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[Continued on next page]

(54) Title: TEMPORARY PROTECTIVE COVER FOR OPERATIVE DEVICES

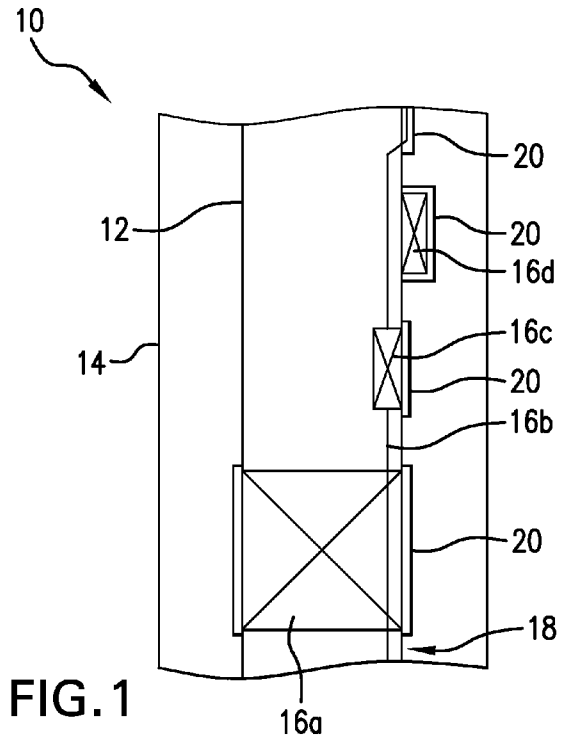

FIG. 1

(57) Abstract: A system for providing temporary protection, including an operative device located at an external surface of a member. A cover is externally disposed with respect to the operative device for initially protecting the operative device. The cover is chemically reactive to a downhole fluid for removal of the protective cover. A method of temporarily protecting an operative device is also included.

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Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

Published:

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

TEMPORARY PROTECTIVE COVER FOR OPERATIVE DEVICES

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Application No. 13/365494, filed on February 3, 3012, which is incorporated herein by reference in its entirety.

BACKGROUND

[0002] One challenge in the downhole drilling and completions industry is that components must be arranged to survive both the running-in process and the harsh downhole environments. During run-in, for example, components can experience high shear forces from contact with other tubulars or rock, dirt, sand, etc. in open portions of the borehole. For example, collision with a radially disposed tubular, borehole wall, etc., can result due to curvature or other imperfections of a borehole or string being run therein, misalignment or lack of centering of a string in a borehole, etc. As another example, grit, sand, dirt, fines, biopolymers, and other solid components in downhole fluids, reservoirs or formations, drilling mud, etc. can gather or collect around operative devices, negatively affecting their performance. Any damage or deterioration in performance, particularly during the run-in process, will adversely affect the operative device during later stages of completion and/or production. Accordingly, protection of operative devices, particularly temporarily during run-in, is desired and developments therein are well received by the industry.

BRIEF DESCRIPTION

[0003] A system for providing temporary protection, including an operative device located at an external surface of a member, and a cover externally disposed with respect to the operative device for initially protecting the operative device, the cover chemically reactive to a downhole fluid for removal of the protective cover.

[0004] A method of temporarily protecting an operative device including causing relative movement between a first member and a second member radially disposed therewith, the first member including an operative device located at an external surface thereof, the operative device arranged with a protective cover, exposing the protective cover to a downhole fluid, and removing the protective cover as the result of a chemical reaction between the downhole fluid and the protective cover.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] The following descriptions should not be considered limiting in any way. With reference to the accompanying drawings, like elements are numbered alike:

[0006] Figure 1 is a cross-sectional view of a string having a plurality of operative devices protected by temporary covers installed thereon;

[0007] Figures 2A and 2B show two embodiments for forming the protective covers for the operative devices of Figure 1; and

[0008] Figure 3 is a cross-sectional view of an embodiment including a removable material in powder form.

DETAILED DESCRIPTION

[0009] A detailed description of one or more embodiments of the disclosed apparatus and method are presented herein by way of exemplification and not limitation with reference to the Figures.

