(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
24 May 2018 (24.05.2018)

WIPO | PCT

(10) International Publication Number
WO 2018/094217 A1

(51) International Patent Classification:
E21B 23/04 (2006.01) *E21B 23/06* (2006.01)

(21) International Application Number:
PCT/US2017/062312

(22) International Filing Date:
17 November 2017 (17.11.2017)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
15/355,613 18 November 2016 (18.11.2016) US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report (Art. 21(3))*

(54) Title: HIGH PRESSURE INTERVENTIONLESS BOREHOLE TOOL SETTING FORCE

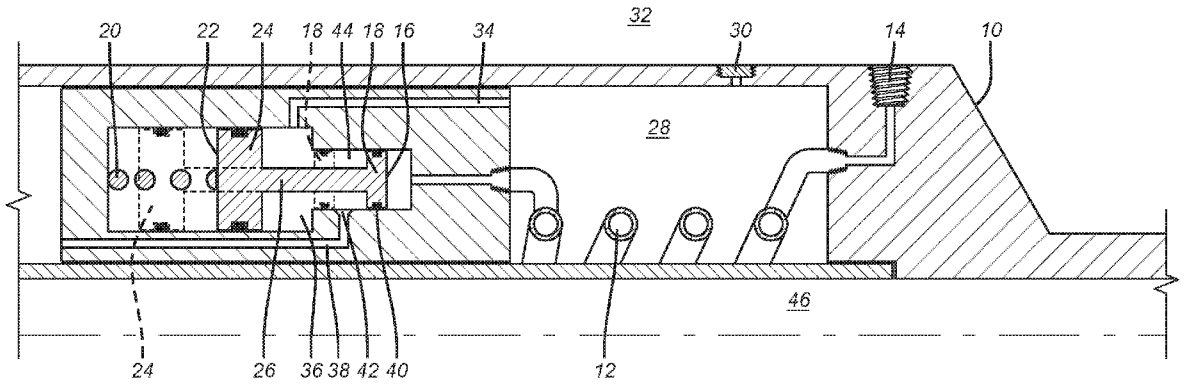

FIG. 1

(57) Abstract: A high pressure compressed gas source is separated from an actuation piston by a pilot valve that is selectively operated with raising annulus pressure to break a rupture disc to provide access to a shuttle type valve. Movement of the shuttle valve using pressure applied to opposing pistons of different sizes connected to a common shaft translates the shaft against a spring bias to open the valve on the high pressure source. This allows the high pressure to reach the actuating piston to operate the tool. One application can be setting a packer without well intervention.

WO 2018/094217 A1

HIGH PRESSURE INTERVENTIONLESS BOREHOLE TOOL SETTING FORCE

Inventor: Darren E. Bane

FIELD OF THE INVENTION

[0001] The field of the invention is setting mechanisms for borehole tools that need high actuation force and more particularly where the actuation force is non-interventionally released from a remote location with a pilot circuit.

BACKGROUND OF THE INVENTION

[0002] Tools have been set before using available annulus hydrostatic pressure that is allowed to selectively move actuation systems when a barrier is broken. One example of such a design is US 2009/0229832 where annulus pressure at a desired location is raised to break a rupture disc to then allow pressure to release a lock and move an actuation mechanism to set a packer. However, there is a limit to the amount of force that such systems that use pressures slightly higher than hydrostatic to actuate a tool. The present invention seeks to address this issue with the use of a stored potential energy force that can be selectively released to set a tool such as a packer. The use of a pressurized inert gas such as nitrogen allows the use of a much smaller actuation piston thereby making the internal packer drift dimension larger to enhance production capability. In a preferred embodiment annulus hydrostatic and optionally some added applied surface pressure are used to break a rupture disc to allow pressure in the annulus to operate a shuttle valve to open the high pressure source to the actuating piston. These and other aspects of the present invention will be more readily apparent from a review of the description of the preferred embodiment and the associated drawing while recognizing that the full scope of the invention is to be found in the appended claims.

[0003] US 2003/0041596 is cited to illustrate the use of pilot valves 44 to operate other valves 46 in hydraulic circuits in the context of a garbage truck using a pilot line 70.

SUMMARY OF THE INVENTION

[0004] A high pressure compressed gas source is separated from an actuation piston by a pilot valve that is selectively operated with raising annulus pressure to break a rupture disc to provide access to a shuttle type

valve. Movement of the shuttle valve using pressure applied to opposing pistons of different sizes connected to a common shaft translates the shaft against a spring bias to open the valve on the high pressure source. This allows the high pressure to reach the actuating piston to operate the tool. One application can be setting a packer without well intervention.

