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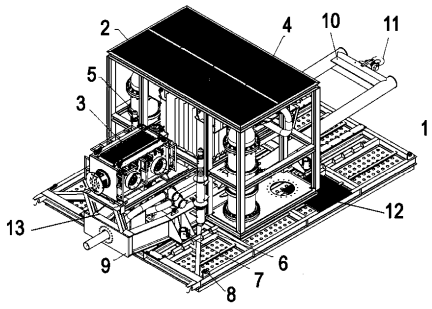
(54) Title **PLET with Integrated pump module**

(57) Abstract

The present invention relates to a subsea PLET 1 with an upstream flow jumper connection 20. The PLET includes a bypass valve 27 and a valve 26 of each of a pump inlet and a pump outlet, each in fluid connection with a pipeline 24. At least one pump module coupling 21 is in fluid connection with the valve 26 of each of the pump inlet and pump outlet. At least one pump module guiding means enables guiding of a pump module onto the subsea PLET 1.



The present invention relates to integration of a pump module into a PLET to avoid fabrication and installation of a separate foundation and jumpers for the pump module.

The pressure in subsea hydrocarbon reservoirs is often reduced as the reservoir is depleted and a boosting pump pumping the hydrocarbon fluid becomes necessary sometime in the lifespan of the well of the reservoir. The boosting pump is then typically installed on foundation such as a mud mat on the seabed close to a Pipeline Termination Assembly (PLET) when a boosting pump is needed. Jumpers are installed between the boosting pump and the PLET and valves on the PLET are opened whereby a loop through the boosting pump is formed. A bypass arrangement must to be added to the flowline.

The present invention is a simplification that reduces fabrication and makes installation of a separate pump foundation and jumpers (four connections) unnecessary. Only one connector needs be disconnected when retrieving the pump module, and the installation and retrieval is thus simplified. The bypass arrangement can be a part of a PLET.

The PLET may be arranged with a dual-bore hub and a bypass valve arrangement to rout the flow to the pump module. The pump module can be landed on the dual-bore hub and connected when a pressure in a pipeline must be boosted.

The PLET is prepared to be upgraded and enables a pump module to be installed if required. The PLET reduces stresses and takes up the expansion of the pipeline. The module with the boosting pump can easily and cost effectively be installed at a later stage as needed. A separate mud mat and jumpers are thus omitted, and the installation is quick and cost effective.

The present invention concerns a subsea PLET with an upstream flow (inlet) jumper connection. The PLET includes a bypass valve and a valve of each of a pump inlet and a pump outlet, each in fluid connection with a pipeline. At least one

pump module coupling is in fluid connection with the valve of each of the pump inlet and the pump outlet. At least one pump module guiding means enables guiding of a pump module onto the subsea PLET.

The pump module coupling may be a dual-bore pump module coupling.

The pump module coupling may be a vertical coupling.

The jumper connection may be a vertical jumper connection.

The subsea PLET may further include a vertical UTA landing interface.

The subsea PLET may further include a pump module with a well fluid pump and motor assembly and at least one PLET coupling in fluid connection with the least one pump module coupling.

The pump module coupling may be a dual-bore vertical pump module coupling, and the at least one vertical PLET coupling may be one vertical dual-bore PLET coupling.

The subsea PLET may further include a UTA.

The UTA may further include flying leads connecting the UTA and the PLET.

The least one pump module guiding means may include two pump module guide posts to facilitate installation of the pump module onto the PLET.

The subsea PLET may further include at least four PLET lock down points (7) to secure the PLET frame to the mud mat.

Short description of the enclosed drawings:

Fig. 1 is a perspective view of a PLET and a boosting pump module according to the invention;

Fig. 2 is a perspective view of the PLET frame of fig. 1, without the boosting pump module and a mud mat;

Fig. 3 is a perspective view of the PLET frame of fig. 1 and 2 without the boosting pump module and with a mud mat;

Fig. 4 is a schematic representation of a PLET and an independent pump module for boosting pressure in a pipeline according to the prior art; and

Fig. 5 is a schematic representation of a boosting pump module on a PLET for boosting pressure in a pipeline according to the invention.

