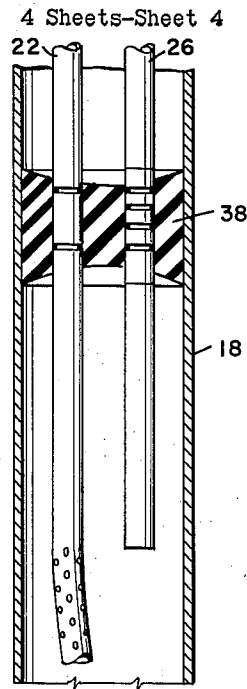


FIG. 10

INVENTOR  
J. A. HAEBER

BY *J. H. McCarthy*  
HIS AGENT

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UNDERWATER DUAL TUBING WELL  
COMPLETION

John A. Haeber, Houston, Tex., assignor to Shell Oil Company, a corporation of Delaware  
Filed July 30, 1959, Ser. No. 830,624  
7 Claims. (Cl. 166—46)

This invention relates to drilling of offshore wells and pertains more particularly to a method and apparatus for completing wells drilled in offshore waters which may be anywhere from 100 to 1500 or more feet deep. The present invention is especially concerned with a method and apparatus for suspending, packing off, and locking down dual tubing strings in a casing and tubing suspension body or casinghead positioned under water.

For purposes of illustration the present invention will be described with regard to a method and apparatus for installing dual parallel tubing strings in an underwater casinghead. However, the method and apparatus, with minor modifications, is equally applicable to the installation of single tubing strings, dual concentric tubing strings, or three or more parallel strings.

It is an object of the present invention to provide a method and apparatus which may be employed from an operational base above the surface of the water to install one or more tubing strings in a well which has been drilled at an offshore location wherein the well casinghead is located below the surface of the water.

A further object of the present invention is to provide a method and apparatus for maintaining control of the pressure within the well throughout the time needed to install production tubing strings therein from a remote location above the surface of the water.

Another object of the present invention is to provide a method and apparatus for installing, from a remote location above the surface of the water, a tubing string within a well having a well casinghead positioned below the surface of the water in a manner such that the complete pressure control of the well is maintained at all times while emergency auxiliary pressure control of the well is also available substantially throughout the entire operation of installing the tubing string.

In the drilling and completion of an oil well at an offshore location in a manner described in copending patent application, Serial No. 830,538, filed July 30, 1959, and entitled "Underwater Well Completion Method," wherein the well casinghead is located on the ocean floor, it takes considerable time to run one or more tubing strings down through the casinghead. It is therefore desirable to have available at the top of the casinghead, blow-out preventers as auxiliary means for controlling the well pressure in the event that the well starts to blow out. Therefore, it is preferred that the tubing string or strings be run through one or more blow-out preventers into the well to a predetermined depth, say 10,000 feet. In the event that multiple strings are being run into the well, considerably more time is taken in this operation as generally the tubing strings must be run one at a time because of the difficulties encountered in running them together. It is therefore another object of the present invention to provide blow-out preventers on an underwater well casinghead which are secured to the casinghead during the running of tubing strings therein and later removed from the casinghead prior to attaching the wellhead assembly thereto.

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

FIGURES 1-4 are schematic views showing the installation of dual tubing strings into an underwater well casinghead;

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FIGURES 5-7 are schematic views showing the lowering of a wellhead assembly on an underwater well casinghead;

FIGURE 8 is a longitudinal view taken in cross-section of a running tool including guide means for installing dual tubing strings in an underwater well;

FIGURE 9 is a longitudinal view taken in cross-section of the lower end of a wellhead assembly connected to dual tubing strings;

FIGURE 10 is a diagrammatic view illustrating an arrangement of packers and tubing within a well; and,

FIGURE 11 is a plan view of the tubing lock-down assembly of FIGURE 9.

