

[72] Inventor **Chester B. Falkner, Jr.**
Whittier, Calif.
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 [73] Assignee **Deep Oil Technology, Inc.**
Long Beach, Calif.

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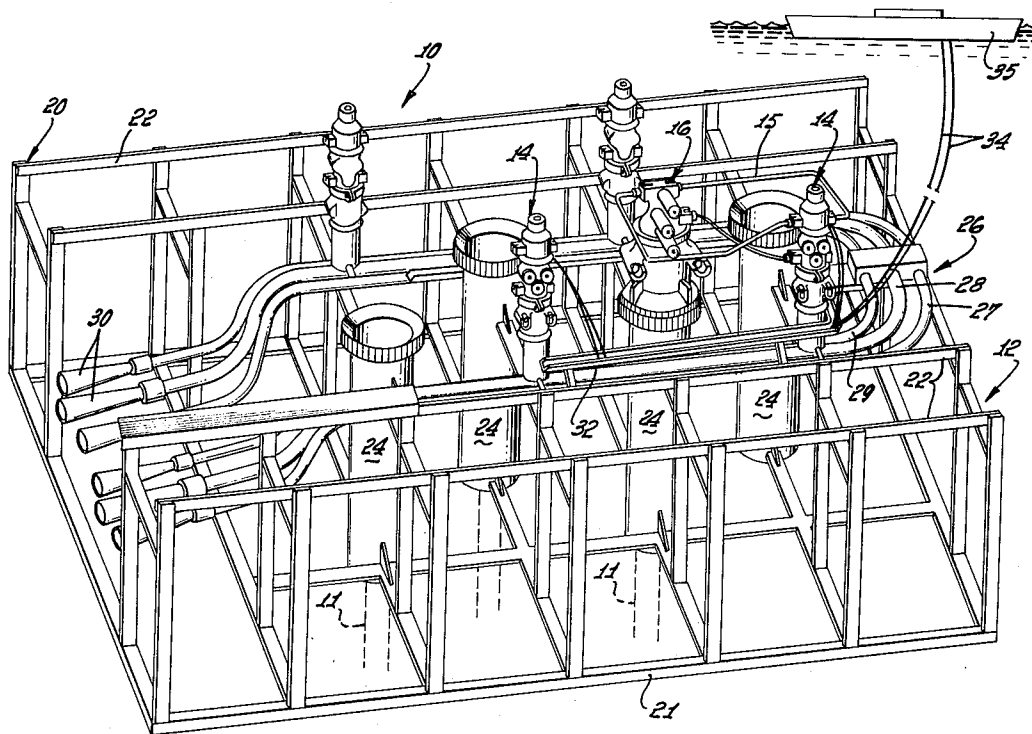
Primary Examiner—Marvin A. Champion
Assistant Examiner—Richard E. Favreau
Attorney—Miketta, Glenny, Poms and Smith

[54] **SUBSEA WELLHEAD SYSTEM**
15 Claims, 7 Drawing Figs.

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285/18
 [51] Int. Cl. **E21b 43/01**
 [50] Field of Search **166/.5, .6**

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ABSTRACT: An apparatus and method for a subsea wellhead station having one or more producing well holes wherein an oil production control unit is separate from and adjacent to a wellhead unit for a well hole, each of said units being removable for repair and maintenance at a remote location independently of the other unit. The production control unit contains necessary equipment affording remote control of production of oil, directing such production into test or collection lines, monitoring pressures of production oil from its associated well hole, controlling gas injection into the well hole, and maintaining and controlling desired production oil pressure conditions.



