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(54) Title: MODULAR DRILLING FLUID CONTROL SYSTEM

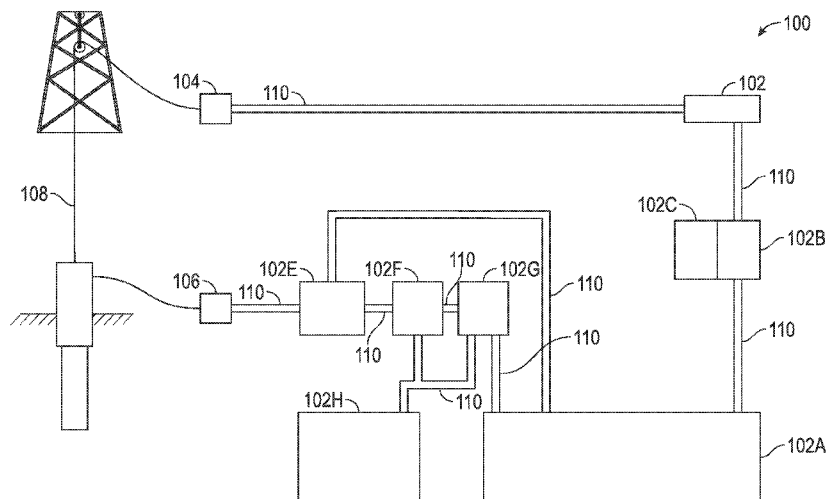


FIG. 1

(57) Abstract: A drilling fluid control system (100) has subsystem modules (102A-102H), an output (104) and an input (106) connected with interconnecting conduit (110). Each subsystem module (102A-102H) has a function. The subsystem modules (102A-102H) may be an active mud pit module (102A), a mud mixing module (102B), a chemical storage module (102C), a rig pump module (102D), a back pressure control module (102E), a primary shaker module (102F), a secondary shaker module (102G) and/or a shaker pit module (102H). The subsystem modules (102A-102H) with the same function may be interchanged without changing the input (102), the output (102) and the interconnecting conduit (110) of the drilling fluid control system (100). Additionally, the subsystem modules (102A-102H) are configured to fit within intermodal shipping containers.



SPECIFICATION

TITLE

"MODULAR DRILLING FLUID CONTROL SYSTEM"**CROSS-REFERENCE TO RELATED APPLICATIONS**

This application claims the benefit of U.S. Provisional Patent Application No. 61/819,045, filed 3 May 2013 (03/05/2013), the disclosure of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

The present invention generally relates to drilling fluid control systems for on-shore drilling rigs. More specifically, the present invention relates to modular drilling fluid control systems for on-shore drilling environments having self-contained subsystem modules with standardized interfaces. The subsystem modules may be, for example, a drilling fluid storage module, a mud mixing module, a chemical storage module, a back pressure control module, a choke manifold module, a solids control module, a primary shaker module, a secondary shaker module, a solids dryer module, and/or a shaker pit module.

Boreholes are frequently drilled into the Earth's formation to recover deposits of hydrocarbons and other desirable materials trapped beneath the Earth's surface. Traditionally, a well is drilled using a drill bit attached to the lower end of what is known in the art as a drill string. The drill string is traditionally a long string of sections of drill pipe that are connected together end-to-end through rotary threaded pipe connections. The drill string is rotated by a drilling rig at the surface thereby rotating the attached drill bit. Drilling fluid, often referred to as "mud", is typically pumped down through the bore of the drill string and exits through ports at the drill bit. Drilling fluid serves many purposes. For example, drilling fluid may lubricate the drill bit. Drilling fluid may also be used to control the pressure in the well bore. Additionally, drilling

fluid may move solids from the well bore to the surface. To manage the functions of the drilling fluid, a drilling rig has a fluid control system. The fluid control system may be organized into subsystems to accomplish these tasks.

Subsystems may include, for example, mud mixing systems, drilling fluid circulation systems, back pressure control systems, solids control systems, drilling fluid storage systems and/or chemical storage systems. Each of these subsystems may have different configurations and capabilities depending on the needs of the particular well being drilled.

Traditionally, the subsystems of a fluid control system are custom designed and then assembled at the drill site. While the major components of a subsystem may be standard, such as a shale shaker, the conduit that connect each major component may be customized, and the utility connections may be specially made for the particular drill rig. Additionally, the major components may also be specially configured for a specific application.

Designing a new fluid control system requires that each subsystem be individually designed, including the interconnecting conduit and the utility connections. The position of each individual bolt and the length of each pipe is designed and prototyped. This process extends the design time and introduces errors into the system. After the subsystem is designed, each discrete part is ordered or manufactured and then transported to the drill site. The fluid control system is then assembled from discrete parts. However, a drill rig may not be in a favorable environment which makes assembly of the subsystems difficult and cumbersome. Additionally, on-site assembly complicates quality control and maintenance procedures. As a result, the time required to set up a new drill rig and the costs associated with exploring a new drill site may increase dramatically.

Additionally, when a component of the fluid control system malfunctions, the entire rig is shut down, and the

malfunctioning component is repaired. The component may be repaired on-site. However, the process of diagnosing the problem, repairing the component and testing the repair causes delays. Alternatively, the nature of the repair may require that the component be removed and subsequently repaired off-site. Often, the process of removing and transporting the component is burdensome. If the component is repaired off-site, a spare component is required to replace the malfunctioning component. With either situation, drilling the well may be delayed, and the cost of the well may increase.

