

3,136,363

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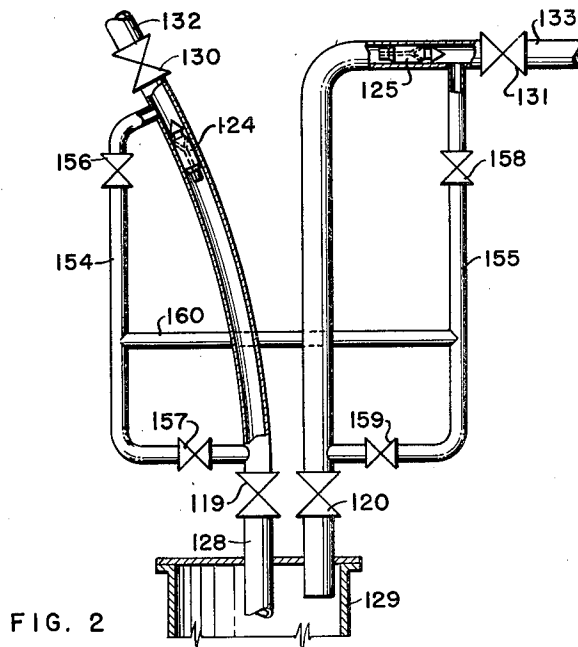
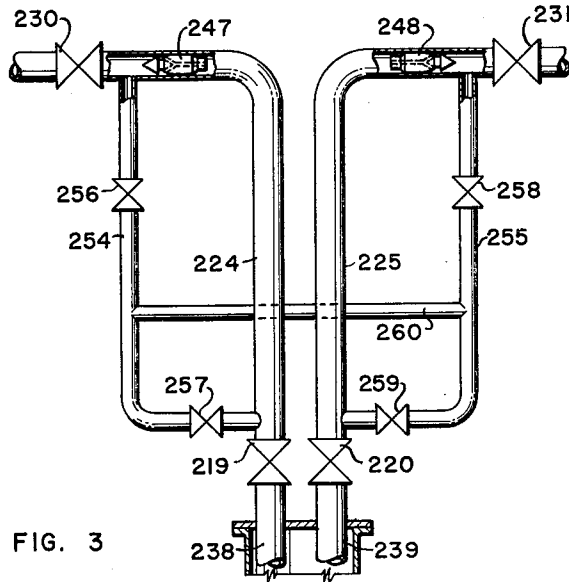
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HIGH PRESSURE WELLHEAD ASSEMBLY

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2 Sheets-Sheet 2



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HIGH PRESSURE WELLHEAD ASSEMBLY

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5 Claims. (Cl. 166-91)

This invention relates to equipment used at the top of an oil or gas well and pertains more particularly to a wellhead assembly adapted to be secured to the top of a well casinghead for controlling the fluid flow from the well while providing apparatus whereby substances such as chemicals as well as substances having a physical structure such as tools, instruments or other devices can be made to enter a high pressure well from a lower pressure flowline outside the well.

A recent development in the drilling and completion of oil and gas wells has been the drilling and completion of underwater wells wherein the wellhead assembly and casinghead may be positioned hundreds of feet below the surface of the water at an offshore location, one such method being described in copending patent application, Serial No. 830,538, filed July 30, 1959. In order to carry out maintenance and other operations on wells wherein the wellhead assembly is positioned a considerable distance below the surface of the water, methods for carrying out these operations have been developed. One of these methods has been classified as a "through-the-flowline" well maintenance technique. For performing the required operations involved in maintaining wells in this manner, various tools and other devices which are capable of being pumped into and out of the well bore through the production or fluid flowline have been developed. Since these maintenance tools and other devices must be pumped into a well bore, and since they are not able to pass around right angle bends in the normal wellhead assembly, a new type of a wellhead has been developed as described in copending patent application, Serial No. 834,095, filed August 17, 1959, now Patent No. 3,101,118.

Although a wellhead assembly has been developed into which tools and other devices may be pumped through the flowlines and into the well, well servicing operations have been hampered in many cases due to the fact that the flexible flowlines, which are generally used from underwater wells, do not withstand the high pressures encountered in many wells. For wells up to around 5,000 p.s.i. it is possible for the present flexible flowlines to take the full well pressure in the line. Since many wells may have pressures up to 10,000 p.s.i., it may be seen that any attempt to handle them in a 5,000 p.s.i. flowline would lead to rupture of the flowline.

It is, therefore, a primary object of the present invention to provide a wellhead assembly provided with a wellhead control manifold system whereby tools, instruments and other substances may be caused to enter a high pressure well from a low pressure flowline without exposing the low pressure flowline to the high pressures of the well.

