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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
29 August 2019 (29.08.2019)

WIPO | PCT

(10) International Publication Number
WO 2019/164607 A1

(51) International Patent Classification:
E21B 41/00 (2006.01) *E21B 17/00* (2006.01)

(21) International Application Number:
PCT/US2019/014150

(22) International Filing Date:
18 January 2019 (18.01.2019)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
15/902,768 22 February 2018 (22.02.2018) 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).

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))*

(54) Title: ADDITIVELY MANUFACTURED DOWNHOLE COMPONENT INCLUDING FRACTAL GEOMETRY

(57) Abstract: A resource exploration and recovery component including a fractal geometry.

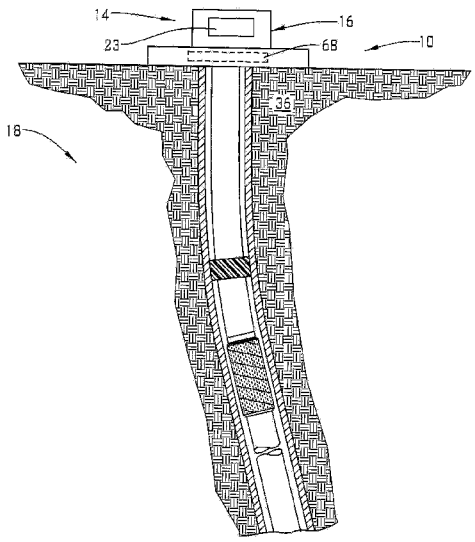


FIG. 1

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ADDITIVELY MANUFACTURED DOWNHOLE COMPONENT INCLUDING FRACTAL GEOMETRY

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Application No. 15/902768, filed on February 22, 2018, which is incorporated herein by reference in its entirety.

BACKGROUND

[0002] In the resource exploration and recovery industry, various components are used to guide fluids along a selected flow path. Backup rings may be employed to guide to support a packer during deployment, and screens may be employed to guide and filter fluid flowing into a tubular. Downhole operations are often performed in harsh operating conditions such as high pressures and high temperatures. It is desirable that components such as backup rings and screens be capable of withstanding such harsh conditions.

[0003] In certain conditions, expansion of a backup ring may be limited by downhole conditions. Screen components may become clogged. Existing backup ring geometry limits a rate and degree of expansion. Similarly, existing screen manufacturing techniques are limited in how screen openings may be formed. Accordingly, the art would appreciate downhole components that are capable of withstanding harsh operating conditions for prolonged periods.

SUMMARY

[0004] Disclosed is a resource exploration and recovery component including a fractal geometry.

[0005] Also disclosed is a resource exploration and recovery system including a first system and a second system fluidically connected to the first system. The second system includes a tubular. A tool is supported by the tubular. The tool includes a fractal geometry.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] The following descriptions should not be considered limiting in any way. With reference to the accompanying drawings, like elements are numbered alike:

[0007] FIG. 1 depicts a resource exploration and recovery system including component having a fractal geometry, in accordance with an aspect of an exemplary embodiment;

[0008] FIG. 2 depicts the component of FIG. 1 in the form of a backup ring, in accordance with an aspect of an exemplary embodiment; and

[0009] FIG. 3 depicts the component of FIG. 1 in the form of sand screen assembly including a fractal geometry, in accordance with an aspect of an exemplary embodiment.

DETAILED DESCRIPTION

[0010] 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.

[0011] A resource exploration and recovery system, in accordance with an exemplary embodiment, is indicated generally at 10, in FIG. 1. Resource exploration and recovery system 10 should be understood to include well drilling operations, resource extraction and recovery, CO_2 sequestration, and the like. Resource exploration and recovery system 10 may include a first system 14 which, in some environments, may take the form of a surface system 16 operatively and fluidically connected to a second system 18 which, in some environments, may take the form of a downhole system. First system 14 may include a control system 23 that may provide power to, monitor, communicate with, and/or activate one or more downhole operations. First system 14 may also include additional systems such as pumps, fluid storage systems, cranes and the like (not shown).

[0012] Second system 18 may include a tubular string 30 formed from a plurality of tubulars, one of which is indicated at 32 that is extended into a wellbore 34 formed in formation 36. Wellbore 34 includes an annular wall 38 which may be defined by a surface of formation 36, or, in the embodiment shown, by a casing tubular 40. Tubular string 30 is shown to support a packer 44 that is supported by a first component or backup ring 46 and a second component or backup ring 48. Tubular string 30 is also shown to support a screen assembly 60.

[0013] Reference will now follow to FIG. 2 in describing first backup ring 46 with an understanding that second backup ring 48 may include similar structure. Backup ring 46 includes a body 70 that defines a fractal geometry 78. Body 70 may be formed using additive manufacturing techniques and includes an outer surface 82 and an inner surface 84 defining a thickness (not separately labeled). A plurality of voids 86 extend through outer surface 82 and inner surface 84. Plurality of voids 86 reduce an overall amount of material required to form backup ring 46 yet maintain a selected structural integrity of body 70.

[0014] Body 70 may be defined by a material that is deposited and hardened/sintered/fused into the fractal geometry. The material may take on a variety of forms including high strength materials such as Stainless Steel 316L, Titanium Ti64, Nickel Alloy IN625 as well as materials such as CarbonMide® and EOS PEEK HP3 and the like. It should be understood that other materials may be used. Further, it should be understood that each of the plurality of fused layers 73 may be formed from the same material, or composites of more than one material. Still further, one or more of the plurality of fused layers 73 may be formed from different materials.

[0015] Reference will now follow to FIG. 3 in describing sand screen assembly 60 in accordance with an aspect of an exemplary embodiment. Sand screen assembly 60 is formed from a plurality of layers 106 including a first layer 110, a second layer 112 and a third layer 114. It should be understood that the arrangement shown is exemplary, the number and arrangement of layers may vary. Each of the first, second, and third layers may be formed from additive manufacturing techniques. First layer 110 includes a first fractal geometry 118, second layer 116 includes a second fractal geometry 120 and third layer 114 includes a third fractal geometry 122. In the exemplary aspect shown, each of the first, second, and third fractal geometries 118, 120, and 122 takes the form of a Sierpenski Carpet. However, it should be understood that other fractal geometries are contemplated including, but not limited to, Sierpenski Triangles and Appolonian Gaskets.

[0016] In accordance with an aspect of an exemplary embodiment, first fractal geometry 118 defines a first plurality of voids or openings 128, second fractal geometry 120 defines a second plurality of voids or openings 129 and third fractal geometry 122 defines a third plurality of voids or openings 130. Each of the first layer 110, second layer 112 and third layer 114 is offset relative to another of the first, second and third layers 110, 112, and 114 such that openings having similar sizes are not aligned with one another. In this manner, first, second and third layers 110, 112, and 114 may be formed into screen assembly 60 and employed downhole to filter out less desirable constituents of formation fluids passing into system of tubulars 30.

[0017] Set forth below are some embodiments of the foregoing disclosure:

[0018] Embodiment 1: A resource exploration and recovery component including a fractal geometry.

[0019] Embodiment 2: The resource exploration and recovery component according to any prior embodiment, wherein the resource exploration and recovery tool is a backup ring.

[0020] Embodiment 3: The resource exploration and recovery component according to any prior embodiment, wherein the backup ring includes an outer surface and an inner surface, one or more voids are formed in the backup ring extending through the outer surface and the inner surface.

[0021] Embodiment 4: The resource exploration and recovery component according to any prior embodiment, wherein the resource exploration and recovery component is additively manufactured.

[0022] Embodiment 5: The resource exploration and recovery component according to any prior embodiment, wherein the resource exploration and recovery component comprises a sand screen, the fractal geometry defining openings in the sand screen.

[0023] Embodiment 6: A resource exploration and recovery system including a first system, a second system fluidically connected to the first system, the second system including a tubular, and a tool supported by the tubular, the tool including a fractal geometry.

[0024] Embodiment 7: The resource exploration and recovery system according to any prior embodiment, wherein the tubular includes a packer, the tool comprising a backup ring arranged adjacent to the packer.

[0025] Embodiment 8: The resource exploration and recovery system according to any prior embodiment, wherein the backup ring includes an outer surface and an inner surface, one or more voids are formed in the backup ring extending through the outer surface and the inner surface.

[0026] Embodiment 9: The resource exploration and recovery system according to any prior embodiment, wherein the tool is additively manufactured.

