

(84) **Designated States** (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, 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, ME, 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))*

AN OBJECT, METHOD, AND SYSTEM

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to U.S. Provisional Patent Application No. 18/329,797, filed on June 6, 2023, in the United States Patent and Trademark Office, and all the benefits accruing therefrom under 35 U.S.C. § 119, the content of which is incorporated herein in its entirety by reference.

BACKGROUND

[0002] In the resource recovery and fluid sequestration industries, objects are used to precipitate changes in the borehole system. Often the changes are precipitated by landing an object on a seat and pressuring thereagainst. Other ways are also known. Expected results are not always achieved though, and information about what changes actually occurred can be late in coming to an operator. The art would well receive alternate technologies that improve information response times.

SUMMARY

[0003] An embodiment of a tripping object, including a sensor, and a disappear on demand material shell surrounding the sensor.

[0004] An embodiment of a tool for a borehole environment, including an activator comprising a disappear on demand material, a data collector disposed in contact with the activator.

[0005] An embodiment of a method for taking an action in a borehole and immediately collecting data, including conveying an object to a feature in a borehole, engaging the feature with the object causing a change based upon the object engaging the feature, disappearing the shell, and collecting data with the sensor.

[0006] An embodiment of a borehole system, including a borehole in a subsurface formation, a feature in the borehole, an object disposed on the feature.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The following descriptions should not be considered limiting in any way. With reference to the accompanying drawings, like elements are numbered alike:

[0008] Figure 1 is a schematic cross sectional view of an object as disclosed herein;

[0009] Figures 2 and 3 are sequential schematic views illustrating action of the object in a borehole system as disclosed herein;

[0010] FIG. 4A is a schematic diagram of an embodiment of a disintegrable downhole article comprising a polymer matrix, an energetic material, and an reinforcing fiber;

[0011] FIG. 4B is a microstructure of a cross section of the disintegrable downhole article of FIG. 4A;

[0012] FIG. 5 is a schematic diagram of another embodiment of a disintegrable downhole article comprising a polymer matrix, an energetic material, and an reinforcing fiber;

[0013] FIG. 6A shows a coupon made from a polymer having an oxygen content of 2-30 wt%, an energetic material, and a reinforcing fiber;

[0014] FIG. 6B shows the disintegrated coupon of FIG. 6A; and

[0015] FIG. 7 is a graph of pressure (pound per square inch, psi) versus time (second, sec) illustrating the pressure in an autoclave as a function of time after the energetic material in the coupon of FIG. 6A is activated in the autoclave; and

[0016] Figure 8 is a view of a borehole system including an object as disclosed herein.

DETAILED DESCRIPTION

[0017] 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.

[0018] Referring to Figure 1, an object 10 is illustrated schematically and in cross section to provide an interior view thereof. The object 10 comprises a sensor 12 that is disposed within a disappear on demand (also called disintegrate on demand or degrade on demand) material shell 14. The sensor 12 may also include or be connected to a power source 16 that is also disposed within the shell 14. In embodiments the power source may be a battery. The object 10 may further contain either within the shell 14 or in contact with the shell 14, a trigger 18 that upon a signal will trigger a chemical reaction within the shell 14 that is self-sustaining and will reduce the shell to rubble in short order (in about 10 seconds). In embodiments the trigger 18 is an igniter. The signal may be an electromagnetic signal, may be a temperature-based or pressure-based signal, may be a vibrational-based signal, etc. The trigger 18 includes a receiver for whatever type of signal is to be employed to cause the trigger to react and cause the disappear on demand material shell 14 to degrade.

[0019] In embodiments, there may also be a core material 20 disposed within the shell 14. The core material 20 may surround and/or encapsulate the sensor 12 and may have a

density lower than a borehole fluid to which the core material 20 will be exposed at least when the shell 14 disappears. The lower relative density than the borehole fluid to which it is exposed will tend to float the core material and with it the sensor back to surface. This may be in addition to flow direction or may be in spite of flow direction in various applications. The sensor 12 may collect data such as temperature, pressure, pH, etc., immediately after the shell 14 degrades and then continuously or periodically while it is either moving through the borehole or even if stationary. The data may be recorded in the sensor for later downloading at surface or may be communicated real time if the sensor 12 is also supplied with a transmitter.

[0020] The object 10 may be run the form of a ball, a dart or even a profiled geometry such that the object may selectively land in a landing feature. Selective profile as used herein includes each of these since each may be selective based upon size alone if not geometry. Figure 1 is therefore representative of each. In each case, the shell 14 when its activator utility is complete, i.e., the landing feature is shifted, for example, and the shell is degraded, will release the sensor.

[0021] Referring to Figures 2 and 3, the operation alluded to above is illustrated. In Figure 2, the object 10 has landed on a feature 22 of a borehole structure 24. The difference in position of the structure 24 between Figures 2 and 3 illustrates that the object 10 when seated on the feature 22 has been pressured up upon to shift a sleeve 26 of the structure 24. The sleeve is to be taken as representative for any activation that might be needed and that is possible through use of an object 10. Once the feature 22 has moved the sleeve 26, the signal for disappear on demand is sent or automatically generated and the shell 14 disappears or degrades within seconds to release the sensor 12 and in some cases the core 20 to secure data and in some cases move back toward or to the surface.

[0022] Through the use of the object 10, data may be recorded right at the source of a change in the borehole that was created by the object without any delay. The data recorded then is unadulterated by inputs that might over time have changed various readings and therefore could impact appropriateness of decisions made thereon.