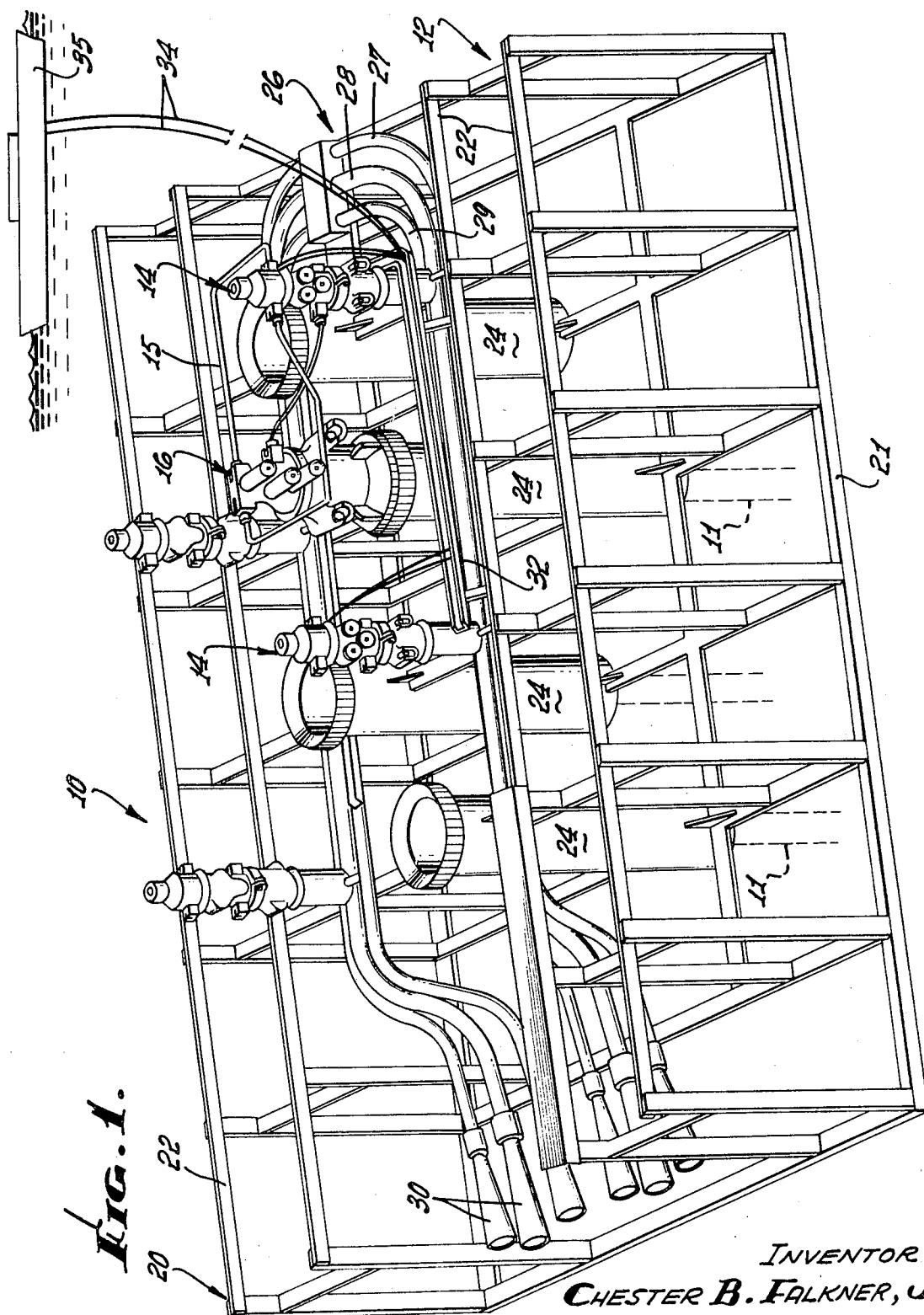
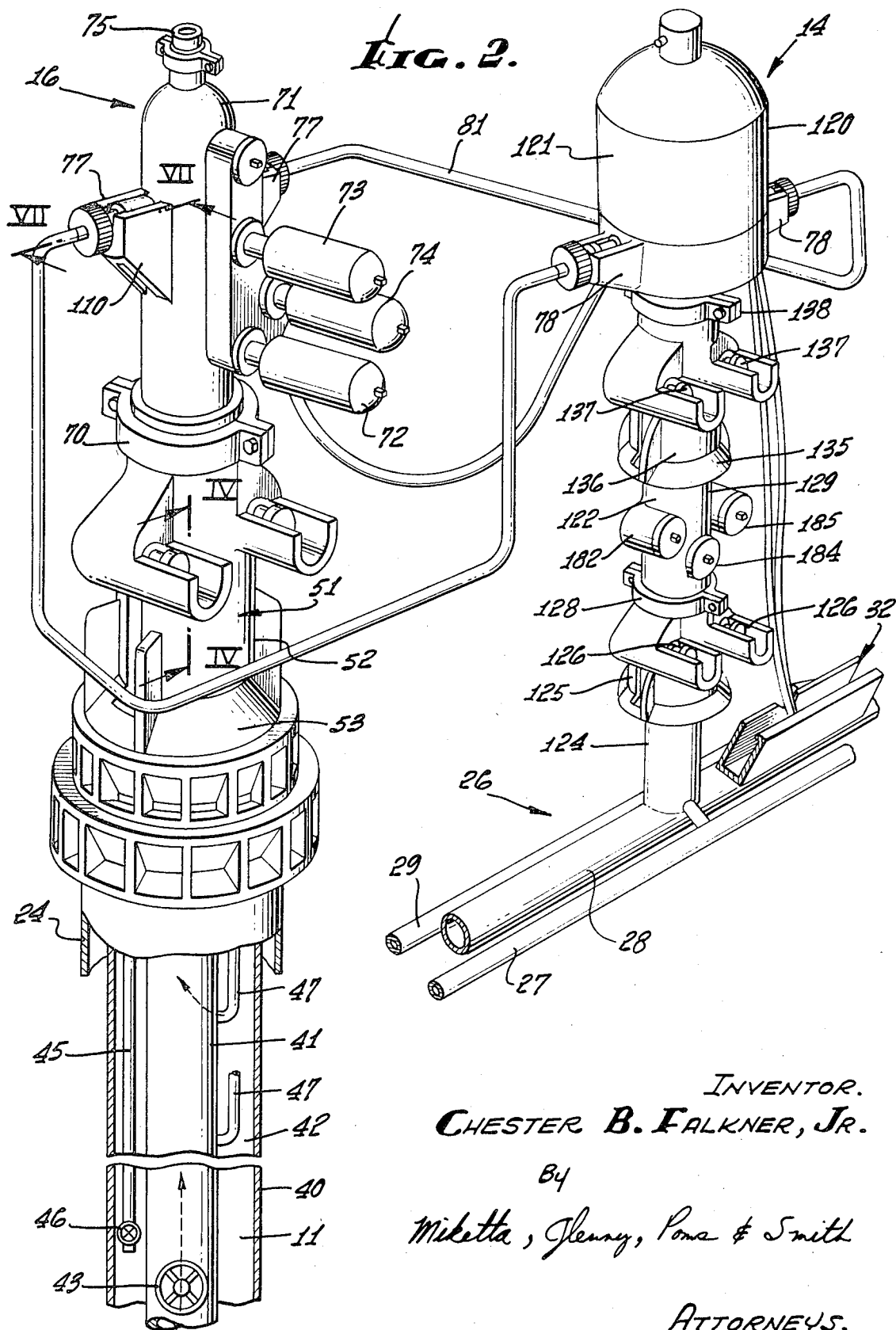
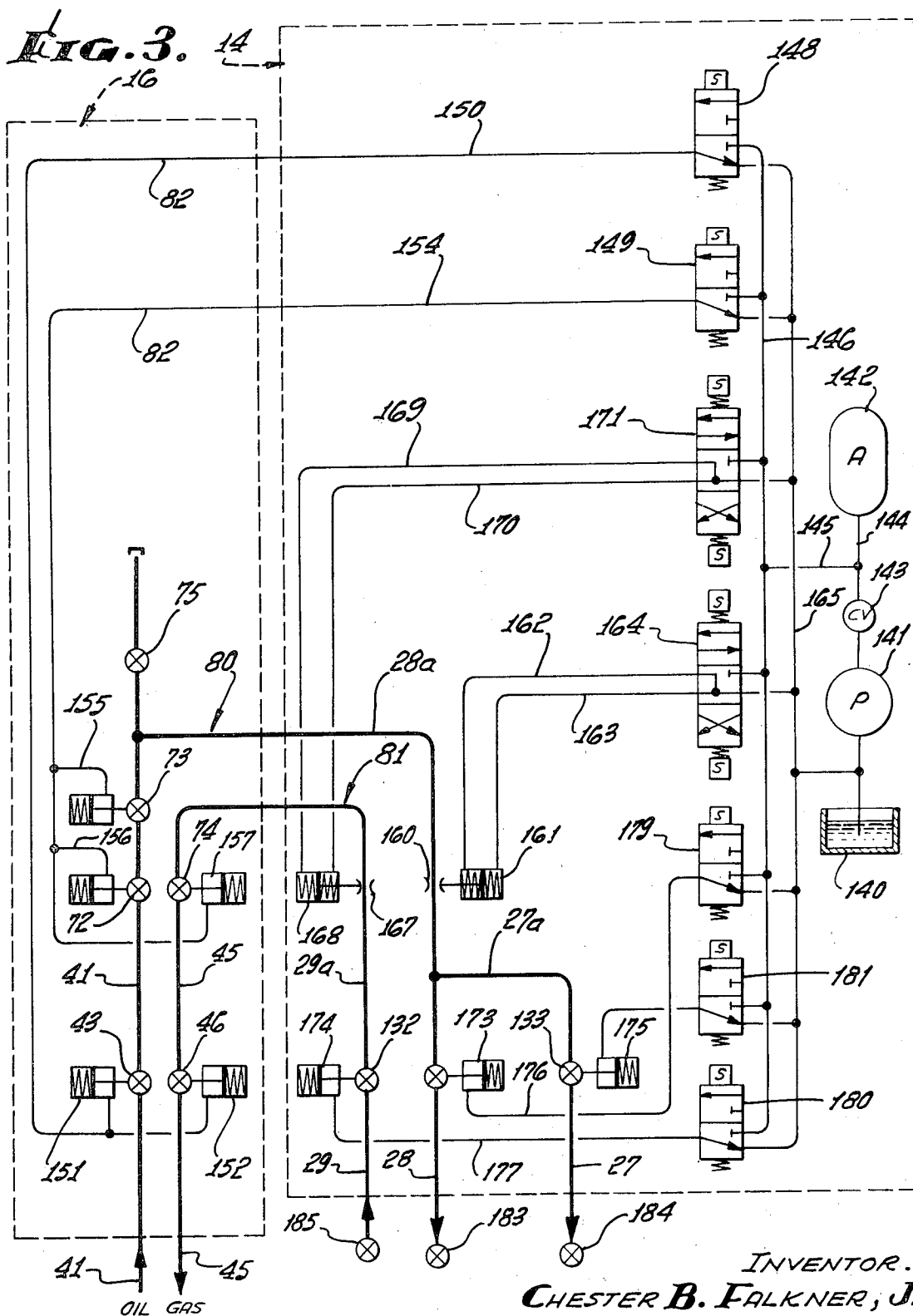