Referring to FIGURE 1 of the drawing, an underwater well which has been drilled in any suitable manner, such for example, as by the method described in copending patent application Serial No. 830,538, filed July 30, 1959, and entitled "Underwater Well Completion," wherein a well casinghead or a casing and tubing suspension body 11 is positioned on the ocean floor, the top of the casing head 11 being closable during drilling and completion operations by one or more blow-out preventers 13 and 14. A marine conductor pipe string 15 is secured to the top of the uppermost blow-out preventer 14 and extends upwardly through the water to an operational base above the surface of the water such as the deck of a drilling barge 16.

As illustrated in FIGURE 1, the well is ready to have a string of tubing run down into the well through the equipment on the casinghead which comprises the marine conductor 15 and the blow-out preventers 13 and 14 which are locked securely together in a fluidtight manner and also locked to the casing and tubing suspension body or casinghead 11 in a manner shown in copending patent application, Serial No. 830,538, filed July 30, 1959.

In some circumstances, for example, on development wells drilled in areas where well pressures are known to be low, tubing may be run into place within the well casing with blow-out preventers 13 and 14 omitted and the marine conductor 15 connected directly to the casinghead 11. However, it is preferred that blow-out preventers be employed.

If a single string of tubing is to be run into the well, it is provided with a temporary or permanent tubing hanger or any suitable stop member at its upper end by which the tubing string is otherwise prevented from dropping further into the well. Preferably, the well is provided with a pair of tubing strings so that tools, instruments, or other devices may be circulated down through the tubing to the bottom of the well and returned by reverse circulation. Due to the difficulty of simultaneously installing multiple strings of parallel tubing in an offshore well which may be thousands of feet deep, the tubings are preferably installed one at a time.

A tubing string 22 is shown in FIGURE 8 as being fixedly secured at its upper end to a tubing hanger 23 or other suitable stop member which in turn is temporarily secured in any suitable manner to a tubing guide member 24 and run into the well as shown in FIGURE 1. The interior of the tubing guide tool 24 (FIGURE 8) is provided with a sloping surface 25 by which a second tubing string 26 is guided into a bore 28 which is parallel to the tubing string 22.

The tubing guide tool 24 is shown in FIGURE 8 as being secured by means of a split ring connector 31 to a tubing hanger 23. The split ring connector 31 may be secured by screws 33 or any other suitable means. The upper end of the tubing string 22 is preferably connected to a slope-shouldered donut hanger 34 to hold it down in place as the tubing is run into the well. The upper end of the tubing guide tool 24 is provided with one or more

J-slots 30 adapted to engage a pin of a J-tool 30 secured to the lower end of a running pipe string 17 (FIGURE 1).

Prior to running the tubing strings 22 and 26 into the well, a Baker Oil Tool, Inc., Model "D" wireline-set single bore production packer 37 is installed in the inner casing string 18 (FIGURE 10) to close it above the production interval 19 to control the well pressure after removal of the blow-out preventers 13 and 14 (FIGURE 1) and prior to setting the wellhead assembly. Alternatively, instead of employing a packer 37 in which the lower end of tubing string 22 is slidably seated, the well casing 18 may be closed to formation fluids under pressure by filling the casing with a fluid such as water or drilling mud.

Additionally, a Brown Oil Tool Company Model "J" dual bore hydraulically-set packer 38 may be run into the well on the first tubing string 22 to seat slidably therein the bottom of the second tubing string 26 after it has been run. The wireline-set packer 37 in the bottom of the casing 18 is provided with a wireline retrievable plug 39 in a manner well known in the art, which plug is subsequently removed after the wellhead assembly is installed. The lower packer 37 and its plug 39 provide a temporary closure means for containing the well pressure during completion of the well, while the dual production packer 38 prevents casing pressures and corrosive fluids from going up the well during the production thereof.

In a preferred embodiment of the present invention, the lower portion of the tubing string below the dual packer 38 is perforated, to permit circulation of a fluid down one tubing 22 and up the other tubing 26 at a point above closed packer 37.