[0010] Referring now to Figure 1, a system 10 is shown having a tubular string 12 runnable in a borehole 14. The string 12 could take the form of one or more tubulars run into the borehole for performing downhole operations, e.g., related to completion, production, etc. The borehole 14 could include both cased and open portions therealong. The string 12 includes a plurality of operative devices 16a-16d (collectively referred to as the "operative devices 16"). The operative devices 16 share in common that they protrude from, at least partially form, are disposed at, or are otherwise in communication with an external surface 18 of the string 12. The external surface 18 is a radially outer circumferential surface in Figure 1, but could alternatively be any other external surface, regardless of whether it is outwardly or inwardly facing.

[0011] When the operative devices 16 are located at an external surface, e.g., the external surface 18, the operative devices are exposed to contact with radially disposed tubulars (e.g., liners, casing, etc.), borehole walls (e.g., open sections of the borehole 14), fluids (e.g., downhole fluids in an annulus formed between the tubular string 12 and the borehole 14), etc., all of which may damage or negatively impact performance. Accordingly, the cover 20 could, e.g., provide sufficiently high hardness, e.g., readable on the Rockwell B scale or harder, yield strength, e.g., above about 200 MPa, etc., in order to protect against abrasion, shear stresses, and/or to prevent the accumulation of materials in or about the operative device, e.g., by filling any openings or voids in, through, or about the operative devices 16, etc.

[0012] In another embodiment, as opposed to the string 12, the operative devices 16 could be included on any other movable or runnable tubular, or a permanently installed or immovable member that is located adjacent to a movable or runnable component. The operative devices 16, even when installed in an immovable component, can be damaged by exposure to or contact with any of the aforementioned entities e.g., during run-in of the string 12, run-in of a radially disposed tubular, relative movement of the operative device with some other member, etc.

[0013] The operative devices 16 could be any device operable downhole, such as sensors (distributed or otherwise), probes, fibers, wires, screens, cables, seals, packers, etc. and could be arranged for measuring (e.g., strain, acoustics vibration, pressure, temperature, etc.), filtering, sealing, isolating, communicating, etc. For example, the operative device 16a is disposed axially with or circumferentially about the tubular string 12 and could be, for example, a mesh, wire wrap, foam, shape memory, bead pack, slotted liner, or other type of screen or filter, e.g., for enabling production of hydrocarbons while screening particulates. The operative device 16b could be, for example, optical fiber for monitoring conditions in the tubular string 12, the operative device 16a, etc., for enabling communication with the foregoing, etc. The operative device 16b could include portions both internal to the string 12 (e.g., where it is in communication with the external surface 18 due to openings in the device 16a or some a screen), and external to the string 12, as shown. The operative devices 16c and 16d could be, for example, sensors recessed into the external surface 18 and protruding therefrom, respectively, e.g., for measuring acoustics, strain, temperature, vibration, or some other borehole condition or parameter. Again, these are given as examples only of various operative devices that could experience damage or deterioration of performance due to their placement at an external surface. For example, the operative devices 16 could become clogged or blocked so that they can not filter, measure, monitor, sense, etc., or subjected to high stress or strain, resulting in deformation, breakage, damage, etc., either of which would disadvantageously affect performance of the devices 16.

[0014] Radial or circumferential external surfaces of the operative devices 16 are each provided with a protective cover 20. The covers 20 could be, e.g., films, layers, laminae, coatings, plates, sleeves, sheets, tubes, etc. that are placed over the operative devices 16. For example, in the embodiment of Figure 2A, the covers 20 are formed by winding one or more strips 20a (e.g., helically, circumferentially, etc.) about the operative device 16, a portion thereof, the tubular to which the device 16 is secured, etc. In another embodiment, shown in Figure 2B, a thin sheet 20b is disposed over the operative device 16. Further

embodiments are described below with respect to Figure 3. According to any embodiment, a purpose of the covers 20 is to block, cover, and generally protect the operative devices 16, e.g., from contact with or exposure to some potentially damaging entity. For example, the covers 20 could protect delicate sensors positioned at an external surface of a string from colliding with radially adjacent tubulars or other members during run-in. While inclusion of the covers 20 initially prevents the operative devices 16 from functioning, the covers 20 are advantageously made from a material that is chemically reactive with a downhole fluid such that after initial protection of the operative devices 16 (e.g., during run-in of a tubular string) the covers 20 can be removed for enabling the operative devices 16 to perform their designated functions. "Chemically reactive" is intended to mean that the covers 20 are dissolvable, corrodible, consumable, disintegrateable, etc. or otherwise undergo a chemical reaction, e.g., dissociation, synthesis, etc., for forming new chemical products with the fluid, breaking the material down into base components (e.g., particles, ions, molecules, etc.), etc. For example, the covers 20 could be made from magnesium, aluminum, controlled electrolytic metallic materials (described in more detail below), etc. and be removed upon exposure to one or more fluids available or deliverable downhole, such as water, brine, acid, oil, etc.