A further object of the present invention is to provide a wellhead assembly having a wellhead control manifold system whereby flow control chokes employed to reduce well pressures to acceptable flowline pressures can be changed from a remote location by pumping the chokes to and from the wellhead through the flowline without exposing the low pressure flowline to the high well pressures.

Another object of the present invention is to provide a wellhead assembly including a wellhead control manifold system whereby slugs of various chemicals may be injected into the well from a low pressure flowline into a high pressure well.

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

FIGURE 1 is a schematic view illustrating many of the components which may be arranged as an underwater wellhead assembly for carrying out the objects of the present invention; and,

FIGURES 2 and 3 are alternative arrangements of dual flowlines at the top of a wellhead.

Although the wellhead assembly of the present invention is described hereinbelow with regard to a well having two parallel strings of production tubing suspended therein, it will be readily apparent that the present wellhead assembly can be modified so as to be employed on wells having a single tubing string or two concentric tubing strings, or on wells having three or more parallel strings of tubing suspended within a well casing.

Referring to FIGURE 1 of the drawing, a casinghead closure member 11 having an annular sealing element 12 carried on its outer surface is shown as positioned on the inner sloping seating surface 13 at the top of a casinghead 14, thus closing the casinghead 14 in a fluidtight manner. The casinghead closure member 11 is provided with a pair of vertical conduits centrally disposed in side-by-side arrangement and extending vertically down through the casinghead closure 11 in register with a pair of strings of production tubing (not shown) suspended within the well. For purposes of illustration, it may be considered that the well casinghead 14 and the wellhead assembly of the present invention are mounted on an offshore well and are positioned underwater.

Fixedly secured to the top of the casinghead closure member 11, as by bolts 17, is a master valve 18 having dual gates or closure elements 19 and 20 by which the well may be shut in upon closing of both gates of the valve 18. Preferably, a second master valve 18a having dual closure elements 19a and 20a is mounted above the master valve 18 as a safety precaution. The valves 18 and 18a are preferably of the remotely-controlled full-opening type, that is, the gate or plug controlling the flow within the valve is of a type that, when opened, furnishes a straight passageway through the valve of a diameter substantially equal to that of the vertical conduits 15 and 16.

Fixedly secured to the top of the master valve 18a is a Y spool piece 21 having a pair of vertical conduits 22 and 23 therethrough in register, through master valves 18 and 18a, with the vertical conduits 15 and 16 in the casinghead closure member 11.

Smoothly curving from the vertical conduits 22 and 23 of the Y spool piece 21 are a pair of side conduits 24 and 25 which branch upwardly and outwardly through the side wall of the spool piece 21. These branching side conduits 24 and 25 may be in the form of independent nipples, as will be described hereinbelow with regard to FIGURE 2, when it is not desired to employ any vertical conduits 22 and 23. The curvature of the side conduits or nipples 24 and 25 depends, to some extent, upon the length and the flexibility of the tools, instruments or other devices to be circulated down into the well through the side conduit. Thus, with presently developed tools, the radius of curvature of the side conduits or nipples 24 and 25 may be on the order of five feet.

Each of the side conduits or nipples 24 and 25 are provided with flanges 26 and 27, or other coupling means, for connecting a pair of control valves 30 and 31 to the side conduits 24 and 25. A pair of production flowlines 32 and 33 are connected to the other side of the control valves 30 and 31. The flowlines 32 and 33 which lead to the top of the wellhead assembly eventually curve outwardly and downwardly to the ocean floor and then run

along the ocean floor to the shore or to some tank positioned offshore for collection or separation purposes. In the event that the sections of production flowlines 32 and 33, directly connected to the control valves 30 and 31 are metal, they should be smoothly curved in an arc of a radius not less than that which would permit objects to be circulated therethrough into the well. It is quite apparent that whether the flowlines 32 and 33 are of a rigid or flexible material, all curves therein must have a minimum radius of not less than that required for circulation of objects therethrough.

