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[Continued on next page]

(54) Title: CHOKE AND KILL SYSTEM

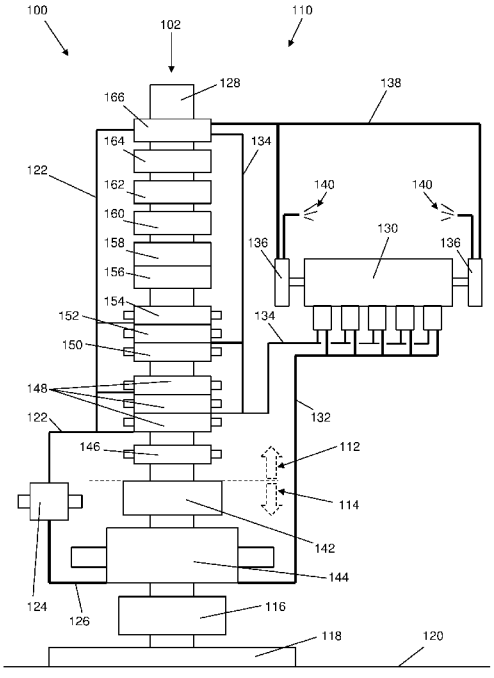

FIG. 1

(57) Abstract: A choke and kill system, and a method of adapting a low pressure drilling rig for use in a high pressure application. The system as a low pressure stack and a high pressure blowout preventer stack fluidly connected to the low pressure stack. A choke is fluidly connected to a low pressure choke line of the low pressure stack and is connected to a high pressure choke line of the high pressure blowout preventer stack. The choke is adapted to reduce the pressure from the high pressure choke line to the low pressure choke line.

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CHOKE AND KILL SYSTEM

FIELD OF THE INVENTION

[0001] The invention relates to a choke and kill system. In particular, although not exclusively, the invention relates to a choke and kill system for a deep-water drilling rig.

BACKGROUND OF THE INVENTION

[0002] Choke and kill systems are used with drilling rigs to control a well. In particular, choke lines are used to control circulation of a well under pressure or subject to pressure fluctuations by diverting some of the flow, and kill lines are used to place a column of heavy fluid into a well bore in order to prevent flow of wellbore fluids.

[0003] The majority of current deep-water drilling rigs are installed with a Blow Out Preventer (BOP) and a choke and kill system rated for 15,000psi.

[0004] As the quest to find and prove new reserves moves further out to sea and to deeper waters, to include oil reservoirs with expected pressures at the BOP of 20,000psi or more, the rating of the current 15,000psi systems will be exceeded. This has led to BOPs designed for 20,000psi or more. Naturally, these new BOP designs also require a 20,000psi choke and kill system.

[0005] The new BOP designs typically require the entire drilling vessel and its drilling related systems to be up-sized to cope with the new 20,000psi BOP and choke and kill equipment. The costs to replace the drilling vessel and drilling equipment to enable drilling of deeper reserves can be very expensive.

[0006] It will be clearly understood that any reference herein to background material or information, or to a prior publication, does not constitute an admission that any material, information or publication forms part of the common general knowledge in the art, or is otherwise admissible prior art.

OBJECT OF THE INVENTION

[0007] It is an object of the invention to overcome or at least alleviate one or more of the above problems and/or provide the consumer with a useful or commercial choice.

SUMMARY OF INVENTION

[0008] In one form, although it need not be the only or indeed the broadest form, the invention resides in a choke and kill system for a deep water drilling rig, the choke and kill system comprising:

a low pressure stack of the deep water drilling rig;

a high pressure blowout preventer stack of the deep water drilling rig fluidly connected to the low pressure stack;

a choke fluidly connected to a low pressure choke line of the low pressure stack, the choke fluidly connected to a high pressure choke line of the high pressure blowout preventer stack, the choke adapted to reduce the pressure from the high pressure choke line to the low pressure choke line.

[0009] Preferably, the choke and kill system further comprises a high pressure kill line fluidly connected to the high pressure blow out preventer stack. Typically the high pressure kill line is adapted to convey fluid to the high pressure blow out preventer stack. Preferably the fluid is drilling fluid which may also be referred to as “mud”.

[0010] In one aspect of the present invention, the high pressure kill line may extend to a surface vessel, where a pump is adapted to supply mud to the high pressure kill line.

[0011] Preferably, the choke and kill system comprises a subsea pump that is adapted to pump mud into the high pressure kill line. Preferably, the subsea pump is a high pressure subsea pump. Typically the subsea pump is adapted to receive mud from a low pressure kill line of the drilling riser. Preferably, the subsea pump increases the pressure of the mud from the low pressure kill line to the high pressure kill line. Alternatively the subsea pump may be adapted to

receive mud from a low pressure auxiliary line of the drilling riser. Preferably, the subsea pump increases the pressure of the mud from the low pressure auxiliary line to the high pressure kill line.

[0012] Preferably the subsea pump is driven hydraulically. Preferably the subsea pump is driven by a hydraulic motor. More preferably, the subsea pump is driven by at least one radial hydraulic piston motor. Preferably, hydraulic fluid to drive the subsea pump is supplied by a riser auxiliary line of the drilling riser. Preferably, the hydraulic fluid is seawater. More preferably, once the hydraulic fluid has been used to drive the subsea pump, the hydraulic fluid is discharged to the sea.

[0013] Preferably the subsea pump comprises ceramic bearings. Preferably the subsea pump uses seawater for lubrication.

[0014] Preferably the subsea pump is located at or near the high pressure blow out preventer stack. Preferably the subsea pump is adjacent the high pressure blow out preventer stack. More preferably the subsea pump is mounted to the high pressure blow out preventer stack. Typically the subsea pump is mounted to a frame of the high pressure blow out preventer stack.

[0015] Preferably the choke utilises a control system from the low pressure stack. Preferably the choke is adapted to utilise a hydraulic control system from the low pressure stack. Preferably the choke is adapted to utilise a multiplexer control system from the low pressure stack.

[0016] Preferably the choke is located at or near the high pressure blow out preventer stack. Preferably the choke is adjacent the high pressure blow out preventer stack. More preferably the choke is mounted to the high pressure blow out preventer stack. Typically the choke is mounted to a frame of the high pressure blow out preventer stack. Preferably the choke and kill system comprises multiple chokes. More preferably, the choke and kill system comprises multiple chokes in a single body. Preferably the multiple chokes are provided in a redundant arrangement.

[0017] Preferably the low pressure stack includes at least one low pressure blowout preventer.

[0018] Preferably the high pressure blow out preventer stack comprises at least one high pressure blow out preventer. Preferably the high pressure blow out preventer stack comprises a plurality of high pressure blowout preventers. Preferably the high pressure blowout preventer stack comprises a wellhead connector to connect to a well. Preferably the wellhead connector is located towards a lower end of the high pressure blowout preventer stack. Preferably the high pressure blowout preventer stack comprises a mandrel to which the low pressure stack connects to. Preferably the mandrel is located towards an upper end of the high pressure blowout preventer stack.

[0019] Preferably, the choke and kill system comprises multiple redundant sensors to adjust the choke. Preferably, the choke and kill system comprises multiple pressure sensors to adjust the choke. Preferably, the choke and kill system comprises multiple temperature sensors to adjust the choke.

[0020] Typically, low pressure equipment (e.g. low pressure choke line, low pressure kill line, low pressure stack, low pressure blow out preventer) is rated at less than or equal to 15,000psi. Typically, high pressure equipment (e.g. high pressure choke line, high pressure kill line, high pressure blow out preventer, high pressure blow out preventer stack, high pressure pump, high pressure subsea pump) is rated above 15,000psi. Preferably, high pressure equipment is rated at least at 20,000psi. More preferably, high pressure equipment is rated at least at 25,000psi.

[0021] In another form the invention resides in a drilling rig comprising a choke and kill system as described in this specification.

[0022] In a further form the invention resides in a deep water drilling vessel comprising a drilling rig and a choke and kill system as described in this specification.

[0023] In yet another form the invention resides in a method of adapting a low pressure drilling rig for use in a high pressure application, the method including the steps of:

connecting a high pressure blowout preventer stack to a low pressure stack of the low pressure drilling rig;

fluidly connecting a choke to a low pressure choke line of the low pressure stack; and

fluidly connecting the choke to a high pressure choke line of the high pressure blowout preventer stack;

wherein the choke is adapted to reduce the pressure from the high pressure choke line to the low pressure choke line.

[0024] Preferably, the method further includes the step of fluidly connecting a high pressure kill line to the high pressure blowout preventer stack.

[0025] Preferably the step of fluidly connecting a high pressure kill line to the high pressure blowout preventer stack includes fluidly connecting a low pressure kill line of the low pressure stack to a subsea pump and fluidly connecting the subsea pump to the high pressure kill line such that the subsea pump can pump fluid from the low pressure kill line to the high pressure kill line, increasing the pressure of the fluid from the low pressure kill line to the high pressure kill line.

[0026] Further forms and/or aspects of the present invention will become apparent from the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] To assist in understanding the invention and to enable a person skilled in the art to put the invention into practical effect, preferred embodiments of the invention will be described by way of example only with reference to the accompanying drawings, wherein:

[0028] FIG 1 shows a schematic view of a choke and kill system according to the present invention; and

[0029] FIG 2 shows a schematic view of a choke and kill system according to a further embodiment of the present invention.

DETAILED DESCRIPTION OF THE DRAWINGS

[0030] With reference to FIG. 1, there is shown a choke and kill system 100 for a deep water drilling rig 110. The deep water drilling rig 110 has a low pressure stack indicated by dashed arrow 112 and a high pressure blowout preventer stack indicated by dashed arrow 114. In this embodiment, the low pressure stack is rated at 15,000psi and the high pressure stack is rated at 25,000psi. A person skilled in the art will appreciate that the terms "low" and "high" are relative terms. The low pressure stack 112 in this embodiment is an existing stack to which the high pressure blow out preventer stack 114 has been connected. The high pressure blow out preventer stack 114 has a wellhead connector 116 which connects to a wellhead 118 located on the seafloor 120.

[0031] The low pressure stack 112 has a low pressure choke line 122. As the low pressure choke line 122 is rated at 15,000psi, it is not suitable for the high pressure blow out preventer stack 114. To overcome this, the choke and kill system 100 has a choke 124 (rated to 25,000psi) that is fluidly connected to the low pressure choke line 122 and a high pressure choke line 126 (rated to 25,000psi) which in turn is fluidly connected to the high pressure blow out preventer stack 114. In this manner, the choke 124 reduces the pressure from the high pressure choke line 126 to the low pressure choke line 122. The choke 124 comprises multiple chokes (not shown) in a single body. The multiple chokes (not shown) are provided in a redundant arrangement. The choke 124 utilises the control system (not shown) such as a hydraulic control system and/or a multiplexer control system.

[0032] The choke and kill system 100 has a subsea pump 130 which can supply fluid in the form of mud or cement to the high pressure blow out preventer stack 114 via a high pressure kill line 132 (rated at 25,000psi) and

into the wellbore 102 in order to stop flow from the wellbore 102 (i.e. kill the high pressure well). Mud is well known in the art and can be for example a drilling fluid.

[0033] The subsea pump 130 receives mud from a low pressure kill line 134 (rated at 15,000psi). In an alternate embodiment (not shown), the subsea pump 130 receives mud from a low pressure auxiliary line.

[0034] The subsea pump 130 is driven by radial hydraulic piston motors 136. The radial hydraulic piston motors 136 are driven by seawater which is pumped through a boost line 138. Once the seawater has driven the radial hydraulic piston motors 136, it is discharged to the sea as indicated at 140.

[0035] The subsea pump 130 has ceramic bearings (not shown), in this manner, seawater, in which the subsea pump 130 is submerged, can be used to lubricate the ceramic bearings (not shown).

[0036] Although the subsea pump 130 is shown separate from the high pressure blow out preventer stack 114 for clarity, it will be appreciated that the subsea pump 130 is typically mounted to a frame (not shown) of the high pressure blow out preventer stack 114.

[0037] The high pressure blow out preventer stack 114 has a mandrel 142 to which the low pressure stack 112 connects. The high pressure blow out preventer stack 114 also has a high pressure blow out preventer 144. In another embodiment (not shown) the high pressure blow out preventer stack 114 has two or more high pressure blowout preventers.

[0038] The low pressure stack 112 has a subsea stack test ram 146. The low pressure stack 112 has pipe rams 148. The low pressure stack 112 has a casing shear ram 150, a lower blind shear ram 152 and an upper blind shear ram 154. The low pressure stack 112 has an adapter spool 156. A riser connector 158 is attached to the adapter spool 156. The low pressure stack 112 has a lower annular blow out preventer 160 and an upper annular blow out preventer 162. The low pressure stack 112 has a flex joint 164. The low pressure stack 112 has a riser adapter 166. The riser connector 158, the lower

annular blow out preventer 160, the upper annular blow out preventer 162, the flex joint 164 and the riser adapter 166 are part of an upper section of the low pressure stack, this upper section may also be referred to as a lower marine riser package. It will be appreciated that in alternate embodiments (not shown), the low pressure stack 112 may have different configurations.