[0015] Figure 3 is schematically used for generically describing a variety of alternate embodiments for providing the cover 20 for protecting a generic member 22. That is, in the embodiment of Figure 3, the cover 20 is formed by filling openings, pores, interstices, gaps, windows, spaces, cavities, etc. (generally, the "openings 24") located between elements 26 of the member 22 with a removable material 28 at an external surface 30 of the member 22. In one embodiment, the openings 24 are cavities, gaps, or open spaces formed about the elements 26, which take the form of sensors or probes that are located at the external surface 30 of the member 22. Other arrangements of sensors and other devices (e.g., resembling the operative devices 16c or 16d) could be similarly protected. In one embodiment the member 22 is a foam filter or screen, the openings 24 are pores located between microspheres or cellular walls, represented by the elements 26, and the material 28 of the cover 20 is formed by powder, particulate, grit, etc. that is smeared, rubbed, spread, impregnated, inserted, installed, or otherwise formed in or applied to the external surface 30 of the member 22. In one embodiment the material 28 is a controlled electrolytic metallic powder, as described in more detail below. The openings in other screens, filters, etc. (e.g., resembling the device 16a) could be similarly "pre-clogged" in this way. In another example, the foregoing is assumed and an optical fiber is disposed within the screen and protected by the cover 20. In

another embodiment, the elements 26 represent a bundle of fibers in cross-section, and the openings 24 represent the open space between the fibers and the member 22 at the external surface 30. Other wires, cables, conduits, fibers, etc. (e.g., resembling the operative device 16b) in other embodiments could be similarly protected.

[0016] Materials appropriate for the purpose of protective covers 20 include controlled electrolytic metallic materials. The controlled electrolytic materials as described herein are lightweight, high-strength metallic materials. Examples of suitable materials and their methods of manufacture are given in United States Patent Publication No. 2011/0135953 (Xu, et al.), which Patent Publication is hereby incorporated by reference in its entirety. These lightweight, high-strength and selectably and controllably removable materials include fully-dense, sintered powder compacts formed from coated powder materials that include various lightweight particle cores and core materials having various single layer and multilayer nanoscale coatings. These powder compacts are made from coated metallic powders that include various electrochemically-active (e.g., having relatively higher standard oxidation potentials) lightweight, high-strength particle cores and core materials, such as electrochemically active metals, that are dispersed within a cellular nanomatrix formed from the various nanoscale metallic coating layers of metallic coating materials, and are particularly useful in borehole applications. Suitable core materials include electrochemically active metals having a standard oxidation potential greater than or equal to that of Zn, including as Mg, Al, Mn or Zn or alloys or combinations thereof. For example, tertiary Mg-Al-X alloys may include, by weight, up to about 85% Mg, up to about 15% Al and up to about 5% X, where X is another material. The core material may also include a rare earth element such as Sc, Y, La, Ce, Pr, Nd or Er, or a combination of rare earth elements. In other embodiments, the materials could include other metals having a standard oxidation potential less than that of Zn. Also, suitable non-metallic materials include ceramics, glasses (e.g., hollow glass microspheres), carbon, or a combination thereof. In one embodiment, the material has a substantially uniform average thickness between dispersed particles of about 50nm to about 5000nm. In one embodiment, the coating layers are formed from Al, Ni, W or Al_2O_3, or combinations thereof. In one embodiment, the coating is a multi-layer coating, for example, comprising a first Al layer, an Al_2O_3 layer, and a second Al layer. In some embodiments, the coating may have a thickness of about 25nm to about 2500nm.