BRIEF DESCRIPTION OF THE DRAWING

[0005] Figure 1 illustrates the hydraulic circuit for actuating a borehole tool.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0006] Figure 1 illustrates a housing **10** that defines a high pressure fluid chamber **12** in a coiled shape that is accessed for charging by a connection **14**. Chamber **12** has pressures orders of magnitude higher than annulus **32** pressure and could be in the order of 5000 PSI or more. Chamber **12** communicates with face **16** of piston **18** and that force is resisted by spring **20** pushing against face **22** of piston **24**. Pistons **18** and **24** are held together by shaft **26** for tandem movement to the left as shown by the dashed positions of pistons **18** and **24**.

[0007] Chamber **28** is accessed from removal of barrier **30** from the surrounding annulus **32** preferably by raising the hydrostatic pressure in annulus **32**. Pressure in chamber **28** communicates through passage **34** to pilot chamber **36** after barrier **30**, which is preferably a rupture disc, breaks. Pressure in chamber **36** creates a net force against spring **20** because the diameter of piston **24** is larger than piston **18**. When pistons **18** and **24** move to their dashed positions pressure in chamber **12** is communicated through passage **38** to actuate a setting piston for a borehole tool that is not shown. This occurs because piston **18** has a seal **40** that crosses over opening **42** into passage **38** while remaining in bore **44**. Spring **20** is compressed as pistons **18** and **24** move left. Piston **18** stays in bore **44**.

[0008] Those skilled in the art will appreciate that there can be many variations to the concept of actuation without intervention coupled with the use of a high pressure source that is released to move an actuation piston to actuate a borehole tool. For example, the rupture disc **30** can be replaced with a disintegrating plug that responds to well fluids or thermal inputs. The barrier **30** can be a shape memory material that changes shape after exposure to

temperatures above a critical temperature to change shape to allow fluid communication to the chamber **28** from the annulus **32**. Motorized sleeve valves are also contemplated but represent a more complicated way to provide access to the annulus **32**. Alternatively the access can be from the tubing side using passage **46** although a wall opening to the tubular string is generally less preferred by operators than using access and pressure from annulus **32** for the access to pressure to move the pistons **18** and **24**.

[0009] The coil spring **20** can be replaced with a stack of Belleville washers or a pressurized compressible gas to maintain the pistons **18** and **24** in the initial position. While chamber **12** is represented as a volume inside a coil for the provision of some flexibility to the applied pressure or to compensate for thermal loads other volume shapes are contemplated such as cylindrical. The rate of piston movement can be controlled after access is obtained from the annulus **32** or the tubing **46**. In another option the pressure source for moving the tandem pistons **18** and **24** can also be contained in housing **10** so that access to the tubing or the annulus is avoided. In this case the pilot gas pressure can be remotely released with a variety of signals to open a valve on the pilot gas supply to operate a valve to release the high pressure gas supply to the tool operating piston. Of course, this will add complication to the actuation system including a local power supply to receive and process a signal and then operate a motor to open a valve on the low pressure pilot supply system. Another alternative can be to have only a high pressure gas supply with a remotely actuated valve responsive to an interventionless signal that is locally processed to actuate a single valve on the high pressure reservoir to communicate it to the setting piston. The issue here may be the power requirements for the actuator to move a single valve holding back very high pressure upward of 5000 PSI.

[0010] The above description is illustrative of the preferred embodiment and many modifications may be made by those skilled in the art without departing from the invention whose scope is to be determined from the literal and equivalent scope of the claims below:

I claim:

1. An actuation assembly for an actuation piston (38) operated borehole tool, comprising:

an actuation chamber (12) containing a pressurized fluid **characterized by being** selectively isolated from the actuation piston by a valve (40,42) further comprising a valve member (18), said valve member responsive to a remotely generated signal (30,32) to non-interventionally move said valve member to communicate said pressurized fluid (12) to said actuation piston (18,40,42 to operate the borehole tool.

2. The assembly of claim **1**, wherein:

said signal travels through an annulus (32) surrounding the borehole tool.

3. The assembly of claim **1**, wherein:

said signal travels through the borehole tool.

4. The assembly of claim **1**, wherein:

said signal comprises hydrostatic pressure in a surrounding annulus (32) around the borehole tool.

5. The assembly of claim **4**, wherein:

said signal further comprises enhanced pressure applied to said annulus (32) around the borehole tool.

6. The assembly of claim **1**, wherein:

fluid in a surrounding annulus around the borehole tool removes a barrier (30) leading to said valve member (18).

7. The assembly of claim **6**, wherein:

said barrier (30) breaks, moves to expose a port (42) or disintegrates.

8. The assembly of claim **6**, wherein:

said valve member comprises connected spaced apart pistons (18,24,26) of unequal surface area defining a pilot chamber (36) therebetween.

9. The assembly of claim **8**, wherein:

said removal of said barrier (30) communicates pressure from an annulus (32) surrounding the borehole tool to said pilot chamber (36) to create a net force on said valve member (18).

10. The assembly of claim **9**, wherein:

said net force is opposed by a bias force (20) acting on said valve member (24).

