

CAPPING STACK FOR USE WITH A SUBSEA WELL

FIELD OF THE INVENTION

[0001] The present invention relates to blowout preventer systems for use with subsea wells. More particularly, the present invention relates to capping stacks as used in association with the wellhead or the blowout preventer. More particularly, the present invention relates to capping stacks having a plurality of flow passageways formed therein so as to allow the fluid from the subsea well to pass upwardly therethrough and therefrom.

BACKGROUND OF THE INVENTION

[0002] As the worldwide demand for hydrocarbon fuel has increased, and known onshore reserves have not kept up with the demand, there has been increasing activity in offshore oil exploration and production. Reserves of oil known to exist in the offshore areas have steadily increased and an increasing percentage of world production is from these offshore areas. The offshore environment has presented numerous new challenges to the oil drilling industry which have been steadily overcome to allow efficient drilling and production in these areas, although the costs have been considerably higher than those of onshore operations.

[0003] Not only has the offshore environment made production more difficult to accomplish, it has also generally increased the risk of environmental damage in the event of a well blowout or other uncontrolled loss of hydrocarbons into the sea. As a result, known safety equipment, such as blowout preventers which have been used successfully in onshore operations, have been used in offshore operations also. In spite of safety precautions, blowouts of offshore oil wells are known to occur and will occur in the future.

[0004] Subsea drilling operations may experience a blowout, which is an uncontrolled flow of formation fluids into the drilling well. These blowouts are dangerous and costly, and can cause loss of life, pollution, damage to drilling equipment, and loss of well production. To prevent blowouts, blowout prevention equipment is required. This blowout prevention equipment typically includes a series of equipment capable of safely isolating and controlling the formation pressures and fluids at the drilling site. BOP functions include opening and closing hydraulically-operated pipe rams, annular seals, shear rams designed to cut the pipe, a series of remote-operated valves to allow control the flow of drilling fluids, and well re-entry equipment. In addition, process and condition monitoring devices complete the BOP system. The drilling industry refers to the BOP system as the BOP stack.

[0005] The well and the BOP connect the surface drilling vessel to a marine riser pipe, which

carries formation fluids (e.g., oil, etc.) to the surface and circulates drilling fluids. The marine riser pipe connects to the BOP through the Lower Main Riser Package (LMRP) which contains a device to connect to the BOP, an annular seal for well control, and flow control devices to supply hydraulic fluids for the operation of the BOP. The LMRP and the BOP are commonly referred to, collectively, as simply the BOP. Many BOP functions are hydraulically controlled, with piping attached to the riser supplying hydraulic fluids and other well control fluids. Typically, a central control unit allows an operator to monitor and control the BOP functions from the surface. The central control unit includes a hydraulic control system for controlling the various BOP functions, each of which has various flow control components upstream of it.

[0006] While many of the techniques used in onshore operations can be applied in the offshore environment, they often prove to be less effective and require a much longer time period for implementation. For example, while relief wells can be drilled to intercept the blowout well, a great amount of time may be required in the drilling operation. In drilling the relief wells, platforms or other drilling support decks must be located and transported to the blowout site before drilling operations can begin. Due to the rugged offshore environment, more time is required to drill the relief wells than would be required in onshore operations. As a result of all of these difficulties, many months can pass between the occurrence of an offshore oil well blowout and the successful final capping of the blown-out well. In the intervening time, large quantities of oil and gas can escape into the ocean with serious environmental impact.

[0007] While a portion of the hydrocarbons lost from a subsea well blowout may be trapped and skimmed by various containment booms and oil skimmer ships, substantial quantities of hydrocarbons can still escape such containment equipment. It can be seen that once the hydrocarbons are allowed to reach the ocean, surface wave action tends to disperse the lighter hydrocarbons which may mix with water or evaporate into the air. The gaseous hydrocarbons, of course, tend to escape into the atmosphere. The heavier ends of the crude oil often form into globules or tar balls which may flow at, or just below, the water's surface so as to make it difficult to contain or to skim up.

[0008] In the past, various patents and patent publications have issued relating to systems for the containment of oil spills and blowouts. For example, U.S. Patent No. 4,324,505, issued on April 13, 1982 to D. S. Hammett, discloses a subsea blowout containment method and apparatus. This blowout containment apparatus comprises an inverted funnel adapted for positioning over a

wellhead to receive fluids from the well and direct them into a conduit extending from the funnel to surface support and processing equipment. The funnel and conduit are supported from the sea's surface, preferably by a vessel such as a barge. The barge carries the equipment to receive the full flow of fluids from the well, to process the fluids, and to conduct the liquids to a nearby tanker where the recovered liquid hydrocarbons may be stored.