[0017] These powder compacts (or the physical structures constructed or manufactured therefrom) provide a unique and advantageous combination of mechanical strength properties, such as compression and shear strength, low density and selectable and

controllable corrosion properties, particularly rapid and controlled dissolution in various borehole fluids. The fluids may include any number of ionic fluids or highly polar fluids, such as those that contain various chlorides. Examples include fluids comprising potassium chloride (KCl), hydrochloric acid (HCl), calcium chloride ($CaCl_2$), calcium bromide ($CaBr_2$) or zinc bromide ($ZnBr_2$). For example, the particle core and coating layers of these powders may be selected to provide sintered powder compacts suitable for use as high strength engineered materials having a compressive strength and shear strength comparable to various other engineered materials, including carbon, stainless and alloy steels, but which also have a low density comparable to various polymers, elastomers, low-density porous ceramics and composite materials.

[0018] In addition to high strength for protecting the operative devices 16, controlled electrolytic metallic materials are readily tailorable or conditionable for setting a rate of removal of the covers 20. That is, the duration of desired protection can be set by altering the reactivity of the controlled electrolytic materials, e.g., changing the materials and/or proportions of materials used, such that the cover 20 is removed by the downhole fluid to enable the operative devices 16 to function properly at an appropriate time. If non-tailorable materials are used (e.g., materials other than controlled electrolytic metallic materials), then the duration of protection can be controlled instead by setting the thickness of the covers 20 with respect to a predicted rate of removal of the cover 20 in response to the downhole fluids (of course, the thickness of controlled electrolytic materials can also be set for assisting in control of the rate of removal thereof). For example, if it is known that the running-in of a string including an operative device thereon will take an hour (of course, other periods of time could be necessary in actual use), the thickness and/or reactivity of the covers 20 can be modified (e.g., by setting the thickness, by tailoring the composition of a controlled electrolytic metallic material, etc.) in order to ensure that the cover 20 is in place (and suitably robust to offer protection) for at least the one hour period of time in which it will take the string to run, and after which is chemically removed for enabling the operative device to function.

[0019] 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

What is claimed is:

1. A system for providing temporary protection, comprising:

an operative device located at an external surface of a member; and

a cover externally disposed with respect to the operative device for initially protecting the operative device, the cover chemically reactive to a downhole fluid for removal of the protective cover.

2. The system of claim 1, wherein the cover is formed as a layer, coating, film, sleeve, plate, sheet, wound strip, or combinations including at least one of the foregoing.

3. The system of claim 1, wherein the operative device is arranged for sensing or monitoring at least one downhole condition or parameter.

4. The system of claim 1, wherein the operative device is radially recessed into the member at the external surface.

5. The system of claim 1, wherein the operative device is radially protruding from the external surface.

6. The system of claim 1, wherein the operative device is part of the member and forms the external surface.

7. The system of claim 1, wherein the operative device is a fiber, wire, cable, conduit, or combinations including at least one of the foregoing.

8. The system of claim 1, wherein the cover is disposed within at least one opening in communication with the external surface and the operative device.

9. The system of claim 8, wherein the cover comprises a powder positioned in the at least one opening.

10. The system of claim 9, wherein the operative device is at least one sensor and the at least one opening is open space formed between the at least one sensor and the member at the external surface.

11. The system of claim 9, wherein the operative device is a screen and the opening is provided therein for enabling the passage of fluids therethrough.

12. The system of claim 11, wherein the screen is a foam filter and the at least one opening is at least one pore in the foam filter, the powder pre-clogging the at least one pore at the external surface.

13. The system of claim 1, wherein the cover comprises controlled electrolytic metallic material.

14. A method of temporarily protecting an operative device comprising:

causing relative movement between a first member and a second member radially disposed therewith, the first member including an operative device located at an external surface thereof, the operative device arranged with a protective cover;

exposing the protective cover to a downhole fluid; and

removing the protective cover as the result of a chemical reaction between the downhole fluid and the protective cover.

15. The method of claim 14, wherein the operative device is arranged for sensing or monitoring a condition or parameter.

16. The method of claim 14, wherein the protective cover is formed as a powder located in at least one opening in communication with the external surface and the operative device.

