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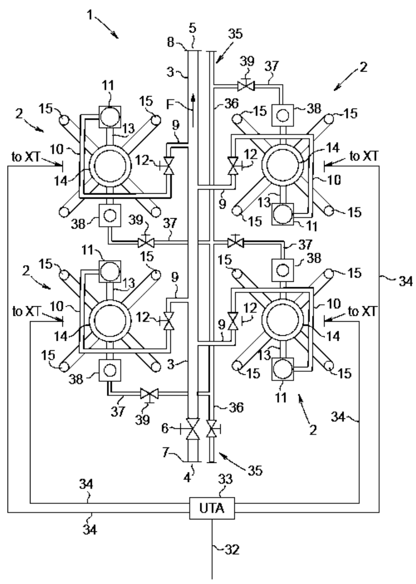
(54) Title **A flow base system for subsea wells**
(57) Abstract

A flow base system (1) for subsea wells is disclosed, the flow base system comprising a header pipe (2) for production fluid extended through the flow base system, wherein from opposite sides of the header pipe (3) a set of flow base modules (2), respectively, is connected for supply of production fluid to the header pipe (3) via individual branch pipes (10) connecting the header pipe (3) with a Christmas tree (XT) interface (11) arranged for vertical connection to an XT respectively. The flow base system (1) is installed in a well template structure (18), wherein a flow base module (2) respectively is inserted into each well slot (S1-S4) formed in the well template structure (18).



A flow base system for subsea wells

TECHNICAL FIELD OF THE INVENTION

The present invention relates to a flow base system for subsea wells.

BACKGROUND AND PRIOR ART

The infrastructure of subsea hydrocarbon production fields typically comprises rigid and flexible piping and manifolds to collect production fluid from subsea wells. Subsea wells can be grouped in template solution, or spread out as standalone satellite wells regularly/irregularly distributed over the field. If wells can be grouped closely together, templates can be used for controlling the spacing between the wells. For the purpose of this disclosure, subsea wells which are closely grouped and guided in a template will be named template wells.

In general terms, a template is a structure which is placed on the seabed to provide guidance and support for other equipment such as drilling and completion equipment, wellheads, Christmas trees (XT), manifolds and pipeline connection equipment.

A production well template is a welded structure that supports manifold piping and valves for production fluid from wells which are grouped together at a single seabed location. The number of wells is limited by the size of the well template, which has an individual section or slot for each well connected to the template. Typical sizes include 2, 4, 6 and 8 slot configurations.

Template installation typically includes landing of a prefabricated piping deck onto the template. The piping deck typically includes the flowlines and valves necessary to conduct production fluid from the template, as well as the hydraulic lines required to operate the manifold and XT valves. Since maintenance and repairs on deep water equipment requires implementation of ROV-assisted structures, the piping deck, e.g., may be separately retrievable in order to avoid dismantling of the entire production system in case of damage to the piping components.

In shallow water installations, at water depths less than 200 m, diver-assisted intervention is possible and ROV-related structures are not necessary. However, there is a need for structures with fewer components to simplify intervention procedures. There is also a constant need for more compact configurations on subsea structures.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a non-complex, low cost flow base system for subsea wells while also permitting tying-in of standalone wells and clusters of wells of an existing infrastructure.

It is another object of the present invention to provide a flow base system that is scalable up to standard 6-slot production well templates, at least.

It is yet another object of the present invention to provide a flexible flow base system that will fit in most common subsea field layout architectures.

Still other objects include the provision of a versatile flow base system which permits implementation of, e.g., pigging modules and well intervention systems.

One or more of these objects is met in a flow base system for subsea wells, the system comprising a header pipe for production fluid extended through the flow base system, wherein from opposite sides of the header pipe a set of flow base modules, respectively, is connected for supply of production fluid to the header pipe via individual branch pipes connecting the header pipe with a coupling interface arranged for vertical connection to a Christmas tree (XT) respectively. The flow base system is installed in a frame structure similar to a well template structure, such that a flow base module respectively is inserted into the well slots formed in the frame structure. This embodiment permits protection of the flow base components under a common top cover for the frame structure. This embodiment is also a compact and cost saving solution which combines one singular protection structure with a non-complex piping and instrumentation diagram (P&ID).