[0009] U.S. Patent No. 4,405,258, issued on September 20, 1983 to O'Rourke et al., describes a method for containing oil and/or gas within a blow-out cover dome. This method includes the steps of deploying a containment dome in shallow water near the location of the seabed where the containment dome is to be located. The containment dome has an upper expanded dome-like fluid impervious membrane, a fluid impervious hollow peripheral ring attached to the periphery of the membrane to provide a depending bag-like container, and discrete water drainage means within the bag-like container for connection to pump conduit means therefrom. Wet sand from the seabed is then pumped into the bag-like container. Water is then drained from the wet sand through the water drainage means so as to provide a body of drained sand disposed within the bag-like container and providing a hollow peripheral ring as a hollow peripheral torus acting as a self-supporting structure and as an anchor for the dome-like structural unit. The dome is then charged with a buoyant amount of air and the buoyed dome is floated out to the site where the dome is to be deployed. It is then submerged by controllably releasing the air while substantially simultaneously filling the dome with water, thereby sinking the dome until the lighter-than-water fluid is captured within the dome.

[0010] U.S. Patent No. 4,828,024, issued on May 9, 1989 to J. R. Roche, describes a diverter system and blowout preventer. The system comprises a blowout preventer attached above a spool having a hydraulically-driven sleeve/piston. An outlet flow passage exists in the spool. This outlet flow passage can be connected to a vent line. The outlet flow passage is closed off by the sleeve wall when the spool piston is at rest. Hydraulic ports are connected above and below the blowout preventer annular piston and above and below the spool annular piston. The ports below the blowout preventer piston and above the spool piston are in fluid communication with each other. A hydraulic circuit is provided having two valves between a source of pressurized hydraulic fluid and a drain.

[0011] U.S. Patent No. 5,984,012, issued on November 16, 1999 to Wactor et al., provides an emergency recovery system for use in a subsea environment. This emergency recovery system

has a casing that is open at each end with a shackle connected to one end of the casing with the opposite end of the shackle designed for connection to appropriate points on the main stack and lower marine riser package in any orientation. A flexible sling with a closed loop formed at each end is used with one of the closed loops releasably connected to the shackle and the end of the casing. The other end of the sling has a flotation member attached to the sling adjacent the closed loop. The sling is fan folded as it is lowered into the casing. The flotation member is shaped to fit inside the other end of the casing with the closed end loop of the sling protruding from the casing. The flotation member is constructed of synthetic foam and is sized to provide sufficient buoyancy to fully extend the sling when the release ring is released by a remotely operated vehicle in a subsea environment.

[0012] U.S. Patent No. 7,165,619, issued on January 23, 2007 to Fox et al., teaches a subsea intervention system that includes a BOP module and CT module. A tool positioning system is used for positioning a selected subsea tool stored within a rack with a tool axis in line with the BOP axis, while a marinized coiled string injector is moved by positioning system to an inactive position. Power to the subsea electric motors is supplied by an electrical line umbilical extending from the surface for powering the pumps. An injector is provided that includes a pressure compensator roller bearing and a pressure-compensated drive system case.

[0013] U.S. Patent No. 7,597,811, issued on October 6, 2009 to D. Usher, provides a method and apparatus for subsurface oil recovery using a submersible unit. The submersible vehicle is positioned above the bed of a diver supported on a platform above the pollutant. A wand at one end of a pipe evacuated by a centrifugal pump is manipulated to draw the pollutant to the surface for treatment or disposal.

[0014] U.S. Patent No. 7,921,917, issued on April 12, 2011 to Kotrla et al., shows a multi-deployable subsea stack system. This subsea stack system includes a lower marine riser package, a blowout preventer stack with a first ram blowout preventer, and an additional blowout preventer package releasably coupled to the blowout preventer stack and comprising a second ram blowout preventer. The subsea blowout preventer stack assembly can be deployed by coupling a drilling riser to the lower marine riser package that is releasably connected to the blowout preventer stack. The lower marine riser package and blowout preventer stack are then attached to a subsea wellhead and then landed on the additional blowout preventer package that is coupled to the subsea wellhead.

[0015] U.S. Patent Publication No. 2009/0095464, published on April 16, 2009 to McGrath et al., provides a system and method for providing additional blowout preventer control redundancy. This system has backup or alternate fluid flow routes around malfunctioning BOP control components using a remotely-installed removable hydraulic hose connection. The backup fluid flow route sends pressure-regulated hydraulic fluid to a BOP operation via an isolation valve rigidly attached to the BOP, then to a hose connected to an intervention panel on the BOP, and finally through a valve that isolates the primary flow route and establishes a secondary flow route to allow continued operation.