During the operating life of a drilling rig, the requirements of the fluid control system may change. Traditionally, to change a subsystem, each component of the subsystem is removed individually. Additionally, a new subsystem is designed, transported and installed. The new subsystem is then be tested. This process may introduce errors into the system that may be costly to remedy.

A need, therefore, exists for fluid control subsystem modules that have standardized inputs and outputs. Further, a need exists for a modular fluid control system that is easily transportable, configurable and installable. A need also exists for a fluid control system that is designed using previously designed subsystem modules.

SUMMARY OF THE INVENTION

The present invention generally relates to drilling fluid control systems for on-shore drilling rigs. More specifically, the present invention relates to a drilling fluid control system for on-shore drilling environments having self-contained subsystem modules with standardized interfaces. The drilling fluid control system may have subsystem modules arranged to fit in an available space at a drill rig site. The subsystem modules may be a drilling fluid storage module, a mud mixing module, a chemical storage module, a back pressure control module, a choke manifold module, a solids control module, a primary shaker module, a

secondary shaker module, a solids dryer module and/or a shaker pit module. The subsystem modules may be arranged to optimize the flow of the drilling fluid through the drilling fluid control system. Further, the drilling fluid control system may have an input and an output that may interface with a drill rig. The drilling fluid control system may also have interfacing conduit that connects the individual subsystem modules together. Each subsystem module may have a function with interfaces. Further, the subsystem modules with the same function may have the same interfaces so that they are interchangeable. Subsystem modules with the same function may be changed without changing the interfacing conduit.

Each subsystem module may have a base, a support structure, interfaces and/or internal components. Additionally, the subsystem module may have a floor panel. The base may be rectangular in shape and may be configured to fit inside a shipping container. To facilitate transporting the subsystem module by a forklift, the base may have forklift holes. Additionally, the base may have an interface region running the length of the base to secure the subsystem module into the shipping container. Further, the support structure may be connected to the base to form a frame. The frame may be configured to fit within the internal dimensions of a standard intermodal shipping container. The support structure may have the same length and/or width as the base. Alternatively, the support structure may have a length and/or a width less than the length and/or width of base.

In an embodiment, the subsystem module may have a collapsible support structure and support guides. The support guides may be connected to the base. Further, a portion of the collapsible support structure may slide over the support guides so that the collapsible support structure may have a collapsed position and an extended position. Further, the subsystem module may have a locking mechanism that, when engaged, may prevent the collapsible support structure from moving between the collapsed position and the extended

position. When the collapsible support frame is in the collapsed position, the subsystem module may fit within the intermodal shipping container.

An advantage of the present invention is to provide a drilling fluid control system with a modular subsystem where the modular subsystems with the same function may be interchanged. The modular subsystem may be changed when the modular subsystem needs repair or when the drilling fluid control system needs a differently configured subsystem with the same function.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagram of an embodiment of a fluid control system.

FIG. 2 is an isometric view of an embodiment of a fluid control system.

FIG. 3A is a side view of an embodiment of a subsystem module.

FIG. 3B is a front view of an embodiment of a subsystem module.

FIG. 4A is an isometric view of an embodiment of a subsystem module with a collapsible frame with the frame in the compact position.

FIG. 4B is an isometric view of an embodiment of a subsystem module with a collapsible frame with the frame in the extended position.

DETAILED DESCRIPTION

The present invention relates to a drilling fluid control system for on-shore drilling environments having subsystem modules with standardized interfaces. As used herein, a slurry refers to a mixture of drilling fluid and solids.

FIG. 1 and FIG. 2 generally illustrate an embodiment of a drilling fluid control system 100. The drilling fluid control system 100 may have subsystem modules 102A-102H and an output 104, an input 106 and interfacing conduit 110. The

subsystem modules 102A-102H may include an active mud pit module 102A, a mud mixing module 102B, a chemical storage module 102C, a rig pump module 102D, a back pressure control module 102E, a primary shaker module 102F, a secondary shaker module 102G and/or a shaker pit module 102H. Other modules may include a dryer module (not shown) and/or an operator module (not shown). However, the present invention is not limited to the subsystem modules 102A-102H. The subsystem modules 102A-102H required for a particular embodiment will be apparent to a person having ordinary skill in the art. The subsystem modules 102A-102H may be connected by the interfacing conduit 110.

The output 104 may connect to a drill rig 108. The drilling fluid that exits the output 104 may be pumped by the rig pump module 102D into a drill string of the drill rig 108. The drilling fluid may be pumped into the well bore of the drill rig 108. Solids from the drilling process may accumulate in the drilling fluid in the well bore to form a slurry. The slurry may flow into input 106 and into the back pressure control module 102E. However, the subsystem modules 102A-102H may be organized according to the requirements of a particular embodiment.

Each subsystem module 102A-102H may be configured to fit into a shipping container. The external dimensions of each module may be designed to fit within the interior dimensions of the shipping container. Additionally, the subsystem module 102A-102H may be configured so that the subsystem module 102A-102H may be separated into more than one unit with each unit configured to fit the internal dimensions of the shipping container. For example, the mud mixing module 102B may be configured so that the mud mixing module 102B may separate into two units with each individual unit having dimensions to fit into a separate shipping container.