Fig. 1.

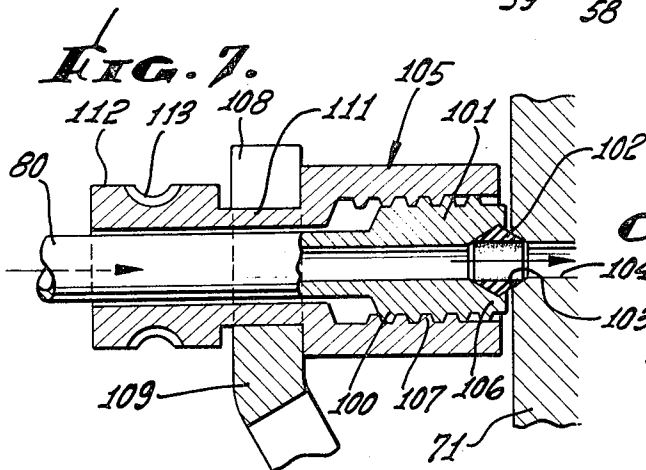
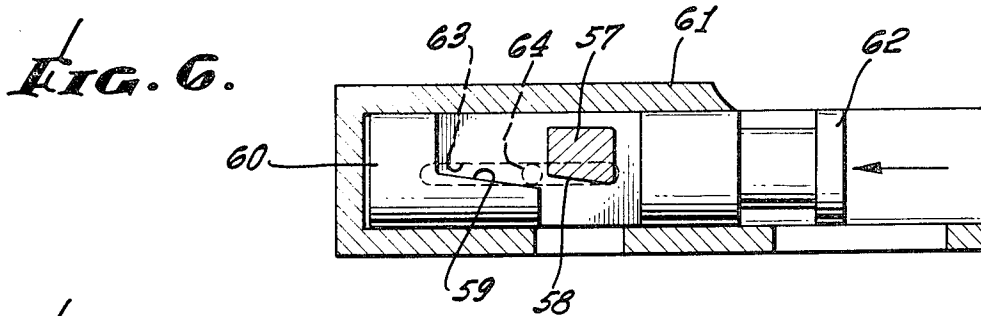
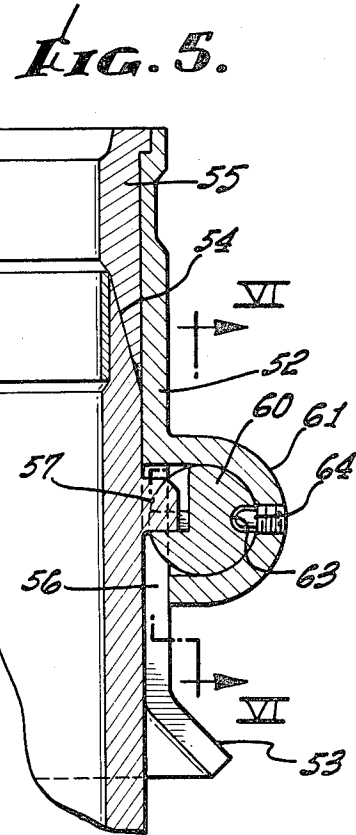
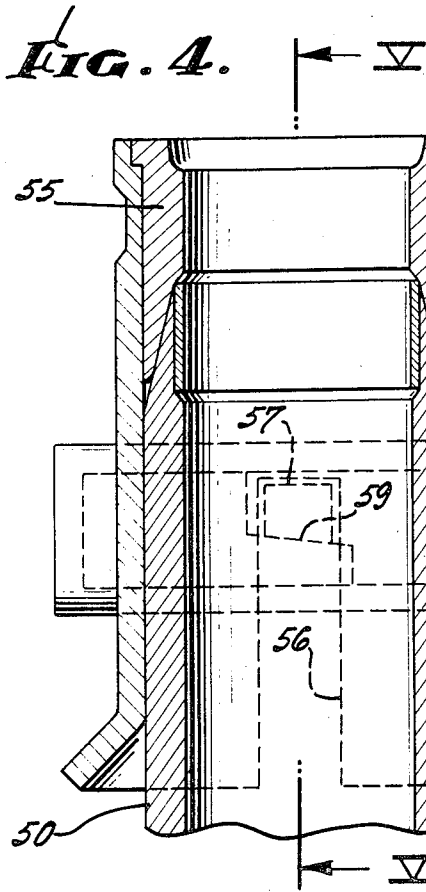
INVENTOR.
CHESTER B. FALKNER, JR.
 By
Miketta, Jerny, Pons & Smith
 ATTORNEYS.