Fig. 1 is a perspective view of a PLET 1 (Pipeline end terminations) according to the invention. The PLET 1 includes a pump module 2 to boost pressure in a pipeline if required. The PLET 1 is initially only prepared for accepting a pump module 2 as boosting the pressure in a pipeline not is necessary for transporting well fluids from new wells as new wells have sufficient pressure. The pump module 2 sits inside a standard VCCS 4 (Vertical Clamp Connection System). A UTA 3 (Umbilical Termination Assembly) can be landed on the PLET 1 to provide power and control to the pump module 2. The PLET 1 includes a frame with a bulkhead 9. A lifting yoke 10 with a padeye 11 is pivotally supported in the PLET frame. The PLET frame sits on a mud mat 12 and is secured to the mud-mat with PLET lock down points 7 and PLET retaining brackets 6. Two pump module guide posts 5 facilitate installation of the pump module onto the PLET 1. Pad eyes 8 at each corner of the mud mat 12 facilitate deployment.

Fig. 2 is a perspective view of the PLET frame of fig. 1, showing the pipeline 24 extending through the bulkhead. Four PLET lock down points 7 are provided to secure the PLET frame to the mud mat. The lifting yoke 10 with a padeye 11 is pivotally supported in pivotal joint 23 and allows the PLET frame to be lifted and lowered. The UTA is secured to a vertical UTA coupling 22, and power to the pump module and control and power to valves inside the PLET are received through an umbilical and through flying leads from the UTA.

A pump module dual-bore connector or coupling 21 provides a coupling for both the inlet and the outlet of the pump in the pump module. A vertical manifold jumper connector 20 allows installation of a jumper between a subsea manifold connected to wellheads and the PLET. The vertical pump module dual-bore connector 21 and the vertical manifold jumper connector 20 may be designed as hubs and form fluid couplings.

A flow-path is formed from the manifold, through the jumper, through the vertical manifold jumper connector 20, through a first bore of the module dual-bore connector 21 through the pump module, through a second bore of the module dual-bore connector 21, out of the pipeline and to a hydrocarbon receiving facility.

Fig. 3 is a perspective view of the PLET of fig. 2 installed on a mud mat 12, but before a pump module is installed on the PLET. This is the typical situation before the well pressure is too low to provide a sufficient flow. When the pressure and flow rate is insufficient, a pump module is installed on top of the PLET that already is prepared for the pump module. The bypass valve 27 is open until a pump module is installed. When a pump module is installed, the bypass valve 27 is closed and the inlet pump circuit valve 26a and the outlet pump circuit valve 26b are opened. The inlet pump circuit valve 26a and the outlet pump circuit valve 26b connect the vertical manifold jumper connector 20, and the pipeline 24 through the module dual-bore connector 21 and the pump module.

A pressure cap 33 is installed in the port of the pump module dual-bore coupling 21. The pressure cap 33 is in place until the pump module is installed and prevents contamination and ingress of unwanted substance / dirt / etc. The pressure cap 33 also forms a second barrier in addition to the valves 26a, 26b to prevent leakages and to provide a double barrier, fail-safe system. The pressure cap 33 is removed after a clamp connector 34 is opened and before the pump module is installed.

Fig. 4 is a schematic representation of an independent pump module 30 for boosting pressure in a pipeline according to the prior art. The pump module 30 is

connected to a bypass module 31 with two jumpers 32 and two connectors on each of the pump module and the bypass module. The four connections are typically made up with an ROV in four separate operations. The bypass module includes two pump circuit valves 26 and a bypass valve 27. The pipe line 29 is connected to the bypass module through releasable couplings 28. In bypass mode, the bypass valve 27 is open and the two pump circuit valves 26 are closed. In pumping mode, the bypass valve 27 is closed and the two pump circuit valves 26 are open.

Fig. 5 is a schematic representation of a boosting pump module 2 on a PLET for boosting pressure in a pipeline 24 according to the invention. The pump module 2 includes a motor and pump assembly 30 and one vertical dual-bore PLET coupling 25 connected to the PLET 1 through one vertical dual-bore pump module connector or coupling 21 on the PLET. The coupling is made up when the pump module 2 is lowered onto the PLET 1. The PLET 1 includes two pump circuit valves 26 and a bypass valve 27. The pipeline 24 is connected to the bypass module through the releasable coupling 28 formed in part of the vertical manifold jumper connector 20. In bypass mode, the bypass valve 27 is open and the two pump circuit valves 26 are closed. In pumping mode, the bypass valve 27 is closed and the two pump circuit valves 26 are open.