The shipping container may be any intermodal shipping container suitable for shipping on a truck, a train and/or a cargo ship. The subsystem module 102A-102H may be configured

to fit an ISO shipping container with dimensions based on the ISO 6346 standard. For example, the subsystem module 102A-102H may be configured to fit a twenty-foot intermodal shipping container. Alternatively, the subsystem module may be configured to fit a forty-foot intermodal shipping container. Additionally, the shipping container may be made from corrugated weathering steel. However, the dimensions of the subsystem modules 102A-102H are not limited to fit within the twenty-foot intermodal container or within the forty-foot intermodal container. The subsystem modules 102A-102H may be configured to fit into any other shipping container known to persons of skill in the art.

As shown in FIG. 2, the subsystem modules 102A-102H may be stackable. The subsystem modules 102A-102H may also be arranged to optimize the drilling fluid control system 100 and/or to fit within the available space at the drilling site.

Referring to FIGS. 3A and 3B, each subsystem module 102 may have a base 200, a support structure 202, interfaces 204A-204C and/or internal components 206. Additionally, as shown in FIGS. 4A and 4B, the subsystem module 102 may have a floor panel 210. The base 200 may be rectangular in shape and may be configured to fit inside a shipping container. The base 200 may have forklift holes 212 to facilitate transporting the subsystem module 102 by a forklift. Additionally, the base 200 may have an interface region 208 running the length of the base 200 to secure the subsystem module 102 into the shipping container. The support structure 202 may be connected to the base 200 to form a frame that fits within the internal dimensions of the shipping container. The support structure 202 may have the same length and/or width as the base 200. Alternatively, the support structure 202 may have a length and/or a width less than the length and/or width of base 200. In a further embodiment, the subsystem module 102 may not have a support structure 202. The support structure 202 may be constructed of conventional

steel hollow structural sections.

Referring to FIGS. 4A and 4B, the subsystem module 102 may have a collapsible support structure 300, support guides 302 and locking mechanisms 304. The support guides 302 may extend perpendicularly from the base 200. A portion of the collapsible support structure 300 may slide over the support guides 302. The collapsible support structure 300 may move up and down on the support guides 302 so that the collapsible support structure 300 has a collapsed position and an extended position. Engaging the locking mechanisms 304 may prevent the collapsible support structure 300 from moving between the collapsed position and the extended position. Releasing the locking mechanisms 304 may allow the collapsible support structure 300 to move between the collapsed position and the extended position. FIG. 4A shows the collapsible support structure 300 in the collapsed position. FIG. 4B shows the collapsible support structure 300 in the extended position. The collapsible support structure 300 may be in the collapsed position to allow the subsystem module 102 to fit into a standard intermodal shipping container. Having the collapsible support structure 300 in the extended position may allow internal components 206 that require more space while the subsystem module 102 is in operation than otherwise may fit in the subsystem module 102 with the support structure 202.

The interfaces 204A-204C of each subsystem module 102 may include inputs 204A, outputs 204B and/or utility connections 204C. The inputs 204A may include conduit to input drilling fluid into the subsystem module 102. For example, the back pressure control module 102E may have a conduit input to receive slurry from the drill rig 108. The inputs 204A may also include an opening on top of the subsystem module 102. For example, the shaker pit module 102H may have an input on top to receive solids from a primary shaker module 102F. The outputs 204B may be conduit for fluid. For example, the output 204B of the rig pump module

102D may be a conduit to supply drilling fluid to the drill rig 108 via the output 104 of the drilling fluid control system 100. Alternatively, the outputs 204B may be conduit for solids. For example, the secondary shaker module 102G may have the output 204B to conduct solids to the shaker pit module 102H. The subsystem module 102 may have multiple outputs 204B. For example, the primary shaker module 102F may have an outlet 204B for fluid connected to the secondary shaker module 102G and an outlet 204B for solids connected to shaker pit module 102H. Additionally, a subsystem module may not have an output 204B. For example, shaker pit module 102H may not have an output 204B. Modules that require power and/or connections to computer controls may have utility connections 204C. For example, the back pressure control module 102E may have a utility connection 204C that has a power connection and a connection to a computer control system that controls and/or monitors pressure in the well bore. Alternatively, the subsystem module 102 may not have the utility connection 204C. For example, the chemical storage module 102C may not have a utility connection. However, the above examples are not the only embodiments of the present invention. Whether the subsystem module 102 requires the interfaces 204A-204C will be apparent to a person having ordinary skill in the art.

Each subsystem module 102 has a function. The internal components 206 of the subsystem module 102 are different depending on the function of the subsystem module 102. For example, the function of the primary shaker module 102F may be to separate the drilling fluid from the slurry. The internal components 206 of the primary shaker module 102F may include a shale shaker such as the MD-3 shale shaker manufactured by the assignee of the present invention. However, a subsystem module 102 that has the same function may have different internal components 206. For example, the primary shaker module 102F may instead have a Mongoose Pro Shale Shaker manufactured by the assignee of the present

invention. However, the present invention is not limited to the above example. The internal components 206 necessary for the subsystem module 102 will be apparent to a person having ordinary skill in the art.