INVENTOR.
CHESTER B. FALKNER, JR.

By
Miketta, Glenn, Poma & Smith
ATTORNEYS.



INVENTOR.
CHESTER B. FALKNER, JR.

By
Miketta, Glenn, Pons & Smith

ATTORNEYS.

SUBSEA WELLHEAD SYSTEM

BACKGROUND OF THE INVENTION

Prior wellhead structures used at producing well holes have included a unitary complex arrangement of Christmas tree and production control equipment combined into a single assembly at the top of a well hole. In other prior installations, production control equipment was utilized within the well hole and was separated from Christmas tree equipment located at the top of the well hole. In still other prior installations, production control equipment was not employed at the well site.

Such prior proposed systems include several disadvantages, especially when utilized in a subsea wellhead installation where the wellhead was located beneath the surface of the ocean and was not readily accessible. In installations employing a single unitary assembly of Christmas tree and production control equipment before a component part thereof or the unit could be removed for maintenance or repair, entry was required into the well bore to plug the well. In the installations where control equipment was operable within the well or downhole, tubing was required to be withdrawn in order to maintain or repair faulty downhole equipment. Moreover, in such downhole production control installations, the flexibility of the control operations were substantially limited and reduced.

In those installations where control equipment was not installed at the well site, the lack of such production control equipment increased safety hazards and resulting damages to the well or flow line systems in the event the production flow became uncontrolled, an prohibited gathering or providing a common manifold for production fluids from several wells having different producing conditions. The effect of such disadvantages of such prior proposed production installations in a subsea environment was greatly increased and resulted in a substantial increase in costs of labor and material in order to provide maintenance and repair for production control equipment of a subsea well.

SUMMARY OF THE INVENTION

The present invention relates to a subsea wellhead system which is so constructed and arranged that repair and maintenance of the production control equipment for an associated well hole may be readily accomplished without the problems and disadvantages of prior proposed subsea production control installations. The present invention contemplates a novel arrangement of Christmas tree equipment or a wellhead unit which is associated with a subsea well hole and separate from and adjacent thereto is a production control unit which is readily disconnected and removable from its location adjacent the wellhead unit so that it may be raised to the surface of the ocean for maintenance and repair above water and at a remote station. The subsea wellhead system contemplated by the present invention does not require entry into the well per se to service items which commonly need maintenance or repair, and therefore, does not require withdrawal of production tubing from the well. The present wellhead system is so arranged that where a plurality of adjacent wells are being produced the production oil flow conditions in each well may be readily monitored and regulated to provide the most effective production characteristics for that well and may be also regulated so that the production oil flow may be controlled so that the flow may join production oil flowing from adjacent wells with the minimum interference or interaction between the flow and pressure conditions of the adjacent wells. The arrangement of the present wellhead system provides a method and a construction whereby unit replacement can be quickly and readily made so that repair and maintenance can be performed in a suitably equipped maintenance shop.

The principal object of the present invention therefore is to disclose and provide a novel subsea wellhead system in which a wellhead unit or a production control unit may be readily

disassembled from the wellhead structure without interference with the other unit for removal for repair and maintenance at a remote location.

An object of the present invention is to disclose and provide a subsea wellhead system wherein equipment normally requiring periodical service and maintenance is located in a production control unit which is readily removable from the wellhead assembly.

Another object of the invention is to disclose and provide a subsea wellhead system for a plurality of wellheads wherein a selected wellhead may be serviced and maintained while the remaining wellheads remain in production.

Another object of the invention is to disclose and provide a subsea wellhead system wherein a plurality of production control units, each being adjacent to an associated wellhead, may direct their production flow into a common manifold in such a manner that production flow pressure may vary from wellhead to wellhead.

A further object of the invention is to disclose and provide an integral power system in the production control unit for operating valves, controllers and regulators on both the wellhead unit and the production control unit for effectively regulating the production of oil from a well hole.

Other objects of the invention include an arrangement of wellheads and associated production control units which facilitates maintenance and control, facilitates underwater manipulation of various connections of the wellhead and production control units, permits switching of production fluid from the well into different parts of a common production manifold for permitting testing of production fluid from a selected well, and controls and regulates the production control equipment and wellhead equipment from a remote location such as a vessel on the surface of the ocean.

A specific object of the invention is to disclose and provide a separable removable subsea unit for a wellhead which is readily operable under water and may employ pressure-equalizing oil-filled compartments for critical components and which may be readily removed as a unit by remote actuated devices.

Various other objects and advantages of the present invention will be readily apparent from the following description of the drawings in which an exemplary embodiment of the invention is shown.

IN THE DRAWINGS

FIG. 1 is a perspective view of an exemplary wellhead system embodying the present invention, some of the wellhead units being omitted for clarity;

FIG. 2 is an enlarged perspective view of a wellhead unit and an associated production control unit for a well hole in the system shown in FIG. 1;

FIG. 3 is a schematic flow diagram showing operation of the wellhead unit and production control unit shown in FIG. 2 for a well hole;

FIG. 4 is a fragmentary sectional view taken in a vertical plane passing through the axis of the wellhead unit shown in FIG. 2 and generally indicated by the line IV—IV of FIG. 2;

FIG. 5 is a fragmentary sectional view taken in the plane indicated by line V—V of FIG. 4;

FIG. 6 is a fragmentary sectional view taken in the planes indicated by lines VI—VI of FIG. 5; and

FIG. 7 is a fragmentary sectional view of a pipe connection taken in a vertical plane generally indicate by line VII—VII of FIG. 2.