[0016] U.S. Patent Publication No. 2009/0260829, published on October 22, 2009 to D. J. Mathis, provides a subsea tree safety control system that limits the probability of failure on demand of a subsea test tree. A safety shut-in system is provided for actuating a safety valve of the subsea test tree. The safety shut-in system includes a surface control station positioned above a water surface connected via an umbilical to a subsea control system positioned below the water surface so as to actuate the safety valve.

[0017] U.S. Patent Application Serial No. 13/160,032, filed on June 14, 2011 to the present assignee, discloses a diverter system for a subsea well. This diverter system is commonly known as a "capping stack". This diverter system includes a body having a flow passageway extending therethrough, a ram affixed to the body and extending in transverse relationship to the flow passageway, at least one channel in fluid communication with the flow passageway so as to allow fluid in the flow passageway to pass outwardly of the body, and at least one flowline in valved communication with the flow passageway of the body so as to selectively allow a fluid to be introduced into the flow passageway. The body has an inlet end and an outlet end. The inlet end is suitable for application to an outlet of a blowout preventer. The ram is actuatable so as to change a flow rate of fluid passing through the flow passageway. The channel includes a first channel in valved communication with the flow passageway and a second channel in valved communication with the flow passageway. Each of these channels extend in transverse relationship to the flow passageway so as to pass fluid from the flow passageway to a location away from the body.

[0018] The product that is sold by Trendsetter Engineering, Inc. that is the subject of U.S. Application Serial No. 13/160,032 has been a highly successful product for the company. This product is relatively heavy and has a weight in the order of between 100 to 150 tons. Since the

flow diverter sends the fluid flow in perpendicular relationship to the flow from the blowout preventer, there is a possibility of erosion to the internal components of the capping stack when the fluid flows at very high rates. The single centralized bore is limited by the available valve/ram sizes. In this product, the central bore extends entirely through the body of the capping stack. As such, in order to install the capping stack, the central bore remains open during installation. As such, the fluid flowing from the blowout preventer will pass freely through the central bore of the capping stack during installation. Once the product is installed on the blowout preventer, the central bore is closed by rams (in the nature of a blowout preventer) so as to stop the flow through the central bore of the capping stack. At that time, the channels can be either closed so as to retain the flow of fluids in the well or open so as to allow the fluids to be removed from the capping stack.

[0019] After extended use of the present invention, it was found that it would be desirable to significantly reduce the weight of the capping stack. The weight of the capping stack requires that the capping stack be assembled on location. Very few airplanes have the capacity to carry the entire assembled capping stack to the desired location. The relatively large size of the this capping stack can be somewhat difficult to maneuver between the risers of tension leg platforms or spar platforms. Additionally, although the capping stack is within the limits of cranes associated with offshore platforms, it does require the maximum capacity of such equipment. Since the capping stack is required to be assembled at the location, additional testing is required once the capping stack is reassembled. Although the capping stack is very heavy, the actual weight of the capping stack is of no particular value for the closing or control of the well.

[0020] It is an object of the present invention to provide a capping stack of relatively small size and of minimal weight.

[0021] It is another object of the present invention to provide a capping stack having bores and flowlines which minimize the effects of erosion when fluids flow through such bores and flowlines at high flow rates.

[0022] It is another object of the present invention to provide a capping stack that has a minimal number of components.

[0023] It is another object of the present invention to provide a capping stack that does not require reassembly and retesting.

[0024] It is another object of the present invention to provide a capping stack which avoids the

use of rams for the closing of the flow passageway.

[0025] It is another object of the present invention to provide a capping stack that provides the ability to capture fluids from the subsea well.

[0026] It is a further object of the present invention to provide a capping stack which allows the weight of the capping stack to be actively used to create pressure against the flow of fluid from the well.

[0027] It is still another object of the present invention to provide a capping stack that can be easily maneuvered between the risers of tension leg platforms or spar platforms.

[0028] It is still a further object of the present invention to provide a capping stack that is relative easy to handle on boats and offshore platforms and easily within the limits of existing equipment.

[0029] It is still a further object of the present invention to provide an assembled capping stack that can be shipped as air freight, on demand, to a desired location.

[0030] It is still a further object of the present invention to provide a capping stack that minimizes the risk of damage to a wellhead.

[0031] These and other objects and advantages of the present invention will become apparent from a reading of the attached specification and appended claims.