The subsystem modules 102 of the drilling fluid control system 100 are interchangeable with the subsystem modules 102 with the same function. That is, the interfaces 204A-204C of the subsystem module 102 with the same function are in the same location relative to the subsystem module 102. Additionally, the subsystem modules are configured so that the base 200 and the support structure 202 are substantially the same for subsystem modules 102 that have the same function. Because the interfaces 204A-204C, the base 200 and the support structure 202 are the same in a subsystem module 102 regardless of the composition of the internal components 206, one subsystem module 102 may be interchanged with another subsystem module 102 with the same function. For example, a primary shaker module 102F with the internal components 206 that include a MD-3 shale shaker may be replaced with a primary shaker module 102F with the internal components 206 that include a Mongoose Pro shale shaker. The subsystem modules 102 may be changed when the needs of the drilling fluid control system 100 change with a minimum of downtime. Additionally, replacing the subsystem module 102 may not require changes to the interfacing conduit 110.

While the present disclosure has been described with respect to a limited number of embodiments, those skilled in the art, having benefit of this disclosure, will appreciate that other embodiments may be devised which do not depart from the scope of the disclosure as described herein. Accordingly, the scope of the present disclosure should be limited only by the attached claims.

CLAIM

1. A system comprising:
 - subsystem modules each having an operational function and internal components associated with the operational function wherein each subsystem module further has a base and a support structure connected to the base to form a frame;
 - interfaces on the subsystem modules; and
 - interfacing conduit connecting the subsystem modules.
2. The system of claim 1 wherein the frame is configured to fit within a shipping container.
3. The system of claim 1 further comprising:
 - a collapsible support structure connected to support guides connected to the base and extending perpendicularly from the base wherein a portion of the collapsible support structure moves in a first direction relative to the support guides to configure the collapsible support structure in a collapsed position and further wherein the collapsible support structure moves in a second direction relative to the support guides to configure the collapsible support structure in an extended position.
4. The system of claim 3 further comprising:
 - a locking mechanism configured to restrict the collapsible support structure from moving between the collapsed position and the extended position.
5. The system of claim 1 wherein the interfaces of each subsystem module have at least one of an input, an output or a utility connection.
6. The system of claim 1 wherein the subsystem modules having the same operational function are interchangeable with each other.
7. The system of claim 1 wherein the subsystem modules are configured so that the base and the support structure are substantially the same for subsystem modules that have the same operational function.
8. The system of claim 1 wherein the subsystem modules having the same operational function may be replaced without

changing the interfacing conduit.

9. The system of claim 1 wherein the interfaces of the subsystem module having the same operational function are located in the same location relative to the subsystem module.

10. The system of claim 1 wherein the subsystem modules are stackable.

11. The system of claim 1 wherein the base has an interface region extending a length of the base to secure the subsystem module into a shipping container.

12. The system of claim 1 further comprising:

an input and an output configured to interface the subsystem modules with a drilling rig.

13. The system of claim 1 wherein the subsystem modules are separated into more than one unit with each unit configured to fit within a shipping container.

14. The system of claim 1 wherein the subsystem modules are configured to fit within an available space at a drilling site.

15. The system of claim 1 wherein the subsystem modules are movable to optimize the operation of the system.

16. A method of providing a modular fluid control system, the method comprising:

attaching subsystem modules to a base and a support structure connected to the base to form a frame wherein each subsystem module has an operational function and internal components associated with the operational function and further wherein each subsystem module has interfaces; and

connecting the interfaces of the subsystem modules with conduit.

17. The method of claim 16 further comprising:

configuring the subsystem modules to optimize the operation of the modular fluid control system.

18. The method of claim 16 further comprising:

connecting an input to receive fluid into one of the subsystem modules and connecting an output to supply fluid to a drilling rig.

19. A system comprising:

subsystem modules arranged in support frames wherein the subsystem modules each have a function and internal components associated with the function; and

conduit connecting the subsystem modules to provide control of a fluid through the subsystem modules.

20. The system of claim 19 wherein the subsystem modules are configured to separate into more than one unit with each unit configured to fit within a shipping container.