From the construction of the present wellhead assembly, it may be seen that tools and instruments may be readily circulated down through the production flowline 32, the side conduit or nipple 24, and thence through the vertical conduits 22 and 15, down into a low pressure well. However, on circulating a tool (not shown) up from the bottom of the well, by reversing the circulation of fluid through conduits 32 and 33, the tool would be driven up the vertical conduit 15 and conduit 22 and become lodged therein rather than sweeping out the side conduit 24 and thence through the production flow line 32. It, therefore, has been found necessary to provide the vertical conduits 22 and 23 of the Y spool piece 21 with diverting plugs 34 and 35 which are removably positioned therein to close the vertical conduits 22 and 23 above the side conduits 24 and 25. The lower ends 36 and 37 of the tool diverting plugs 34 and 35, respectively, are shaped in a manner such that the lower tapered face thereof forms a continuation of the inner wall of the smoothly curved side conduits 24 and 25. That is, the lower end 37 of plug 35 is curved in a manner so as to bend in an arc of the same radius as the side conduit 25, while at the same time having a concave face machined, cut, or formed so that a concave portion is curved in a radius equal to that of the inside of the conduits 24 and 25.

The tool diverting plugs 34 and 35 are provided with fishing heads 40 and 41 by which the plugs 34 and 35 may be removed, as by means of a wire line fishing tool. The tool diverting plugs 34 and 35 are also provided with suitable retractable latching or stop means in a manner well known to the art for fixedly positioning the plugs in place so that the well pressure does not force them upwardly out of alignment with the side conduits 24 and 25. Retractable latching means 42 and 43 are well known to the art and are used on many wire line tools. The latches 42 and 43 may be withdrawn or set in any suitable manner, as by manipulation of the fishing heads 40 and 41 with wire line or other tools. If desired, the plugs may also be provided with O-ring seals 44 and 45.

As described in copending patent application, Serial No. 834,095, filed August 17, 1959, suitable guide means are provided on the tool diverting plug 35 and on the interior wall of the vertical bore 23 of the Y spool piece 21 above the side conduit 25 for orienting the plug 35 to its proper position within the vertical bore 23 of the Y spool piece 21. Precise location of the plug within the conduit 23 is necessary in order to be able to circulate tools through the side conduit 25. If a wellhead of the present invention were to be employed above the surface of the water, the plugs 34 and 35 could be oriented into their proper position by hand with the use of suitable orienting markings on the top of the plugs. However, where generally the wellhead assembly of the present invention is to be positioned underwater where it is necessary to drop the plugs 34 and 35 into place or lower them by means of a wire line, it is essential that they be provided with guide means for their proper orientation. Any suitable guide means may be employed. In the event that an object or substance, such as a packer or a chemical, is to be circulated down the well for permanent use therein and it is not meant to be circulated back to the surface, then it is apparent that no diverting plugs 34 and 35 are needed in the spool piece 21 during that operation. Fixedly secured to the top of the Y spool piece 21 is a control valve

46 which is preferably of the identical design as the master valves 18 and 18a, having dual passageways therethrough will fill opening plugs or gates therein.

When the flowlines 32 and 33 are connected to low-pressure-rated flowlines which extend to shore, it is necessary to provide the side conduits 24 and 25 with suitable landing surfaces for removably seating and securing a pair of chokes 47 and 48 therein when the present wellhead assembly is employed on a high-pressure well. The chokes are pressure-reducing devices well known to the art and since their specific design and construction is a matter of choice and does not constitute part of the present invention, they will not be further described here. The chokes are provided with fishing heads 49 and 50 whereby they may be withdrawn from their seated position by a suitable tool. Each of the side conduits or nipples 24 and 25 are provided with a bypass conduit 54 and 55 around the chokes 47 and 48. Preferably, to facilitate the many operations which can be carried out with the present wellhead assembly, the conduits 54 and 55 extend from a point just above the master valve 18a to just below the control valves 30 and 31. Each of the conduits 54 and 55 is provided with a pair of valves 56 and 57, 58 and 59, respectively. A cross-over conduit 60 is provided which is in communication between the two bypass conduits 54 and 55 at a point between the pairs of valves therein.

The entire wellhead assembly of the present invention is preferably covered by a fluidtight chamber 66 to protect the component parts from the corrosive action of sea water and the accumulation of marine growth thereon. The valves 18, 18a, 30, 31 and 46 may be either electrically, pneumatically or hydraulically actuated by any suitable valve system well known to the art. In this particular installation an electric cable 67 is provided for conducting electric signals to energize the series of electrically actuated pilot valves 68-75 which control the flow of the hydraulic pressure fluid from electrically driven pumps 76 and 77. The pressure fluid is contained in reservoirs 78 and 79.

