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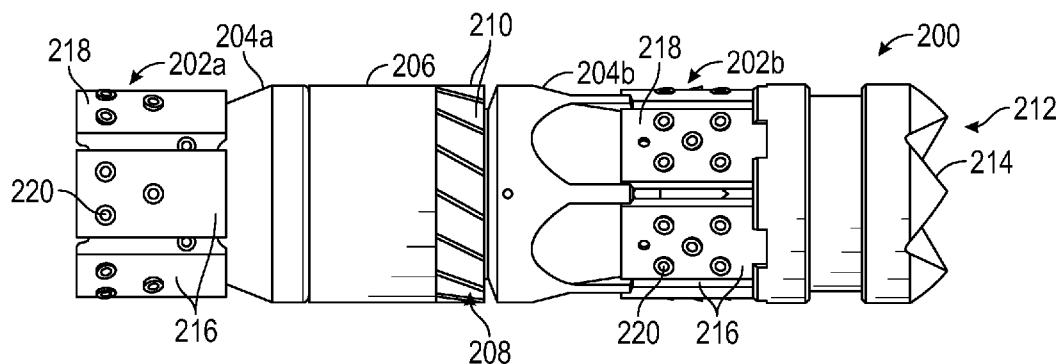


FIG. 2

(57) Abstract: A button includes a body including a void. The void pierces the body completely therethrough, and the body is made of a moldable material.

PATENT APPLICATION

VOIDED MOLDABLE BUTTONS

CROSS-REFERENCE TO RELATED APPLICATION

[0001] The present document is based on and claims priority to US Provisional Application Serial No.: 62/829,208, filed April 4, 2019, which is incorporated herein by reference in its entirety.

BACKGROUND

[0002] In a variety of well fracturing applications, a wellbore is initially drilled and cased. A frac plug is then pumped down and actuated to form a seal with the surrounding casing. Once the casing is perforated, the frac plug is used to prevent fracturing fluid from flowing farther downhole, thus forcing the fracturing fluid out through the perforations and into the surrounding formation. In some applications, multiple frac plugs may be deployed to enable fracturing at different well zones. Each frac plug includes a sealing element, which is deformed into sealing engagement with the surrounding casing. The frac plug also includes one or more slip assemblies having a plurality of slips. The slips may include buttons, which are used to anchor the frac plug in the casing. To ensure sealing and sufficient anchoring with the casing, the frac plug tends to be formed with relatively precise and expensive components. In addition to the expense, the construction of such a frac plug also can lead to difficulties associated with milling out the frac plug after completion of the fracturing operation.

SUMMARY

[0003] According to one or more embodiments of the present disclosure, a button includes a body comprising a void, wherein the void pierces the body completely therethrough, and wherein the body is made of a moldable material.

[0004] According to one or more embodiments of the present disclosure, a method includes deploying a downhole tool into a cased wellbore, and anchoring the downhole tool to the cased wellbore, wherein the downhole tool includes: a plurality of slips, each slip of the plurality of slips including: a slip body; and at least one button disposed in the slip body, wherein the at least one button includes: a body including a void, wherein the void pierces the body completely therethrough, and wherein the body of the at least one button is made of a moldable material.

[0005] According to one or more embodiments of the present disclosure, a method of manufacturing a button includes using a mold to form a body including a void, wherein the void pierces the body completely therethrough.

[0006] However, many modifications are possible without materially departing from the teachings of this disclosure. Accordingly, such modifications are intended to be included within the scope of this disclosure as defined in the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Certain embodiments of the disclosure will hereafter be described with reference to the accompanying drawings, wherein like reference numerals denote like elements. It should be understood, however, that the accompanying figures illustrate the various implementations described herein and are not meant to limit the scope of various technologies described herein, and:

[0008] FIG. 1 is a schematic illustration of an example of a downhole tool deployed in a wellbore according to one or more embodiments of the present disclosure;

[0009] FIG. 2 is a perspective view of a frac plug having voided moldable buttons according to one or more embodiments of the present disclosure;

[0010] FIG. 3 is the frac plug of FIG. 2 set in casing according to one or more embodiments of the present disclosure;

[0011] FIG. 4(a) is a perspective view of a voided moldable button according to one or more embodiments of the present disclosure;

[0012] FIG. 4(b) is a top view of a voided moldable button according to one or more embodiments of the present disclosure;

[0013] FIG. 5(a) is a perspective view of a solid button; and

[0014] FIG. 5(b) is a top view of a solid button.