BRIEF SUMMARY OF THE INVENTION

[0032] The present invention is a capping stack for use with a subsea well. The capping stack includes a body with a flow passageway extending therethrough. The flow passageway has an inlet suitable for connection to a fluid passageway of a blowout preventer or to a wellhead of subsea well. The body has a first bore having one end opening to an outlet end of the flow passageway. The first bore extends upwardly from the flow passageway. The body of the second bore has one end opening to the outlet end of the flow passageway. The second bore also extends upwardly from the flow passageway. A first flowline is affixed to the first bore and extends upwardly therefrom. A second flowline is affixed to the second bore and extends upwardly therefrom. A first valve is cooperative with the first flowline so as to be movable between an open position and a closed position. The open position is suitable allowing fluids from the subsea well to flow through the first flowline. The closed position is suitable for blocking fluids from passing outwardly of the first flowline. A second valve is cooperative the second flowline so as to be movable between an open position and a closed position. The open position of the second valve allows fluid from the subsea well to flow through the second flowline. The closed position

of the second valve blocks fluid from passing outwardly of the second flowline.

[0033] In the present invention, a connector is affixed to a lower end of the body. The connector is suitable for connecting the body to either the blowout preventer or the wellhead. A frame is connected to the body and extends upwardly therefrom.

[0034] The first bore diverges away from the second bore in a direction away from the outlet end of the flow passageway. The first bore extends an angle of 60° or less to vertical. The second bore extends at an angle of 60° or less to vertical. One end of the first bore is in spaced relation to the end of the second bore at the outlet end of the flow passageway. Each of the first and second bores has a cross-sectional area less than a cross-sectional area of the flow passageway.

[0035] In the present invention, there can be a third bore having one end opening to the outlet end of the flow passageway. The third bore extends upwardly from the flow passageway. A third flowline is affixed to the third bore and extends upwardly therefrom. A third valve is cooperative with the third flowline so as to be movable between an open position and a closed position. The open position of the third valve allows fluids from the subsea well to flow through the third flowline. The closed position of the third valve blocks fluids from passing outwardly of the third flowline. The third bore diverges away from the first and second bores in a direction away from the outlet end of the flow passageway.

[0036] In the present invention, the first valve can include a pair of valves that are cooperative with the first flowline. The pair of valves are in spaced relationship to each other. The second valve can also be a pair of valves that are cooperative with the second flowline. The pair of valves of the second valve are in spaced relationship to each other.

[0037] Each of the first and second flowlines includes a first portion having a first end and a second end. The first end connected to the respective bore. The first portion extends at an acute angle to vertical away from the respective bore. Each of the first and second flowlines also includes a second portion extending from the second end of the first portion and extending vertically upwardly therefrom. Each of the first and second flowlines has connecting portion at an upper end thereof. This connecting portion is suitable for connection to a conduit so as to allow fluids from the subsea well to flow therefrom.

[0038] A lifting mechanism can be affixed to an upper portion of the frame in a location generally centrally of the frame. This lifting mechanism is suitable for allowing a hoist or a crane to lift the capping stack and to lower the capping stack, as desired.

[0039] The foregoing Section is intended to describe, with particularity, the preferred embodiment of the present invention. It is understood that modifications to this preferred embodiment can be made within the scope of the present invention. As such, this Section is not intended, in any way, to be limiting of the broad scope of the present invention. The present invention should only be limited by the following claims and their legal equivalents.

BRIEF DESCRIPTION OF THE DRAWINGS

[0040] FIGURE 1 is a perspective view of the capping stack of the present invention.

[0041] FIGURE 2 is a cross-sectional view showing the capping stack of the present invention.

[0042] FIGURE 3 is an exploded view showing the relationship of the capping stack of the present invention to a blowout preventer.

[0043] FIGURE 4 is a perspective view showing an alternative embodiment of the capping stack of the present invention.

[0044] FIGURE 5 is an upper perspective view of a further alternative embodiment of the capping stack of the present invention.

[0045] FIGURE 6 is an internal perspective view showing the arrangement of bores formed within the body of the capping stack of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0046] Referring to FIGURE 1, there is shown the capping stack 10 in accordance with the teachings of the present invention. The capping stack 10 includes a body 12 having a connector 14 located at a bottom end thereof. The body 12 has a generally cylindrical configuration. The connector 14 is suitable for connection to either a subsea wellhead or an upper end of a blowout preventer. A frame 16 is affixed to the body 12 at an upper end of the body 12. The frame 16 supports a first flowline 18 and a second flowline 20 thereon. Each of the first flowline 18 and the second flowline 20 extends vertically upwardly. A third flowline 22 can also be supported by the frame 16. As will be described hereinafter, there is a first valve associated with the flowline 18, a second valve associated with the second flowline 20 and a third valve associated with the third flowline 22. As can be seen in FIGURE 1, the frame 16 supports a panel 24. The panel 24 supports a first actuator 26 for control of the valve associated with the first flowline 18, a second actuator 28 that controls the operation of the valve associated with the second flowline 20 and a third actuator 30 that controls the operation of the valve associated with the third flowline 22. A suitable lifting mechanism, such as padeye 32, is positioned on an upper portion

of the frame 16 so as to allow suitable cranes or hoists to lift and lower the capping stack 10, as desired.