1/6

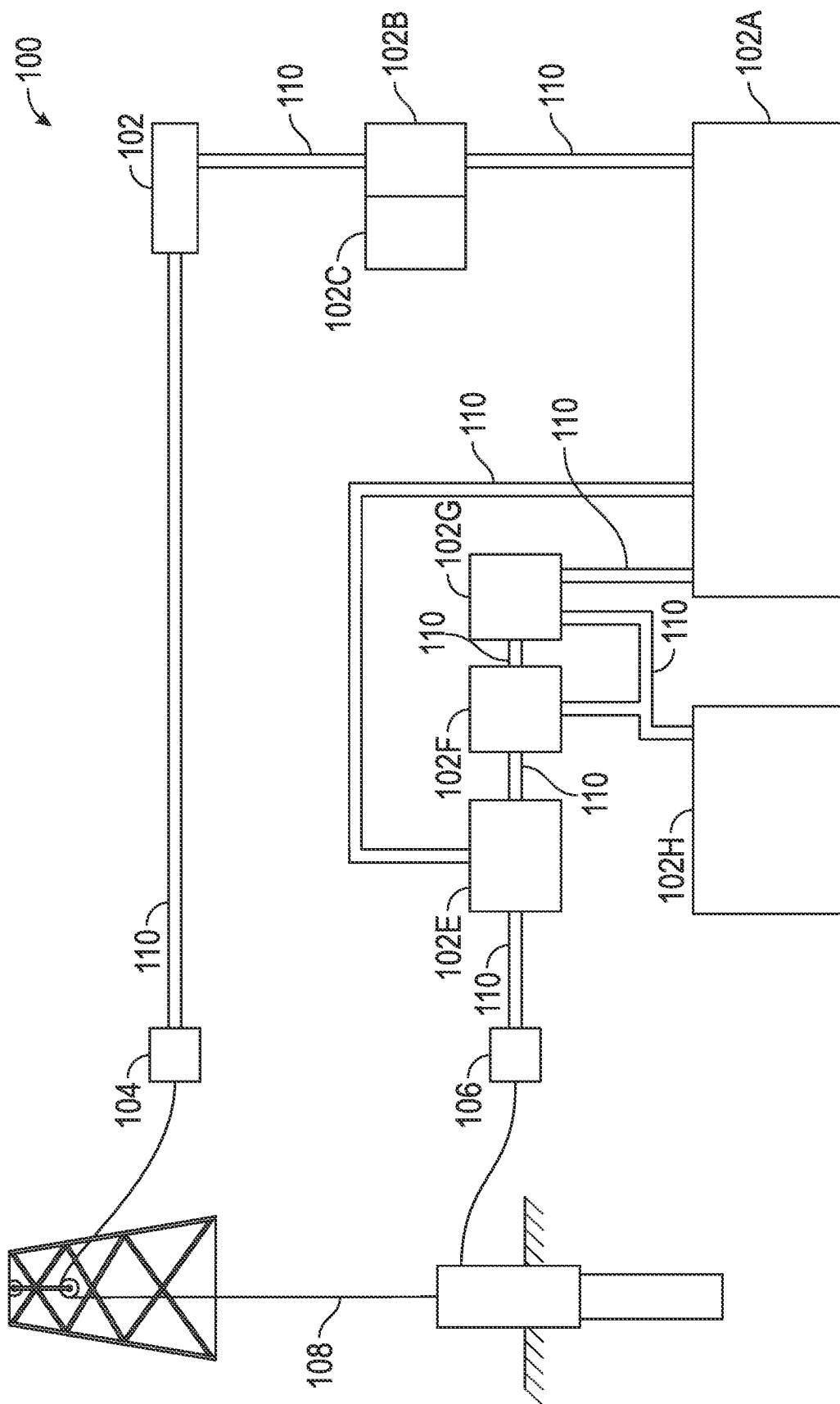


FIG. 1

2/6

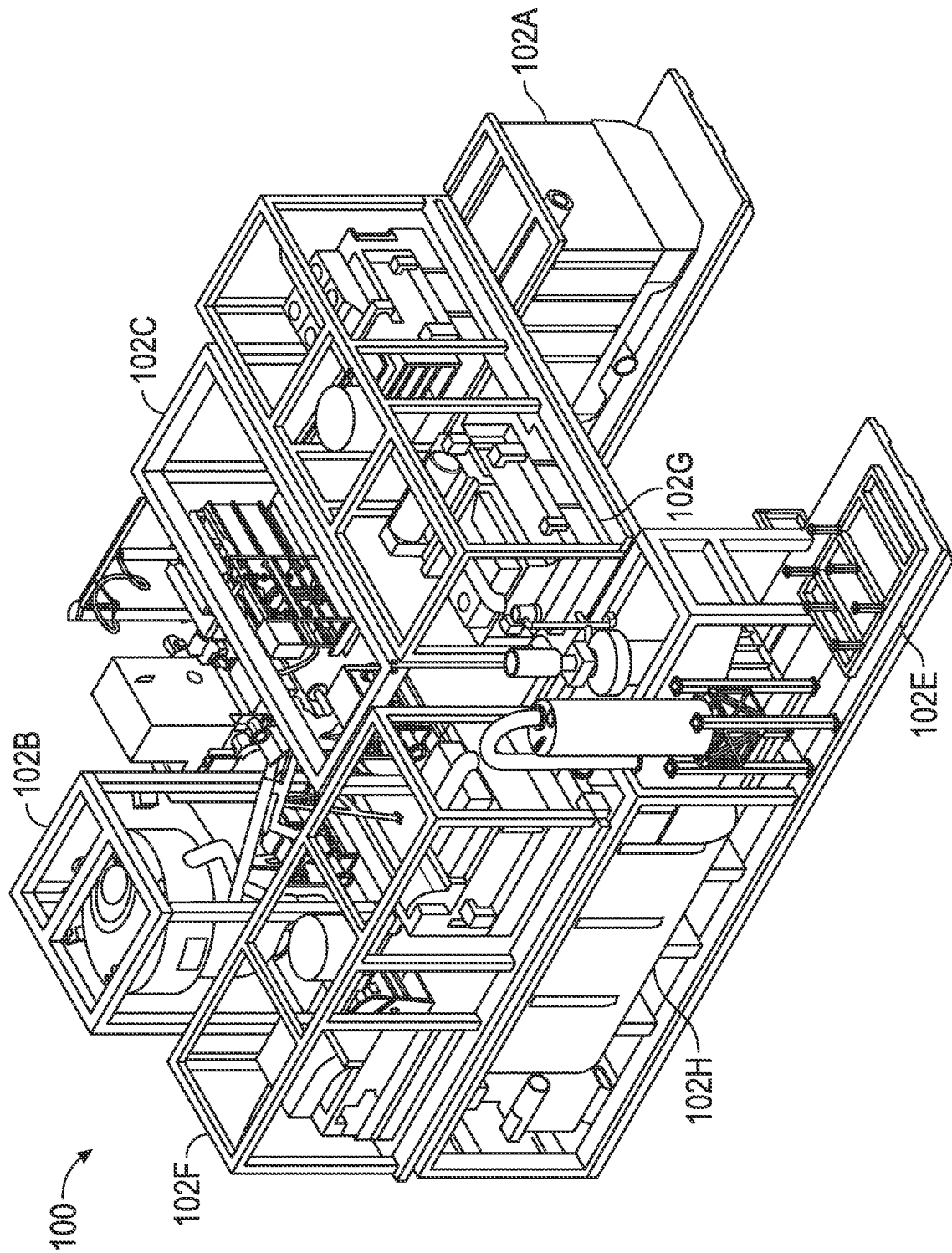


