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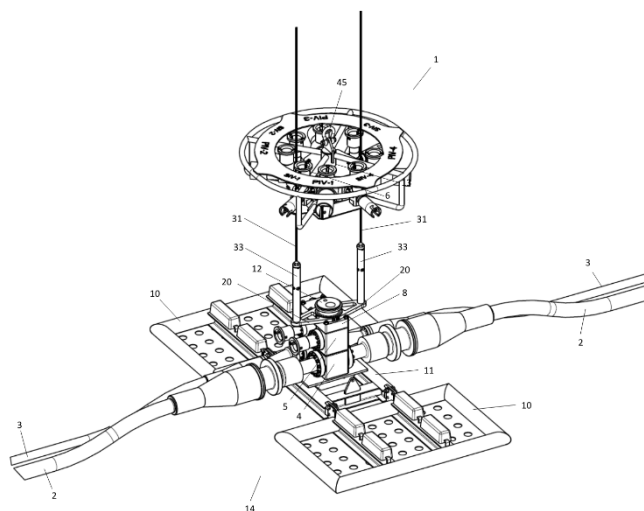
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(54)	Title	Dual service inline manifold system
(57)	Abstract	

A dual service inline-manifold system comprises a manifold module (1) connected to two main service flowlines (2) and two auxiliary flowlines (3) in a daisy chain solution. The system is meant to be used subsea at any water depths for transport and distribution of any production/injection fluid, gas or a mixture of both fluid and gas. The system is supplied with an auxiliary system for e.g., gas-lift, MEG/methanol, or other fluids in parallel with the main service if needed. The main components are a dual inline-tee block (4), a dual valve block (5), a dual hub block (8), and a guiding system (30, 31) for guiding the manifold module (1) upon installation.



Dual service inline manifold system

The present invention relates to a compact building block dual service inline-manifold system, comprising a subsea retrievable dual service manifold module, a dual inline module and a foundation, connected to two main service flowlines and two auxiliary flowlines in a daisy chain configuration. The system is meant to be used subsea at any water depths for transport and distribution of any production/injection fluid, gas or a mixture of both fluid and gas. The system is supplied with an auxiliary system for e.g., gas-lift, MEG/methanol, or other fluids in parallel with the main service if needed.

This invention allows a dual service inline manifold system with two or more branches for each service to be installed together with the flowline in an inline configuration where the dual service manifold module can be installed prior to installation or at a later stage and as such offer added flexibility. A pressure cap with clamp assembly, or other types of protection caps to be assembled in case the dual service inline manifold system are installed without the dual service manifold module.

The dual service manifold module can also be separately retrieved for service at a later stage.

One objective for the dual service inline manifold system of the present invention is to remove the need for separate installation of a foundation, manifold module, and subsea tie-in of flowlines.

Another objective for the dual service inline manifold system of the present invention is to avoid disconnection work of all the flowlines in case the manifold needs to be retrieved, as on a traditional subsea manifold.

Summary of the invention

The objectives are according to the invention achieved by an inline manifold system for transport and/or distribution of fluid, gas or a mixture of fluid and gas, the system comprises:

- a manifold module for main service flow and auxiliary service flow in parallel through a dual service compiler fitting having two or more horizontal main service branches and two or more horizontal auxiliary service branches;

- an inline-tee block having a horizontal main service through bore and a horizontal auxiliary service through bore with coupling interfaces for connection to a main service flowline and to an auxiliary service flowline, respectively, on two opposite sides of the inline-tee block, preferably at surface during layaway, allowing
- 5 flowlines and inline manifold system being installed together with or without the dual service manifold module in place; and
- a vertical main service bore and a vertical auxiliary service bore connecting the horizontal bores of the inline-tee block with the horizontal branches of the compiler fitting, respectively, via a dual service hub block having a dual bore up-facing hub
- 10 arranged on the hub block connectable to a dual bore down-facing hub arranged on the compiler fitting.

According to one embodiment, the system comprises a valve block inserted between the inline-tee block and the hub block. The valve block includes a main

15 service isolation valve arranged in the vertical main service bore and an auxiliary line isolation valve arranged in the vertical auxiliary service bore. This allows to isolate the flow between the flowlines and up-facing hub and avoiding flooding the flowlines when replacing the dual service manifold module or pressure cap with clamp assembly.

20 According to one embodiment, block tension bolts are arranged to secure the inline-tee block, the valve block and the hub block together, and further wherein pre-tension seals for the vertical main service and vertical auxiliary service bores are arranged at interfaces between the blocks.

A connector with operation bucket may preferably be arranged for vertically

25 connecting the compiler fitting with the hub block.

A pressure cap with clamp assembly may preferably be arranged to cover the up-facing hub on the hub block, until connection with the compiler fitting.

In one embodiment, a guiding system comprises two guideposts rising from the hub block, each formed with an anchor interface for interaction with anchors suspended

30 in guide wires effective for guiding the manifold module and compiler fitting during landing on the hub block.

In one embodiment, the guide posts are supported from a guidepost bracket that is directly connected to the up-facing hub of the hub block, and further wherein a connector guide funnel for the vertical connector is arranged, this way minimizing the tolerance loop for both position and alignment.