[0039] The choke and kill system 100 has multiple redundant sensors (not shown) to monitor upstream and downstream pressure and adjust the choke 124.

[0040] With reference to FIG. 2, there is shown a choke and kill system 100 for a deep water drilling rig 110 according to a further embodiment of the present invention. FIG. 2 is similar to FIG. 1, the exception being that in the embodiment shown in FIG. 2, there is no subsea pump. Instead, a high pressure kill line 170 (rated at 25,000psi) extends to a surface vessel (not shown), where a high pressure pump (not shown) is adapted to supply mud to the high pressure kill line 170.

[0041] An advantage of the present invention is that high pressure equipment can be used with existing low pressure equipment such as existing low pressure drilling riser, existing low pressure stack, existing low pressure piping and manifolds on a surface vessel, existing blow out preventers on the low pressure stack, and existing surface vessels which are set up for low pressure operation. This can lead to significant savings as the above mentioned low pressure equipment does not need to be replaced by high pressure equipment.

[0042] An advantage of a further embodiment of the present invention is that the existing low pressure kill line 134 of an existing low pressure stack 112 can be utilised when the high pressure blow out preventer stack 114 is connected to the low pressure stack 112.

[0043] A benefit of utilising a subsea pump 130 in an embodiment of the present invention is that the boost line 138 of the existing low pressure stack

112 can be utilised and no return line is required for the “hydraulic fluid”(i.e. seawater) which is vented to the sea.

[0044] The foregoing embodiments are illustrative only of the principles of the invention, and various modifications and changes will readily occur to those skilled in the art. The invention is capable of being practiced and carried out in various ways and in other embodiments. For example, individual features from one embodiment may be combined with another embodiment. It is also to be understood that the terminology employed herein is for the purpose of description and should not be regarded as limiting.

[0045] In the present specification and claims (if any), the word "comprising" and its derivatives including "comprises" and "comprise" include each of the stated integers but does not exclude the inclusion of one or more further integers unless the context of use indicates otherwise.

CLAIMS:

1. A choke and kill system for a deep water drilling rig, the choke and kill system comprising:

a low pressure stack of the deep water drilling rig;

a high pressure blowout preventer stack of the deep water drilling rig fluidly connected to the low pressure stack;

a choke fluidly connected to a low pressure choke line of the low pressure stack, the choke fluidly connected to a high pressure choke line of the high pressure blowout preventer stack, the choke adapted to reduce the pressure from the high pressure choke line to the low pressure choke line.

2. The choke and kill system of claim 1, further comprising a high pressure kill line fluidly connected to the high pressure blow out preventer stack.

3. The choke and kill system of claim 1 or 2, wherein the high pressure kill line is adapted to convey drilling fluid to the high pressure blow out preventer stack.

4. The choke and kill system of claim 3, wherein the high pressure kill line extends to a surface vessel, where a pump is adapted to supply drilling fluid to the high pressure kill line.

5. The choke and kill system of any one of the preceding claims, further comprising a subsea pump that is adapted to pump drilling fluid into the high pressure kill line.

6. The choke and kill system of claim 5, wherein the subsea pump is adapted to receive drilling fluid from a low pressure kill line of the drilling riser.

7. The choke and kill system of claim 6, wherein the subsea pump increases the pressure of the drilling fluid from the low pressure kill line to the high pressure kill line.

8. The choke and kill system of any one of claims 1 to 5, wherein the subsea pump is adapted to receive drilling fluid from a low pressure auxiliary line of the drilling riser.

9. The choke and kill system of claim 8, wherein the subsea pump increases the pressure of the drilling fluid from the low pressure auxiliary line to the high pressure kill line.

10. The choke and kill system of any one of claims 5 to 9, wherein the subsea pump is driven hydraulically.

11. The choke and kill system of claim 10, wherein the subsea pump is driven by at least one radial hydraulic piston motor.

12. The choke and kill system of claim 10 or 11, wherein hydraulic fluid to drive the subsea pump is supplied by a riser auxiliary line of the drilling riser.