In FIG. 1 there is illustrated an exemplary subsea wellhead system generally indicated at 10 embodying the present invention. In such subsea wellhead system a plurality of well holes generally indicated at 11 are drilled in an ocean floor in a preselected pattern and arrangement. In this example, the well holes 11 are arranged in spaced parallel rows, the well hole in one row being longitudinally offset from the well hole in the adjacent row. Each well hole may include an outer well casing

which extends above the ocean floor surface and which may support in well-known manner inner casings and production pipe (not shown). After drilling, each well hole may be capped in well-known manner. It will be readily understood that the arrangement of well holes 11 may be varied with respect to pattern, however in the practice of the present invention it is desirable that the upper heads of well holes be closely grouped or clustered within a selected area at the template but deflected or directionally drilled as required below the sea floor to facilitate use of a wellhead template frame construction generally indicated at 12.

Template frame construction 12 may be prefabricated and preassembled at a convenient work location above water to correspond with the preselected pattern of well holes 11. When template frame construction 12 is completed as fully described later, the entire assembly may be lowered by suitable well-known means into operative relation with well holes 11. One of the important features of this invention is the provision on template construction 12 of readily removable production control units 14 which are separate from and adjacent to and interconnected by connecting lines 15 to wellhead units 16 which are similarly readily removable and recoverable for service and maintenance above water. In the compact relatively closely clustered arrangement of well holes, the production control units are readily operable to facilitate controlling production flow and manifolding of such production flow from the several well holes to provide an efficient wellhead production operation as described in detail hereafter.

Wellhead template frame construction 12 may comprise a suitable braced and reinforced frame means 20 of metal members of suitable section and including base members 21 adapted to be supported on or at an ocean floor. Along opposite longitudinal side portions of frame 20 are supported spaced horizontal parallel rail members 22 which provide a track for an underwater manipulating device or robot (not shown) which may travel along said rail members for stopping opposite a production control unit 14 or wellhead unit 16 for work thereon as required. Between the side rail members 22 is a longitudinal opening or space within which are supported from frame means 20 a plurality of vertically disposed conductor guide means 24, each conductor guide 24 being positionable at an associated well hole 11 and readily ensleeved over the upwardly extending outer casing portion of the well hole 11. Frame means 20 also supports in prearranged assembly manifold means generally indicated at 26 which comprises in this example a plurality of flow pipes 27, 28 and 29 arranged in parallel relation and extending around the outer portions of said longitudinal opening for connection to each production control unit. At one end of frame means 20 the pipes 27, 28 and 29 may be provided with suitable known flared pipe connector or coupling means 30 for connection to flow lines for conducting production flow, gas, and test flows to a remote location. The remote location for production flow may be an underground storage tank, a storage platform station, or suitable tank storage means at the surface of the water.

Frame means 20 also carries a control duct means 32 provided with selected suitable control means which may be connected to each production control unit 14 and also through suitable lines 34 to a remote control station 35 indicated exemplarily as a vessel at the surface of the water. Depending upon location of the subsea wellhead system 10, the remote location for the controls may be on land, on a vessel, or at a suitably supported or anchored above surface platform station. It will be understood that the remote control means employed may comprise various well-known control means, such as an electrical cable extending from the remote location to the subsea wellhead assembly, an acoustical system, or a fluid pressure system employing hydraulic or pneumatic means to control the production control units and wellhead units as described more fully hereafter.

As indicated above, the wellhead template frame construction means 12 equipped with the conduit guides 24, manifold

pipe means 26, production control units 14, and control conduit means 32 may be preassembled and prefabricated out of water and then lowered into operative position and relationship with respect to the pattern of well holes 11. When the template means 12 is so positioned and located, wellhead units 16 may be lowered into assembly with each conductor guide 24 and the wellhead equipment enclosed thereby. As best viewed in FIG. 2 each well hole 11 includes an outer casing 40 which encloses a production tubing 41 defining an annular chamber 42 within outer casing 40. At a selected depth of approximately 300 feet more or less beneath the ocean floor a normally open production tubing string valve means 43 may be provided, said valve means 43 being of suitable well-known ball valve type for controlling production flow of oil throughout the production tubing string 41 and capable of shutting off said flow upon closure thereof by control means described hereafter. Adjacent valve means 43 there may be provided in the annular space 42 a gasline 45 having a gas valve 46 for introducing gas into the production pipe string 41 for lift purposes. At selected intervals above valve means 43 gaslines 47 may be provided in annular space 42 for injection at suitable vertically spaced intervals into production pipe string 41 of injection gas for artificial lift purposes.

At the top of conductor guide 24 and outer casing 40 the wellhead may include an upstanding axial mandrel 50 enclosing well-known means for providing a connection to the production pipe string 41 and casing means within the conductor guide tube. The upstanding mandrel 50 is part of a wellhead connector means described and claimed in copending application Ser. No. 775,872 filed and owned by a common assignee, said application being incorporated by reference herein. In general, the wellhead connector means generally indicated at 51 comprises in addition to upstanding mandrel 50 a barrel 52 having a downwardly and outwardly flared skirt 53 to facilitate alignment entry of the top tapered portion 54 of the mandrel into the barrel 52. In fully inserted position tapered end 54 seats against a correspondingly tapered internal sleeve 55 carried by barrel 52 at its top portion. Barrel 52 is provided with diametrically opposite longitudinally extending slots 56 open at their bottom ends for reception therein of diametrically oppositely disposed outwardly projecting locking lugs 57 carried on mandrel 50. Each locking lug 57 has an inclined wedge surface 58 wedgingly and lockingly cooperable with an inclined wedge surface 59 provided on a locking bolt 60. Bolt 60 is slidably received within a transverse part circular housing 61 formed on barrel 52, said housing 61 extending beyond the outer surface of barrel 52 in a generally U-shaped cross-sectional configuration to facilitate gripping of an actuating head 62 on the outer end of bolt 60 by a claw or other power-operated mechanism of an underwater manipulator or robot device. Bolt 60 is guided longitudinally and held against rotation by a longitudinally extending slot 63 therein which receives a guide pin 64 threaded in housing 61.

Thus when barrel 52 is lowered over mandrel 50 which projects from the wellhead within conductor guide 24 and locking bolt 60 are in retracted position as shown in FIG. 6, it will be apparent that the locking lugs 57 will enter slots 56 and be located adjacent the top of said slots so that when the locking bolt is pulled outwardly the inclined wedge surface 59 will move beneath the bottom wedge surface 58 on the locking lug and wedgingly interlock the barrel 52 with the mandrel 50. In some installations, the wedge surface and bolt may be arranged so that the bolt is moved inwardly for locking.