In FIGURE 1 of the drawing, the upper end of a first tubing string 22, with the tubing hanger 23 and guide member 24 connected thereto, are shown as being lowered through conductor pipe 15 by a running string 17 and running head 30 by which they are run into position within the casinghead 11. In FIGURES 2 and 8, the second tubing string 26 is shown as being run into place through the tubing hanger 23 and guide member 24, it being understood that at the time this operation is carried out the tubing hanger 23 is seated on the hanging shoulder 40 of the innermost casing string 18, as shown in FIGURE 8. After the first tubing string 22 has been lowered into position, the running string 17 is withdrawn to the surface and is not used during the running of the second string 26 but only at the end of this operation. The upper end of the second tubing string 26 equipped with a suitable element such as a hanger 53 (FIGURE 9) is lowered from the barge into the guide tool by a wire line or J-tool and running string similar to elements 17 and 30 which are used to lower the upper end of the first tubing string into place.

With the tubing strings 22 and 26 installed within the well, as shown in FIGURE 3, the marine conductor pipe 15 and its landing head have been disconnected from the blow-out preventers 13 and 14 and withdrawn upwardly to the drilling barge 16. A running string 17 is then run down to unlock the blow-out preventers 13 and 14 in a manner described in copending application, Serial No. 830,538, filed July 30, 1959, after which the disconnected blow-out preventers are raised together with their associated equipment to the drilling barge 16. In some wellhead arrangements, the blow-out preventers may be raised to the surface along with the marine conductor if hydraulically-operated means are used to lock the preventers to the casinghead.

A running string 17 (FIGURE 4) have a J-tool 30 attached to the lower end thereof is run into the casing and tubing suspension body or casinghead 11 to engage the tubing guide tool 24. By means of the running string 17, the tubing guide tool 24, together with the two tubing strings 22 and 26 connected thereto, are withdrawn upwardly from the landed position on the shoulder 40 (FIGURE 8) of the casing hanger 41 and pulled upwardly

(FIGURE 4) to the barge 16 where the tubing hanger 23 is disconnected from the tubing guide member 24.

The tubing guide tool 24 (FIGURE 8) is removed by unscrewing the set screws 33 of the split ring connector 31 and substituting for guide tool 24 the lower end of a tubing hanger lock-down device 50, which is in turn secured by a flange at the top of member 50 to the bottom of a wellhead assembly or production control unit 49 (FIGURE 5). The tubing hanger lock-down body 50 is provided with a pair of vertical conduits 51 and 52 arranged to register with the tubing strings 22 and 26.

Prior to connecting the split ring connector 31 to the tubing hanger lock-down body 50, the second tubing string 26 is suspended by means of a donut hanger 53 seated on shoulder 54. A threaded hold-down collar 55 is installed with sealing subs 56 and 57 positioned above the collar 36 and 55. The sealing ring 58 is positioned between elements 23 and 50. Primary packing O-ring seals 60 and 61 contain the annulus pressure while a seal 62 is provided in the sloping face of the top of the lock-down body 50 to keep sea water out of the installation. As illustrated, the weight of the tubing strings 22 and 26 is supported with the sloping face 63 of the hold-down body 50 bearing against the mating face on the upper end of the tubing and casing suspension body or casinghead 11. However, if desired, a portion or all of the weight may be put on shoulder 40 by having tubing hanger 23 rest thereon.

The lock-down body 50 (FIGURE 9) is provided with a series of hydraulically and radially-slidable locking dogs 64 adapted to move outwardly from the body 50 and seat in the annular groove 42 of the casing and tubing suspension body 11. A piston 65 is adapted to move vertically under fluid pressure from conduit 66, forcing the dogs 64 outwardly to lock in the annular groove 42. When fluid pressure is applied through conduit 67 to move the piston in the opposite direction, the locking dogs 64 become unlatched so that an upward pull on the body 50 retracts them. An annular seal 69 is preferably employed also. A third pressure conduit 70 may be provided in the head of the lock-down body 50 (FIGURE 11) in order to obtain the tubing annulus well pressure.