[0027] Embodiment 10: The resource exploration and recovery system according to any prior embodiment, wherein the tool comprises a sand screen mounted to the tubular, the fractal geometry defining openings in the sand screen.

[0028] Embodiment 11: The resource exploration and recovery system according to any prior embodiment, wherein the sand screen is formed from a plurality of layers, each of the plurality of layers including the fractal geometry.

[0029] The use of the terms “a” and “an” and “the” and similar referents in the context of describing the invention (especially in the context of the following claims) are to be construed to cover both the singular and the plural, unless otherwise indicated herein or clearly contradicted by context. Further, it should further be noted that the terms “first,” “second,” and the like herein do not denote any order, quantity, or importance, but rather are

used to distinguish one element from another. The modifier "about" used in connection with a quantity is inclusive of the stated value and has the meaning dictated by the context (e.g., it includes the degree of error associated with measurement of the particular quantity).

[0030] The teachings of the present disclosure may be used in a variety of well operations. These operations may involve using one or more treatment agents to treat a formation, the fluids resident in a formation, a wellbore, and/or equipment in the wellbore, such as production tubing. The treatment agents may be in the form of liquids, gases, solids, semi-solids, and mixtures thereof. Illustrative treatment agents include, but are not limited to, fracturing fluids, acids, steam, water, brine, anti-corrosion agents, cement, permeability modifiers, drilling muds, emulsifiers, demulsifiers, tracers, flow improvers etc. Illustrative well operations include, but are not limited to, stand alone screens, gravel packing, hydraulic fracturing, stimulation, tracer injection, cleaning, acidizing, steam injection, water flooding, cementing, etc.

[0031] 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.

CLAIMS

What is claimed is:

1. A resource exploration and recovery component comprising a fractal geometry (78).

2. The resource exploration and recovery component according to claim 1, wherein the resource exploration and recovery tool is a backup ring (46).

3. The resource exploration and recovery component according to claim 2, wherein the backup ring (46) includes an outer surface (82) and an inner surface (84), one or more voids (86) are formed in the backup ring (46) extending through the outer surface (82) and the inner surface (84).

4. The resource exploration and recovery component according to claim 1, wherein the resource exploration and recovery component is additively manufactured.

5. The resource exploration and recovery component according to claim 1, wherein the resource exploration and recovery component comprises a sand screen, the fractal geometry (78) defining openings in the sand screen.

6. A resource exploration and recovery system (10) comprising:

a first system (14);

a second system (18) fluidically connected to the first system (14), the second system (18) including a tubular (40); and

a tool supported by the tubular (40), the tool including a fractal geometry (78).

7. The resource exploration and recovery system (10) according to claim 6, wherein the tubular (40) includes a packer (44), the tool comprising a backup ring (46) arranged adjacent to the packer (44).

8. The resource exploration and recovery system (10) according to claim 7, wherein the backup ring (46) includes an outer surface (82) and an inner surface (84), one or more voids (86) are formed in the backup ring (46) extending through the outer surface (82) and the inner surface (84).

9. The resource exploration and recovery system (10) according to claim 6, wherein the tool is additively manufactured.

10. The resource exploration and recovery system (10) according to claim 6, wherein the tool comprises a sand screen mounted to the tubular (40), the fractal geometry (78) defining openings in the sand screen.

11. The resource exploration and recovery system (10) according to claim 10, wherein the sand screen is formed from a plurality of layers (106), each of the plurality of layers (106) including the fractal geometry (78).