The barrel 52 forms the lower part of a wellhead unit 16 which has been preassembled before lowering into the water. Barrel 52 may be connected by well-known clamp means 70 to a wellhead Christmas tree housing 71 of generally cylindrical elongated form and coaxially aligned with the mandrel 50 and the production string 41. Wellhead housing 71 supports production master flow valves 72 and 73, said valves 72 and 73 being normally open and adapted to be closed when production control unit 14 is to be recovered. Wellhead unit

housing 71 also supports gas flow valve means 74 of annulus valve type and which is normally open and adapted to be closed for recovery of production control unit 14. At the top of housing 71 may be a swabbing valve means 75 which is normally closed and is adapted to be opened for access to the wellhead housing 71 for swabbing purposes.

Wellhead unit 16 is also provided with pipe connector means 77 for connecting production oil lines, gaslines, and control cables to wellhead unit 16, the opposite ends of said production oil lines, gaslines and control cables being connected by similar connector means 78 to production control unit 14. In this example, production oil flow is connected from wellhead unit 16 to production control unit 14 through pipe 80 which may be suitably bent so as not to interfere with access to various valves and connections on the wellhead and production units by a manipulator device. Gas flow between the units 16 and 14 is provided by pipe 81 suitably bent and configured for the same purpose. Control cable 82 connects the units 16 and 14 in similar manner to provide control of the master valves 72, 73 and 74 and the shutoff valves 43, 46. The schematic control and operation of these valves is best shown in FIG. 3 which will be described hereafter.

Connector means 77 and 78 for connecting the oil flow line 80, gasline 81 and control cable 82 to wellhead unit 16 and production control unit 14 may be of the same construction and are described and claimed in copending application Ser. No. 742,435 owned by a common assignee. Briefly, connector means 77 (FIG. 7) includes an externally threaded end portion 100 provided on end 101 of connecting flow pipe 80, said end portion 101 carrying a triangularly cross-sectional shaped seal ring 102 adapted to project beyond the end face of portion 101 for sealing engagement with an outwardly flared counterbore surface 103 provided at the open end of passageway 104 in the wellhead housing 71. The internal end of passageway 104 is connected to the production flow line in well-known manner (not shown). A generally cylindrical collar 105 may be provided with an end portion 106 having internal threads 107 for threaded engagement with the externally threaded portion 101. End portion 106 has an end face 107 spaced from the surface of housing 71 but in relative close proximity thereto so that end face 107 may guide against and reference on the external surface of housing 71 when the collar 105 is guided into engagement with an upwardly opening U-slot 108 provided in a wall 109 spaced from the surface of housing 71 by a pair of spaced projecting tension walls 110. Collar 105 has an intermediate neck portion 111 defined by end portion 106 and the opposite end portion 112 which may carry external gear teeth 113 for rotating collar 105. The intermediate neck portion 111 defines opposed surfaces 114 and 115 which serve as abutment surfaces against wall 110, said abutment surfaces having relatively loose tolerance or spacing with respect to wall 109 so as to permit initial axial misalignment of pipe 80 and collar 105 with respect to the axis of the passageway 104.

When the collar 105 is rotated by engagement of the gear teeth 113 by a suitable tool such as described and claimed in copending application Ser. No. 779,004, rotation of collar 105 will advance end portion 101 of the pipe 80 towards the wellhead housing 71 and any misalignment of the axis of pipe 80 with passageway 104 will be corrected as the abutment surfaces 114 move into full contact with the wall 109. In final rotation of collar 105, the seal means 102 is pressed into sealing contact with the sealing counterbore surfaces 103 on the wellhead housing, and the end portion 106 is in tight abutment with wall 109 in such a manner that the spaced projecting walls 110 are subjected to tension forces.

It will be apparent from the arrangement of the connector means 77 and 78 and the manner in which the interconnecting pipe 80, 81 and cable 83 are bent that a manipulating device mounted on the spaced rails 22 may be readily positioned for engagement of the power-operated tool with each of the end portions which carry the external gears. It should be noted that the axes of the connector devices lie parallel to the rail

members 22 or the path of movement of the manipulator robot device.

In the application Ser. No. 779,004 disclosing as exemplary tool for actuating the connector means 77 and 78, the actuator device comprises a jaw means wherein a lower movable jaw portion is adapted to be opened to permit engagement of a worm thread carried by a fixed jaw portion for rotation of the collar 105 when the lower jaw portion is closed.

Production control unit 14 generally includes valves and flow control means operable by a suitable power means including electric motor, pump, accumulator, and hydraulic oil reservoir suitably contained and enclosed within a top housing means 120 provided on a readily recoverable and removable top production control portion 121 which may be carried by a lower removable production control portion 122 supported from the manifold means 26 carried by the well template assembly. In this example, manifold means 26 includes an upstanding support column 124 carried by manifold means 26, the upper portion of support column 124 serving as a mandrel to provide a readily releasable connection with a lower barrel 125 of the lower production control unit portion 122. The barrel 125 and mandrel portion of the support column 124 are releasably interlocked by wellhead connector means 126 which are constructed and operable in the same manner as the wellhead connector means described in FIGS. 4-6, inclusive. The upper end of barrel 125 may be connected by suitable clamp means 128 to the upper section 129 of the lower production control unit portion 122. Upper section 129 carries suitable wellhead switching valves such as valve means 131 for the oil flow line, 132 for the gasline, and 133 for the oil test line. Valves 183, 185 and 184 are adapted to be closed for shutting off flow between the upper portion of the production control unit and the manifold 26 to isolate a wellhead unit 16 to permit removal of the upper portion 121 of the unit 14 for repair and maintenance.

Upper production control portion 121 is releasably connected to the lower portion 122 by wellhead connector means 135 which includes a barrel 136 and lock bolt means 137 cooperable with an upper mandrel portion of the section 129 in the same manner and construction as described in FIGS. 4-6, inclusive. The production control unit housing 120 may be connected to the upper portion of the barrel 136 by suitable clamp means 138.

Manifold means 26 as previously mentioned includes oil collection or gathering line 28, oil test line 27 and a gasline 29, such lines being connected with each production control unit 14 in the same manner as described for FIG. 2. It will be apparent that a selected production control unit of the several supported by the wellhead template means may be isolated from the manifold means 26 by the isolation valve 183-185, inclusive, carried in the lower portion 122 of the production control unit 14.