Since in this well installation a pair of tubing strings 22 and 26 are employed, the production control unit or wellhead assembly 49 is provided with two flexible flow lines 43 and 44 which are adapted to lay on the ocean floor after the production control unit 49 has been lowered in the casing and tubing suspension body 11 and locked therein as shown in FIGURE 6. The production control unit 49 contains the necessary piping, valves, chokes, and other equipment normally connected together, mounted on the top of a well and known as a "Christmas tree," together with the necessary hydraulic or electrical systems including pumps, reservoirs, tanks, motors, etc., to operate the valves at the head of the well from a remote location.

With the production control unit 49 seated and locked in place on the casinghead or casing and tubing suspension body 11, the running head 30 is disconnected from the top of the production control unit or wellhead assembly 49, or from its lubricator or wellhead closure device 45, and the running string 17 is then pulled upwardly to the surface, with the production control unit 49 left on the ocean floor (FIGURE 7).

I claim as my invention:

1. In oil and gas well completion operations carried out from an operational base positioned above the surface of water, with a marine conductor pipe string extending from said base to an underwater well casinghead, the method of installing a tubing string in a well casing depending from an underwater well casinghead and mounting a wellhead assembly thereon, said method comprising closing said well casing to formation fluids under pressure, running a string of tubing from said base above water down through said marine conductor pipe and

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casinghead and into said casing, attaching a stop member and a running string to the top of said tubing string, landing in said casinghead said stop member with said tubing string depending therefrom and withdrawing said running string, disconnecting from said casinghead said marine conductor pipe and withdrawing it to the above-water base, lowering a tool on a running string within said casinghead to engage said stop member, withdrawing the upper end of said tubing string to a point above the surface of the water, attaching a wellhead assembly to the top of said tubing string, and lowering the upper portion of said tubing string back into said well casing with the wellhead assembly to close said casinghead.

2. In oil and gas well completion operations carried out from an operational base positioned above the surface of water, with a marine conductor pipe string extending from said base to an underwater well casinghead provided with blow-out preventer means for emergency control of the well, the method of installing a tubing string in a well casing depending from an underwater well casinghead and mounting a wellhead assembly thereon, said method comprising closing said well casing to formation fluids under pressure with the blow-out preventer means open, running a string of tubing from said base above water down through said marine conductor pipe and casinghead and into said casing, attaching a stop member and a running string to the top of said tubing string, landing in said casinghead said stop member with said tubing string depending therefrom and withdrawing said running string, disconnecting from said casinghead said blow-out preventer means and withdrawing it to the above-water base with said marine conductor, lowering a tool on a running string within said casinghead to engage said stop member, withdrawing the upper end of said tubing string to a point above the surface of the water, attaching a wellhead assembly to the top of said tubing string, and lowering said upper portion of said tubing string back into said well casing with the wellhead assembly to close said casinghead.

3. In oil and gas well completion operations carried out from an operational base positioned above the surface of water, with a marine conductor pipe string extending from said base to an underwater well casinghead provided with blow-out preventer means for emergency control of the well, the method of installing dual tubing strings in a well casing depending from an underwater well casinghead and mounting a wellhead assembly thereon, said method comprising closing said well casing to formation fluids under pressure by inserting re-openable casing packer means through said marine conductor pipe and casinghead and running it through said well casing to a level above a formation to be produced at which level said casing packer means are set in fluidtight engagement with the inner wall of said casing, running a string of tubing from said base above water down through said marine conductor and casinghead and into said casing, attaching a tubing hanger and tubing guide means and a running string to the top of said tubing string, seating in said casinghead said tubing hanger with said tubing string depending therefrom and withdrawing said running string, guiding a second tubing string through said guide means and tubing hanger to a predetermined depth until it hangs therefrom, disconnecting from said casinghead said blow-out prevented means and withdrawing it to the above-water base with said marine conductor, lowering a tool on a running string within said casinghead to engage said tubing guide means, withdrawing said tubing guide means and connected hanger means and the upper ends of dual tubing strings to a point above the surface of the water, removing said tubing guide means from said tubing hanger means, attaching a wellhead assembly to said tubing hanger in register with said dual tubing strings, lowering said dual tubing strings back into said well casing with the wellhead assembly to close said casinghead.