[0047] FIGURE 2 shows a cross-sectional view of the capping stack 10 of the present invention. The capping stack 10 includes the body 12 having the connector 14 at a lower end thereof. The body 12 has a flow passageway 34 extending vertically therethrough. Flow passageway 34 has a relatively large diameter. The flow passageway 34 has an inlet end 36 and an outlet end 38. As can be seen in FIGURE 2, the body 12 includes a lower body portion 40 that is bolted to an upper body portion 42.

[0048] The upper body portion 42 has a first bore 44 and a second bore 46 extends therethrough. Although the term "bore" is used, it is understood that, within the concept of the present invention, similar items, such as pipe, conduits, hoses, or other devices, could also be considered as "bores".

[0049] In FIGURE 3, it can be seen that the first bore 44 has one end opening to the outlet end 38 of the flow passageway 34. The second bore 46 also has an end opening to the outlet end 38 of the flow passageway 34. Each of the bores 44 and 46 diverge away from each other in a direction away from the outlet end 38 of the flow passageway 34. The ends of the bores 44 and 46 are in spaced relationship to each other at the outlet end 38 of the flow passageway 34. Within the concept of the present invention, each of the bores 44 and 46 extends upwardly at an acute angle of less than 60° to vertical. In the preferred embodiment of the present invention, the bores 44 and 46 should extend at 45° to vertical.

[0050] Through the arrangement of the bores 44 and 46, as shown in FIGURE 2, the fluid passing through the flow passageway 34 is diverted into the bores 44 and 46. Since the bores 44 and 46 extend at an acute angle to vertical, rather than transverse to vertical, there is less possibility of erosion caused by particles entrained within a fluid passing at a high flow rate through the flow passageway 34 and into the bores 44 and 46. Each of the bores 44 and 46 has a cross-sectional area that is less than the cross-sectional area of the flow passageway 34. As such, the flow passageway 34 is diverted into smaller bores.

[0051] The first bore 44 is connected to the first flowline 18. A first valve 48 is cooperative with the first flowline 18 so as to control the flow of fluid into and through the first flowline 18. The first valve 48 is a gate valve. A suitable ROV can be utilized so as to open and close the valve 48. In the closed position, the valve 48 blocks the flow of fluid from the bore 44 into the flowline

18. In the open position, the valve 48 allows for the flow of fluid from the bore 44 through the flowline 18.

[0052] The second bore 46 is connected to the second flowline 20. A second valve 50 is cooperative with the second flowline 20 so as to control the flow of fluid from the bore 46 into and through the second flowline 20. In the open position, the valve 50 allows for the flow of fluid from the bore 46 through the second flowline 20. In the closed position, the valve 50 will block the flow of fluid from the bore 46 into the second flowline 20.

[0053] The first flowline 18 has a first portion 52 that has an end connected to the first bore 44. The first portion 52 extends at the same acute angle that the first bore 44 extends and is axially aligned with the first bore 44. The opposite end of the first portion 52 is connected to a second portion 54. The second portion 54 extends vertically upwardly. The first flowline 18 includes an outlet 56 at an upper end thereof. Outlet 56 is located at a convenient location for the attachment of a conduit, or other piping, such that fluids passing through the first flowline 18 can be diverted to another location, such as surface location. Through this angled relationship, the flow of fluid through the first portion 52 and the second portion 54 is gradually transitioned rather than having any sharp angles (which could cause erosion). It can be seen that there is connection portion 58 located adjacent to the end 56. Connection portion 58 allows the first flowline 18 to be connected to the corresponding conduit.

[0054] The second flowline 20 also includes a first portion 60 and second portion 62 that extend in similar manner as portions 52 and 54 of the first flowline 18. The valves 48 and 50 are respectively connected to the first portion 52 and 60 of the respective flowlines 18 and 20. The second flowline 20 also includes a connection portion 64 located adjacent to the end 66.

[0055] FIGURE 2 further shows the frame 16 as supporting the flowlines 18 and 20 thereon. The frame 16 provides a strong structure for the support of the various components of the present invention. Additionally, another type of lifting mechanism 68 is secured to the frame 16 so as to facilitate the ability to lift and lower capping stack 10, as desired.

[0056] With reference to FIGURE 2, it can be seen that valves 48 and 50 are utilized in the capping stack 10. As such, the capping stack 10 avoids the use of complicated ram mechanisms associated with other capping stacks. The valves 48 and 50 are readily available for use. As such, the constructural complexity associated with installing the ram mechanisms on the capping stack 10 is avoided. Since each of the bores 44 and 46 and the flowlines 18 and 20 are of a relatively

minimal diameter, the requisite flow of fluid through the interior of the capping stack 10 can be achieved. As such, when it is desired to place the capping stack 10 upon a blowout preventer or on a wellhead, the valves 48 and 50 can be opened so as to allow for the free flow of fluid therethrough. As such, if fluids are being released by the blowout preventer, the fluid will enter the flow passageway 34, pass through the bores 44 and 46, and outwardly through the flowlines 18 and 20. Since there is small area of contact between the ends of the bores 44 and 46 at the outlet end 38 of the flow passageway 34, a certain amount of resistance will occur when attempting to lower the capping stack 10 onto the wellhead or the blowout preventer. However, the present invention actually uses the weight of the capping stack 10 so as to overcome any resistance that may be created by this small surface. As such, the present invention effectively utilizes the weight of the capping stack in the capping of the blowout preventer.

[0057] Once the capping stack 10 is installed, the valves 48 and 50 can be closed so as to close off the blowout preventer or the wellhead. When proper pressures are realized, and when suitable conduits are connected to the connection portions 58 and 64 of the capping stack 10, the valves 48 and 50 can be respectively opened so as to allow for the release of fluids therethrough. As such, these fluids can be effectively recovered at another location, such as a surface location.

[0058] FIGURE 3 shows the installation of the capping stack 10 onto a blowout preventer 70. It can be seen that the blowout preventer 70 is secured to a wellhead 72 located at a subsea floor 74. In normal fashion, the blowout preventer 70 is properly secured to the wellhead 72 and extends upwardly therefrom. There is a mandrel 76 located at the upper end of the blowout preventer 70.

[0059] The capping stack 10 is secured by placing the connector 14 over the mandrel 76. Suitable conventional locking mechanisms can be provided whereby the body 12 of the capping stack 10 is secured to the mandrel 76 in fluid-tight relationship. As such, the body 12 can be suitably locked to the mandrel 76 so as to establish a fluid flow relationship between the fluid passing through the mandrel 76 of the blowout preventer 70 and the flow passageway 34 of the body 12.

[0060] FIGURE 3 shows the capping stack 10 as having three bores, and showing in particular, a third bore 78. Third bore 78 can have a third valve 80 positioned thereon. Additionally, the third flowline 22 will extend from the third bore 78. As such, FIGURE 3 shows a total of three bores that are utilized so as to divert the fluid flow from the blowout preventer 70.

[0061] With reference to FIGURE 3, there are certain circumstances where the blowout preventer 70 may be slightly tilted at an angle to vertical. This could occur during a subsea event or if the blowout preventer 70 is improperly installed. In past circumstances, if the capping stack 10 were too heavy, then it could exert forces which would tend to further deflect the blowout preventer 70. The lower weight of the capping stack 10 is less likely to create such forces and will operate so as to maintain the blowout preventer 70 in its existing orientation.

[0062] In certain circumstances, the capping stack 10 could be applied to the wellhead 72 rather than the blowout preventer. Under this circumstance, the connector 14 of the body 12 is simply placed over the wellhead 72 such that the capping stack 10 is joined directly to the wellhead 72 so as to control for the release of fluids from the well.

[0063] FIGURE 4 shows another embodiment of the capping stack 100 of the present invention. Capping stack 100 includes a body 102 and flowlines 104, 106 and 108 extending upwardly therefrom. Importantly, in FIGURE 4, it can be seen that the first flowline 104 includes a first valve actuator 106 provided on the frame 108. A second valve actuator 110 is also supported by the frame 108.

[0064] The first flowline 104 will include a first valve associated with the actuator 106 and a second valve 112 located at an upper end thereof. As such, these valves will be in spaced relationship to each other. It is found that, under certain circumstances, customers desire to have redundancy in the control of fluids from the subsea well. As such, applying two valves to each of the flowlines 104 and 106 can accomplish this purpose. Flowline 104 will also include a transition section 116 so as to allow for a suitable connector to be applied to flange 118 so as to allow for the release of fluids from the first flowline 104. The second flowline 106 also includes a valve associated with the actuator 104 located on the first portion of the transition member 106 adjacent to the bores and the body 102 and a second valve 120 positioned in spaced relationship to the first valve. Another diverter member 122 is located at the upper end of the second flowline 106 so as to allow for the diverter member 122 to transmit fluids outwardly of the flange portion 124.

[0065] The capping stack 100 includes various lifting bars 126, 128 and 130 extending upwardly therefrom. Additionally, a padeye 132 can be directly affixed to the frame 108. As such, these lifting mechanisms facilitate the ability to lift and lower the capping stack 100.