- 5 In one embodiment, blind caps installed at the coupling interfaces instead of the main service flowline and auxiliary service flowline on one side of the inline-tee block, this way configuring the inline manifold system as a flowline end manifold.

The piping of prior art manifold systems may preferably be replaced by fittings and drilled blocks.

- 10 In one embodiment, both up- and downstream main and auxiliary service flowlines are connected to one inline-tee block keeping all flowline forces within one singular component, thus avoiding complicated load paths through a multiplicity of components.

- 15 In one embodiment, the main service flowline and the auxiliary service flowline are installed in parallel, connecting the auxiliary service flowline to the main service flowline up- or downstream of a tensioner for the main service flowline, by means of bundle clamps in a piggyback configuration.

- 20 Connecting the flowline to the dual service inline manifold system at surface means that a requirement for a flowline alignment system is no longer needed. This significantly reduces the size of the subsea module. The dual service inline manifold system allows both main service flowline and auxiliary flowline to be installed in one go by connecting the auxiliary flowline to the service flowline after the tensioner for main service flowline by bundle clamps in a piggyback configuration. This solution will have a big saving on the installation duration.

- 25 According to one embodiment, the dual inline module main components are a dual inline-tee block, a dual valve block, a dual hub block, and a guiding system for guiding the retrievable dual service manifold module during lift-off and landing. The dual inline-tee block may be rigidly connected to the foundation via the center base structure.

- 30 The dual inline-tee block main features are a horizontal through main service bore with a bore diameter typical 6" to 12" and a horizontal through auxiliary bore with a bore diameter

typical 2" to 8". All horizontal bore ends are preferably designed with a dry mate connection interface, such as a flange interface 40a/40b, for connection of main service flowline and auxiliary flowlines. This design minimizes the load path between the upstream and downstream flowlines as the forces will be kept within the dual inline-tee block only.

- 5 According to one embodiment, a vertical main service bore and a vertical auxiliary bore (with a horizontal offset bore) are preferably drilled through all the dual inline module blocks, connecting the flow path from the dual inline-tee block to the dual bore up-facing hub. Typical bore diameters for the vertical bores are 6"-10" for main service bore and 2"-6" for auxiliary bore.
- 10 A dual valve block can be stacked on the top of the dual inline-tee block if isolation of the flow between dual bore up-facing hub and flowlines are required, this again allows the dual service manifold module to be disconnected and connected without flooding the flowlines. The dual valve block may be designed to be an integrated part of the vertical main service isolation valve and vertical auxiliary line isolation valve by machining the gate or ball cavity
- 15 directly into the block.

The dual hub block can either be connected directly to the dual inline-tee block or dual valve block if valves are required. The dual hub block may be designed with a dual bore up-facing hub allowing for a subsea diver or diver-less connection to the dual service manifold module with the dual bore down-facing hub.

- 20 All blocks in the dual inline module stack may be secured and pre-tensioned together by block tension bolts. A seal for vertical main service bore and seal for vertical auxiliary bore are preferably installed between the blocks to ensure pressure integrity in the system.

- 25 The foundation may consist of a center base structure and two of mud mats, the mud mats are preferably designed to be hinged or pivoted to vertical position to simplify handling during transport and on vessel deck or to allow the system passing through a stinger or other restricted areas on the vessel during subsea installation if required. The mud mats may be designed to be slidable on the seabed and can be scaled in size to meet the support requirement for the different soil conditions without changing the center base structure. The
- 30 center base structure may be equipped with an interface for a hinged inline-tee installation frame that can be connected to a vessel crane, or a buoyancy reducing tension in flowline

and ensure correct orientation during installation from vessel to the seabed. The hinged inline-tee installation frame can be released after landing at seabed by releasing an installation frame lock pin.

The guideposts on each side of the dual bore up-facing hub will ensure final guiding of the dual service manifold module during landing by matching connector guide funnels on the vertical connector. The guidepost top may be designed with a guide wire anchor interface allowing use of guide wire with anchor to ensure guiding of modules onto the guideposts.

A pressure cap with clamp assembly or other protection caps to be in place during installation of inline-tee system if dual service manifold module is not installed.

- 10 The dual service manifold module is based on a dual service compiler fitting with two or more horizontal main service branch and two or more horizontal auxiliary branch. In one embodiment, each branch on the dual service manifold module is equipped with a main service branch isolation valve and a horizontal main service branch line connection with typical 4" to 6" bore or an auxiliary branch isolation valve with horizontal auxiliary branch
- 15 line connection with typical 2"-3" bore. The valves can either be integrated in the dual service compiler fitting or bolted to the dual service compiler fitting.

- The dual service compiler fitting can be drilled with vertical main service and auxiliary bores from the dual bore down-facing hub and up to the respective horizontal main service branch and horizontal auxiliary branch. The horizontal branches for main service and auxiliary are
- 20 preferably elevated at different levels to avoid interfering with each other.

- The present invention provides according to one embodiment a compact building block dual service inline-manifold system comprising a dual service manifold module, a dual inline module and a foundation, connected to two main service flowlines and two auxiliary flowlines in a daisy chain solution. The system is meant
- 25 to be used subsea at any water depths for transport and distribution of any production/injection fluid, gas or a mixture of both fluid and gas. The system is supplied with an auxiliary system for e.g., gas-lift, MEG/methanol, or other fluids in parallel with the main service if needed.