FIG. 2

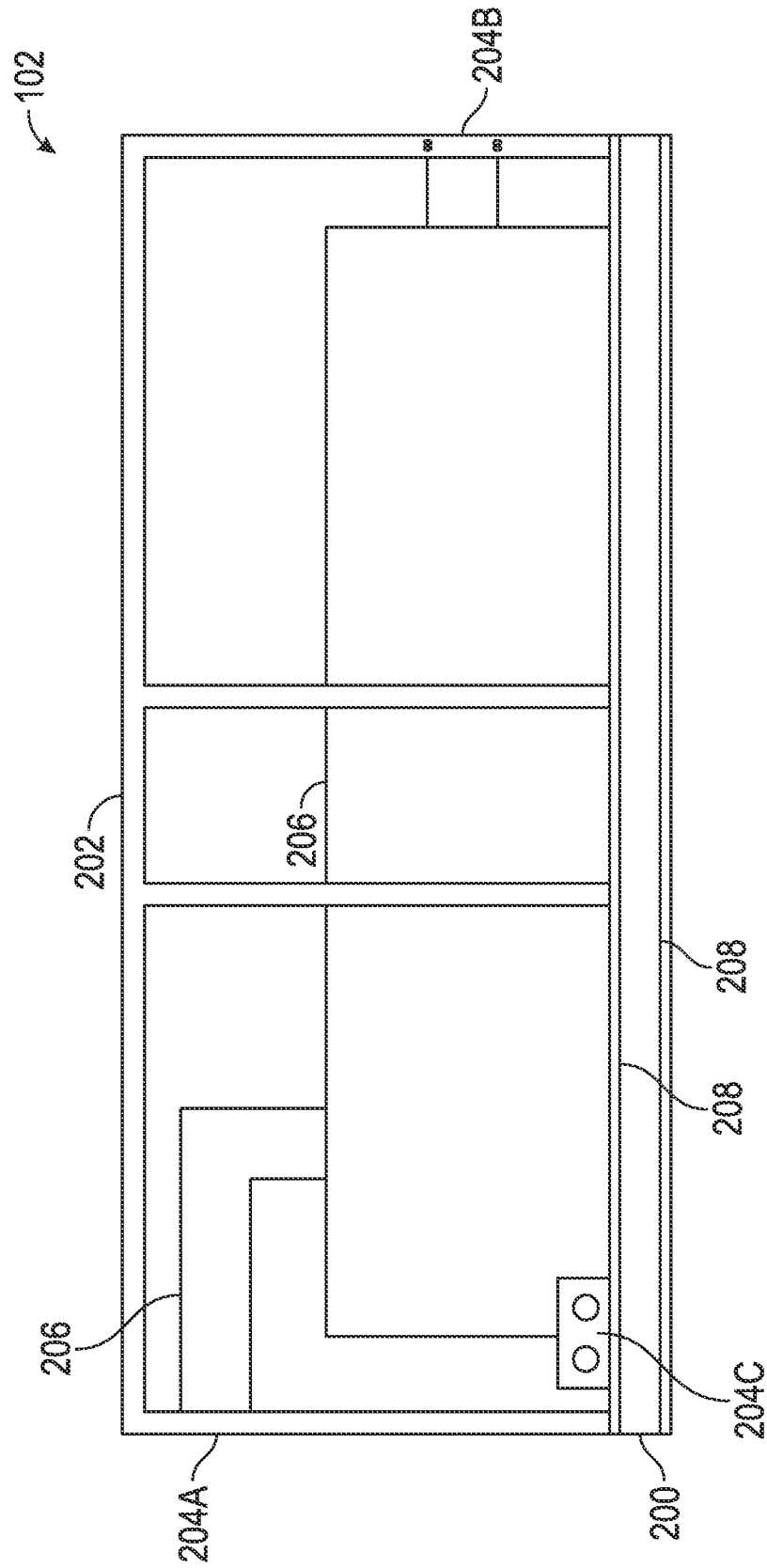


FIG. 3A

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