4. In oil and gas well completion operations carried

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out from an operational base positioned above the surface of water, with a marine conductor pipe string extending from said base to an underwater well casinghead provided with blow-out preventer means for emergency control of the well, the method of installing dual tubing strings in a well casing depending from an underwater well casinghead and mounting a wellhead assembly thereon, said method comprising closing said well casing to formation fluids under pressure by inserting casing packer means through said marine conductor pipe and casinghead and running it through said well casing to a level above a formation to be produced at which level said casing packer means is set in fluidtight engagement with the inner wall of said casing, running a string of tubing from said base above water down through said marine conductor and casinghead and into said casing, attaching a tubing stop member and tubing guide means and a running string to the top of said tubing string, landing in said casinghead said tubing stop member with said tubing string depending therefrom and withdrawing said running string, guiding a second tubing string through said tubing guide means to a predetermined depth until it hangs therefrom, disconnecting from said casinghead said blow-out preventer means and withdrawing it to the above-water base with said marine conductor, lowering a tool on a running string within said casinghead to engage said tubing guide means, withdrawing said tubing guide means and connected stop member and the upper ends of said dual tubing strings to a point above the surface of the water, removing said tubing guide means from said tubing stop member, attaching a wellhead assembly to said tubing stop member in register with said dual tubing strings, lowering said dual tubing strings back into said well casing with the wellhead assembly to close said casinghead and to seat the lower end of one of said tubing strings in said casing packer means within the casing, remotely locking said wellhead assembly on said casinghead, opening the casing packer means to permit well fluid to pass therethrough, and producing said well.

5. Apparatus for installing dual tubing strings in an offshore well having an underwater well casinghead wherein the operations are carried out from an operational base above the surface of the water, said apparatus comprising a well casinghead positioned below the surface of water with a casing extending therefrom into the ocean floor, a marine conductor connected to the top of said casinghead in a fluidtight manner and extending upwardly therefrom to a point above the surface of the water, a first tubing string within said casinghead and casing, stop means secured on the outside of said tubing string at the upper end thereof, said stop means adapted to seat on said casinghead, tubing guide means removably attached to said stop member, and a second tubing string in said casinghead and casing in seating position in said stop means.

6. Apparatus for installing dual tubing strings in an offshore well having an underwater well casinghead wherein the operations are carried out from an operational base above the surface of the water, said apparatus comprising a well casinghead positioned below the surface of water with a casing extending therefrom into the ocean floor, blow-out preventer means removably secured to the top of said casinghead for emergency control of well pressure, a marine conductor connected to said blow-out preventer means in a fluidtight manner and extending upwardly therefrom to a point above the surface of the water, a first tubing string within said casinghead and casing, stop means secured on the outside of said tubing string at the upper end thereof, said stop means adapted to pass through said blow-out preventers and seat on said casinghead, tubing guide means having an offset vertical bore therethrough and being removably attached to said stop member, a second tubing string in said casinghead and casing having been guided into a seating position through the offset vertical bore in said stop means by said tubing

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guide means, and casing closure means in said casing preventing the upward passage of well fluid therein.

7. Apparatus for installing dual tubing strings in an offshore well having an underwater well casinghead wherein the operations are carried out from an operational base above the surface of the water, said apparatus comprising a well casinghead positioned below the surface of water with a casing extending therefrom into the ocean floor, blow-out preventer means removably secured to the top of said casinghead for emergency control of well pressure, a marine conductor connected to said blow-out preventer means in a fluidtight manner and extending upwardly therefrom to a point above the surface of the water, a first tubing string within said casinghead and casing, stop means secured on the outside of said tubing string at the upper end thereof, said stop means adapted to pass through said blow-out preventers and seat on said casinghead, tubing

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guide means having an offset vertical bore therethrough and being removably attached to said stop member, and a second tubing string in said casinghead and casing having been guided into a seating position through the offset vertical bore in said stop means by said tubing guide means.

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