A two unit well head assembly for submarine oil well completions which includes suspension means for production pipes, connection means for electric lines and hydraulic control lines, valves for controlling flow through passageways in the well head and guide means to ensure correct alignment of the assembly.
Fig. 1
Fig. 6
BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to a production well-head designed for oil-wells situated at great depth with the aim of facilitating its installation and the systematic checking and maintenance of all flow and pressure checking apparatus and all associated measuring and control fittings, the correct functioning of which is necessary to the working of the well.

2. Description of the Prior Art

The pressure and flow checking equipment of the submarine production well-head differs from that of a land well by the manner in which its fittings are installed and maintained. However, the overall structure of a submarine well-head is at present substantially the same as that of an ordinary land well.

Although such a similarity is the cause of considerable problems when the well is submerged at shallow depth, it can still allow the well to be properly worked. On the other hand, when the depth is increased, an operational defect in any production checking fitting requiring attention entails, in addition to the loss of production due to closing down the well, the costly attention of work teams at great depth, divers or robots. In addition it is economical to automate or remotely control certain safety fittings and controls for routine operations such as opening, closing and regulation of the well flow, to avoid costly work in situ. However, the complexity of these automatic or remotely controlled fittings necessitates their planned maintenance or replacement. To reduce to a minimum the costs of servicing and production stoppages, it is advantageous to make this maintenance or replacement simple and automatic, which leads to modification to the conventional design of production well-heads.

SUMMARY OF THE INVENTION

According to the present invention there is provided a well-head assembly suitable for a submarine oil-well, comprising a drilling-head having a chuck for suspension of production pipes including in addition to the production string and the pipe connected to the annular space, all channels for electric lines and hydraulic controls necessary for control of the valves and apparatus situated in the well; a first, combined, detachable unit including a first series of channels, electric lines and hydraulic controls to be connected to the set of production pipes, electric lines and hydraulic controls of the well, the said channels and lines of the first unit being adapted to be aligned with the production pipes and lines of the well for their simultaneous connection, and secondly, valves in the said channels which are externally controllable to close or open the said channels; a connector adapted to lock the said first unit onto the boring head; a second combined and detachable unit including all channels and lines for simultaneous connection to the first unit in the same manner as that in which the latter is connected to the boring head; and a production products collection channel passing through the second and the first units to open into a lateral channel, the said channels of the second unit including all metering and control apparatus necessary to the working of the well.

This combined structure overcomes the disadvantages resulting from difficulties in replacing faulty elements. In fact, as the first unit only contains valves, which are moreover rarely operated, defects can only arise in the second unit, the latter including all the control and checking fittings of all devices — including safety fittings — necessary to the proper working of the well. As the second unit is situated in the upper part of the well-head and is provided with at least one connector to connect it to the first unit, faulty materials can be changed simply by disconnecting the second unit from the first, after ensuring that the valves in the production channels have been closed, and raising the second unit to the surface. Such an operation can only be effected with present well equipment by withdrawing each defective fitting or maintaining it individually by diver or by means of a manipulating module submersible at atmospheric pressure, these means moreover being slow, costly and also limited to shallow depths. In addition, the invention enables practically any fault to be anticipated. In fact, knowing the failure statistics of the various fittings of which the second unit is composed, it is sufficient, at the end of a service period of this lower unit at the mean time between failures of the fitting of which the failure frequency is highest, to exchange the said unit for an identical unit and then systematically overhaul it on the surface.

A further object of the invention is a well-head of this type in which the said channels and lines of the second unit terminate in addition at a multiple connection device similar to the device for connection of the second and first units, the axes of the channels corresponding to the production pipes being in addition coincided with the axes of these pipes.

The main advantage of this well-head is that it allows, whenever it is required, the direct control of the well by any vessel, mobile platform or other surface support, this control being effected not only by means of electric and hydraulic lines to transmit power and commands but also by the production channels. In particular it is possible to effect any cable work because of the alignment of the channels of the units and the well-pipes.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 shows a diagrammatic section of the boring head and means for attachment of a support structure;

FIG. 2 is a diagrammatic view showing the first detachable unit after its connection to the piping head;

FIG. 3 is a diagrammatic view of the first detachable unit showing two means for protection of the boring head and the unit after connection;

FIG. 4 shows a section along line IV—IV of FIG. 3;

FIG. 5 shows a diagrammatic view of the first detachable unit;

FIG. 6 shows a diagram of the main circuits of the assembly formed by the first and second detachable units;

FIG. 7 shows a diagrammatic elevation of the checking equipment forming an integral part of the second detachable unit, and

FIG. 8 shows a diagrammatic plan of the checking equipment of the second detachable unit.
DESCRIPTION OF A PREFERRED EMBODIMENT

Although the casing heads and in particular the chuck for suspension of the production piping may be of any design for clarity of description, FIG. 1 shows the boring head to which a first detachable unit is connected. The suspension chuck 40 of the production string 41 and pipe 42 leading to the annular space is locked and sealed on drilling head 8 by seals 14, 43 and fastening means of any suitable type. It rests by any known device on piping 45, the latter itself resting on an internal shoulder of drill head 8. In the example shown, drill head 8 rests on a shoulder of intermediate pipe 46 in outer casing 25.

In the example shown in FIG. 2, the base of the wellhead equipment consists essentially of a guide structure 13 which may, for example, include guide columns 13a. Structure 13 can be attached to outer casing 25 in any manner. This structure does not form part of the invention and may be of any type.

In accordance with a first embodiment of the invention which is illustrated in FIG. 2, drill head 8 is associated with a seal and support fitting 7 which is as seen more clearly in FIG. 1, locked onto piping 46 and locked laterally against outer casing 25 by a mechanism 7a. This fitting is rigidly connected through flange 6 to a base consisting essentially of a horizontal plate 1 having a lateral rim 2 (FIG. 2), with an opening formed in it for passage of conduits connected to unions as 3 and 4 and a horizontal bearing surface 5. The seal and support fitting 7, surrounding drill head 8 in a rigid and tight manner, constitutes with the well an assembly which is tight to sea-water and well effluent.

This feature offers the advantage of being able to fit on surface 5 any means facilitating the connection of detachable unit 9, the upper and lower extreme edges of which are indicated by broken lines 15 and 16, respectively. In particular, the tightness obtained by drill head 8, seal and support fitting 7 and surfaces 1, 2 and 5 permits the location of a service module submersible at atmospheric pressure inside which a team can carry on with the operation of connecting unit 9 to drill head 8, passages 22 and 24. FIG. 1, integral with unions 49 and 50 of unit 9 penetrating respectively into the inside of the production string 41 and the pipe 42 of the annular space.

It will be noticed that the submersible module could be guided by any means forming part of base 1 or even of bearing surface 5, or that the submersible module could include on its external surface pieces in the form of truncated cones or simple forks cooperating with columns 13a.

In the example shown in FIG. 2, columns 13a pass through plate 1 in a region adjacent to its periphery. As the locating process does not form part of the invention, the guide structures which enable the ends of columns 13a to be introduced into the orifices provided in platform 1 may be of any type and have not been included in the drawings. Guide cones rigidly attached to platform 1 could serve as a guide structure.

With unit 9 is associated a mechanical connector 51, which locks unit 9 onto drill head 8 when the latter, suitably positioned to coincide the axes of unions 49 and 50 with the axes of conduits 41 and 42, is depressed for simultaneous insertion of unions 49 and 50 into the corresponding conduits. This operation also causes the automatic connection of all other electrical or hydraulic lines represented diagrammatically by 52 and 53, FIG. 4, respectively. Elephants 55 permit the checking of the bottom hole pressure metering apparatus and hydraulic lines 53 permit the control of the bottom hole safety valves.

The precise alignment and positioning of unit 9 relative to the casing head and the chuck for suspension of the production piping are obtained by manual guiding, assisted by any appropriate means such as block and tackle, strainer, etc.

The chuck for suspension of the production piping has itself been positioned on completion of the well, using as a reference the guide means which have been used for boring.

As the tools for positioning of this suspension chuck do not form part of the invention, they are neither described nor illustrated here.

In accordance with a second embodiment of the invention which is shown in FIG. 3, outer casing 25 is associated with a support structure 13 and a guide structure 55. A carrying tool guided by 55 comes to rest on the said support structure 13, impacts and forces due to guiding and initial contact being transmitted to the resistant pipes of greater diameter. The said carrying tool surrounds and supports unit 9, by means of a suspension controlled, for example, by hydraulic rams. The final approach, the precise alignment and then the soft connection of unit 9 onto drill head 8 can then be controlled, the alignment and orientation of the channels in unit 9 and the corresponding production pipes in the wells being obtained by any known means, such as guide cones and columns, bolts and positioning grooves.

The guide structure 55 can optionally include in its upper part a conical portion to serve as an auxiliary guide to the lower part of unit 9. It may have any desired form compatible with the loads to be supported and enables a second structure 56 rigidly connected to unit 9 to rest on permanent structure 13. The guide structure 55 of drill head 8 and structure 56 of unit 9 preferably consists of plates and angle-iron leaving a free passage for the controls of valves 17, 18, 52 for opening or closing the channels formed in unit 9 and shown diagrammatically in FIG. 6. Shock-absorbing blocks between unit 9 and structure 56 deaden possible shocks on connection of the second unit.

In this same Figure, the connection of unit 9 and drill head 8 has been represented by rectangle 47. In addition to valves 18 and 19 which open or close channels 23 and 24 connected to the production string 41 and pipe 42, a valve 17 has been provided which opens or closes the header conduit 21 connecting unit 9 with union 3. The latter is connected to the above-mentioned channels by circuits of unit 22 which will be described below.

Each of the three valves 17 to 19 can be controlled by any control device, for example by means of a manipulator placed on a tool-holder or by means of the device which is used to bring unit 9 onto the boring head. These valves can be controlled manually, particularly when the unit shown in FIG. 2 is used with a service module submersible at atmospheric pressure.

Thus unit 9 only contains simple, robust and reliable fittings which permit isolation of the well and can consequently be left in place for a very long period, so as to avoid any servicing during the lifetime of the well.
Detachable unit 22, FIG. 5, is connected to unit 9 in a manner similar to the connection of unit 9 to boring head 8 and has channels 56, 57 and 58, shown diagrammatically in FIG. 6, which are connected respectively to channels 21, 23 and 24 in unit 9 via connection portion 48. A hydraulic connector 59, FIG. 5, locks units 9 and 22 together as unit 22, originally oriented in the position suitable for alignment of the axes of the above-mentioned channels, is lowered onto unit 9 to simultaneously connect all the corresponding channels. A bolt and groove — or positioning finger — device ensures the positioning of unit 22. In order to avoid uselessely overloading the drawings, only connections 56 and 58 have been shown. It is, however, clear that the connections of the electrical and hydraulic lines corresponding to lines 52 and 53 of unit 9, FIG. 4, are effected simultaneously.

Functionally, unit 22 can be considered as a production shaft similar to a conventional land production shaft but having neither the first master production valve nor valves 19 and 17 for isolation of the annular header space.

Channel 57 above production string 41 has a safety valve 68 with automatic or controlled closure, the controls being electrical or hydraulic. A top valve 70 can be operated by a manipulator or an electric or hydraulic motor when it is required to carry out work in the well. For this purpose, a column (not shown) which contains all the necessary channels and lines is connected onto the head 22a of unit 22, FIG. 5, by means of any appropriate connector, represented diagrammatically by bolt 60. As soon as vertical access to the well is no longer necessary and the manipulator ceases its action, valve 70 closes again automatically, the internal pressure of the well and the action of a spring contributing to holding this valve closed.

Work in the annular space is carried out after opening valve 27 at the top of channel 58 and progresses in a manner identical to that just described for vertical access to the production string by opening valve 70.

Valve 54, which is usually held closed, can be controlled hydraulically to purge the annular space by means of branch 61 which opens out, through nozzle 63 downstream of the hydraulically controlled, adjustable nozzle 62, in collection channel 56.

Lateral valve 26 enables the production evacuation into the collection channel 56 and from there into the header channel 21 to be controlled. Valve 26 is controlled hydraulically remotely or by any automatic safety device.

Unit 22 is also rigidly connected to hydraulic control units represented diagrammatically by their containers 30, 31 and 32, FIGS. 7 and 8, to a remote metering unit 33 and to an electrical distribution system 34, these various elements being incorporated in a protective structure 22b.

The arrangement of the containers permits access to the various valves in unit 22 to control or check them by means of an external manipulator.

The hydraulic units 30, 31, 32 contains the electric pumps and the electrodistributive devices which direct the hydraulic power to the selected valve or fitting.

The electrical distribution unit 34 consists of a tight container enabling the electrical assembly to be maintained at atmospheric pressure. This assembly controls the valves and fittings of the well-head.

Remote metering unit 33 enables the work and service parameters, such as well-head pressure, annular pressure, collection pressure, hydraulic system pressure and voltage and intensity of the control and power circuits to be measured and transmitted remotely. This unit similarly enables the position indication of each valve and temperatures to be transmitted.

As an example, FIG. 6 shows pressure transducers 64, 65 and 66 in channels 56, 57 and 58 and a temperature transducer 67 in channel 56. However, as the so-called measurement transmission circuits do not form part of the invention, these circuits have not been shown.

Unit 22 thus equipped can be connected by its upper end 22c to any multiple connection device of a tight column suspended from a surface support and particularly containing electric lines, remote-metering lines, hydraulic control lines and two strings of rods, one connected to the production channel 57, the other to the annular space channel 58. The well can thus be placed at any moment under the direct control of an appropriate surface unit.

A guiding and protective structure 22b surrounds unit 22 and the various containers 30 to 34, is therefore provided for this purpose.

It is clear that as all the technical elements composing the various units described above have been borrowed from well-known techniques, no purpose would be served by showing in detail the valves, their control devices and, generally, the technological details involved in the various units shown diagrammatically.

What we claim is:
1. In an underwater well assembly having a production pipe assembly for transporting the well output to the water surface, a chuck for suspension of said production pipe assembly having passages therethrough for electric lines and hydraulic lines to control apparatus within the well and a stationary support structure extending laterally from the well assembly, the improvement comprising:
   a. a first unit remotely attached to said chuck, said first unit having a plurality of passageways therethrough in alignment with the passageways in said chuck, and a valve associated with each passageway, said valves being controllable from the outside of said first unit,
   b. a second unit remotely attached to said first unit, said second unit having a plurality of passageways in alignment with those of said first unit,
   c. at least one valve in said second unit communicating with each passageway to control the flow of fluid through said passageways,
   d. control means in said second unit to control the valves in said second unit and to control said apparatus within said well, and
   e. conduit means connecting said first unit to a transportation pipe to transport the well output to the water surface.
2. The improved underwater well assembly of claim 1 wherein a protective structure is affixed to said chuck and said stationary support structure to protect said chuck from later forces.
3. The improved underwater well assembly of claim 1 wherein both first and second units have protective structures affixed thereto, both said protective structures bearing on said stationary support structure.
4. The improved underwater well assembly of claim 1 wherein said chuck and said first unit have interengaging guide means to ensure the correct alignment of the passages.

5. The improved underwater well assembly of claim 1 wherein said first and second units have interengaging guide means to ensure the correct alignment of the passages.

6. The improved underwater well assembly of claim 1 wherein a protective structure is affixed to the external surface of said first unit, said structure having leg portions which bear on said stationary support structure.

7. The improved underwater well assembly of claim 6 wherein said protective structure comprises a plurality of generally flat plates attached to said first unit at equidistant points about its external surface, parallel to the longitudinal axis of said first unit, one end of said plates bearing on said stationary support surface.

8. The improved underwater well assembly of claim 1 wherein a protective structure is rigidly affixed to the external surface of said second unit, said structure having leg portions which bear on said stationary support structure.

9. The improved underwater well assembly of claim 8 wherein the protective structure comprises a plurality of generally flat plates attached to said second unit at equidistant points about its external surface parallel to the longitudinal axis of said second unit, one end of said plates bearing on said stationary support surface.

10. The improved underwater well assembly of claim 10 wherein said control means are surrounded by a protective structure attached to said second unit.

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