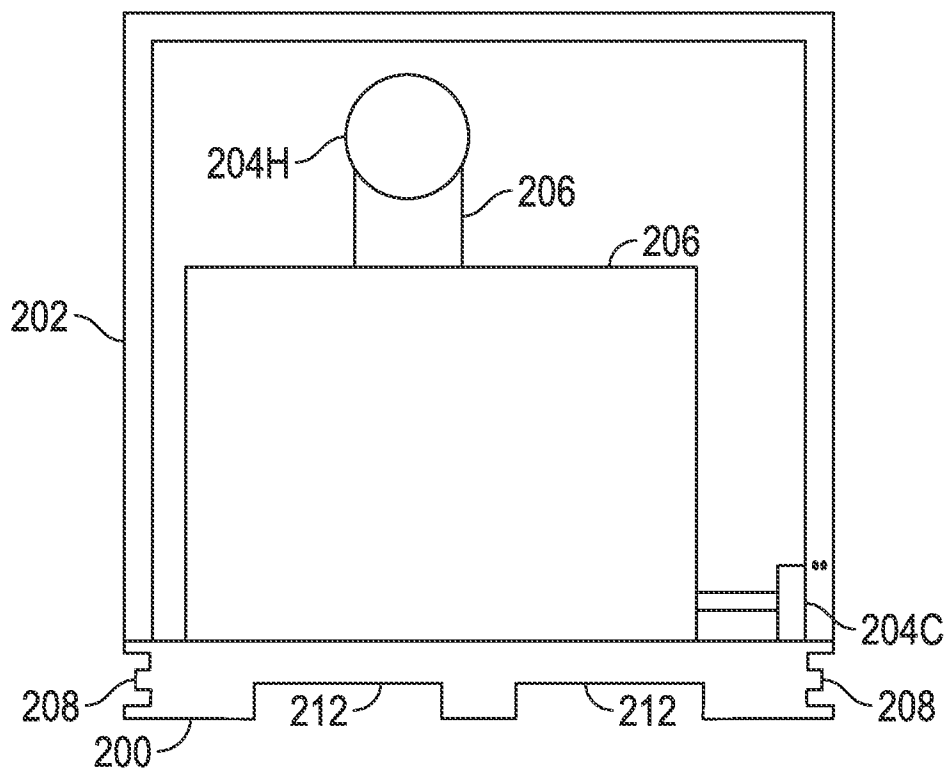
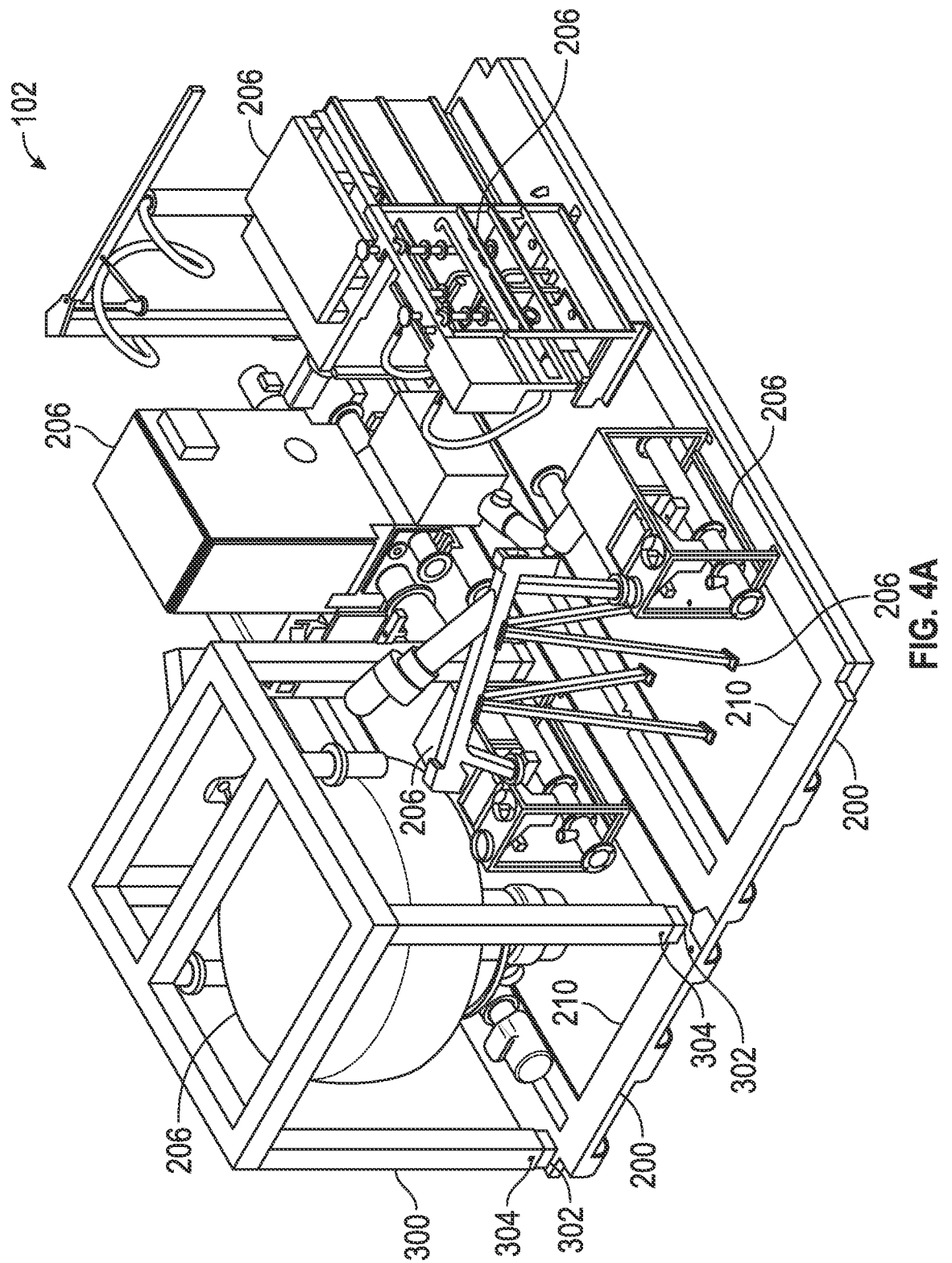