The embodiment shown in the drawings include one vertical dual-bore PLET coupling 25 providing both an inlet and an outlet for the pump in the pump module. In an alternative embodiment, the vertical dual-bore PLET coupling 25 could be substituted with a separate inlet and a separate outlet for the pump module. Such a solution requires two couplings and two clamp connectors instead of one. A vertical dual-bore PLET coupling 25 is however advantageous as one coupling only requires one ROV operation for making up the coupling, because the solution is more compact and is easier to connect thus providing easier docking.

In the embodiment shown on the figures, the pump module coupling is shown as a vertical dual-bore pump module coupling (the flow inside the coupling flows in a vertical direction) as the pump module is lowered from a vessel above and onto

the PLET from above. Other embodiments may include one or more horizontal or angled pump module couplings and the pump module could be maneuvered sideways or at an angle with dedicated equipment or ROVs. Alternatively, the connections could be provided by short jumpers after docking. Normally is however the most advantageous and least cumbersome method to use vertical couplings and installation directly from above. The above explanation is also relevant for the vertical manifold jumper connector 20.

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# CLAIMS

1. A subsea PLET (1) with an upstream flow jumper connection (20), comprising a bypass valve (27) and a valve (26) of each of a pump inlet and a pump outlet, each in fluid connection with a pipeline (24);
at least one pump module coupling (21) in fluid connection with the valve (26) of each of the pump inlet and pump outlet; and
at least one pump module guiding means enabling guiding of a pump module onto the subsea PLET (1).

2. The subsea PLET (1) of claim 1, wherein the pump module coupling (21) is a dual-bore pump module coupling.

3. The subsea PLET (1) of claim 1or 2 wherein the pump module coupling (21) is a vertical coupling.

4. The subsea PLET (1) of claim 1, 2 or 3 wherein the jumper connection (20) is vertical jumper connection,

5. The subsea PLET (1) of claim 1, or 2 further including a vertical UTA landing interface (22).

6. The subsea PLET (1) of any of the previous claims, further including a pump module (2) with a well fluid pump and motor assembly and at least one PLET coupling in fluid connection with the least one pump module coupling (21).

7. The subsea PLET (1) of claim 6 wherein the pump module coupling (21) is a dual-bore vertical pump module coupling, and the at least one vertical PLET coupling is one vertical dual-bore PLET coupling (25).

8. The subsea PLET (1) of any of the previous claims, further including a UTA.

9. The subsea PLET (1) of claim 8, further including flying leads connecting the UTA and the PLET.

10. The subsea PLET (1) of any of the preceding claims, wherein the least one pump module guiding means includes two pump module guide posts (5) to facilitate installation of the pump module onto the PLET (1).

11. The subsea PLET (1) of any of the preceding claims, further including at least four PLET lock down points (7) to secure the PLET frame to the mud mat.