In another arrangement of the present wellhead assembly, shown in FIGURE 2, the side conduits or nipples 124 and 125 are in communication through valves 119 and 120 with a tubing string 128 within the well and the annulus 129 outside the tubing string 128, respectively. In this arrangement, there are no vertical conduits from the well and the side conduit or nipple 125 does not have to be a smoothly curving section of pipe since tools or instruments can only be circulated through flowline 132 and nipple 124 into the tubing string 128. However, slugs of chemicals could be injected into the well through either nipple 124 or 125. The well head control manifold system of FIGURE 2 is provided with control valves 130 and 131, bypass conduits 154 and 155, valves 156-159 and bypass conduit 160, all of these elements being similar to their respective counter parts described hereinabove with regard to FIGURE 1.

In some installations where it is not desired to circulate tools in the well but merely to inject slugs of chemicals therein, the wellhead assembly may be of the type shown in FIGURE 3 which is not provided with any smoothly curving conduit but merely with a pair of nipples 224 and 225 having right-angle bends in which to seat a pair of chokes 247 and 248 on the downstream side of control valves 230 and 231. The nipples 224 and 225 are in communication through valves 219 and 220 with individual parallel tubing strings 238 and 239. Like the assembly of FIGURE 1, the apparatus in FIGURE 3 is provided with bypass conduits 254 and 255 having valves 256-259 therein and a bypass conduit 260.

The operation of the wellhead of the present assembly will be described with regard to the operation of removing the flow-control choke 47 from the side conduit or nipple 24 (FIGURE 1) without subjecting the low-pressure flowline attached to flowline 32 to high well pressures.

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As a first step, all flow of fluid from the well is stopped by closing valves 30, 19a and 19, as well as valves 31, 20a and 20. It is to be understood that valves 46, 56, 57, 58 and 59 are normally closed. In order to pump a choke retrieving tool through flowline 32 to engage choke 47, valves 30, 56, 57, 58 and 31 would be opened. The choke retrieving tool would be pumped through flowline 32 and valve 30 to engage the fishing head 49 of choke 47. As the choke retrieving tool is pumped into place, the fluid in front of it will pass through bypass conduit 54, cross-over conduit 60, bypass conduit 55 and through control valve 58 to be discharged above choke 48 and thence out through valve 31 and flowline 33.

After the tool is latched onto the choke, the combined tool and choke would be returned to the starting point of the tool by reversing the flow of fluid in the above-described path. Thus, fluid would be pumped in through flowline 33, through valve 31, valve 58, bypass line 55, cross-over conduit 60, bypass conduit 54, and thence through valve 56 or valve 57 into the nipple 24 and through valve 30 into flowline 32. A new choke could then be pumped through flowline 32 in a similar manner with the fluid ahead of the choke passing through the manifold system, in the manner described hereinabove, to pass out the flowline 33. Again the running tool could be returned to its starting point by reversing the flow of fluid from flowline 33 through the manifold and out flowline 32. Instead of pumping fluid in through flowline 33, the flowing fluid stream from the well may be utilized, if desired, for returning the tools to their starting point. For example, the choke-retrieving tool and the choke could be returned to shore, or to a production platform, by closing valve 31, opening valves 20 20a and 58 and allowing well fluid to flow up conduit 16 through valves 20 and 20a, through pressure-reducing choke 48, through valve 58 and bypass 55, cross-over conduit 60 and thence through valve 57 into the side nipple 24 below the choke 47 and its running tool (not shown) attached thereto.

In another operation, various tools or other devices could be installed in the well by positioning the tool or instrument in a vertical or near-vertical position within the side nipple 24 after the choke 47 has been removed therefrom, and subsequently allowing the tool or instrument to fall freely through the master valves 19a and 19 down the conduit 15 and into the tubing string (not shown) in communication therewith. The operation would be accomplished in the following manner. After valves 19 and 20 were closed the choke 47 would be removed from the side conduit or nipple 24 in a manner described hereinabove. The downhole tool or instrument is then pumped through flowline 32 and valve 30 until it is seated in the nipple 24 above valve 19a. During this pumping operation, valves 30, 57, 58 and 31 are open so that fluid passes through the manifold and out the flowline 33. After the tool is in the nipple 24 above the valve 19a, valves 30 and 57 are closed and valves 19 and 19a are open to allow the tool to fall freely down the tubing string. When it is desired to return the tool to the nipple 24 above valve 19a, the fluid coming up the conduit 15 from the well is directed through open valves 19, 19a and 57, through cross-over conduit 60 and thence through open valve 59, choke 48 and open valve 31 into the flowline 33. After the tool has reached its position above valve 19a in the nipple 24, valves 19a and 19 are closed and the tool may then be pumped back to a platform by flowing the fluid in the reverse manner.