13. The choke and kill system of claim 12, wherein the hydraulic fluid is seawater.

14. The choke and kill system of claim 12 or 13, wherein once the hydraulic fluid has been used to drive the subsea pump, the hydraulic fluid is discharged to the sea.

15. The choke and kill system of any one of claims 5 to 14, wherein the subsea pump comprises ceramic bearings.

16. The choke and kill system of any one of claims 5 to 15, wherein the subsea pump uses seawater for lubrication.

17. The choke and kill system of any one of claims 15 to 16, wherein the subsea pump is located at or near the high pressure blow out preventer stack.

18. The choke and kill system of claim 17, wherein the subsea pump is mounted to the high pressure blow out preventer stack.

19. The choke and kill system of any one of the preceding claims, wherein the choke utilises a control system from the low pressure stack.

20. The choke and kill system of claim 19, wherein the control system is a hydraulic control system.

21. The choke and kill system of claim 19 or 20, wherein the choke is adapted to utilise a multiplexer control system from the low pressure stack.

22. The choke and kill system of any one of the preceding claims, wherein the choke is located at or near the high pressure blow out preventer stack.

23. The choke and kill system of claim 22, wherein the choke is mounted to the high pressure blow out preventer stack.

24. The choke and kill system of any one of the preceding claims, comprising multiple chokes.

25. The choke and kill system of claim 24, wherein the multiple chokes are located in a single body.

26. The choke and kill system of any one of the preceding claims, wherein the low pressure stack includes at least one low pressure blowout preventer.

27. The choke and kill system of any one of the preceding claims, wherein the high pressure blow out preventer stack comprises a plurality of high pressure blowout preventers.

28. The choke and kill system of claim 27, wherein the high pressure blowout preventer stack comprises a wellhead connector to connect to a well.

29. The choke and kill system of any one of the preceding claims, wherein the high pressure blowout preventer stack comprises a mandrel located toward an upper end of the high pressure blowout preventer stack to which the low pressure stack connects.

30. The choke and kill system of any one of the preceding claims, further comprising at least one of pressure and temperature sensors to adjust the choke.

31. The choke and kill system of any one of the preceding claims, wherein the low pressure stack is rated at less than or equal to 15,000psi and the high pressure stack is rated above 25,000psi.

32. A drilling rig comprising a choke and kill system as claimed in any one of the preceding claims.

33. A method of adapting a low pressure drilling rig for use in a high pressure application, the method comprising the steps of:

connecting a high pressure blowout preventer stack to a low pressure stack of the low pressure drilling rig;

fluidly connecting a choke to a low pressure choke line of the low pressure stack; and

fluidly connecting the choke to a high pressure choke line of the high pressure blowout preventer stack;

wherein the choke is adapted to reduce the pressure from the high pressure choke line to the low pressure choke line.

34. The method of claim 33, further comprising the step of fluidly connecting a high pressure kill line to the high pressure blowout preventer stack.

35. The method of claim 33 or claim 34, wherein the step of fluidly connecting a high pressure kill line to the high pressure blowout preventer stack includes fluidly connecting a low pressure kill line of the low pressure stack to a subsea pump and fluidly connecting the subsea pump to the high pressure kill line such that the subsea pump can pump fluid from the low pressure kill line to the high pressure kill line, increasing the pressure of the fluid from the low pressure kill line to the high pressure kill line.