- The dual inline module main components are in this embodiment a dual inline-tee
- 30 block, a dual valve block, a dual hub block, and a guiding system for guiding the

retrievable dual service manifold module. The dual inline-tee block is rigidly connected, e.g., bolted to the foundation via the center base structure.

The main service flowlines and auxiliary flowlines are meant to be connected to the dual inline module at the surface and as such be installed together during flowline
 5 layaway, the two flowlines may then be bundled in a piggyback configuration.

A dual service manifold module is designed to land subsea and connect to the dual inline module. The dual service manifold module is in one embodiment designed with four branches for main service and four branches for auxiliary.

Further details and advantages of the system according to the present invention will appear
 10 from the dependent claims and the following description.

Brief description of the drawings

Embodiments of the present invention will be described below with reference made to the accompanying schematic drawings. In the drawings:

15 Fig. 1 is an isometric view of a typical dual service inline manifold system, shown in a typical in-service mode with flowlines and branch lines connected,

Fig. 2 is an exploded isometric view of the main components in a typical dual service inline manifold system with the dual service manifold module 1, dual inline module 9 and foundation 14,

20 Fig. 3 is an exploded isometric view of a typical dual inline module 9 with the three main parts, dual inline-tee block 4, dual valve block 5, dual hub block 8 and guide system for dual service manifold module 1,

Fig. 4 is a plan section view of dual service manifold module 1 and dual inline module 9 with vertical connector 27,

25 Fig. 5 is a top view of dual service compiler fitting 13 showing horizontal main service and auxiliary flow path,

Fig. 6 is an isometric view of a typical dual service inline manifold system in installation mode with an inline-tee installation frame 34, dual service manifold module 1 replaced by a pressure cap with clamp assembly 35,

Fig. 7 is an isometric view of a typical dual service inline manifold system and shows the dual service manifold module 1 being installed or retrieved, guided by guide wire with anchor 31,

Fig. 8 is an isometric view of a typical dual service manifold module 1 without manifold module structure 28,

Fig. 9 is an isometric view of a typical dual service manifold system configured as a flowline end manifold in installation mode, and

Fig. 10 is a plan schematic view of a vertical dual flowline installation.

Detailed description of preferred embodiments of the invention

Fig. 1 is an isometric view of a typical dual service inline manifold system with a dual service manifold module 1, a dual inline module 9 and a foundation 14. Shown in a typical in-service mode with main service flowlines 2 and main service flowline termination 17, and with auxiliary flowlines 3 and auxiliary flowline termination 18 connected to the dual inline module 9. Dual service manifold module 1 connected to four of main service branch line 23 with main service branch line termination 21 and four of auxiliary branch line 24 with auxiliary branch line termination 22. A manifold module structure 28 is shown on the top of the dual service manifold module 1. This structure serves both as an impact protection and ROV grab bar.

Fig. 2 is an exploded isometric view of the main components in a typical dual service inline manifold system with the dual service manifold module 1, dual inline module 9 and foundation 14. The dual inline module 9 and foundation 14 are mechanical locked to each other, the dual service manifold module 1 are designed to be subsea installed and retrieved by lifting-line assisted by ROV or diver.

Fig. 3 is an exploded isometric view of a typical dual inline module 9 showing a dual inline-tee block 4 with a flange interface for main service bore 40a and a flange

interface for auxiliary bore 40b. Dual valve block 5 with a vertical main service isolation valve 6, a vertical auxiliary line isolation valve 7 and valve operation buckets 36. At the top there is a dual hub block 8 with a dual bore up-facing hub 12 and guiding system for guiding the dual service manifold module 1 comprising two guidepost brackets 20 and two fixed guideposts 33 with guide wire anchor interface 30. A seal for vertical main service bore 42a and a seal for vertical auxiliary bore 42b are installed between the blocks to ensure pressure integrity in the system. Block tension bolts 39 secure the blocks and ensure sufficient compression for the vertical seals 42a/42b.

Fig. 4 is a plan section view of the dual service manifold module 1 and dual inline module 9. Dual inline-tee block 4 shown at the bottom with the horizontal through main service bore 15a and horizontal through auxiliary bore 15b. Dual valve block 5 is shown with vertical main service isolation valve 6 and vertical auxiliary line isolation valve 7 in open position. The dual hub block 8 with the dual bore up-facing hub 12 is shown at the top of the dual inline module 9. A horizontal offset auxiliary bore 43 is added in the dual hub block 8 to offset the vertical auxiliary bore 16b, ensuring auxiliary flow path from the dual inline-tee block 4 and up to the dual service manifold module 1. The connection between the dual service manifold module 1 and dual inline module 9 is a subsea connection with a respectively dual bore down-facing hub 32 and a dual bore up-facing hub 12 secured and pre-tensioned by a vertical connector 27, operated by a connector operation bucket 36. In the dual service compiler fitting 13, the vertical main service bore 16a ends up in the horizontal main service branches 29a and vertical auxiliary bore 16b ends up in the horizontal auxiliary branch 29b.

Fig. 5 is a top view of dual service compiler fitting 13 showing main service and auxiliary horizontal flow paths. The horizontal main service branch 29a is elevated above the horizontal auxiliary branch 29b avoiding interference between the bores. All horizontal branches end up in a flange interface 44a for main service branch or a flange interface 44b for auxiliary branch.

Fig. 6 is an isometric view of a typical dual service inline manifold system in installation mode with an inline-tee installation frame 34 connected to the center base structure 11 by pivotable installation frame lock pins 41. Both main service

flowline 2 and auxiliary flowline 3 are connected during installation in a piggyback configuration secured by bundle clamps 47. The dual service manifold module 1 are in this case replaced by a pressure cap with clamp assembly 35, ensuring pressure barrier until dual service manifold module 1 are installed.

- 5 Fig. 7 is an isometric view of a typical dual service inline manifold system showing the dual service manifold module 1 being installed or retrieved, lifted by the dual service manifold module lifting interface 45 and pre-guided by guide wires with anchors 31 attached to the guide wire anchor interface 30. Guideposts 33 to ensure final guiding until dual bore down-facing hub 32 and dual bore up-facing hub 12
10 intervenes.

Fig. 8 is an isometric view of a typical dual service manifold module 1, manifold module structure 28 removed for clarity. Dual service compiler fitting 13 is shown with both main service branch isolation valves 25 and auxiliary branch isolation valves 26 connected. All valves are shown with flange connection towards the dual
15 service compiler fitting 13 and integrated horizontal main service branch line connection 37 and horizontal auxiliary branch line connection 38. A vertical connector 27 with connector guide funnel 19 is mechanically connected to the dual service compiler fitting 13.

Fig. 9 is an isometric view of a typical dual service manifold system configured as a
20 flowline end manifold in installation mode. Main service flowline 2 and auxiliary flowline 3 on one side only and open-end blinded by blind caps 46.

Fig. 10 is a plan schematic view of a vertical dual flowline installation, showing main service flowline 2 in vertical feed from the reel 52 through the VLS tower 50 by the tensioner for main service flowline 49 and auxiliary flowline 3 in horizontal feed
25 from the reel 53 through the tensioner for auxiliary flowline 48 into the VLS tower 50. At vessel deck 51 the auxiliary flowline 3 is connected to the main service flowline 2 by bundle clamps 47 in a piggyback configuration.

The invention is of course not in any way restricted to the embodiments described above. On the contrary, many possibilities to modifications thereof will be apparent
30 to a person skilled in the art without departing from the basic idea of the invention such as defined in the appended claims.

CLAIMS

1. An inline manifold system for transport and/or distribution of fluid, gas or a mixture of fluid and gas, the system comprising:
 - a manifold module (1) for main service flow and auxiliary service flow in parallel through a dual service compiler fitting (13) having two or more horizontal main service branches (29a) and two or more horizontal auxiliary service branches (29b);
 - an inline-tee block (4) having a horizontal main service through bore (15a) and a horizontal auxiliary service through bore (15b) with coupling interfaces (40a, 40b) for connection to a main service flowline (2) and to an auxiliary service flowline (3), respectively, on two opposite sides of the inline-tee block (4); and
 - a vertical main service bore (16a) and a vertical auxiliary service bore (16b) connecting the horizontal bores (15a, 15b) of the inline-tee block (4) with the horizontal branches (29a, 29b) of the compiler fitting (13), respectively, via a dual service hub block (8) having a dual bore up-facing hub (12) arranged on the hub block (8) connectable to a dual bore down-facing hub (32) arranged on the compiler fitting (13).
2. The inline manifold system of claim 1, comprising a valve block (5) inserted between the inline-tee block (4) and the hub block (8), the valve block including a main service isolation valve (6) arranged in the vertical main service bore (16a) and an auxiliary line isolation valve (7) arranged in the vertical auxiliary service bore (16b).
3. The inline manifold system of claim 1 or 2, wherein block tension bolts (39) are arranged to secure the inline-tee block (4), the valve block (5) and the hub block (8) together, and further wherein pre-tension seals (44a, 44b) for the vertical main service and vertical auxiliary service bores (16a, 16b) are arranged at interfaces between the blocks (4; 5; 8).

4. The inline manifold system of any previous claim, comprising a connector (27) with operation bucket (36), the connector (27) arranged for vertically connecting the compiler fitting (13) with the hub block (8).
- 5 5. The inline manifold system of claim 4, comprising a pressure cap with clamp assembly (35) arranged to cover the up-facing hub (12) on the hub block (8), until connection with the compiler fitting (13).
6. The inline manifold system of any previous claim, wherein a guiding system
10 comprises two guideposts (33) rising from the hub block (8), each formed with an anchor interface (30) for interaction with anchors suspended in guide wires (31) effective for guiding the manifold module (1) and compiler fitting (13) during landing on the hub block (8).
7. The inline manifold system of any previous claim, comprising blind caps (46) installed at the coupling interfaces (40a, 40b) instead of the main service flowline (2) and auxiliary service flowline (3) on one side of the inline-tee block (4), this way configuring the inline manifold system as a flowline end manifold.
8. The inline manifold system of any previous claim, wherein the piping of prior art manifold systems is replaced by fittings and drilled blocks.
9. The inline manifold system of any previous claim, wherein both up- and downstream main and auxiliary service flowlines (2, 3) are connected to one
25 inline-tee block (4) keeping all flowline forces within one singular component, thus avoiding complicated load paths through a multiplicity of components.
10. The inline manifold system of any previous claim, wherein the main service flowline (2) and the auxiliary service flowline (3) are installed in parallel, connecting the auxiliary service flowline (3) to the main service flowline (2) up-
30 or downstream of a tensioner (49) for the main service flowline, by means of bundle clamps (47) in a piggyback configuration.

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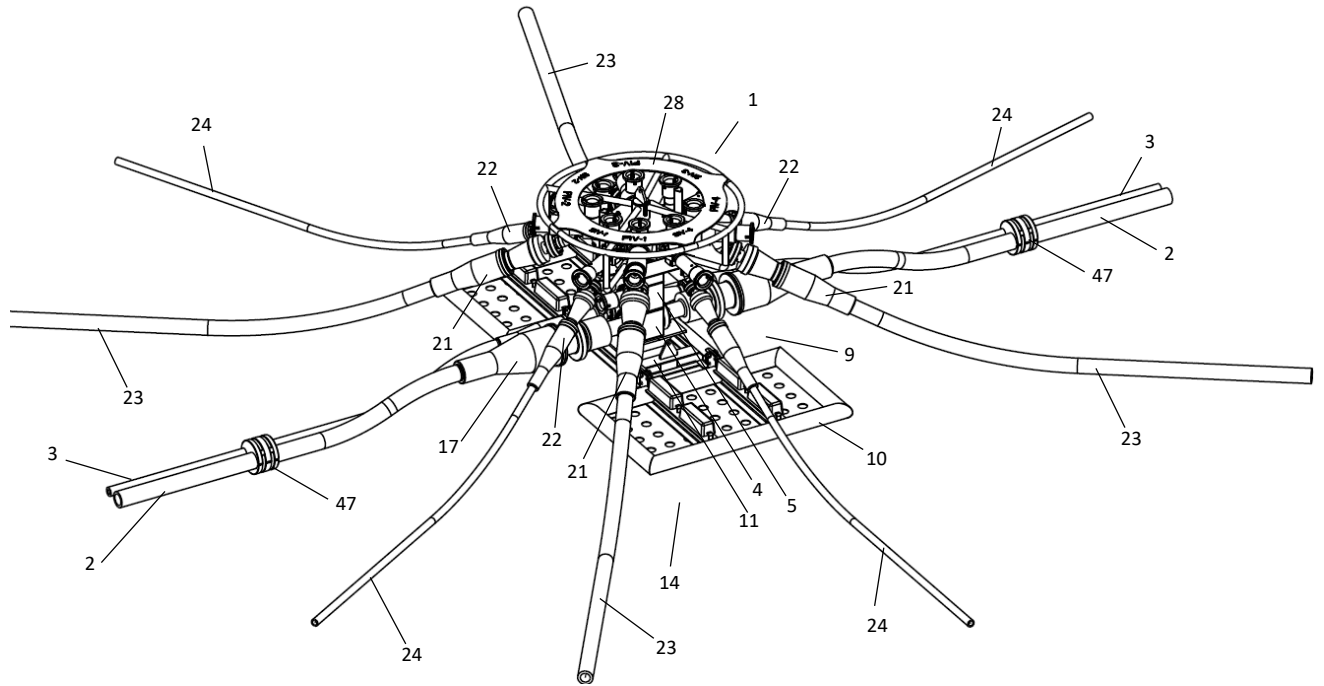


Fig. 1

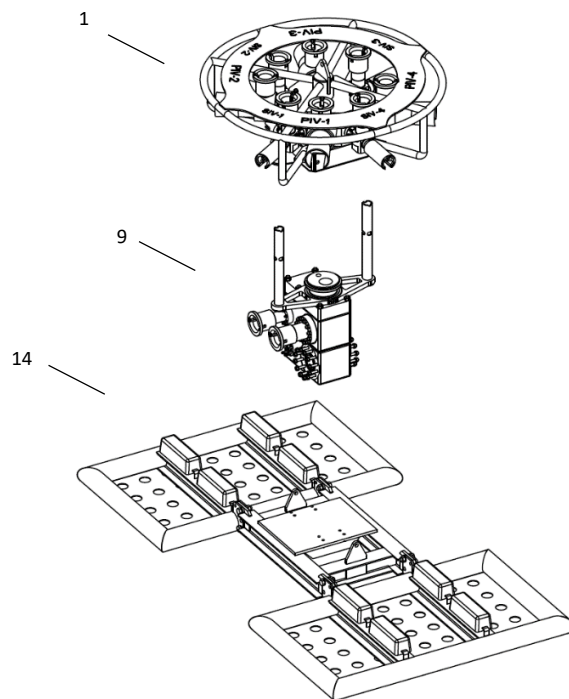


Fig. 2

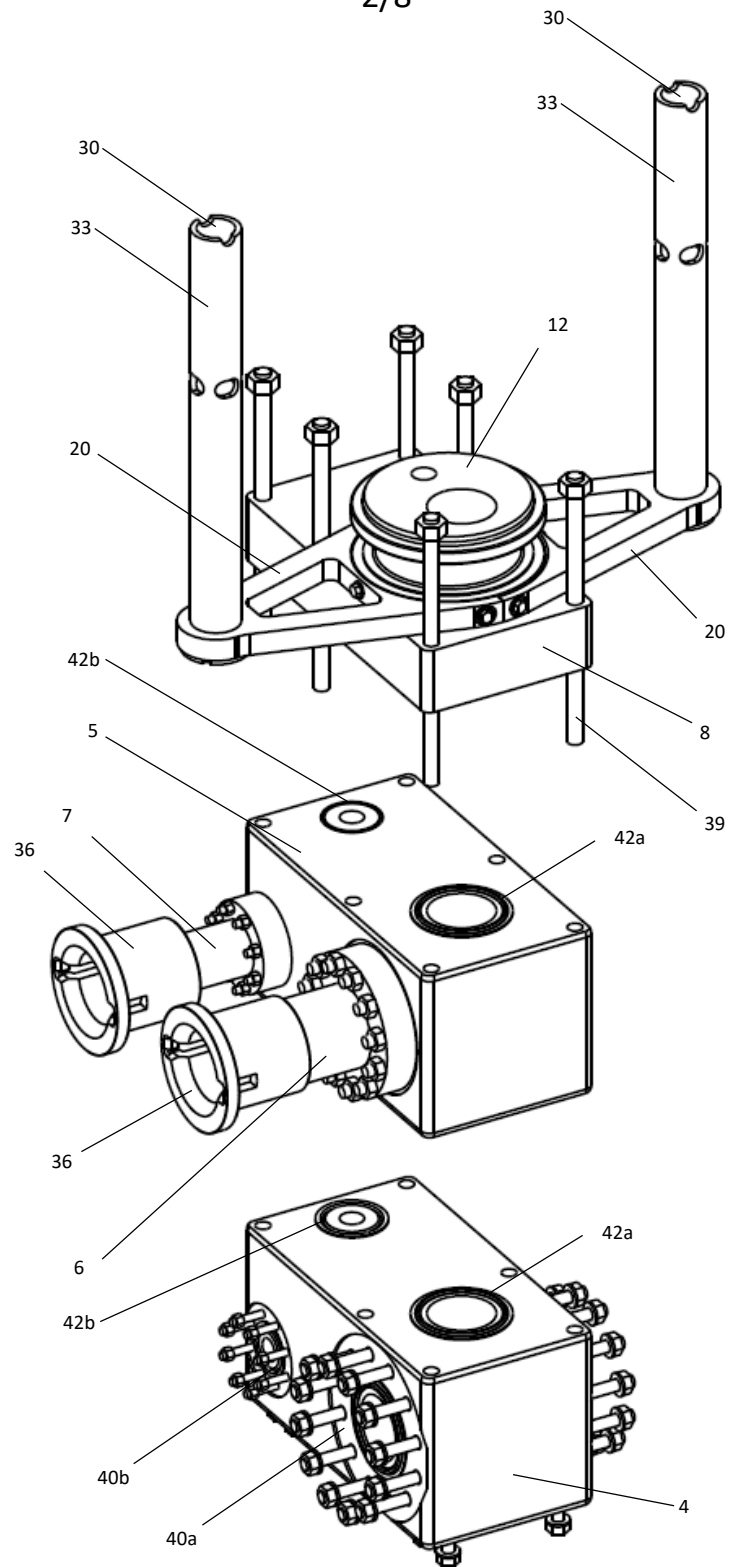


Fig. 3



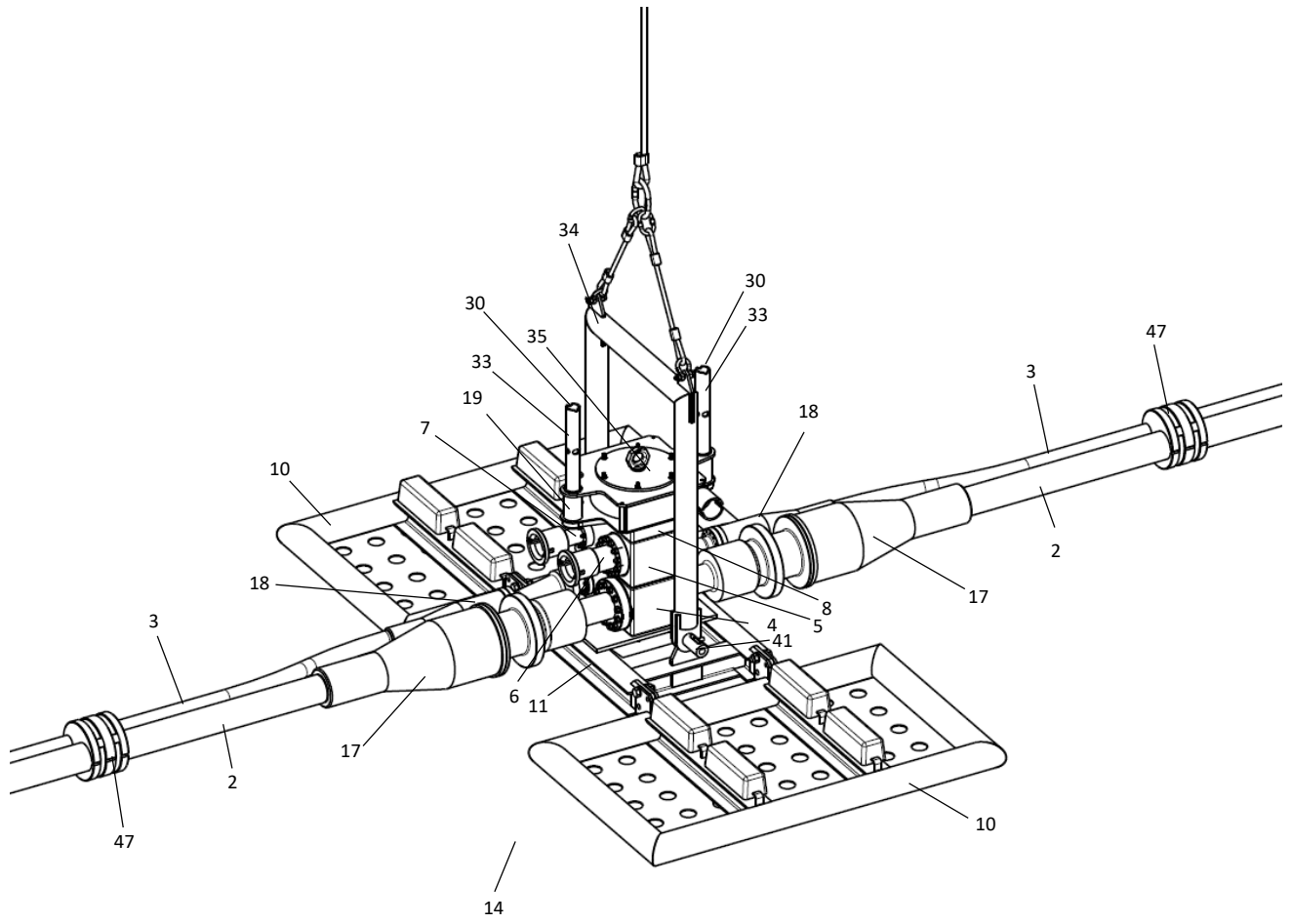


Fig. 6

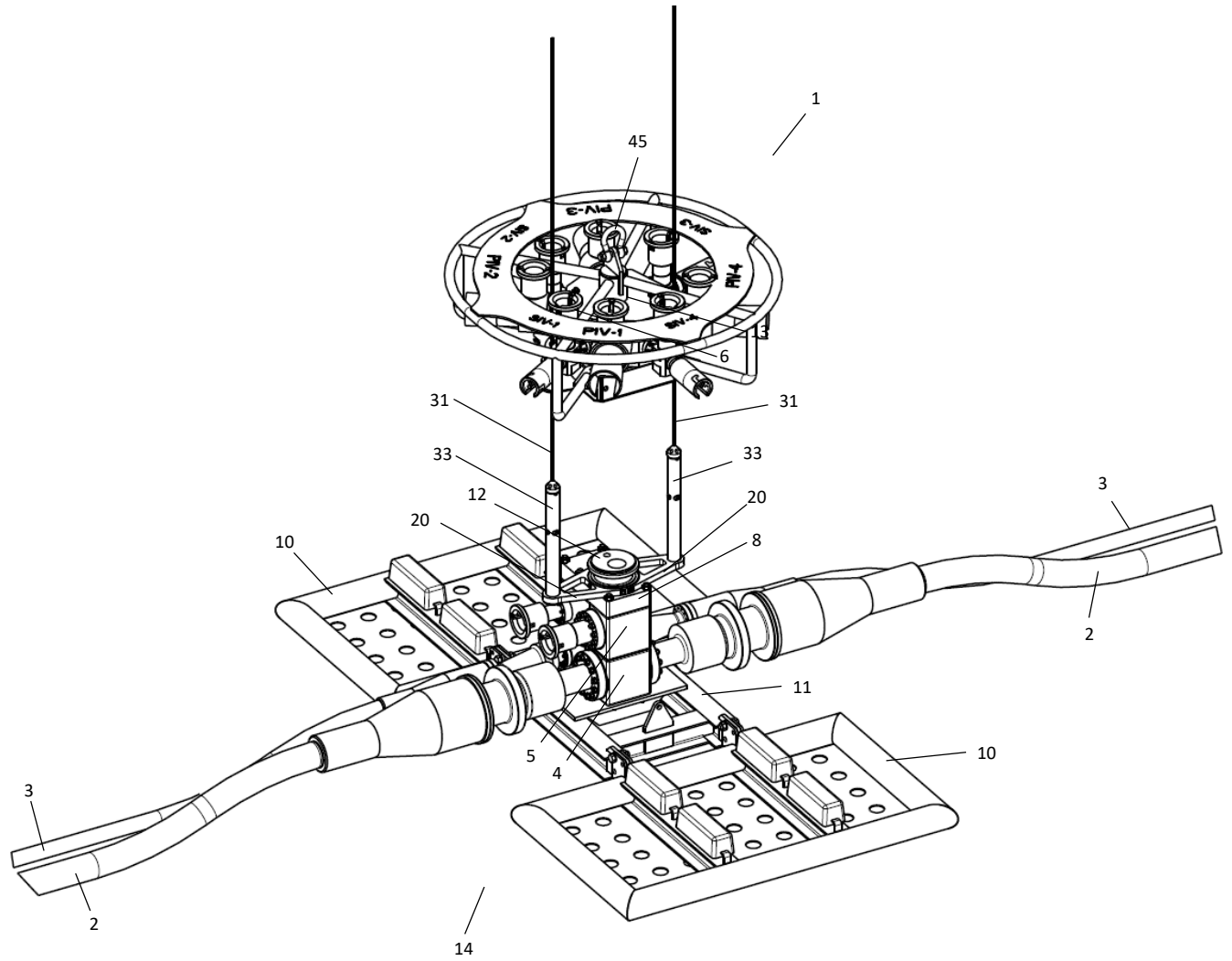


Fig. 7

This exploded perspective view shows the manifold assembly with the following components labeled:

- 13**: Top flange of the manifold body.
- 19**: Bottom flange of the manifold body.
- 25**: Six vertical ports with internal valves.
- 26**: Four side ports with flanges and bolts.
- 27**: A bracket or support structure at the base.
- 36**: A vertical pipe or tube extending from the top.
- 37**: Four horizontal pipes or tubes connected to the side ports.
- 38**: Four horizontal pipes or tubes connected to the top ports.

[illegible]

Fig. 9

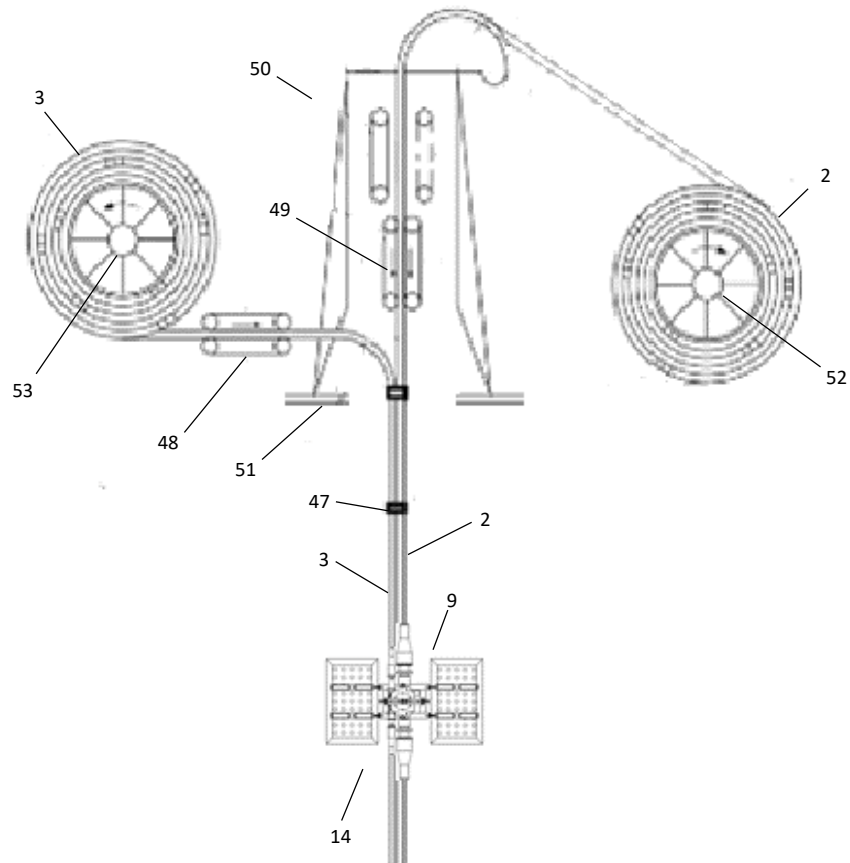


Fig. 10

Item table

1	Dual service manifold module
2	Main service flowline
3	Auxiliary flowline
4	Dual inline-tee block
5	Dual valve block
6	Vertical main service isolation valve
7	Vertical auxiliary line isolation valve
8	Dual hub block
9	Dual inline module
10	Mud mat
11	Center base structure
12	Dual bore up-facing hub
13	Dual service compiler fitting
14	Foundation
15a	Horizontal through main service bore

15b	Horizontal through auxiliary bore
16a	Vertical main service bore
16b	Vertical auxiliary bore
17	Main service flowline termination
18	Auxiliary flowline termination
19	Connector guide funnel
20	Guidepost bracket
21	Main service branch line termination
22	Auxiliary Branch line termination
23	Main service branch line
24	Auxiliary branch line
25	Main service branch isolation valve
26	Auxiliary branch isolation valve
27	Vertical connector
28	Manifold module structure
29a	Horizontal main service branch
29b	Horizontal auxiliary branch
30	Guide wire anchor interface
31	Guide wire with anchor
32	Dual bore down-facing hub
33	Guidepost
34	Inline tee installation frame
35	Pressure cap with clamp assembly
36	Operation bucket
37	Horizontal main service branch line connection
38	Horizontal auxiliary branch line connection
39	Block tension bolt
40a	Flange interface for main service bore
40b	Flange interface for auxiliary bore
41	Installation frame lock pin
42a	Seal for vertical main service bore
42b	Seal for vertical auxiliary bore
43	Horizontal offset auxiliary bore
44a	Flange interface for main service branch
44b	Flange interface for auxiliary branch
45	Dual service manifold module lifting interface
46	Blind cap
47	Bundle clamp
48	Tensioner for auxiliary flowline
49	Tensioner for main service flowline
50	VLS Tower
51	Vessel deck
52	Reel for main service flowline
53	Reel for auxiliary flowline