[0066] FIGURE 5 shows a further embodiment of the capping stack 200 of the present invention.

Capping stack 200 includes a body 202 having a connector 204 located at a lower end thereof. The capping stack 200 includes four flowlines 206, 208, 210 and 212. The frame 214 supports each of the flowlines 206, 208, 210 and 212 such that they extend upwardly vertically. FIGURE 5 shows a bucket 216 for the control of the valve associated with the flowline 210 and a bucket 218 for the control of the valve associated with the flowline 220. Suitable additional buckets (not shown) can be utilized so that an ROV can effectively control the operation of the flowlines 206 and 208. The body 202 will include a total of four bores which extend so as to be connected to each of the flowlines 206, 208, 210 and 212 in the manner described in the previous embodiments. As such, the capping stack 200 allows for the diversion of flow along four separate pathways. The capping stack 200 is adaptable to enhance the capacity to remove greater amounts of fluid from the well or for the ability to reduce the diameter of each of the flowlines 206, 208, 210 and 212, along with the valves associated therewith.

[0067] FIGURE 6 shows a detailed view of the upper body which includes the bore spool 222 of the capping stack 200. As can be seen, the bore spool 222 includes a first bore 224, a second bore 226, a third bore 228 and a fourth bore 230 extending so as to diverge from one another within the bore spool 222. The bore spool 222 has a flange 232 that is suitable for attachment to the lower body portion of body 222. Each of the bores 224, 226, 228 and 230 has a flange thereon whereby the respective bores can be secured to the respective flowlines 206, 208, 210 and 212. Each of the bores 224, 226, 228 and 230 has a lower end that will open to the outlet end 234 of the flow passageway (such as flow passageway 34 in FIGURE 2). In this manner the flow of fluids through the flow passageway 34 is diverted at acute angles to vertical through the respective bores 224, 226, 228 and 230.

[0068] The present invention significantly reduces the size and weight of the capping stack. Since the size is reduced, it is easier to maneuver between the risers of tension leg platforms or spar platforms. Additionally, the relatively small size of the capping stack of the present invention allows the entire capping stack to be positioned within the storage bay of a transport airplane. Since the weight of the capping stack of the present invention is estimated to be between thirty and forty tons, it can be easily transported by conventional air transport planes. As such, the capping stack of the present invention can be stored in one location and delivered to a remote location in a relatively minimal amount of time. As such, the present invention avoids the need to deploy separate capping stacks in the various areas of hydrocarbon production. The relatively

small weight of the capping stack allows it to be easily handled on boats or with existing equipment on an offshore platform.

[0069] The gradual transitions between the flow passageway and the bores and the flowlines reduces the possibility of erosion. If sharp turns of a fluid will occur in a capping stack, then there is the possibility, over time, of the erosion of the internal structures of the capping stack. As such, the gradual transitions provided by the capping stack of the present invention will minimize the risk of erosion caused by the high rates of fluid.

[0070] The present invention has a smaller number of components than existing capping stacks. As such, the amount of testing is reduced. There is less reassembly and retesting of the capping stack. The capping stack, in view of its small size and weight, can be delivered entirely intact to the desired location. As such, it is not necessary to deliver the capping stack in pieces and then assemble the capping stack at the location.

[0071] The present invention utilizes valves instead of rams. As such, it is not limited, in any way, by ram availability or ram sizes. It also avoids the complex mechanisms associated with the installation of such rams.

[0072] The foregoing disclosure and description of the invention is illustrative and explanatory thereof. Various changes in the details of the illustrated construction can be made within the scope of the appended claims without departing from the true spirit of the invention. The present invention should only be limited by the following claims and their legal equivalents.

CLAIMS

I claim:

1. A capping stack for use with a subsea well, the capping stack comprising:
 - a body having a flow passageway extending therethrough, said flow passageway of said body having an inlet end and an outlet end, said inlet end suitable for connection to a fluid passageway of a blowout preventer or to a wellhead of the subsea well, said body having a first bore having one end opening to said outlet of said flow passageway, said first bore extending upwardly from said flow passageway, said body having a second bore having one end opening to said outlet end of said flow passageway, said second bore extending upwardly from said flow passageway;
 - a first flowline affixed to said first bore and extending upwardly therefrom;
 - a second flowline affixed to said second bore and extending upwardly therefrom;
 - a first valve cooperative with said first flowline so as to be movable between an open position and a closed position, said open position allowing fluids from the subsea well to flow through said first flowline, said closed position suitable for blocking fluids from passing outwardly of said first flowline; and
 - a second valve cooperative said second flowline so as to be movable between an open position and a closed position, said open position of said second valve suitable allowing fluids from the subsea well to flow through said second flowline, said closed position of said second valve suitable for blocking fluids from passing outwardly of said second flowline.
2. The capping stack of Claim 1, further comprising:
 - a connector affixed to a lower end of said body, said connector suitable for connecting said body to either the blowout preventer or the wellhead.
3. The capping stack of Claim 1, further comprising:
 - a frame connected to said body and extending upwardly therefrom, said frame supporting said first and second flowlines thereon.
4. The capping stack of Claim 1, said first bore diverging away from said second bore in a direction away from said outlet end of said flow passageway.
5. The capping stack of Claim 4, said first bore extending an angle of 60° or less to vertical, said second bore extending at an angle of 60° or less to vertical.
6. The capping stack of Claim 1, said one end of said first bore being in spaced relation to said one end of said second bore at said outlet end of said flow passageway.