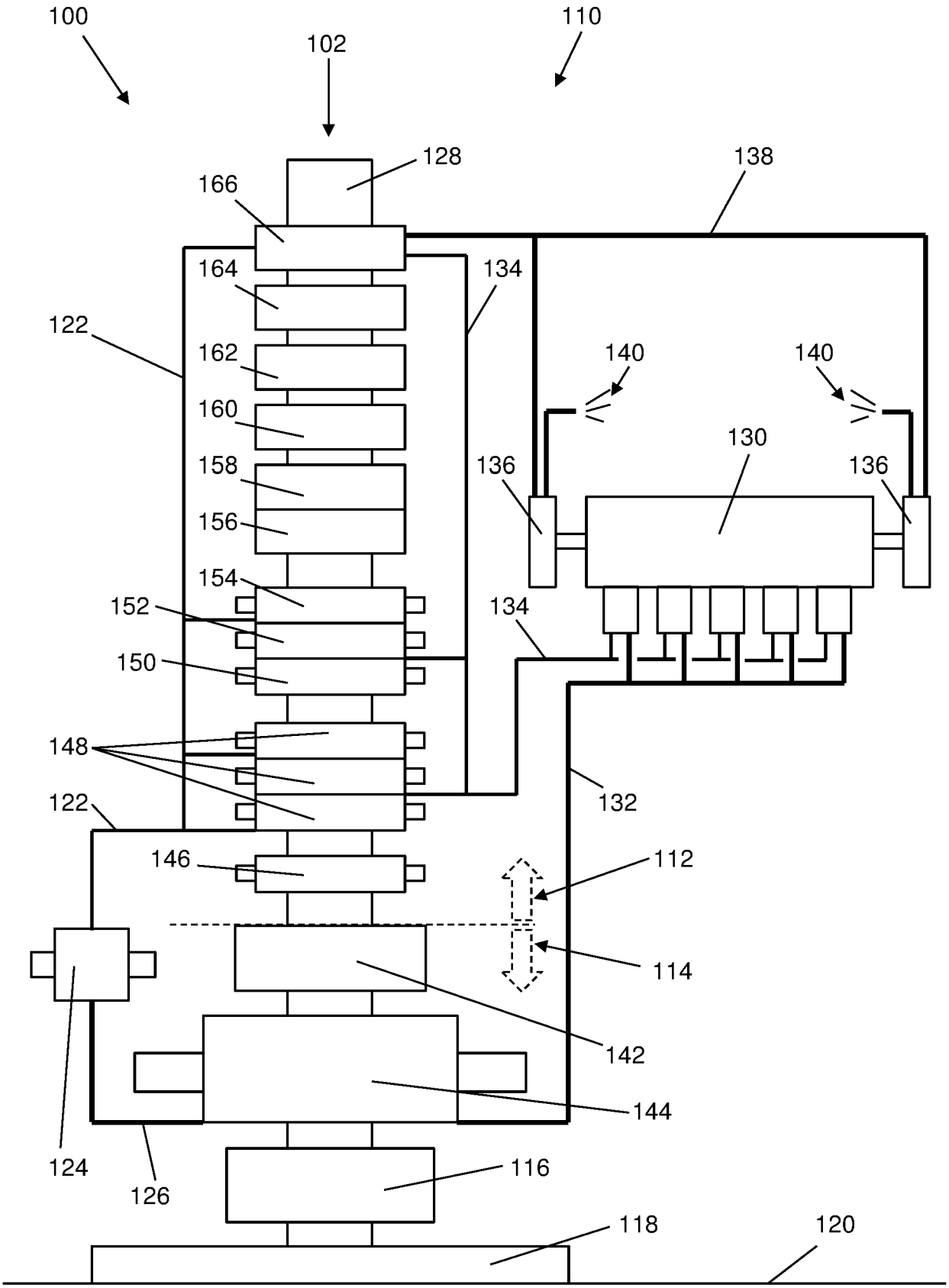
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FIG. 1