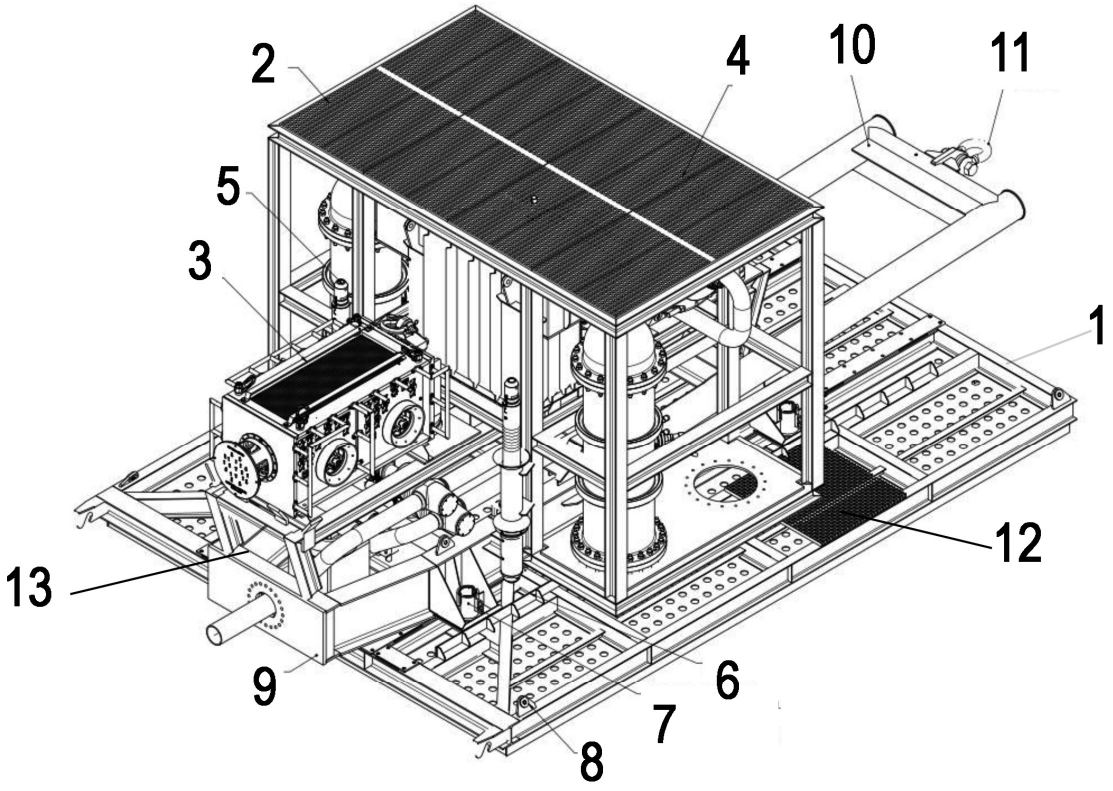


**Fig. 1**

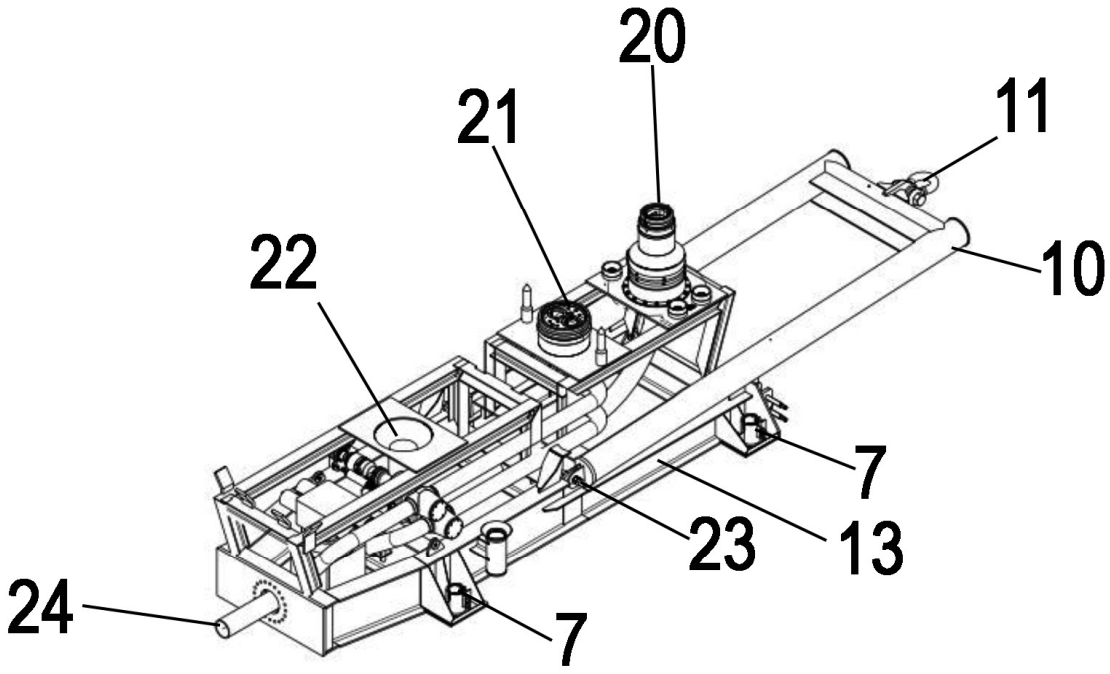