In the production control unit 14 the system of control or actuating valves there shown is operated by pressure fluid from accumulator 142 which flows through line 145 to a common manifold pressure line 146 which supplies pressure fluid to the fluid actuated valves. Production flow and gas valves in the wellhead unit 16 may be controlled by a pair of three-way, two-position valves 148 and 149 which may be solenoid-controlled, spring return-type valves. Valve 148 is connected by fluid control line 150 to normally open under fluid pressure valve operators 151 and 152 of single-acting, spring return-type connected respectively with the oil and gas valves 43 and 46. Thus, actuation of valve 148 will cause pressure fluid to control normally open valves 43 and 46 which move into closed position for shutting off flow of oil and gas from and into the well hole upon pressure decrease and the spring return means. Valve 149 is connected by pressure line 154 to single-acting, spring return-type valve operators 155, 156 and 157 which actuate respectively the production master control valves 73 and 72 and the gas valve 74. Thus, suitable operation of valves 148 and 149 may open or close the production flow control valves in the wellhead unit as well as the gas injec-

tion flow. Valves 148 and 149 are solenoid actuated and controlled by suitable electrical means, acoustical devices or other well-known arrangements for transmitting control signals.

With production control unit 14, production oil from production string 41 is transferred through the oil connector line 80 to an internal flow line indicated at 28a is controlled by a well-known flow-bean-type valve schematically indicated at 160, said valve being actuated by a double-acting spring-centered actuator 161 controlled by pressure fluid from lines 162 and 163 at control valve 164 which may be a four-way, three-position float-centered solenoid control and spring-centered valve construction. Pressure fluid for valve 164 is drawn from manifold line 146, and line 163 is connected to manifold pressure fluid return line 165 which returns pressure fluid to the reservoir 140. The variable flow restriction valve 160 is of well-known type, such as Willis flow-bean-type "S."

Similarly, a flow control valve 167 may be provided in the gas injection line 29a within the production control unit 14, valve 167 being of a type similar to 160 and having a variable flow restriction or flow bean-type construction. Valve 167 is actuated by a double-acting, spring-centered operator 168 connected by pressure fluid line 169 and return line line 170 to a four-way, three-position float-centered, solenoid-controlled spring-centered valve means 171 of the same type and arrangement as valve 164.

Each switching valve 131, 132, 133 in the production control unit 14 may be controlled by operators 173, 174, 175, respectively, each of single-acting, spring return type and connected to pressure fluid by respective lines 176, 177 and 178, each of said lines being connected to respective valves 179, 180 and 181. Each of valves 179, 180 and 181 may be of three-way, two-position solenoid control, spring return type and may be connected as schematically indicated to pressure fluid manifold line 146 and to manifold return line 165.

Mechanical operated isolation valves for production oil line 28, test line 27 and gasline 29 are schematically indicated at 183, 184 and 185 outside of the production control unit 14.

In operation of the production control unit and wellhead unit, it will be apparent that the various pressure fluid valves 148, 149, 171, 164, 179, 180 and 181 may be energized or controlled by suitable electrical means or other control signal means for pressure fluid actuation of their respective normally open under pressure operator valves 151, 152, 155, 156, 157 in the wellhead unit and operator valves 161, 168, 173, 174, 175 in the production control unit. Thus, during production, flow of oil may be readily controlled by the variable flow bean restriction valves 161 so that the rate of flow from each well hole in the well system may be properly correlated to the flow rate of other well holes in the system so that a desired continuous uniform flow of oil is produced by the wellhead system of this invention. It will also be apparent that when it is desired to test oil from any one of the wellhead producing units, the switching valves 131 and 133 of each production control unit may be so actuated as to divert the flow from line 28a into line 27a for obtaining a sample of the oil from the well for testing purposes.

The injection of gas into the well may be readily controlled by actuation of the variable restriction valve 167. Valves 74 and 46 are normally open valves, and of course may be closed in the event injection of gas is not required.

From the schematic diagram of FIG. 3 and the arrangement of the wellhead unit 16, production control unit 14 and connector means 82, 80 and 81 between the units, it will be readily apparent that in the event it is desired to remove the production control unit 14 from the wellhead assembly for maintenance and repair that master control valves in the wellhead unit 72, 73 and 74 may be closed and the isolation valves 183, 184 and 185 may be closed so that upon disconnecting the lines 80, 81 and 82, the upper production control portion 121 may be readily removed by moving the wellhead connector bolts at the wellhead connector means 137 by a suitable mechanical tool means generally described hereinabove. In

this instance, means are provided for removing the pressure fluid from the operators 155, 156 and 157 of the master control valves in the wellhead unit, such reduction of fluid pressure causing the operators to close mechanically (spring return) when pressure is removed.

It will also be apparent that the wellhead unit 16 may be separately and independently removed from the wellhead template frame construction by closing valves 43 and 46, disconnecting the lines 80, 81 and moving the wellhead connector bolts 60 into release position so that the barrel 52 and associated master control valves 72, 73 and 74 may be recovered for repair and maintenance of such valves.

Thus in the wellhead system described above, a plurality of associated sets of wellhead units and production control units may be separately and independently worked upon without interruption of the production flow from the other sets of wellhead and production control units. Each well may be independently controlled and regulated and tested.

The installation of the above-described wellhead system is facilitated by the provision of the wellhead template frame construction already equipped with conductor guide means, production control units, manifold means and control lines. Thus, subsea work on the wellhead system is minimized and yet the work required to install the wellhead system may be readily accomplished by mechanically actuated tools and connections operable from a diving bell or other suitable deep sea structure.

It will be understood that various modifications and changes may be made in the wellhead system and method of installing the system which come within or embody the spirit of the present invention.