When it is desired to inject slugs of chemicals down the well, this may be done in a manner similar to the installation of the down-the-hole tools, described above. A slug of chemical would be located in the nipple 24 between the valves 30 and 19a and subsequently be allowed to gravitate down the tubing string, it being assumed that the chemical would have a higher specific gravity than the well fluid. The present manifolding assembly can also be employed on a gas well and would allow changing

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of the flow control choke, down-the-hole storm chokes, would allow running down-the-hole pressure recorders, etc., as well as injecting chemicals to prevent corrosion, to prevent hydrate, paraffin, and/or asphaltine formations.

We claim as our invention:

1. A wellhead assembly connecting a pair of tubing strings handling high pressures within the well to a pair of flowlines handling fluids at lower pressures outside the well, said wellhead assembly comprising a pair of flow nipples mounted on said wellhead assembly forming at least a portion of the flowlines in fluid communication with a pair of tubing strings within the well, at least one of said nipples being smoothly-curved branching upwardly and outwardly, each of said nipples having a choke landing surface in the bore thereof for seating a choke therein, well control master valve means carried by said wellhead assembly on the well side of said nipples for controlling the well fluid flow therethrough, second valve means at the other ends of said nipples, bypass conduit means in fluid flow communication with each nipple around the choke landing surface thereof, a pair of spaced valve means in each of said bypass conduit means, and cross-over conduit means in communication with and between said two bypass conduit means at a point between the pairs of valve means therein.

2. A wellhead assembly connecting a pair of tubing strings handling high pressures within the well to a pair of flowlines handling fluids at lower pressures outside the well, said wellhead assembly comprising closure means for closing the top of a well casinghead and having a pair of vertical flow conduits therethrough in communication with a pair of tubing strings within the well, a pair of flow nipples mounted on said closure means connecting the flow conduits of said closure means in fluid communication with said flowlines, at least one of said nipples being smoothly-curved branching upwardly and outwardly, each of said nipples having a choke landing surface in the bore thereof for seating a choke therein, well control master valve means carried by said wellhead assembly on the well side of said nipples for controlling the well fluid flow therethrough, second valve means at the other ends of said nipples, bypass conduit means in fluid flow communication with each nipple around the choke landing surface thereof, a pair of spaced valve means in each of said bypass conduit means, and cross-over conduit means in communication with and between said two bypass conduit means at a point between the pairs of valve means therein.

3. A wellhead assembly adapted to be secured to the top of a well casinghead for controlling the fluid flow from said well while providing dual conduit means permitting the entry of substances into a well as well as the circulation of said substances therefrom, said wellhead assembly connecting a pair of tubing strings handling high pressures within the well to a pair of flowlines handling fluids at lower pressures outside the well, said wellhead assembly comprising closure means for closing the top of a well casinghead and having a pair of vertical flow conduits therethrough in communication with a pair of tubing strings within the well, a pair of flow nipples mounted on said closure means connecting the flow conduits of said closure means in fluid communication with said flowlines, said nipples being smoothly-curved branching upwardly and outwardly, each of said nipples having a choke landing surface in the bore thereof for seating a choke therein, well control master valve means carried by said wellhead assembly on the well side of said nipples for controlling the well fluid flow, second valve means at the other ends of said nipples, bypass conduit means in fluid flow communication with each nipple around the choke landing surface thereof, a pair of spaced valve means in each of said bypass conduit means, and cross-over conduit means in communication with and between said two bypass conduit means at a point between the pairs of valve means therein.

4. The apparatus of claim 3 including a removably seated and latched choke positioned on the landing surface in the bore of each of the nipples.

5. A wellhead assembly adapted to be secured to the top of a well casinghead for controlling the fluid flow from said well while providing dual conduit means permitting the entry of substances into a well as well as the circulation of said substances therefrom, said wellhead assembly connecting a pair of tubing strings handling high pressures within the well to a pair of flowlines handling fluids at lower pressures outside the well, said wellhead assembly comprising closure means for closing the top of a well casinghead and having a pair of vertical flow conduits therethrough in communication with a pair of tubing strings within the well, a pair of flow nipples mounted

on said closure means connecting the flow conduits of said closure means in fluid communication with said flowlines, each of said nipples having a choke landing surface in the bore thereof for seating a choke therein, well control master valve means carried by said wellhead assembly on the well side of said nipples for controlling the well fluid flow, second valve means at the other ends of said nipples, bypass conduit means in fluid flow communication with each nipple around the choke landing surface thereof, a pair of spaced valve means in each of said bypass conduit means, and cross-over conduit means in communication with and between said two bypass conduit means at a point between the pairs of valve means therein.

No references cited,