11. The assembly of claim **9**, wherein:

a smaller of said spaced apart pistons (18) initially blocks an actuation passage (38) between said pressurized fluid (12) and the actuation piston until pressure in said pilot chamber (44) moves said smaller piston (18) from a first to a second position where said actuation passage (38)is opened.

12. The assembly of claim **11**, wherein:

said smaller (18) of said spaced apart pistons (18,24) remains in a surrounding bore to retain pressure from said actuation chamber (12) as said pressurized fluid is communicated (38) to said actuation piston.

13. The assembly of claim **11**, wherein:

said bias force (20) acts on a larger (22,24) of said spaced apart pistons (18,24) to maintain said first position of said smaller (18) of said spaced apart pistons.

14. The assembly of claim **13**, wherein:

said bias force (20) is located outside said pilot chamber (36,44).

15. The assembly of claim **14**, wherein:

said bias force (20) comprises at least one of a coiled spring, a stack of Belleville washers and a pressurized compressible gas.

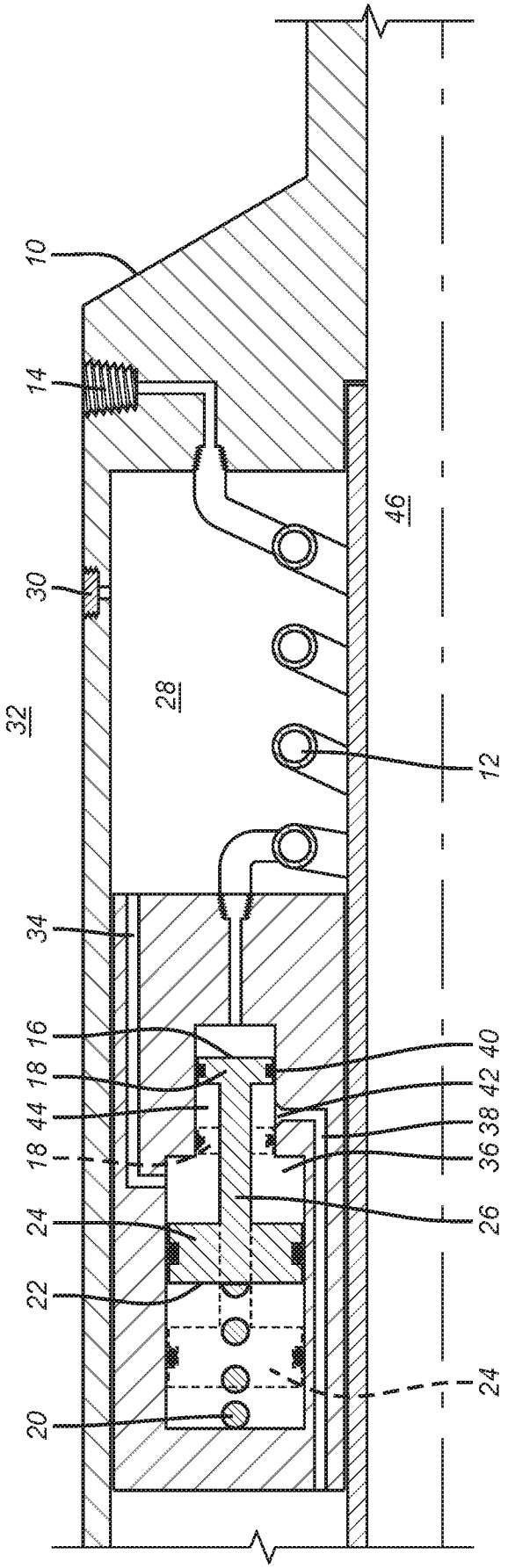

FIG. 1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2017/062312

A. CLASSIFICATION OF SUBJECT MATTER

E21B 23/04(2006.01)i, E21B 23/06(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 23/04; E21B 34/06; E21B 23/06; E21B 34/00; E21B 33/12; F16D 31/02; E21B 34/14; E21B 34/10

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: actuation assembly, chamber, valve member, piston, signal, annulus, barrier, bias force

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 9309745 B2 (PATEL, DINESH R.) 12 April 2016 See abstract, column 3, line 16 - column 4, line 66, column 5, lines 54-59, and figures 3-7.	1-15
A	US 2010-0206579 A1 (GUVEN et al.) 19 August 2010 See claim 1 and figure 2.	1-15
A	US 2005-0224235 A1 (PATEL, DINESH R.) 13 October 2005 See abstract and figures 1-3.	1-15
A	US 2009-0229832 A1 (KING, JAMES G.) 17 September 2009 See abstract and figures 1A-1E.	1-15
A	US 2003-0041596 A1 (FLERCHINGER et al.) 06 March 2003 See abstract and figures 1A-7.	1-15

☐ 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	Date of mailing of the international search report
22 February 2018 (22.02.2018)	**22 February 2018 (22.02.2018)**

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/US2017/062312

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		WO 2009-114371 A3	03/12/2009
US 2003-0041596 A1	06/03/2003	None	