DETAILED DESCRIPTION

[0015] In the following description, numerous details are set forth to provide an understanding of some embodiments of the present disclosure. However, it will be understood by those of ordinary skill in the art that the apparatus and/or method may be practiced without these details and that numerous variations or modifications from the described embodiments may be possible.

[0016] In the specification and appended claims: the terms “up” and “down,” “upper” and “lower,” “upwardly” and “downwardly,” “upstream” and “downstream,” “uphole” and “downhole,” “above” and “below,” and other like terms indicating relative positions above or below a given point or element are used in this description to more clearly describe some embodiments of the disclosure.

[0017] The present disclosure generally relates to an apparatus and method for facilitating a fracturing operation. Specifically, one or more embodiments of the present disclosure are directed to voided buttons made out of a moldable material, such as a powder metal material or a ceramic material, for use in a downhole tool during a fracturing operation. Because the voided button is made out of a moldable material, no machining of the button is required, which provides a significant cost savings. Moreover, the voided button exhibits improved performance during drill out.

[0018] Referring generally to FIG. 1, an embodiment of a downhole tool 20 is illustrated deployed in a well 21. According to one or more embodiments of the present disclosure, the

downhole tool 20 is a frac plug. For example, the frac plug 20 may be deployed in a wellbore 22 to facilitate a fracturing operation. In the example illustrated, the frac plug 20 is deployed in the wellbore 22 so as to isolate a zone of the wellbore 22 so that fracturing fluid 24 may be directed through perforations 26 and into a surrounding formation 28 uphole of the frac plug 20 for fracturing of the surrounding formation 28. It should be noted that the frac plug 20 according to one or more embodiments of the present disclosure may be used in many types of wellbores, such as deviated, e.g., horizontal, wellbores to facilitate fracturing of desired well zones along the horizontal or otherwise deviated wellbore.

[0019] Still referring to FIG. 1, the wellbore 22 may be lined with a casing 30, and each frac plug 20 may be actuated to grip into and seal against the casing 30, thereby sealing or substantially restricting flow of the fracturing fluid 24 downhole of the frac plug 20 in the wellbore 22. As a result, during a fracturing operation, the fracturing fluid 24 is directed through the perforations 26 into the surrounding formation 28 while the frac plug 20 remains anchored to the casing 30. Once the fracturing operation is completed and a given frac plug 20 is no longer of use, the frac plug may be milled and removed from the wellbore 22.

[0020] Referring now to FIG. 2, a perspective view of a frac plug having voided moldable buttons according to one or more embodiments of the present disclosure is shown. Specifically, FIG. 2 shows the frac plug 200 in an unset position. Referring also to FIG. 3, the frac plug 200 of FIG. 2 is shown set in the casing 30. According to one or more embodiments, the frac plug 200 may include a mandrel (not shown) and at least upper and lower slip assemblies 202a, 202b, upper and lower cones 204a, 204b, a sealing element 206, and at least one barrier ring 208 disposed around the mandrel. In one or more embodiments, the at least one barrier ring 208 is disposed adjacent the sealing element 206, and the at least one barrier ring 208 may include a plurality of flanges 210, which may radially expand against an inner wall of the casing 30 and create a circumferential barrier to keep the sealing element 206 from extruding. The frac plug 200 may also include a bottom sub 212 having a chamfered end 214 according to one or more embodiments.

[0021] Still referring to FIGS. 2-3, the upper and lower slip assemblies 202a, 202b of the frac plug 200 may include a plurality of slips 216. Further, each slip 216 may include a slip

body 218 and at least one voided button 220 disposed in the slip body 218. The voided button 220 is further described below with reference to FIGS. 4a and 4b.

[0022] When the frac plug 200 transitions from the run-in-hole unset position of FIG. 2 to the set position of FIG. 3, the upper slip assembly 202a ramps down the upper cone 204a, and the lower slip assembly 202b ramps up the lower cone 204b, causing the upper and lower slip assemblies 202a, 202b to radially expand. The radial expansion of the upper and lower slip assemblies 202a, 202b causes the at least one voided button 220 disposed in the slip body 218 of a given slip 216 to grip and bite into the inner diameter of the casing 30. Further, when the frac plug 200 is in the set position, the sealing element 206 is deformed into sealing engagement with the surrounding casing 30. According to one or more embodiments of the present disclosure, the sealing element 206 may be formed of an elastomeric material or metal material, which is deformed in a radially outward direction until forming a permanent seal with the inside surface of the casing 30. Due to the gripping and biting of the at least one voided button 220 and the sealing of the sealing element 206, the frac plug 200 is able to be effectively anchored to the inside surface of the casing 30 when the frac plug 200 is in the set position. The frac plug 200 may remain anchored to the inside surface of the casing 30 during a fracturing operation, and after the fracturing operation, the frac plug 200 may be drilled out, as previously described.