Fig. 2

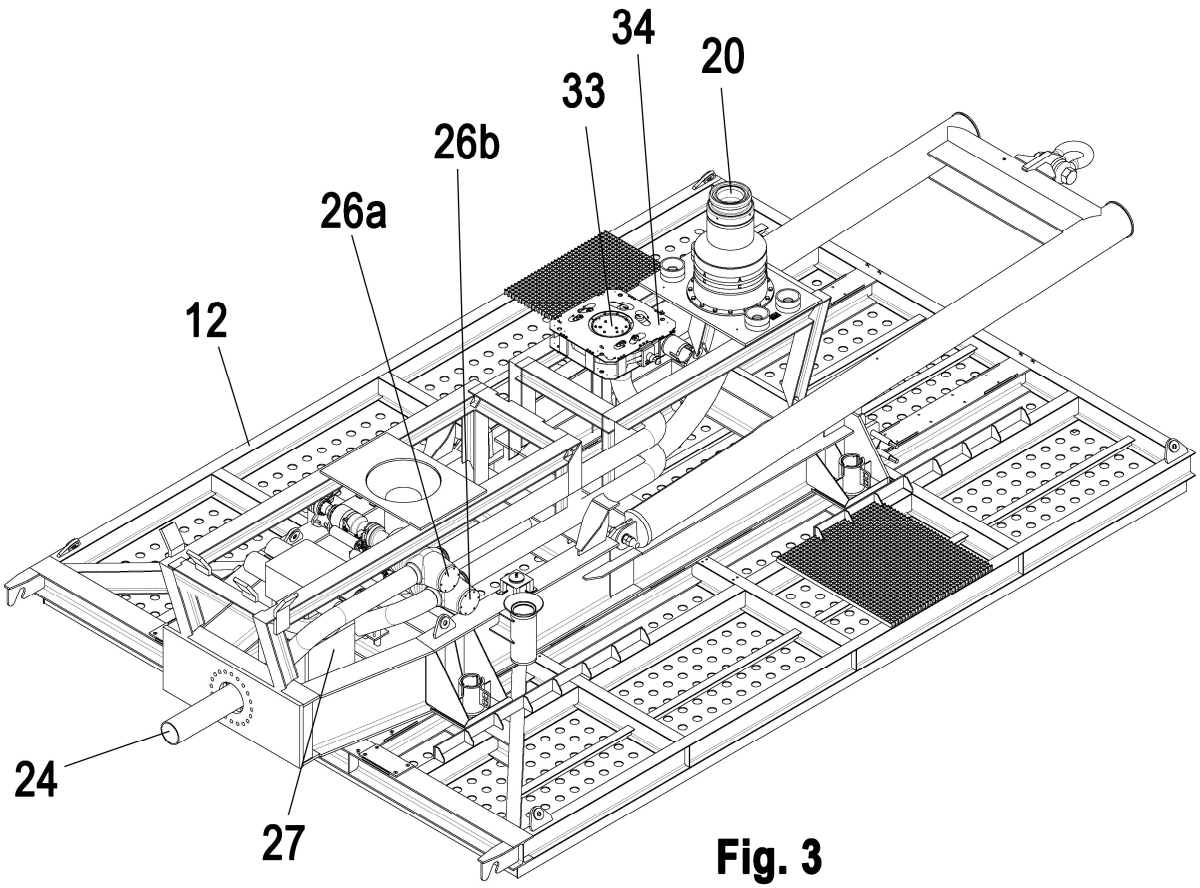


Fig. 3

PRIOR ART