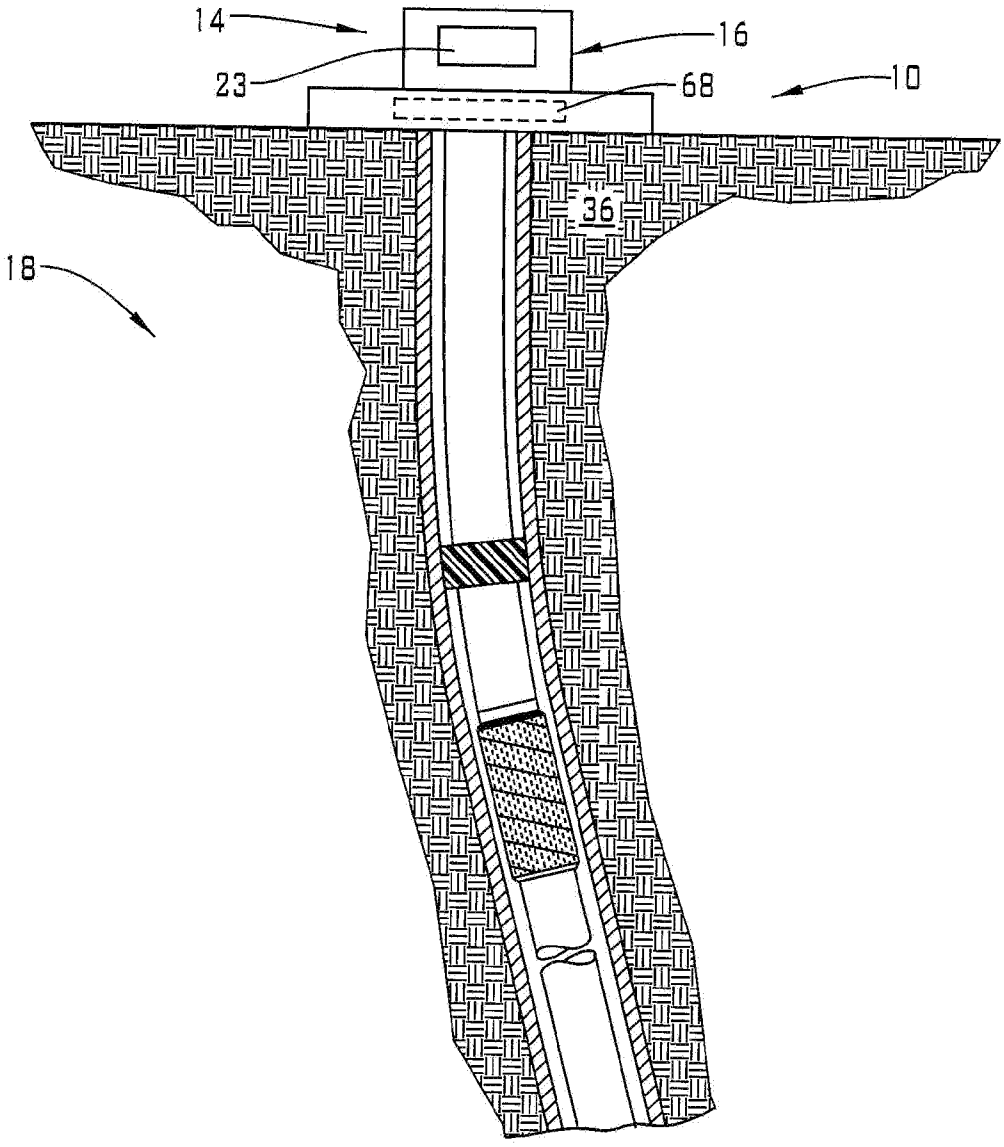


FIG. 1

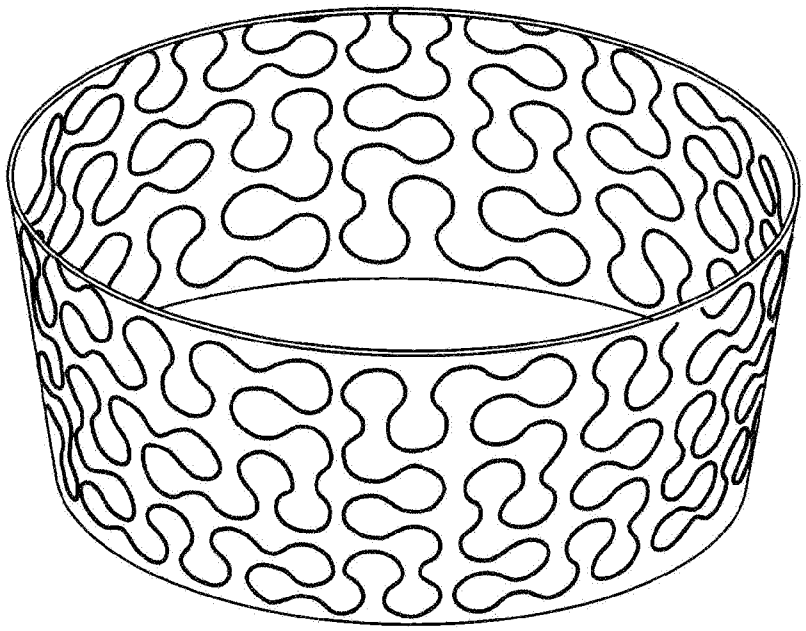


FIG. 2

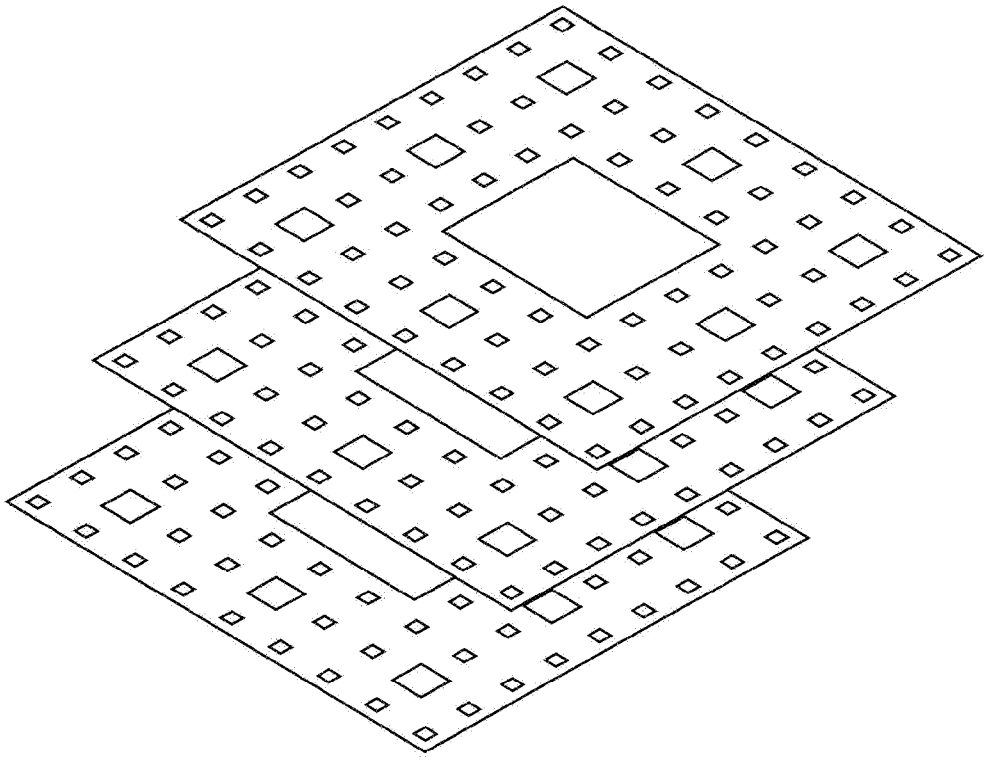


FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2019/014150

A. CLASSIFICATION OF SUBJECT MATTER

E21B 41/00(2006.01)i, E21B 17/00(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 41/00; E21B 23/02; E21B 33/12; E21B 43/00; E21B 43/04; E21B 43/10; G01V 3/12; 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, tubular, backup ring, sand screen, fractal geometry

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2012-0217025 A1 (SHKURTI et al.) 30 August 2012 See paragraphs [0004]-[0045], claim 1 and figures 1, 2A.	1-11
Y	US 2014-0312906 A1 (GOLD, RANDY) 23 October 2014 See claim 1 and figure 4.	1-11
Y	US 2004-0261994 A1 (NGUYEN et al.) 30 December 2004 See paragraph [0088] and figures 15-16.	5,10-11
A	US 2003-0047323 A1 (JACKSON et al.) 13 March 2003 See paragraph [0025] and figure 1.	1-11
A	WO 2008-032045 A1 (HALLIBURTON ENERGY SERVICES, INC. et al.) 20 March 2008 See claims 1-2 and figures 1-5.	1-11

☐ 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
"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
10 May 2019 (10.05.2019)	**10 May 2019 (10.05.2019)**

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/US2019/014150

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