7. The capping stack of Claim 1, each of said first and second bores having a cross-sectional area less than a cross-sectional area of said flow passageway.

8. The capping stack of Claim 1, further comprising:

a third bore having one end opening to said outlet end of said flow passageway, said third bore extending upwardly from said flow passageway;

a third flowline affixed to said third bore and extending upwardly therefrom; and

a third valve cooperative with said third flowline so as to be movable between an open position and a closed position, said open position of said third valve allowing fluids from the subsea well to flow through said third flowline, said closed position of said third valve blocking fluids from passing outwardly of said third flowline.

9. The capping stack of Claim 8, said third bore diverging away from said first and second bores in a direction away from said outlet end of said flow passageway.

10. The capping stack of Claim 1, said first valve comprising a pair of valves cooperative with said first flowline, said pair of valves being in spaced relationship to each other, said second valve another pair of valves cooperative with said second flowline, said another pair of valves being in spaced relationship to each other.

11. The capping stack of Claim 1, each of said first and second flowlines comprising:

a first portion having a first end and a second end, said first end connected to the respective bore, said first portion extending at an acute angle to vertical away from the respective bores; and

a second portion extending from said second end of said first portion and extending vertically upwardly therefrom.

12. The capping stack of Claim 1, each of said first and second flowlines having a connecting portion at an upper end thereof, said connecting portion suitable for connection to a conduit so as to allow fluids from the subsea well to flow therethrough.

13. The capping stack of Claim 3, further comprising:

a lifting mechanism affixed to an upper portion of said frame in a location generally centrally of said frame.

14. A flow diverting system for use with a subsea well, the flow diverting system comprising:

a blowout preventer;

a body connected to an upper end of said blowout preventer, said body having a flow passageway extending therethrough, said flow passageway of said body having an inlet end and an outlet end, said inlet end suitable for connection to a fluid passageway of said blowout preventer, said body having a first bore having one end opening to said outlet end of said flow passageway, said first bore extending upwardly from said flow passageway, said body having a second bore having one end opening to said outlet end of said flow passageway, said second bore extending upwardly from said flow passageway;

a first flowline affixed to said first bore and extending upwardly therefrom;

a second flowline affixed to said second bore and extending upwardly therefrom;

a first valve cooperative with said first flowline so as to be movable between an open position and a closed position, said open position allowing fluids from the subsea well to flow through said first flowline, said closed position blocking fluids from passing outwardly of said first flowline; and

a second valve cooperative said second flowline so as to be movable between an open position and a closed position, said open position of said second valve allowing fluids from the subsea well to flow through said second flowline, said closed position of said second valve blocking fluids from passing outwardly of said second flowline.

15. The flow diverting system of Claim 14, said first bore diverging away from said second bore in a direction away from said outlet end of said flow passageway.

16. The flow diverting system of Claim 15, said first bore extending an angle of 60° or less to vertical, said second bore extending at an angle of 60° or less to vertical.

17. The flow diverting system of Claim 14, further comprising:

a third bore having one end opening to said outlet end of said flow passageway, said third bore extending upwardly from said flow passageway;

a third flowline affixed to said third bore and extending upwardly therefrom; and

a third valve cooperative with said third flowline so as to be movable between an open position and a closed position, said open position of said third valve allowing fluids from the subsea well to flow through said third flowline, said closed position of said third valve blocking fluids from passing outwardly of said third flowline.

18. The flow diverting system of Claim 14, each of said first and second flowlines comprising:

a first portion having a first end second end, said first end connected to the respective bore, said first portion extending at an acute angle to vertical away from the respective bore; and

a second portion extending from said second end of said first portion and extending vertically upwardly therefrom.

19. The flow diverting system of Claim 14, further comprising:

a frame connected to said body and extending upwardly therefrom, said frame supporting said first and second flowlines thereon.

20. The flow diverting system of Claim 19, further comprising:

a lifting mechanism affixed to an upper portion of said frame in a location generally centrally of said frame.