I claim:

1. A subsea wellhead system comprising:
a wellhead template assembly including:
a wellhead means adapted to be associated with a well hole and including a removable wellhead unitary portion, and
a production control means spaced and separated from said wellhead means and including a removable production control unitary portion;
means operably interconnecting said wellhead and production control means;
each of said wellhead and production control unitary portions being adapted to be isolated from the wellhead system;
whereby a selected one of said removable portions is recoverable for maintenance above surface without disturbing the remainder of the wellhead template assembly.
2. A wellhead system as stated in claim 1 wherein said wellhead template assembly includes a plurality of sets of such wellhead and production control means; and
a common manifold means connected to each of the production control means.
3. A wellhead system as stated in claim 1 wherein said production control unitary portions includes
valve means for controlling and regulating flow of fluids into and out of the well hole.
4. A subsea wellhead system as stated in claim 1 including means operably interconnecting said production control means with a remote sea surface location for operating said production control means at said remote location.
5. A wellhead system as stated in claim 1 wherein said wellhead means includes control valves for said production flow line operable into fail-safe closed position and in closed position permitting removal of said production control means.
6. In a subsea wellhead system for a plurality of relatively closely spaced well holes in an ocean floor, the combination of:
a wellhead template assembly at said ocean floor and including template frame means;
a wellhead means associated with each well hole;
a production control means supported on said frame means adjacent to and separate from said wellhead means;

a manifold means connecting each of said production control means;
 each of said wellhead means including a removable recoverable unit comprising valve means for well fluids;
 each of said production control means including a removable unit including flow control means for said well fluids, and
 control means for said valve means in said wellhead means and said production control means; and
 connecting lines for conducting well fluids between said wellhead means and production control means.

7. In a wellhead system including a plurality of well holes in a preselected arrangement, the provision of:
 a wellhead template frame construction including a plurality of conductor guide means arranged in the same pattern as said well holes;
 means on each conductor guide means for connecting a wellhead unit thereto;
 a production control unit carried by said template frame construction adjacent to each conductor guide means and adapted to be connected to an associated wellhead unit;
 manifold means carried by the template frame construction and connected with each production control unit for flow of production oil and gas;
 each of said production control units including separable portions, one portion including valve means for isolating said production control unit from said manifold means; and
 means releasably interconnecting said other production control unit portion to said one portion for recovery of said other portion for maintenance thereof.

8. A wellhead system as stated in claim 7 including:
 a wellhead unit connected to each of said conductor guide means and associated well hole; and
 means releasably interconnecting each of said associated wellhead units and production control units for flow of production oil and gas therebetween and for control of such flow.

9. In a method of establishing a wellhead system for a subsea well installation having a plurality of well holes arranged in a preselected, compact pattern, the steps of:
 placing a prefabricated wellhead template construction having conductor guide means arranged in said preselected pattern in registered operative relation with said well holes, said wellhead template construction including separable removable production control units in adjacent relation to said conductor guide means;
 connecting a preassembled wellhead unit to each well hole and conductor guide means therefor;
 releasably interconnecting each of said wellhead units and adjacent production control units with production oil and gas flow lines;
 and releasably interconnecting each of said wellhead units and adjacent production control unit with control means; whereby each of said production control units may be independently isolated from its associated wellhead unit and wellhead template frame construction for recovery thereof.

10. In a method of establishing and maintaining a wellhead system for a subsea well installation which includes a plurality of well hole locations in a selected pattern, the steps of:
 providing a wellhead template construction having conductor guide tubes arranged in a pattern corresponding to said selected well hole pattern and carrying production control means including separable movable production control units;

lowering and releasably connecting a wellhead means including a separable wellhead unit to said conductor guide tubes;
 releasably interconnecting said wellhead means and said production control means for control of gas and oil flow lines and control means therefor and for isolation of one of said units from the other unit;
 and removing a selected one of said units for maintenance thereof.

11. In a method as stated in claim 10 including the steps of:
 manifolding the gas and oil flow lines of a plurality of production control means whereby one of said units selected for maintenance may be independently isolated for removal and recovery thereof while said other units retain their operable condition

12. In a wellhead system including a plurality of well holes normally adapted to be simultaneously operated, the combination of:
 a wellhead template frame structure;
 wellhead means including a separate wellhead unitary portion on said frame structure and adapted to be associated with a well hole;
 a production control means including a separable production control unitary portion spaced from said wellhead means;
 means operably interconnecting gas and oil flow lines of said wellhead means and production control means;
 control means for said wellhead means and production control means and including
 means for isolating at least one of said separable unitary portions whereby said one separable portion is recoverable and removable for above-surface maintenance.

13. In a wellhead system as stated in claim 12 including:
 a plurality of wellhead means and a plurality of production control means associated therewith;
 and common manifold means for said plurality of production control means.

14. In a wellhead system as stated in claim 13 including track means spaced from said production control means and extending from one production control means to the adjacent production control means;
 means on said wellhead means and production control means for releasing said wellhead unitary portion and production control unitary portion respectively,
 said release means on said wellhead means and production control means being accessible from said track means and adapted for separate independent release of a unitary portion with respect to the other unitary portion.

15. A subsea wellhead system comprising:
 a wellhead template system comprising:
 a plurality of wellhead means each adapted to be associated with a well hole, and
 a plurality of production control means spaced and separated from said wellhead means;
 means operably interconnecting said wellhead and production control means;
 each production control means including means for selectively directing production fluid into a common production manifold or test flow line;
 each of said wellhead and production control means including
 a removable unit adapted to be isolated from the wellhead system,
 whereby a selected one of said removable units is recoverable for maintenance above surface without disturbing the remainder of the wellhead assembly.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,633,667

Dated January 11, 1972

Inventor Chester B. Falkner, Jr.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 1, line 15, delete [include] and insert --included--;
same columne line 33, -delete [an] and insert --and--

Column 3, line 7, delete [by] and insert --be--

Column 4, line 21, delete [gasolines] and insert -- gas
lines--

same column, line 43, "an", second occurrence, should read
-- and --.

Column 6, after line 52,--control unit 14. add ¶

The production control unit housing 120 may be further understood by reference to Fig. 3 which shows a schematic flow diagram for flow and control of the production operations. In Fig. 3 the relatively large rectangular block indicated by dash lines includes the components carried by the production control unit 14 and the smaller rectangular dash line block includes those components associated with wellhead unit 16. Within the production control unit housing 120 may be provided a fluid reservoir 140, a fluid pump 141 and an accumulator 142. A check valve 143 is provided in the line 144 between the pump and accumulator so that a desired fluid pressure may be maintained in the fluid operating lines controlling actuation of the several valve means in the wellhead unit and production control unit.

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,633,667

Dated January 11, 1972

Inventor Chester B. Falkner, Jr.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 7, line 5, delete [With] and insert --Within--

IN THE CLAIMS:

Column 10, line 50 delete [system comprising] and insert --assembly including--

Signed and sealed this 15th day of August 1972.

(SEAL)

Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents