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(56) Documents Cited:
 GB 2340520 A EP 1428975 A1
 WO 2015/065387 A1 US 20060185844 A1
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(54) Title of the Invention: **Property monitoring below a nonpenetrated seal**
 Abstract Title: **Monitoring below a nonpenetrated barrier system**

(57) A nonpenetrated barrier system 10 includes: one or more elements 12 and a component having properties configured to reliably respond to impetus downhole of the one or more elements of the barrier system in a way that is measurable uphole of the one or more of the one or more elements of the barrier system. The system further includes one or more sensors 26 positioned in operable communication with the component uphole of the one or more elements. The elements may be packers and the component may be a mandrel 12 or a ramp 20. The sensor may be a strain gauge that measures strain in the component and may include memory or may be connected to a remote location. The sensor may measure periodically or continuously.

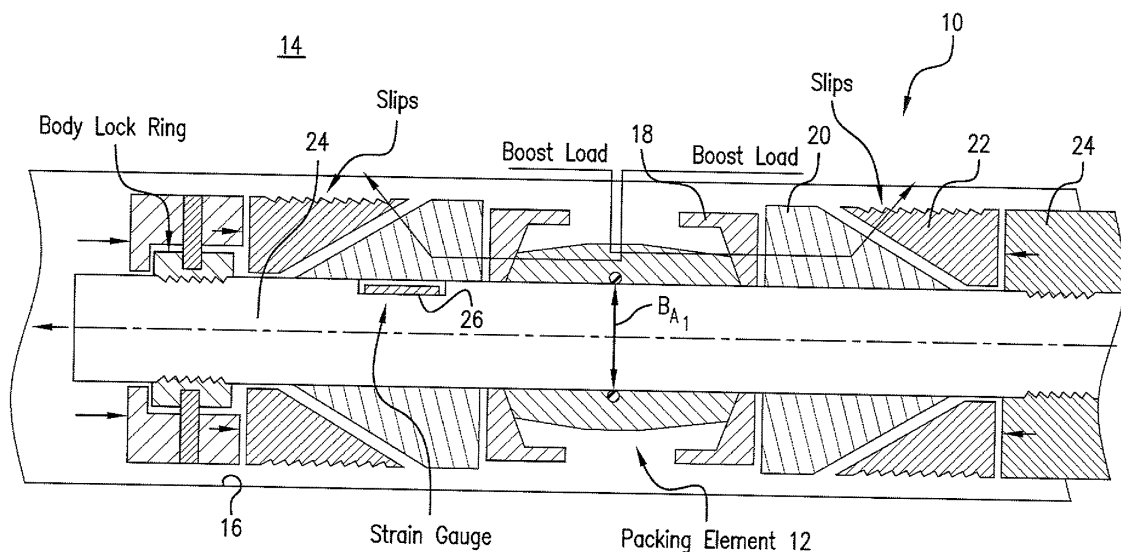


FIG. 1

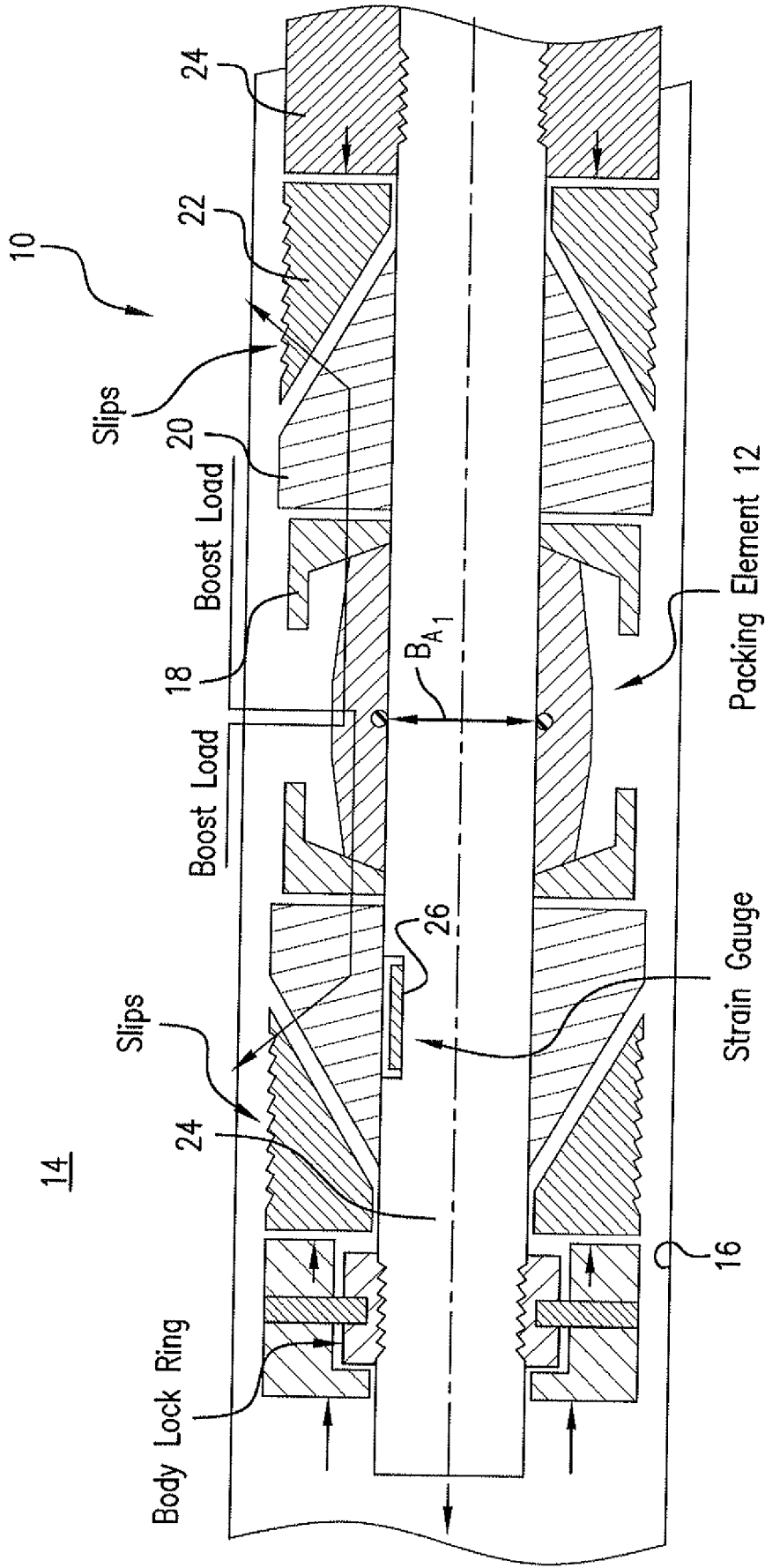


FIG.1

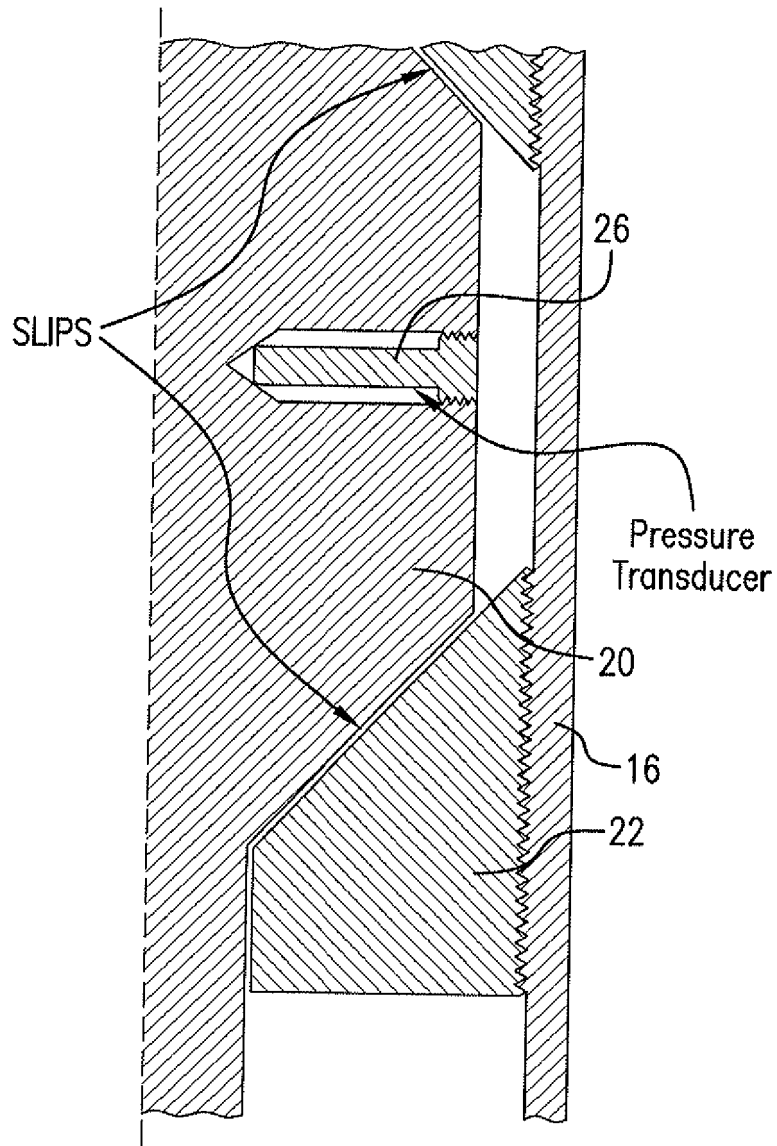


FIG.2

PROPERTY MONITORING BELOW A NONPENETRATED SEAL

BACKGROUND

In the hydrocarbon exploration and recovery art, there is often a need to temporarily or permanently abandon or shut in a wellbore. When such actions are needed, regulations in most locales require one or more nonpenetrated barriers of a barrier system, and often two or more such nonpenetrated barriers, be installed in the downhole environment prior to removal of a Blowout Preventer, a Christmas Tree, an upper completion, for example. This is so that conditions downhole of the removed sections of the wellbore stay downhole and do not result in an uncontrollable situation at the surface. Uncontrolled surface situations are costly. The regulation required nonpenetrated barriers reduce the chance of leaks since in nonpenetrated form, there are no leak paths through the barrier system. Accordingly, the industry has widely adopted similar such regulations and it is up to operators to make them work as anticipated.

In any circumstance where there is more than one barrier in the barrier system, it is often not possible to adequately ascertain the function of each barrier individually. Pressuring up against the more than one barrier and holding pressure could indicate that the first, second, third, etc. barrier is working while the others may or may not be working. This is because provided that at least one of the barriers is holding, the pressure will be stable. Considering that the regulations that require more than one barrier do have a *raison d'être*, the inability to initially test them all and/or the inability to monitor changes downhole of the uphole-most barrier is a practical conundrum for the industry. While the regulations are met by the installation of the more than one barrier in the barrier system, the operational benefits to the well owner vis-a-vis prescience into what is or will occur shortly during subsequent operations is lost without the knowledge of trending conditions downhole of the uphole-most barrier.

The art would well receive configurations adept at solving this consistent problem.

SUMMARY

Disclosed is a nonpenetrated barrier system. The nonpenetrated barrier system includes: one or more elements. The system includes a component having properties configured to reliably respond to impetus downhole of the one or more elements of the barrier system in a way that is measurable uphole of the one or more of the one or more elements of the barrier system. In addition, the system includes one or more sensors positioned in operable communication with the component uphole of the one or more elements.

Also disclosed is a method for monitoring a condition downhole of a nonpenetrated barrier system. The method includes: installing a barrier system and measuring a property of the component that is related to a condition downhole of the one or more elements.

Further disclosed is a method for monitoring conditions downhole of a nonpenetrated barrier system in a borehole. The method includes: positioning a sensor relative to a component of the barrier system and uphole of an uphole-most nonpenetrated element of the barrier system that exhibits a condition created by properties downhole of the uphole-most nonpenetrated element of the barrier system and monitoring the sensor.