FIG. 3B

5/6



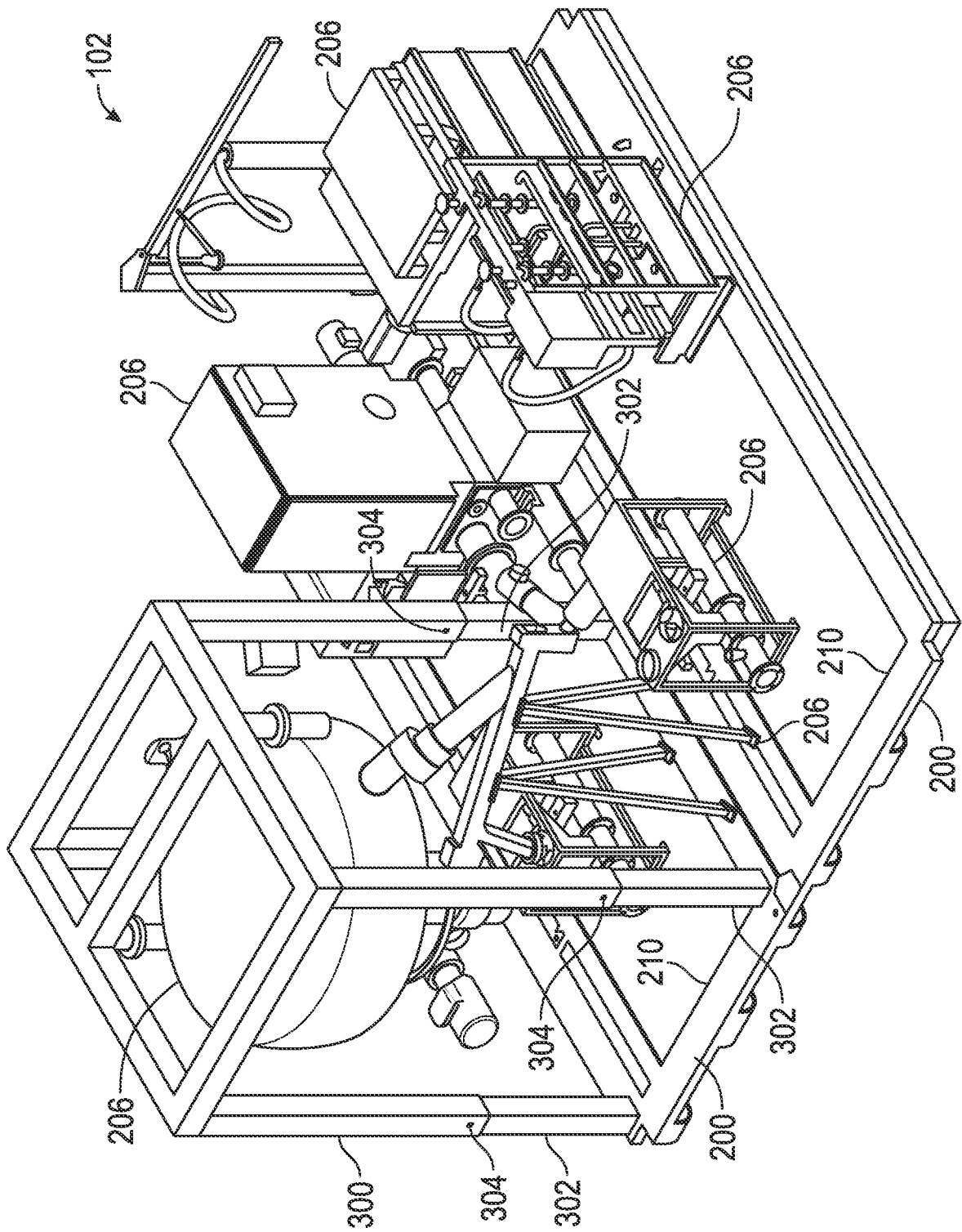


FIG. 4B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2014/036530**A. CLASSIFICATION OF SUBJECT MATTER****E21B 21/06(2006.01)i, E21B 21/08(2006.01)i, E21B 44/00(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

E21B 21/06; B60R 11/00; B65D 19/44; B60R 9/00; B67D 7/00; E21B 21/08; E21B 44/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords: subsystem, module, interface, conduit, base and support

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2008-0283301 A1 (SHERWOOD et al.) 20 November 2008	1, 5-12, 14-19
Y	See paragraphs [0030]-[0046]; claim 1; and figures 1-3.	2-4, 13, 20
Y	US 2012-0160566 A1 (EIA, JAN THORE) 28 June 2012	2, 13, 20
	See paragraph [0027] and figure 1.	
Y	US 2007-0108246 A1 (JENNINGS et al.) 17 May 2007	3-4
	See paragraphs [0023]-[0026] and figure 1.	
A	US 2013-0105020 A1 (NESS, DANNY) 02 May 2013	1-20
	See paragraphs [0012]-[0018] and claim 1.	
A	US 6357365 B1 (HIGGINS et al.) 19 March 2002	1-20
	See claims 1, 11 and figure 1.	



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

26 August 2014 (26.08.2014)

Date of mailing of the international search report

27 August 2014 (27.08.2014)

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2014/036530

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