line is closed and the flow diversion lines are open, the first seal assembly forms a seal around the drillstring while the riser pumps control riser pressure. Alternatively, the flow diversion lines can be closed and the by-pass line can be open while riser pressure is controlled with a choke on the by-pass line and the first seal assembly forms a seal around the drillstring.

In one embodiment, a tie-in to the riser booster line with a port directly above the first sealing element can direct riser booster pump flow to be used as a means to flush cuttings away from the top of the seal assembly to better permit lubrication of the seal face.
Alternatively another type of pump can also be used. When another type of pump is used some modification in the overall arrangement need to be considered. In one embodiment, each pump is a submersible pump.

In one embodiment, each pump is a progressive cavity pump.

In one embodiment, the first port is located between the first sealing assembly and the second sealing assembly, and method further comprises the steps of stopping operation of the booster pump, either opening the first sealing assembly so that it does not seal against a tubular extending along the main passage of the riser body, or opening the by-pass isolation valve so that flow of fluid along the by-pass line is permitted, or both, and reversing the normal operation of the pump in the diversion line so that it pumps fluid along the diversion line from the second port to the first port.

According to another aspect, we provide a riser assembly comprising a main body enclosing a main passage which extends from a first end of the main body to a second end of the main body generally parallel to a longitudinal axis of the main body, the main body being suitable for mounting in a riser so that that main passage forms a part of a main passage of the riser, the riser assembly further including a sealing assembly which is operable to provide a seal between the main body and a tubular extending along the main passage of the main body so as to substantially prevent flow of fluid along the main passage around the tubular, characterized in that the riser assembly further comprises two or more diversion lines each of which extends from a first port in the main body to a second port in the main body, the ports extending through the main body to connect the main passage with the exterior of the main body, the sealing assembly being located in the main body between the first and second ports, wherein a pump is located within each diversion line, each pump being operable to pump fluid along the diversion line in which it is located, wherein each pump is a hose diaphragm pump system which includes a drive motor that powers at least two hose diaphragm pump heads simultaneously.

According to yet another aspect, we provide a method of operating a riser assembly, the riser assembly comprising a riser body enclosing a main passage which extends from a first end of the riser to a second end of the riser generally parallel to a longitudinal axis of the riser, and a first sealing assembly and a second sealing assembly, both of which are operable to provide a seal between the riser body and a tubular extending along the main passage of the riser body so as to substantially prevent flow of fluid of fluid along the main passage around the tubular,

characterized in that the riser assembly further comprises two or more diversion lines, each of which extends from a first port in the main body to a second port in the main body, the first and second ports extending through the main body to connect the main passage with the exterior of the main body and the first sealing assembly being located in the main body between the first and second ports, a pump located within each diversion line and being operable to pump fluid along the diversion line in which it is located from the first port to the second port, wherein each pump is a hose diaphragm pump system which includes a drive motor that powers at least two hose diaphragm pump heads simultaneously, an isolation valve which is operable to move between a first configuration in which the isolation valve permits flow of fluid along the diversion line, and a second configuration in which the isolation valve substantially prevents flow of fluid along the diversion line, the isolation valve being located between the pump and the second port or between the pump and the first port, a riser booster pump, a booster line which extends from the riser booster pump to a third port provided in the main body between the first sealing assembly and the second sealing assembly or directly above the first sealing assembly, the third port connecting the main passage to exterior of the riser body, and a by-pass line which extends between a fourth port and a fifth port provided in the main body, the fourth and fifth ports connecting the main passage to exterior of the main body, the first sealing assembly being located between the fourth and fifth ports, and a by-pass isolation valve which is operable to move between a first configuration in which the by-pass isolation valve permits flow of fluid along the by-pass line, and a second configuration in which the by-pass isolation valve substantially prevents flow of fluid along the by-pass line,

wherein the method includes the following steps: a. operating the second sealing assembly to seal against a tubular extending along the main passage of the riser body, and b. operating the booster pump to pump fluid into the main passage of the riser body via the third port.

Description of the Drawings

Embodiments of the inventive method will now be described, by way of example only, by way of reference to the following drawings of which:

FIGURE 1A, illustrates an embodiment of the invention showing the components of the inventive system within a riser system, with a QCA or RDD positioned at the riser top and the modified riser module containing the RDD, QCA and positive displacement pump modules, in this case, a hose diaphragm pump system(s) positioned at a deep set subsea depth.

FIGURE 1B, illustrates an alternative embodiment of the one shown in Figure 1A when the modified riser module contains the RDD, QCA and submersible PCP's positioned at a deep set subsea depth.