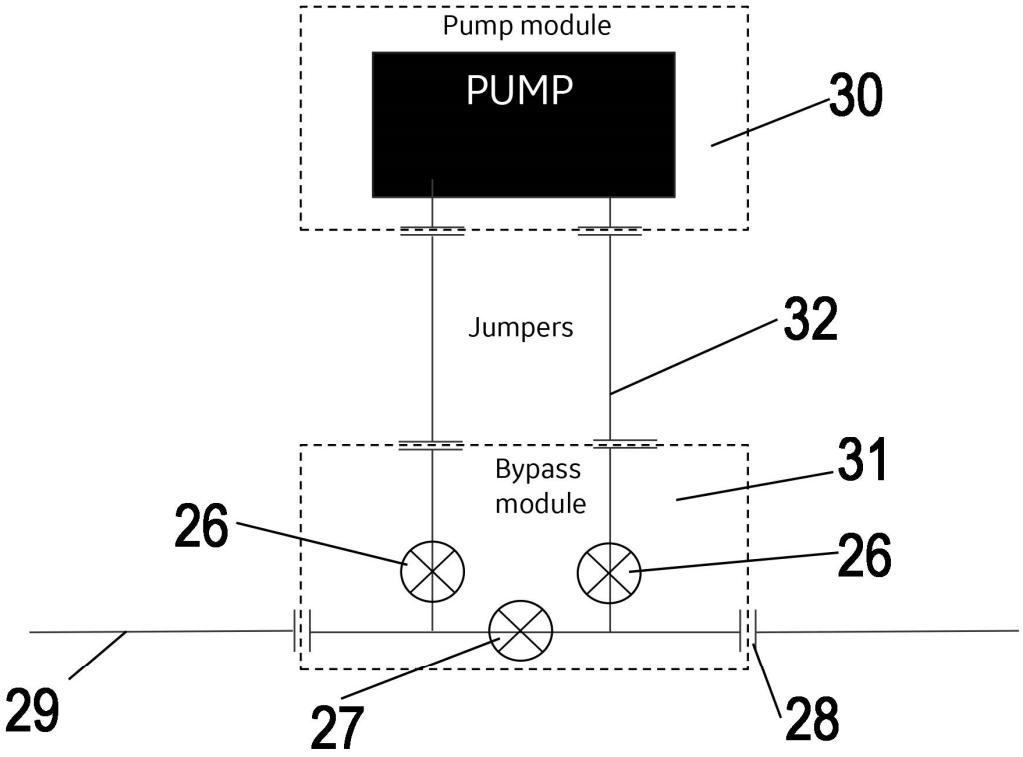


Fig. 4

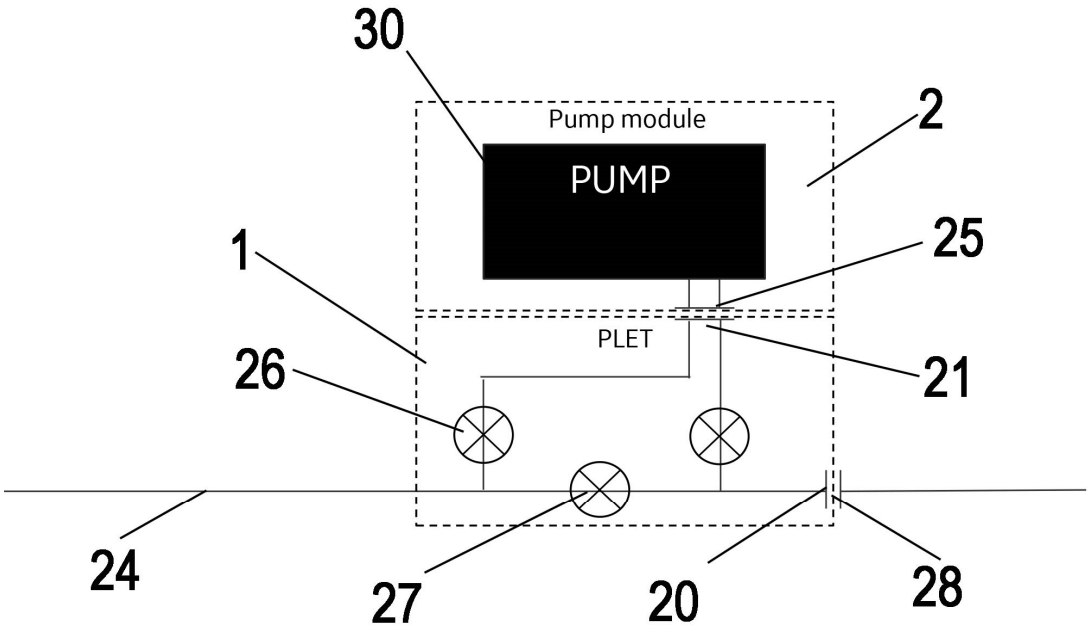


Fig. 5