The modular layout of the flow base system facilitates extensive use of standard components in a streamlined building process. This benefits to reduced costs for installation and testing, e.g. The modular design also facilitates upscaling of the system.

A singular isolation valve on each branch pipe is controllable for opening the branch pipe for flow of production fluid. The concept of providing a single barrier results in simplified piping and control of the flow base system.

Coupling means are arranged in one end of the header pipe for connecting to external subsea equipment. An isolation valve in the same end of the header pipe is controllable for through flow of production fluid from connected external equipment.

The embodiment provides the ability for tying-in standalone satellite wells or interconnected (daisy-chain) wells, and permits connection of another flow base system if appropriate. The embodiment also provides the ability of connecting a pig launcher or receiver in the said end of the header pipe.

In one embodiment, the flow base modules are essentially identical and the flow base modules on one side of the header pipe are turned 180° in relation to the orientation of the flow base modules on the other side of the header pipe.

In alternative configuration, the flow base modules on a first side of the header pipe may be mirrored layouts of the flow base modules on a second side of the header pipe. The first and second sides of the header pipe can advantageously be opposite sides of the header pipe. The advantage of standardization through the repeated use of identical components can still be enjoyed.

Operational control is distributed within the flow base system from an umbilical termination assembly (UTA) associated with the flow base system. This embodiment avoids control tubing since flying leads or cables can be used for distribution of hydraulic fluid and/or electrical power. Thus, XT control within the flow base system is distributed from the UTA via hydraulic and electric flying leads/cables.

A valve control interface is installed for manual intervention by a remotely operated vehicle (ROV) or a diver. This feature can provide redundancy in case other operational control fails.

The XT control in the system can be distributed within the flow base system from an umbilical termination assembly associated with the flow base system.

Furthermore, the XT control can be distributed from the umbilical termination assembly via hydraulic and/or electric flying leads.

A well intervention system may be installed essentially in parallel with the production fluid pipework. The well intervention system comprises a header pipe with branch pipes extended to each flow base module respectively.

The well intervention system allows for supply of gas for enhanced lift of production fluid, or for supply of injection chemicals to the well. The flow base module may thus each comprise two vertical connection systems for the production fluid and for gas lift/chemicals respectively.

Each flow base module of the flow base system comprises a well insert in fixed relation to guiding means arranged for guidance of an XT during landing and installation.

The guiding means can be realized as guide posts/pillars or as funnel-equipped tubes rising from a flow base support, in which the branch pipes and valves as well as the XT interfaces are supported.

The flow base module may be arranged with an extension for connecting to an external supply of production fluid via a jumper pipe. This configuration extends substantially the possibility of tying-in external singular or daisy-chain wells in an existing production field architecture.

SHORT DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will be further explained below with reference made to the drawings. In the drawings:

Fig. 1 is a schematic view illustrating the flow base system.

Fig. 2 is a first perspective view of a subsea well template in which the flow base system is integrated.

Fig. 3 is a second perspective view of the subsea well template in which the flow base system is integrated,

Fig. 4 is a partially broken away perspective view corresponding to Fig. 2, showing details of the flow base system installed in the subsea well template.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

With reference made primarily to Fig. 1, a flow base system 1 comprises a set of flow base modules 2 arranged on opposite sides of a header pipe 3 for production fluid. The header pipe 3 extends through the flow base system from a first or upstream end 4 to a second or downstream end 5 as seen in the direction of flow F through the header pipe. The first end 4 is optionally connectable to external equipment for transport via the header pipe 3. The second end is the discharge end from which production fluid is discharged downstream.

A header isolation valve 6 is arranged in the first end of the header pipe, which also in the same end carries coupling means 7 for connecting to an external supplier of production fluid or to other subsea equipment. These external units can be another flow base system, a standalone satellite well or interconnected daisy-chain wells, or a pigging launcher/receiver e.g. In the discharge end 5, the header pipe carries coupling means 8, such as a flange coupling e.g., arranged for connecting the flow base system to a pipeline, a jumper pipe or to other downstream equipment for fluid transport. The header pipe 3 further comprises a number of pipe joints 9, especially

T-couplings 9 through which the flow base modules 2 are connected to the header pipe 3 at mutually spaced locations along the header pipe.

Each flow base module 2 comprises a branch pipe 10 connecting the header pipe with an XT tree interface 11. An isolation valve 12 on the branch pipe is controllable for opening the branch pipe for flow of production fluid into the header pipe.

The isolation valves 6 and 12 are on/off valves, and can be realized as gate valves e.g.

The isolation valves 6, 12 are releasably connected to the pipe joints or T-branches 9 and branch pipes 10. If necessary, the isolation valves 6, 12 can be removed and replaced. The piping of the flow base system and surrounding structures is permanent and will not be removable. This is possible, since all valves are retrievable.

The XT interface 11 is supported on a flow base support 13 which also carries a well insert 14 in fixed relation to an array of guides 15, the guides 15 are arranged for guidance of an XT when lowered to the flow base module during installation. The XT interface 11 faces upwards for vertical or upright connection to the XT. The XT itself is not part of the invention and is omitted from the drawings for reasons of clarity.

In the shown embodiment, the flow base modules 2 on one side of the header pipe 3 are turned horizontally through180° in relation to the orientation of the flow base modules 2 on the other side of the header pipe 3.

In one embodiment the flow base module is supplementary equipped with an extension and on/off valve for tying-in an external well and supplier of production fluid. In this embodiment a satellite well can e.g. be connected directly to the XT interface 11, if appropriate.

With reference to Figs. 2-4, the flow base system 1 is integrated in a frame structure 18 arranged to be lowered for connecting with a foundation (not shown) that is anchored in the seabed. The frame structure 18 comprises two side-bays 19 and 20 interconnected through a mid-section 21.

Guide funnels 22 in the ends of the side-bays provide guidance for mating with the foundation, particularly in case piling is required for anchoring of the frame structure 18.

Each side bay 19, 20 is a rectangular structure composed of longitudinal beams 23 and transverse beams 24. The beams 23 and 24 define the individual slots S1-S4, which are four in the shown embodiment, and in which a flow base module 2, respectively, is arranged to ensure that the well insert 14 is placed in register with a corresponding well. In mounted position the branch pipes 10 reach into the mid-section for connecting with the header pipe 3, which is suspended in the mid-section 21 to extend substantially through the frame structure 18. Thus, with respect to design and function, the frame structure 18 is essentially similar to a production well template and can be referred to as such.

In this connection it should be pointed out that the modular design of the flow base system permits implementation in templates of other size than the one illustrated, such as 2-, 6- or even 8-slot templates, if appropriate.

The flow base system 1 is protected under a top cover 25 which is supported by a superstructure comprising horizontal or lying beams 26 and vertical or upright struts 27. Over the bays 19 and 20, the top cover 25 comprises hatches 28 respectively which are installed above each slot after installation of the XTs.

The flow base components in the mid-section 21 are covered and protected below a portion of the top cover comprising a valve control interface 29. The valve control interface 29 is supported by a separate superstructure 30, this way building an integrated part of the top cover 25. The valve control interface 29 comprises handles and connections 31 for manual control of the valves of the flow base system by means of an ROV or a diver.

In normal operation, XTs are monitored and controlled from topside management via an umbilical 32 connecting to the XTs via an umbilical termination assembly (UTA) 33. The UTA 33 distributes the control of the XTs via hydraulic and electric flying leads/cables.