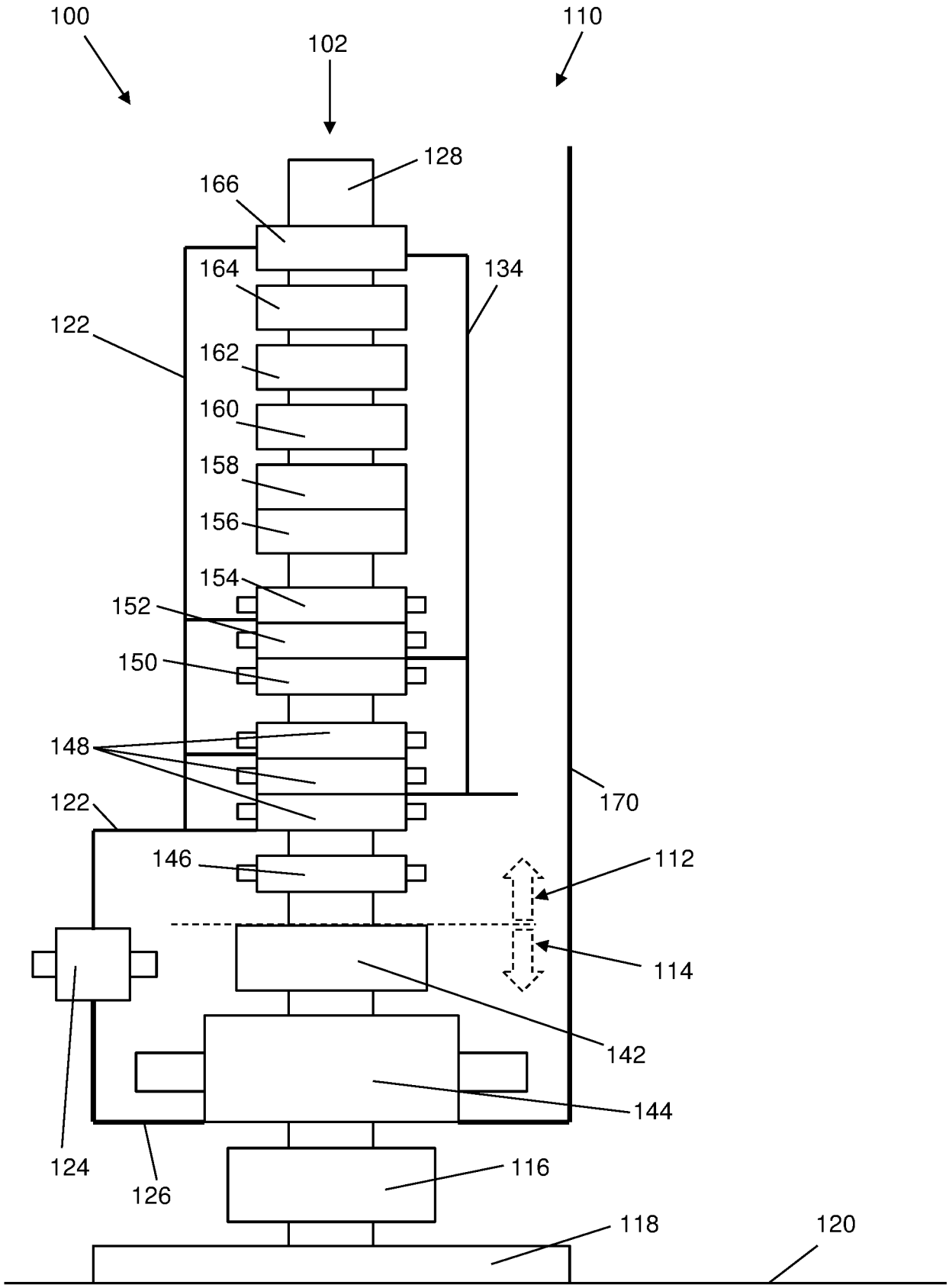
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FIG. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2016/050309

A. CLASSIFICATION OF SUBJECT MATTER

E21B 33/038 (2006.01) E21B 33/06 (2006.01) E21B 34/02 (2006.01) E21B 34/06 (2006.01)

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)

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

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

DATABASES: EPODOC, WPIAP, TXTE (Public English Full Text Cluster); lPC/CPC/LOW: E21B33/038, E21B33/06, E21B34/02, E21B34/06; Keywords: High, First, Low, Second, Pressure, Choke, Reduce, Join, Connect, Blowout, Preventer and similar keywords.

ESPACENET AND AUSPAT: Applicant/Inventor name searched; Viewed cited/citing of relevant documents.

Google patents: Keywords: Choke and kill, high, pressure, blowout preventer, reduce, pressure

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	

[X] Further documents are listed in the continuation of Box C [X] 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

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"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	Date of mailing of the international search report
28 June 2016	28 June 2016
Name and mailing address of the ISA/AU	**Authorised officer**
AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA Email address: pct@ipaustralia.gov.au	Victor Maluki AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No. 0262256112

INTERNATIONAL SEARCH REPORT C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		International application No. **PCT/AU2016/050309**
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2003/023181 A1 (OCEAN RISER SYSTEMS) 20 March 2003 Entire document	1 - 35
A	WO 2008/045381 A2 (FLUOR TECHNOLOGIES CORPORATION) 17 April 2008 Entire document	1 - 35
A	WO 2013/138092 A2 (PROPERTY HOLDINGS INC) 19 September 2013 Entire document	1 - 35
A	US 5848656 A (MOKSVOLD) 15 December 1998 Entire document	1 - 35
A	US 2007/0163782 A1 (KEENER) 19 July 2007 Entire document	1 - 35

INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/AU2016/050309**

This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document/s Cited in Search Report		Patent Family Member/s	
Publication Number	**Publication Date**	**Publication Number**	**Publication Date**
WO 2003/023181 A1	20 March 2003	WO 03023181 A1	20 Mar 2003
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This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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