Finally disclosed is a method for enabling monitoring of a condition downhole of a nonpenetrated barrier system. The method includes: installing a barrier system comprising a component having properties configured to reliably respond to impetus downhole of the one or more elements of the barrier system in a way that is measurable uphole of the one or more of the one or more elements of the barrier system and further including one or more sensors positioned in operable communication with the component uphole of the one or more elements.

BRIEF DESCRIPTION OF THE DRAWINGS

The following descriptions should not be considered limiting in any way. With reference to the accompanying drawings, like elements are numbered alike:

FIG. 1 is a schematic cross sectional view of a portion of a barrier system having an uphole-most barrier and a sensor;

FIG. 2 is a schematic cross sectional view of an alternate placement of a sensor and construction of the barrier system.

DETAILED DESCRIPTION

Referring to Figure 1, a schematic cross sectional representation of one iteration of the teaching hereof is illustrated. That teaching in a broad sense is to position a sensor uphole of a nonpenetrated barrier system while facilitating interrogation of at least one type of borehole condition downhole of a nonpenetrated element of the barrier system. The configuration illustrated takes advantage of measurable changes in material properties uphole of a barrier that are originated downhole of the barrier. For example, pressure changes downhole of the barrier will impart stress to components of the barrier system that are naturally propagated some distance from the origin point. For example, pressure changes on a mandrel downhole of an element of the barrier system can be measured as strain uphole of the uphole-most nonpenetrated element of the barrier system using a sensor such as a strain gauge, for example.

Figure 1 represents at least a portion of a barrier system 10 comprising one or more elements 12 that are settable to extend from a mandrel 14 to a borehole wall 16 thereby providing a barrier to conditions further downhole than the setting location of the element 12, such as a packer. Those of ordinary skill in the art will recognize depictions of backups 18, ramps 20, slips 22 and body lock rings 24. What is not recognizable to one of ordinary skill in the art is one or more sensors 26 located uphole of the element 12 and yet is positioned and configured to provide information about conditions extant downhole of the element 12. In one embodiment the sensor 26 is a strain gauge such as a load cell or calibrated pressure chamber, for example. It will be appreciated from the figure that the sensor 26 is positioned in contact with the mandrel 14 to either monitor continuously, or to periodically query a level of strain in the mandrel 14. It is to be appreciated that noncontact sensors configured to measure whatever the target condition of the component is are also contemplated. This information may be stored locally in a memory and/or sent to

surface or other remote location via a communication configuration such as wireline, electrical conductors, optic fibers, wireless electromagnetic means, MWD equipment, etc. Because the sensor 26 is located uphole of the element 12 and other portions of the barrier system no penetrations are needed in the barrier system and accordingly regulations regarding nonpenetrated barriers being used may be met while at the same time allowing reliable monitoring of conditions downhole of the element whether that be to a volume or multiple volumes defined within the barrier system or conditions entirely downhole of the barrier system as the particular site presents. It is to be understood that although the mandrel is used in this embodiment as the condition carrying configuration, other components may be similarly employed. Components selected should reliably respond to impetus downhole of the barrier system in a way that is measurable uphole of the barrier system.

In use, the system 10 described provides information about the conditions downhole for alert to changing conditions or for planning purposes during efforts to reopen the well. It is certainly useful to know whether when a barrier system is opened if there will be a pressure release from downhole that will need to be contained or if there will be a draw into the downhole environment from a higher pressure uphole of the barrier system that could suck a tool string or components of the barrier system into other well equipment where it is not supposed to be. Clearly either of these situations are better managed up front as they are more costly and would cause delay when only discovered after the reopening operation has begun.

In an alternate embodiment, referring to Figure 2, the sensor 26 is illustrated in another position where a ramp 20 is used as the housing for the sensor 26. As noted above, any location uphole of a nonpenetrated barrier is sufficient provided components selected should reliably respond to impetus downhole of the barrier system in a way that is measurable uphole of the barrier system.