The UTA 33 further distributes well intervention fluid via a well intervention pipework 35. The well intervention pipework 35 comprises a header pipe 36 from which a branch pipe 37 respectively extends to each flow base module 2 for termination in a second XT interface 38, likewise arranged for connection to the XT. In the shown embodiment, there is a vertical or upright connection to the XT. Isolation valves 39 on the branch pipes 37 are controllable for regulating the supply of well intervention fluid to the wells. The well intervention pipework 35 can be used for supply of all kinds of well intervention fluid as is commonly known in the art and used in hydrocarbon production from subsea wells, such as gas for enhanced lift of the production fluid, injection water, or chemical products for wax and hydrate prevention, etc. An isolation valve 40 may be arranged in the downstream end of the header pipe 36 to permit supply of injection water to the well intervention pipework from external source, such as from a subsea water well, if appropriate.

The flow base system as disclosed provides a compact, cost-effective and fabrication friendly solution. The main features of the flow base modules, i.e. the flow base support, XT interfaces and pipework, permits the use of a standard satellite XT into a template system. In other words, the same XT can be used both as satellite and template XT. The system also permits connecting a step-out well from a well slot in case that is required. The tolerance loop between the manifold piping and XT is significantly simplified by the present flow base system since the pipework can be non-retrievable. Thus, no fabrication jigs or precision welding will be required, all tolerances can be taken care of by machining of a limited number of components in the XT flow base.

In shallow water applications, the present flow base system uses diver replaceable valves instead of fully retrievable manifold modules. Also, the pipework is simplified as all control tubing is removed and replaced by hydraulic flying leads (HFL) and electric flying leads (EFL) which are connected directly from UTA, or via a subsea distribution unit (SDU) if appropriate. The overall simplification results in reduced total weight, which in turn permits using a smaller installation vessel.

CLAIMS

1. A flow base system (1) for subsea wells, the flow base system comprising a header pipe (3) for production fluid extended through the flow base system, wherein from opposite sides of the header pipe (3) a set of flow base modules (2), respectively, is connected for supply of production fluid to the header pipe (3) via individual branch pipes (10) connecting the header pipe (3) with a Christmas tree (XT) interface (11) arranged for connection to an XT respectively, characterized in that the flow base system (1) is installed in a well template structure (18), and wherein a flow base module (2) respectively is inserted into each well slot (S1-S4) formed in the well template structure (18).

2. The flow base system of claim 1, wherein the flow base module (2) are connected to the header pipe (3) via T-couplings (9).

3. The flow base system of claim 1 or 2, wherein the flow base modules (2) are essentially identical and the flow base modules on one side of the header pipe (3) are turned 180° in relation to the orientation of the flow base modules on the other side of the header pipe.

4. The flow base system of any previous claim, wherein each flow base module (2) comprises a well insert (14) in fixed relation to guiding means (15) arranged for guidance of an XT during landing and installation.

5. The flow base system of claim 4, wherein the guiding means (15) is realized as guide posts/pillars or as funnel-equipped tubes rising from a flow base support (13), in which the branch pipes (10) and valves as well as XT interfaces (11, 38) are supported.

6. The flow base system of any previous claim, wherein a singular isolation valve (12) on each branch pipe (10) is controllable for opening the branch pipe for flow of production fluid into the header pipe (3).

7. The flow base system of any previous claim, wherein coupling means (7) is arranged in an end (4) of the header pipe (3) for connecting to external subsea equipment.

8. The flow base system of claim 7, wherein an isolation valve (6) in said end (4) of the header pipe (3) is controllable for through flow of production fluid from external equipment.

9. The flow base system of any previous claim, wherein a valve control interface (29) is installed for intervention by a remotely operated vehicle (ROV) or diver.

10. The flow base system of any previous claim, wherein the valves of the system are removable.

11. The flow base system of any previous claim, wherein a well intervention system (35) is installed essentially in parallel with the production fluid pipework.

12. The flow base system of claim 11, wherein the well intervention system (35) comprises a header pipe (36) with branch pipes (37) extended to each flow base module (2).

13. The flow base system of any previous claim, wherein the piping of the system is permanently or non-removably arranged in the system.

14. The flow base system of any of claims 11-13, wherein the fluid of the well intervention system is supplied via an umbilical (32) to an umbilical termination assembly (33) associated with the flow base system.

15. The flow base system of any previous claim, wherein a flow base module (2) comprises an extension (16) for connecting to an external supply of production fluid via a jumper pipe.

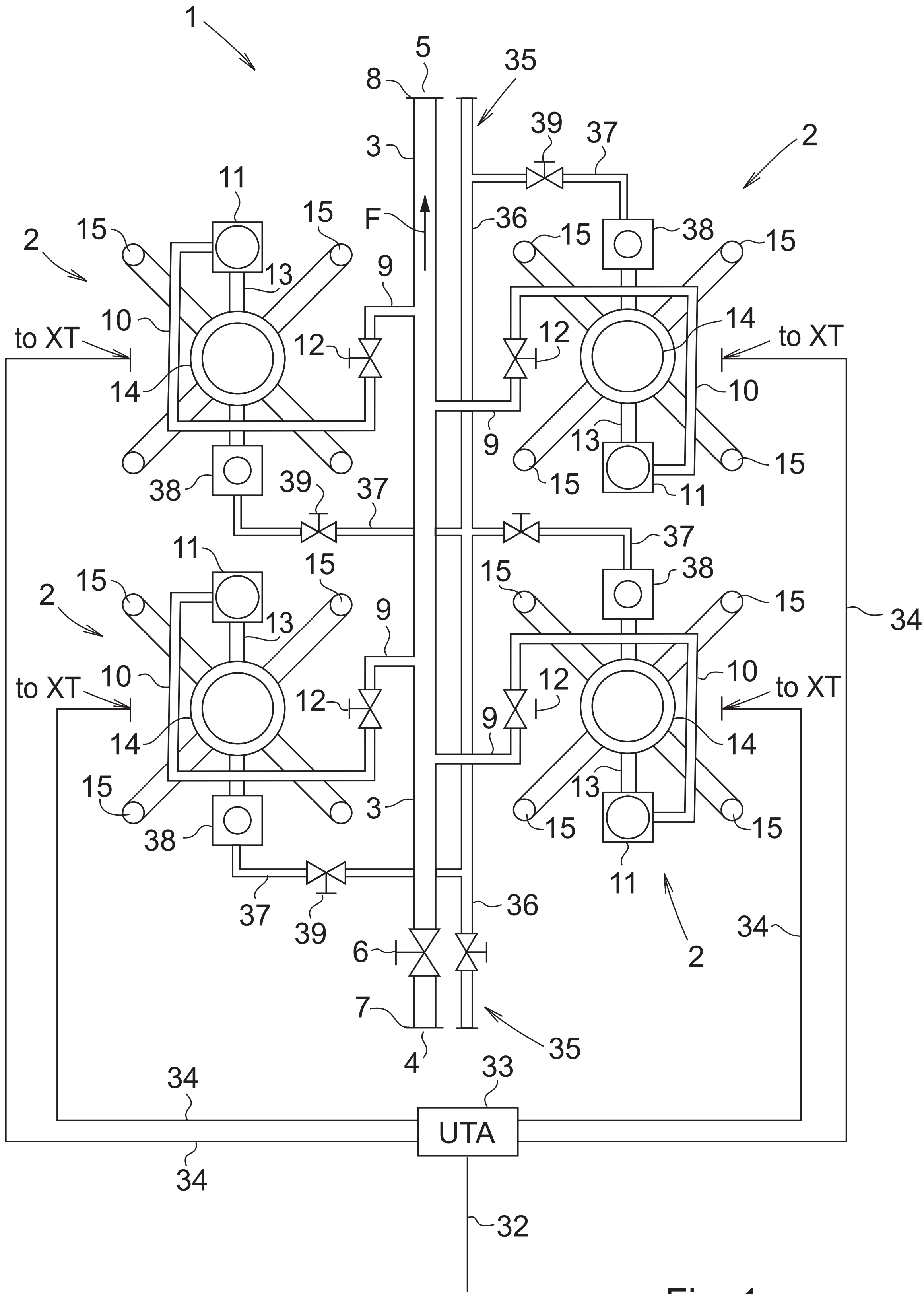

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Fig. 1

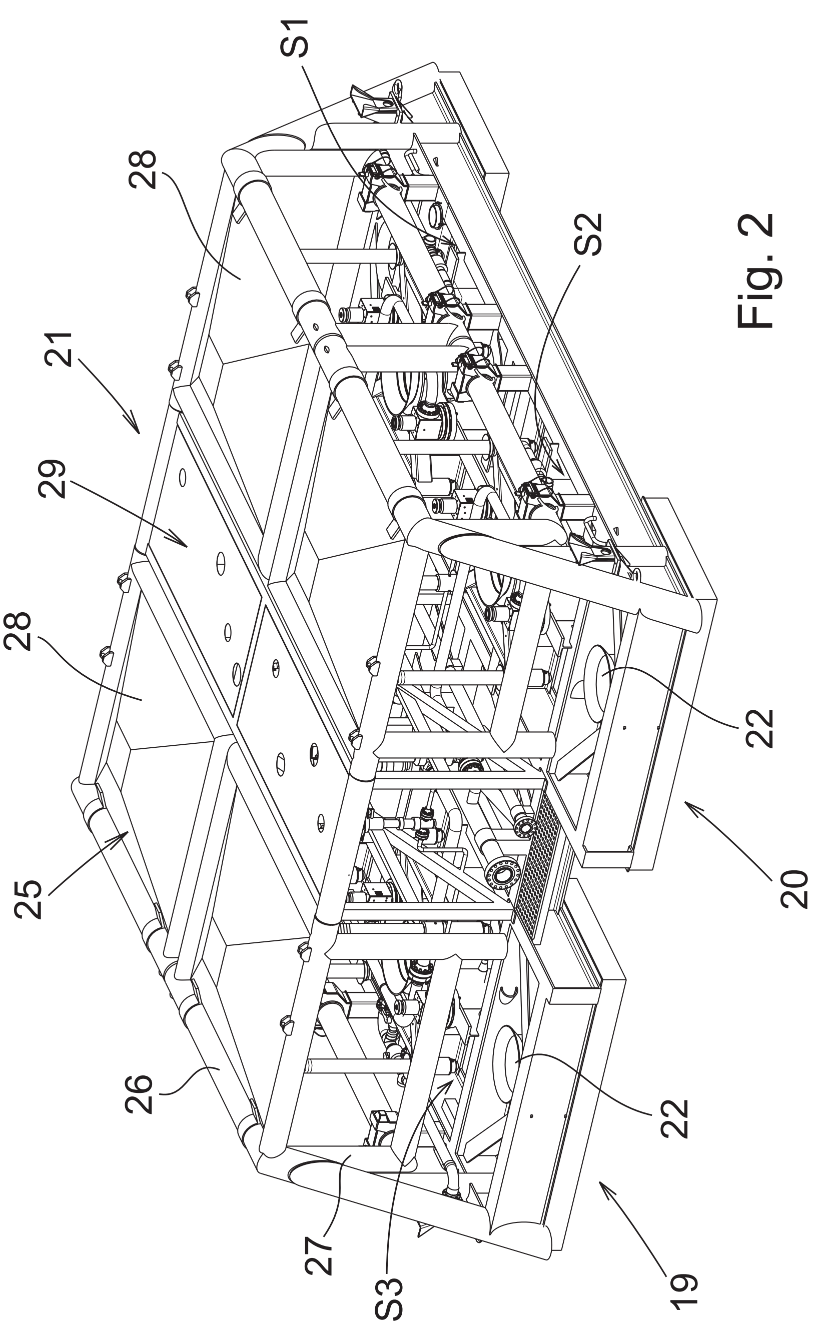

Fig. 2

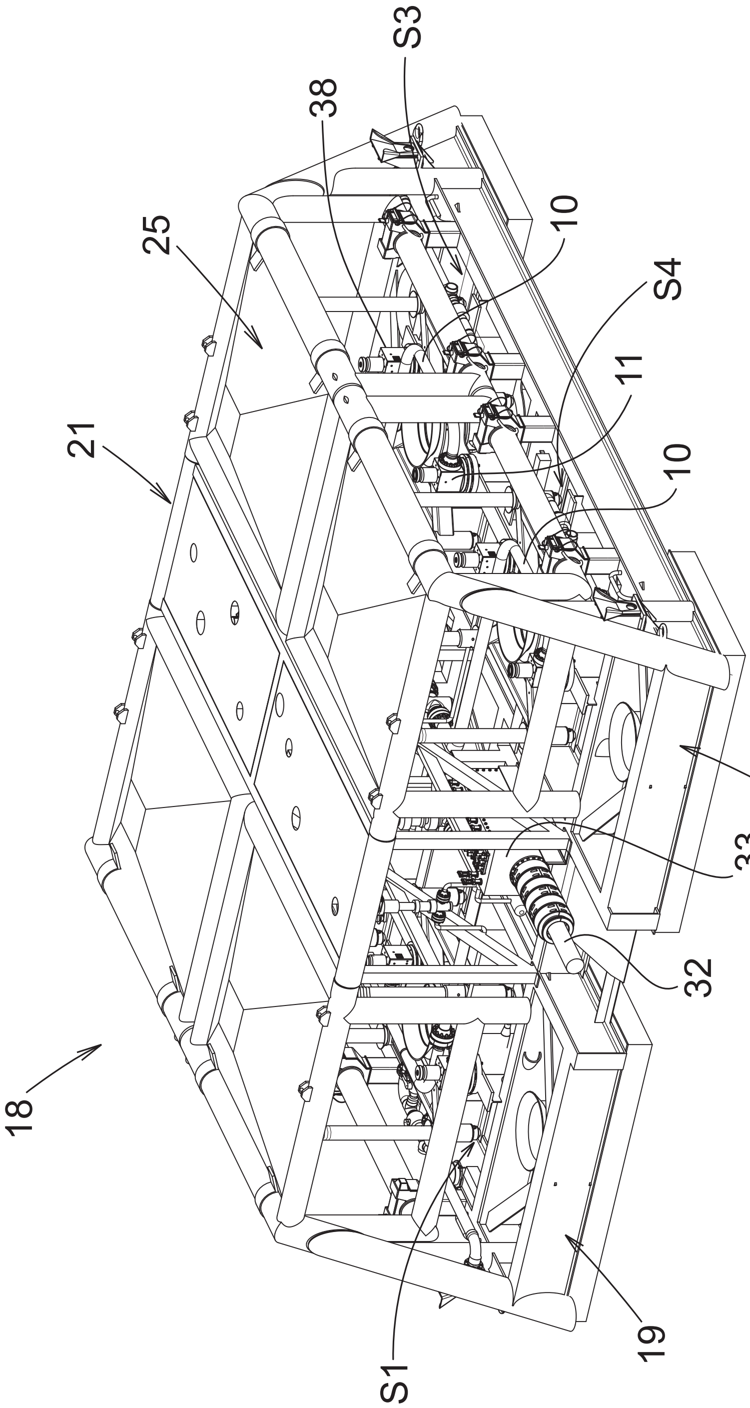

Fig. 3

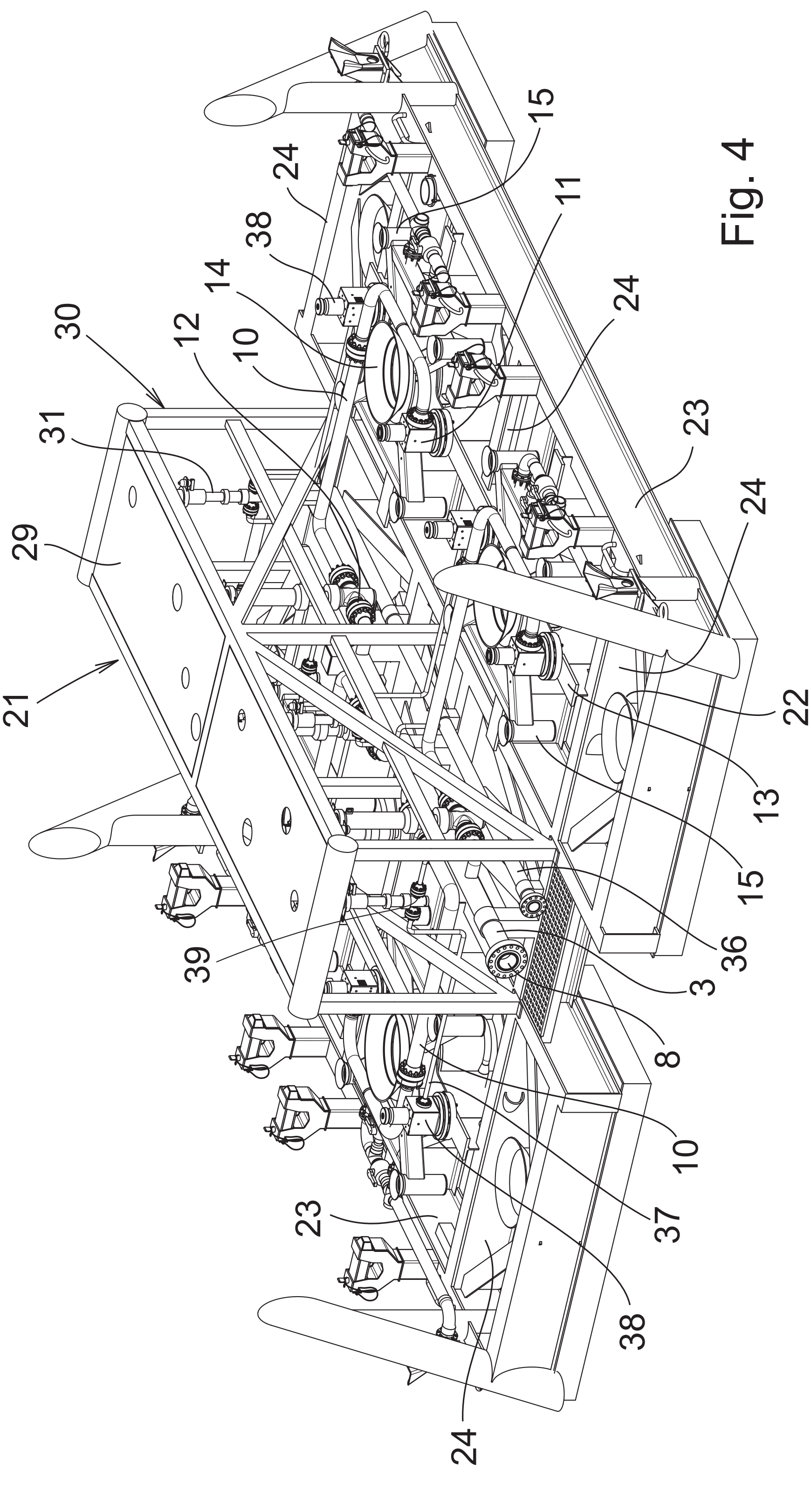
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Fig. 4