[0023] Referring now to FIGS. 4(a) and 4(b), perspective and top views of a voided button 220 according to one or more embodiments of the present disclosure are shown, respectively. As shown, the voided button 220 includes a body 222, which may be cylindrical, for example, and a void 224 that pierces the body 222 completely therethrough. Although the body 222 is shown as being cylindrical in FIG. 4(a), other shapes and configurations of the body 222 are feasible and are within the scope of the present disclosure. As also shown in FIG. 4(b), the void 224 pierces the body 222 through a flat surface of the body 222, according to one or more embodiments of the present disclosure.

[0024] Still referring to FIGS. 4(a) and 4(b), the body 222 of the voided button 220 is made out of a moldable material according to one or more embodiments of the present disclosure. In one or more embodiments, the moldable material may be a powder metal material or a ceramic material, for example. That is, according to one or more embodiments of the present

disclosure, the void 224 is not machined into the body 222 to create the voided button 220. Instead, the voided button 220 is manufactured using powder metal or ceramic during a molding process with the void 220 already present in the mold. Stated another way, powder metal (or ceramic) molding can produce the button in its current form, including voids, without the need for machining. Further, powder metal and ceramic materials have a requisite hardness such that the resulting voided button 220 is sufficiently hard enough to grip and bite the inside surface of the casing 30 when the frac plug 200 is in the set position.

[0025] Due to the affordability of powder metal and the potential to eliminate machine work, the powder metal molding process as previously described may reduce the cost of the voided button 220 by up to 90%. There are commercially available powdered metals, which have low elongation, but comparable tensile strength to 8620 steel. As appreciated by those having ordinary skill in the art, low elongation generally indicates that a material will fracture and mill more easily.

[0026] In other embodiments, 3D printing or additive manufacturing are other manufacturing methods that could be used to manufacture the voided button 220.

[0027] Still referring to FIGS. 4(a) and 4(b), the void 224 facilitates drill out of the voided button 220 and the frac plug 200 after a fracturing operation, for example. That is, the voided buttons 220 according to one or more embodiments of the present disclosure exhibit significantly improved performance during drill out over the solid and un-voided prior art button 500 shown in FIGS. 5(a) and 5(b), for example. In particular, the void 224 allows the voided button 220 to drill out faster and into smaller pieces than the solid and un-voided prior art button 500. As appreciated by those having ordinary skill in the art, the ability to drill out a frac plug quickly is an extremely critical aspect of frac plug performance. The addition of voids 224 to the buttons 220, according to one or more embodiments of the present disclosure, make the voided buttons 220 easier to chip away at while still anchoring the frac plug 200 in place during the fracturing operation.

[0028] Moreover, the synergy of combining a button molded out of powdered metal (or ceramic) with a void completely piercing the body of the button therethrough, according to one or more embodiments of the present disclosure, achieves superior results and exhibits an unmistakable improvement in average fracture size during impact testing over the solid and un-voided prior art button of FIGS. 5(a) and 5(b), for example.

[0029] Although a few embodiments of the disclosure have been described in detail above, those of ordinary skill in the art will readily appreciate that many modifications are possible without materially departing from the teachings of this disclosure. Accordingly, such modifications are intended to be included within the scope of this disclosure as defined in the claims.

CLAIMS

What is claimed is:

1. A button comprising:
a body comprising a void,
wherein the void pierces the body completely therethrough, and
wherein the body is made of a moldable material.
2. The button of claim 1, wherein the moldable material is a powder metal material.
3. The button of claim 1, wherein the moldable material is a ceramic material.
4. The button of claim 1, wherein the void pierces the body through a flat surface of the body.
5. The button of claim 2, wherein the void pierces the body through a flat surface of the body.
6. A downhole tool comprising:
a slip body; and
at least one button of claim 1 disposed in the slip body.
7. The downhole tool of 6, further comprising:
at least one slip assembly comprising a plurality of slips, each slip of the plurality of slips comprising the slip body.
8. The downhole tool of claim 7, further comprising a sealing element.
9. The downhole tool of claim 8, wherein the downhole tool is a frac plug.
10. A downhole tool comprising:
a slip body; and
at least one button of claim 2 disposed in the slip body.
11. The downhole tool of claim 10, further comprising:

- at least one slip assembly comprising a plurality of slips, each slip of the plurality of slips comprising the slip body.
12. The downhole tool of claim 11, further comprising a sealing element.
13. The downhole tool of claim 12, wherein the downhole tool is a frac plug.
14. A method comprising:
- deploying a downhole tool into a cased wellbore; and
 - anchoring the downhole tool to the cased wellbore,
- wherein the downhole tool comprises:
- a plurality of slips, each slip of the plurality of slips comprising:
 - a slip body; and
 - at least one button disposed in the slip body,
 - wherein the at least one button comprises:
 - a body comprising a void,
 - wherein the void pierces the body completely therethrough, and
 - wherein the body of the at least one button is made of a moldable material.
15. The method of claim 14, wherein the moldable material is a powder metal material.
16. The method of claim 14, further comprising:
- initiating a fracturing operation after the anchoring step; and
 - drilling out the downhole tool after the fracturing operation.
17. The method of claim 15, further comprising:
- initiating a fracturing operation after the anchoring step; and
 - drilling out the downhole tool after the fracturing operation.
18. A method of manufacturing a button comprising:
- using a mold to form a body comprising a void,
 - wherein the void pierces the body completely therethrough.
19. The method of claim 18, wherein the body is made of a powder metal material.
20. The method of claim 18, wherein the body is made of a ceramic material.

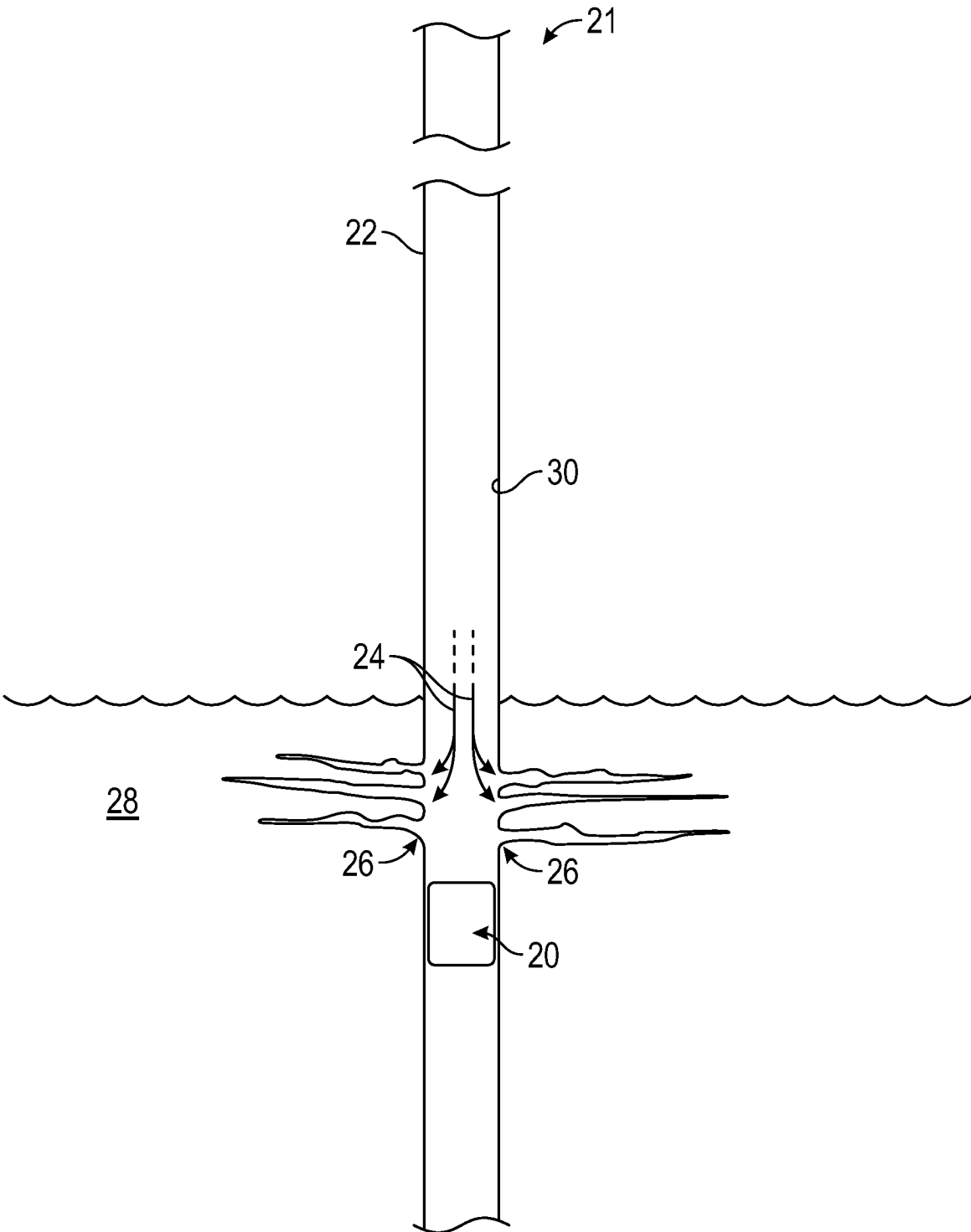


FIG. 1

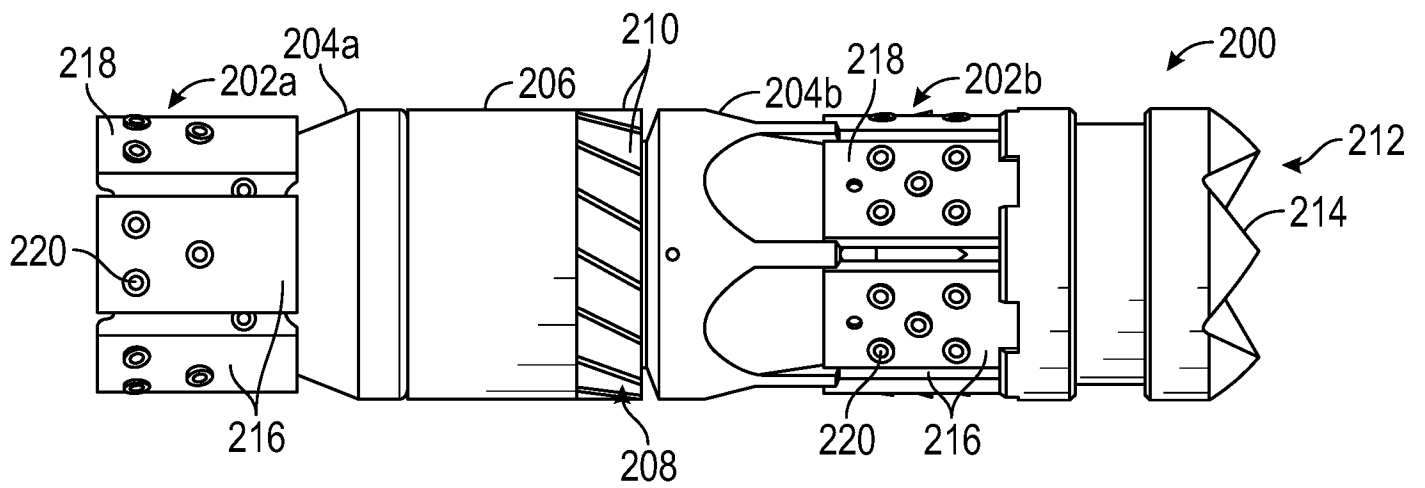


FIG. 2

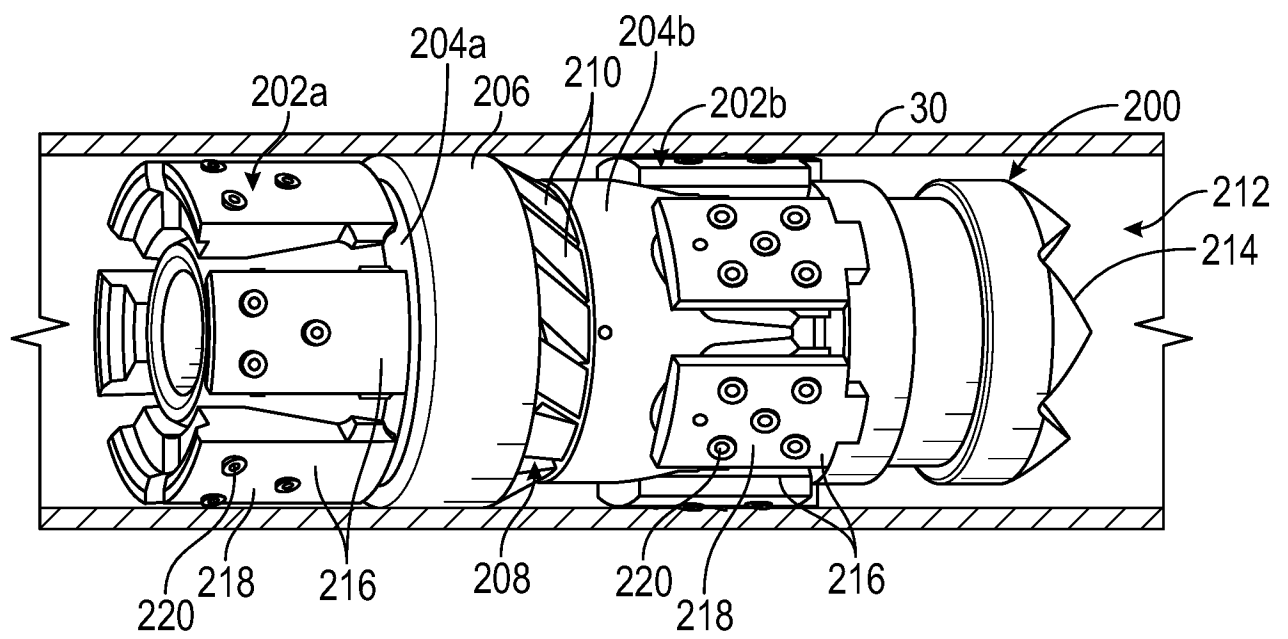


FIG. 3

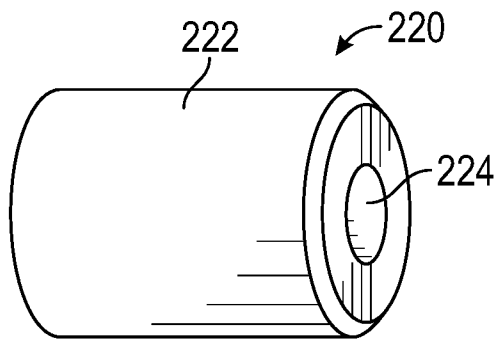


FIG. 4A

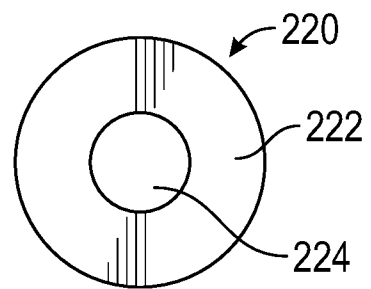


FIG. 4B

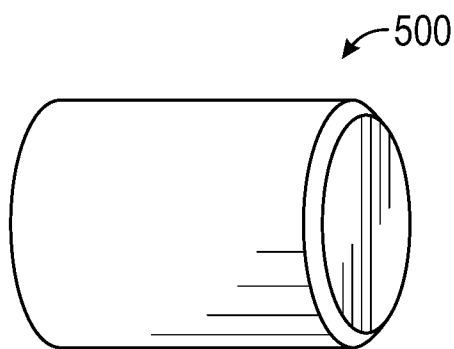


FIG. 5A
Prior Art

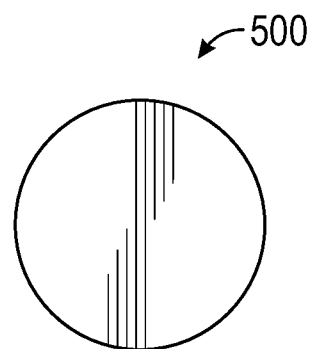


FIG. 5B
Prior Art

A. CLASSIFICATION OF SUBJECT MATTER**E21B 33/12(2006.01)i, E21B 43/26(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 33/12; E21B 17/046; E21B 19/18; E21B 23/01; E21B 23/06; E21B 33/128; E21B 33/129; E21B 33/134; E21B 34/06; E21B 43/26

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: button, void, body, moldable, ceramic, slip

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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A	US 2016-0290096 A1 (SCHLUMBERGER TECHNOLOGY CORPORATION) 06 October 2016 paragraphs [0018]–[0031]; and figures 1–7	1–20
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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

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Name and mailing address of the ISA/KR

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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