While the invention has been described with reference to an exemplary embodiment or embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is

intended that the invention not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope of the claims. Also, in the drawings and the description, there have been disclosed exemplary embodiments of the invention and, although specific terms may have been employed, they are unless otherwise stated used in a generic and descriptive sense only and not for purposes of limitation, the scope of the invention therefore not being so limited. Moreover, the use of the terms first, second, etc. do not denote any order or importance, but rather the terms first, second, etc. are used to distinguish one element from another. Furthermore, the use of the terms a, an, etc. do not denote a limitation of quantity, but rather denote the presence of at least one of the referenced item.

Claims:

- 1 A nonpenetrated barrier system comprising:
 - one or more elements;
 - a component having properties configured to reliably respond to impetus downhole of the one or more elements of the barrier system in a way that is measurable uphole of the one or more of the one or more elements of the barrier system;
 - one or more sensors positioned in operable communication with the component uphole of the one or more elements.
- 2 The nonpenetrated barrier system as claimed in claim 1 wherein the one or more elements is two or more elements.
- 3 The nonpenetrated barrier system as claimed in claim 1 or 2 wherein the one or more elements are packers.
- 4 The nonpenetrated barrier system as claimed in claim 1, 2 or 3 wherein the component is a mandrel.
- 5 The nonpenetrated barrier system as claimed in claim 1, 2 or 3 wherein the component is a ramp.
- 6 The nonpenetrated barrier system as claimed in any preceding claim wherein the sensor is a strain gauge.
- 7 The nonpenetrated barrier system as claimed in any preceding claim wherein the sensor is communicatively connected to a remote location via a communication configuration.
- 8 The nonpenetrated barrier system as claimed in any preceding claim wherein the sensor includes a memory.
- 9 A method for monitoring a condition downhole of a nonpenetrated barrier system comprising:
 - installing a barrier system as claimed in claim 1;
 - measuring a property of the component that is related to a condition downhole of the one or more elements.
- 10 The method as claimed in claim 9 wherein the measuring is continuous.
- 11 The method as claimed in claim 9 wherein the measuring is periodic.

12 The method as claimed in claim 9, 10 or 11 wherein the measuring is measuring strain in the component.

13 The method as claimed in any of claims 9 to 12 wherein the method further comprises communicating measurement data to a remote location.

14 A method for monitoring conditions downhole of a nonpenetrated barrier system in a borehole comprising:

positioning a sensor relative to a component of the barrier system and uphole of an uphole-most nonpenetrated element of the barrier system that exhibits a condition created by properties downhole of the uphole-most nonpenetrated element of the barrier system;

monitoring the sensor.

15 The method as claimed in claim 14 wherein the positioning is in contact with the component.

16 The method as claimed in claim 14 or 15 wherein the sensor is a strain gauge.

17 The method as claimed in claim 14, 15 or 16 wherein the monitoring is periodic.

18 The method as claimed in claim 14, 15 or 16 wherein the monitoring is continuous.

19 A method for enabling monitoring of a condition downhole of a nonpenetrated barrier system comprising installing a barrier system as claimed in any of claims 1 to 8.



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Examiner: Miss Nicola Davies

Claims searched: 1 - 19

Date of search: 12 February 2016

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1 - 19	US2005/167094 A1 (HALLIBURTON) See figure 2 for sensors (30a/30f) and one or more elements (22a/22b) and mandrel 20.
X	1 - 19	US2003/188862 A1 (STREICH ET AL) See the figure for sensors 30 and one or more elements (20/22).
X	1 - 19	EP1428975 A1 (HALLIBURTON) See figure 2 for sensor 30 and one or more elements 16.
X	1 - 19	US2006/185844 A1 (HALLIBURTON) See figure 2 for sensors 40/42/46 and one or more elements 30.
X	1 - 3, 7 - 14 & 19	GB2340520 A (SCHLUMBERGER) See figure 1 for a sensor 34 and one or more elements 20.
X,E	1 - 19	WO2015/065387 A1 (HALLIBURTON) See figure 3 for sensors 56 and one or more elements 54.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^X :

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Worldwide search of patent documents classified in the following areas of the IPC

E21B

The following online and other databases have been used in the preparation of this search report

WPI, EPODOC



International Classification:

Subclass	Subgroup	Valid From
None		