17. The method of claim 14, wherein the first member is part of a tubular string.

18. The method of claim 17, wherein causing relative movement includes running the tubular string.

19. The method of claim 14, wherein the protective cover comprises controlled electrolytic metallic material.

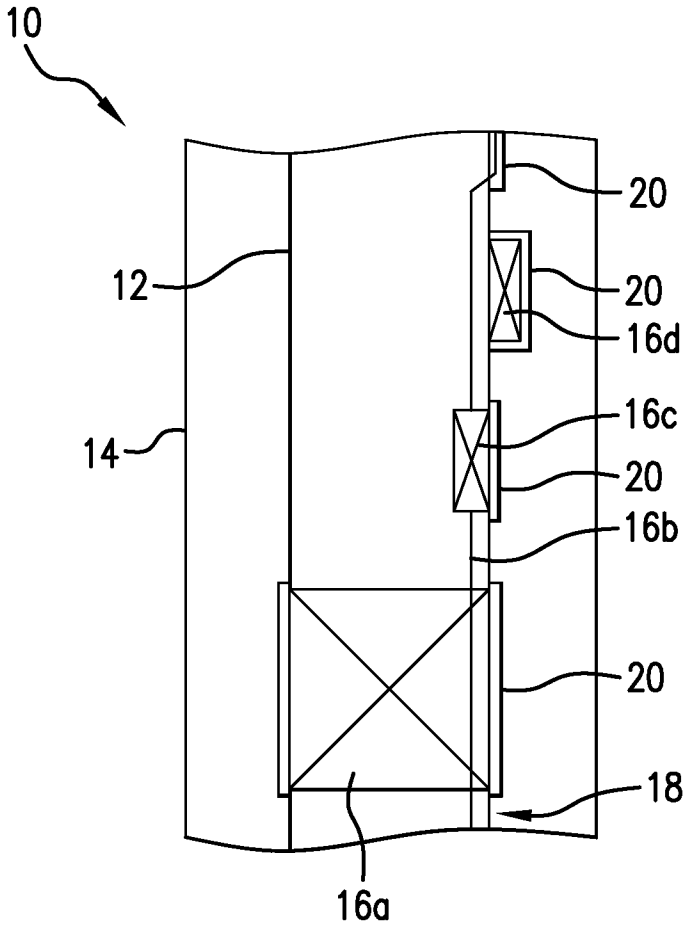

FIG.1

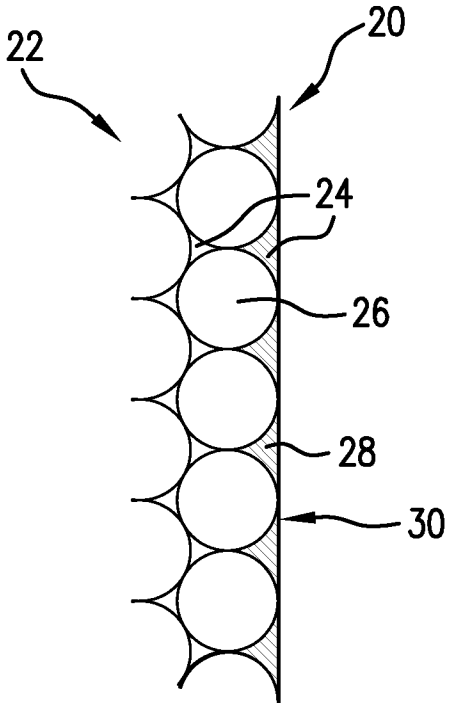

FIG.3

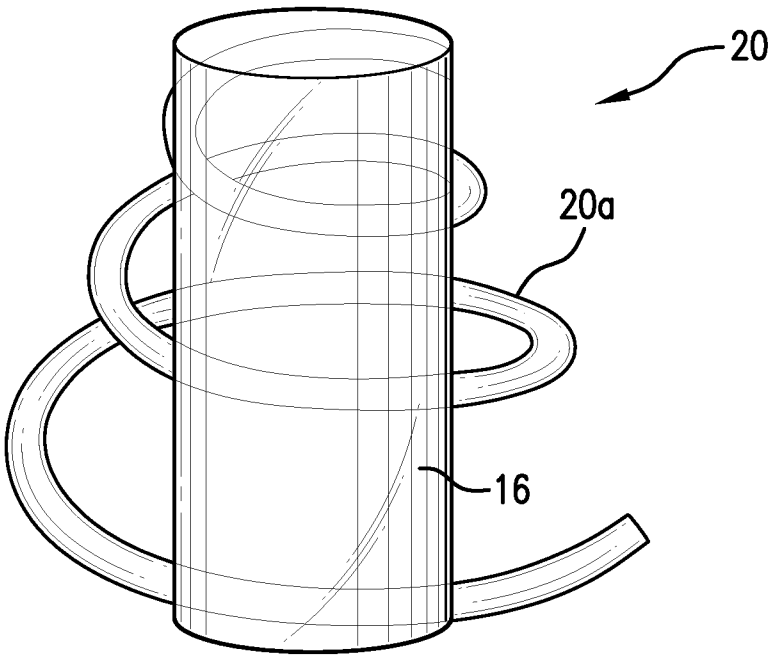

FIG.2A

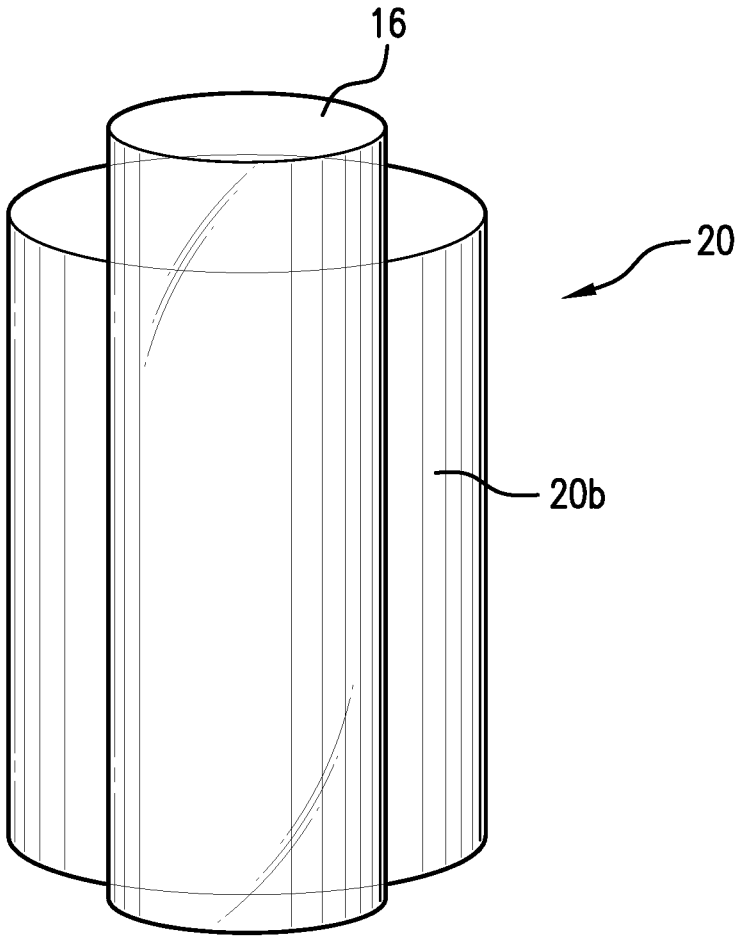

FIG.2B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2012/071742

A. CLASSIFICATION OF SUBJECT MATTER

E21B 21/01(2006.01)i, E21B 33/03(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)

IPC: E21B 21/01; E21B 47/06; E21B 33/12; E21B 19/00; E21B 43/10; E21B 23/00; E21B 17/00

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: downhole tool, operative device, cover, layer, downhole fluid, chemically reactive, and dissolve

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 2008-0099209 A1 (LORETZ, IVES et al.) 01 May 2008 See paragraphs [0015], [0018]-[0022], [0024] and figures 1-3.	1-7,13-15,17-19 8-12,16
Y	US 5310000 A (ARTERBURY, BRYANT A. et al.) 10 May 1994 See column 7, lines 32-60 and figure 10.	8-12,16
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A	US 2004-0055758 A1 (BREZINSKI, MICHAEL M. et al.) 25 March 2004 See paragraph [0075] and figure 11.	1-19

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

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"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
17 April 2013 (17.04.2013)	**22 April 2013 (22.04.2013)**

Name and mailing address of the ISA/KR

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Facsimile No. 82-42-472-7140

Authorized officer

LEE, Jong Kyung

Telephone No. 82-42-481-3360

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

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