FIGURE 2A illustrates an embodiment of the invention showing the components of the inventive system installed within a riser system, with the modified riser module containing the RDD, QCA and positive displacement pump modules, in this case, hose diaphragm pump systems positioned at a deep set subsea depth and absence of a surface RDD or QCA,

CLAIMS

1. A riser assembly comprising a main body enclosing a main passage which extends from a first end of the main body to a second end of the main body generally parallel to a longitudinal axis of the main body, the main body being suitable for mounting in a riser so that that main passage forms a part of a main passage of the riser, the riser assembly further including a sealing assembly which is operable to provide a seal between the main body and a tubular extending along the main passage of the main body so as to substantially prevent flow of fluid along the main passage around the tubular, characterized in that the riser assembly further comprises two or more diversion lines each of which extends from a first port in the main body to a second port in the main body, the ports extending through the main body to connect the main passage with the exterior of the main body, the sealing assembly being located in the main body between the first and second ports, wherein a pump is located within each diversion line, each pump being operable to pump fluid along the diversion line in which it is located, wherein each pump is a hose diaphragm pump system which includes a drive motor that powers at least two hose diaphragm pump heads simultaneously.

2. A riser assembly according to claim 1 wherein each diversion line has a main portion which extends generally parallel to the longitudinal axis of the main body of the riser assembly, and wherein the diversion lines are arranged to be abutting or directly adjacent to the main body.

3. A riser assembly according to claim 1 wherein the at least two hose diaphragm pump heads are provided with check valves.

4. A riser assembly according to any preceding claim wherein each pump is a pump module comprising at least two pumps in parallel.

5. A riser assembly according to any one of claims 1 to 3 wherein each pump is a pump module comprising two pumps in series.

6. A riser assembly according to any preceding claim wherein each pump is operable to pump fluid along the diversion line from the first port to the second port.

7. A riser assembly according to claim 6 wherein the pump is configured to prevent flow of fluid along the diversion line from the second port to the first port.

8. A riser assembly according to any preceding claims wherein each diversion line is provided with a separate first port and second port.

9. A riser assembly according to any preceding claim wherein the riser assembly is further provided with a booster line which extends to a third port provided in the main body, the third port connecting the main passage to exterior of the main body.

10. A riser assembly according to any preceding claims wherein the riser assembly is further provided with a booster line tie-in which extends to an additional port in the main body directly above the seal assembly.

11. A riser assembly according to any preceding claims further including a by-pass line which extends between a fourth port and a fifth port provided in the main body, the fourth and fifth ports connecting the main passage to exterior of the main body, the sealing assembly being located between the fourth and fifth ports.

12. A riser assembly according to any preceding claim including a further sealing assembly which is operable to provide a seal between the main body and a tubular extending along the main passage of the main body so as to substantially prevent flow of fluid of fluid along the main passage around the tubular, the or each first port being located between the two sealing assemblies.

13. A riser assembly according to claim 1, wherein the sealing assembly comprises
    a first sealing assembly and a second sealing assembly, both of which are operable to provide a seal between the main body and a tubular extending along the main passage of the main body so as to substantially prevent flow of fluid of fluid along the main passage around the tubular,
    further comprising a booster line which extends from a riser booster pump before dividing into a first branch which extends to a third port provided in the main body between the first sealing assembly and the second sealing assembly or directly above the first sealing assembly, the third port connecting the main passage to exterior of the main body.

14. A riser assembly according to claim 13 wherein the booster line has a second branch which extends into the main passage at the second end of the main body.

15. A method of operating a riser assembly, the riser assembly comprising

a riser body enclosing a main passage which extends from a first end of the riser to a second end of the riser generally parallel to a longitudinal axis of the riser, and

a first sealing assembly and a second sealing assembly, both of which are operable to provide a seal between the riser body and a tubular extending along the main passage of the riser body so as to substantially prevent flow of fluid of fluid along the main passage around the tubular,

characterized in that the riser assembly further comprises two or more diversion lines, each of which extends from a first port in the main body to a second port in the main body, the first and second ports extending through the main body to connect the main passage with the exterior of the main body and the first sealing assembly being located in the main body between the first and second ports,

a pump located within each diversion line and being operable to pump fluid along the diversion line in which it is located from the first port to the second port, wherein each pump is a hose diaphragm pump system which includes a drive motor that powers at least two hose diaphragm pump heads simultaneously,

an isolation valve which is operable to move between a first configuration in which the isolation valve permits flow of fluid along the diversion line, and a second configuration in which the isolation valve substantially prevents flow of fluid along the diversion line, the isolation valve being located between the pump and the second port or between the pump and the first port,

a riser booster pump,

a booster line which extends from the riser booster pump to a third port provided in the main body between the first sealing assembly and the second sealing assembly or directly above the first sealing assembly, the third port connecting the main passage to exterior of the riser body, and

a by-pass line which extends between a fourth port and a fifth port provided in the main body, the fourth and fifth ports connecting the main passage to

exterior of the main body, the first sealing assembly being located between the fourth and fifth ports, and a by-pass isolation valve which is operable to move between a first configuration in which the by-pass isolation valve permits flow of fluid along the by-pass line, and a second configuration in which the by-pass isolation valve substantially prevents flow of fluid along the by-pass line,

wherein the method includes the following steps:

a. operating the second sealing assembly to seal against a tubular extending along the main passage of the riser body, and
b. operating the booster pump to pump fluid into the main passage of the riser body via the third port.