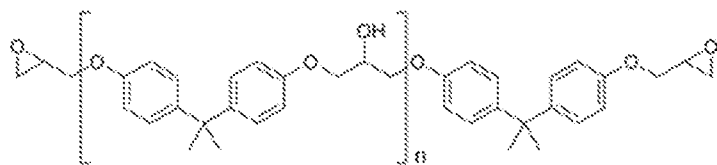
[0023] The disappear on demand material employed herein is an energetic disintegrable material. The energetic disintegrable material includes a polymer matrix; an energetic material configured to generate heat upon activation to facilitate a chemical decomposition of the disintegrable material and at least one of a reinforcing fiber or a filler. The energetic disintegrable material, when initiated undergoes a self-sustained and self-propagated reaction that is not affected by downhole fluid or hydrostatic pressure. The self-sustained and self-propagated reaction generates heat and chemically decomposes a polymer in the polymer

matrix. The decomposed product generated from the polymer decomposition includes small molecules that may exhibit a supercritical state when the temperature and pressure applied to the small molecules exceeds the supercritical temperature and the supercritical pressure of the small molecules. Advantageously, the generation of the small molecules in a supercritical state does not lead to dramatic pressure change, but nonetheless may facilitate the disintegration of the energetic disintegrable material in a safe and controllable manner.

[0024] The polymer matrix comprises a polymer, which provides general material properties such as strength and ductility for tool functions, including for the shell 14. The polymer is non-corrodible in a downhole fluid such as water, a brine, or an acid. The polymer in the polymer matrix has an oxygen content of about 2 to about 30 wt%, preferably about 3 to about 25 wt%, more preferably about 5 to about 20 wt%, based on a total weight of the polymer. Without wishing to be bound by theory, it is believed that when the polymer has an oxygen content within these ranges, the polymer undergoes appropriate activation and decomposition with the energetic materials leading to the decomposed product including small molecules that may exhibit a supercritical state to facilitate the disintegration of the energetic disintegrable material in a safe and controlled manner. The polymer may include at least one of an epoxy, a phenolic resin, an epoxy phenolic resin, a vinyl ester, a polybismaleimide, a cyanate ester, or a polyester.

[0025] As used herein, an epoxy refers to a cured product of an epoxide that contains one or more epoxide groups. The preferred epoxy suitable for use in the energetic disintegrable material may be formed from at least one of an aliphatic epoxide such as butanediol diglycidyl ether, a bisphenol epoxide such as bisphenol-A diglycidyl ether (CAS # 1675-54-3) and/or bisphenol-F diglycidyl ether, or a novolac epoxide such as phenol-formaldehyde polymer glycidyl ether (CAS # 28064-14-4). The curing agent includes an active group that may react with an epoxy group. Examples of such an active group include amino groups and acid anhydride groups. In an aspect, the curing agent is at least one of an aliphatic amine or an aromatic amine.

[0026] The epoxy may contain an aromatic structure and an aliphatic structure in the backbone of the polymers, where the aliphatic structure contains an ether (C-O) bond. The aromatic structure may be difficult to decompose while the aliphatic structure may be easier to decompose. In an aspect, the epoxy contains a polymerized diglycidylether of a bisphenol wherein the number of the repeating units range from 0 to 18, preferably 0 to less than 2.5. For example, the epoxy may include a bisphenol A diglycidyl ether epoxy having the formula,



wherein n is the number of repeating units, and may be 0 to 18, preferably 0 to less than 2.5. Without wishing to be bound by theory, it is believed that when the repeating units are within these ranges, the epoxy may readily decompose when exposed to the heat generated by the self-propagation reaction of the energetic material described herein.

[0027] Phenolic resin, also known as phenolic formaldehyde resin, is a synthetic resin produced from the polymerization of a phenol (C_6H_5OH), an alkyl-substituted phenol, a halogen-substituted phenol, or a combination thereof, and a formaldehyde compound such as formaldehyde ($CH_2C=O$). The polymer may include repeating units such as $-(C_6H_3OH)-CH_2-$.

[0028] Epoxy phenolic resin is phenolic resin modified at the phenolic hydroxyl group to include an epoxide functional group such as $-CH_2-(C_2H_3O)$, where $-(C_2H_3O)$ is a three-membered epoxide ring. The added functionality of the phenolic resin increases the ability for the resin to crosslink, creating a stronger polymer with high resistivities.

[0029] Vinyl ester (vinyl acetate) is a resin produced by the esterification of an epoxy resin with acrylic or methacrylic acids.

[0030] The polybismaleimide may be synthesized by condensation of phthalic anhydride with an aromatic diamine, which yields bismaleimide such as 4,4'-bismaleimidodiphenylmethane, followed by subsequent Michael addition of more diamine to the double bond at the ends of the bismaleimide. The monomer bismaleimide may also be copolymerized with vinyl and allyl compounds, allyl phenols, isocyanates, aromatic amines, or a combination thereof. Bismaleimide is often copolymerized with 2,2'-diallyl bisphenol A.

[0031] Cyanate esters are compounds generally based on a phenol or a novolac derivative, in which the hydrogen atom of the phenolic OH group is substituted by a cyanide group ($-OCN$). Suitable cyanate esters include those described in U.S. Pat. No. 6,245,841 and EP 0396383. Cyanate esters may be cured and postcured by heating, either alone, or in the presence of a catalyst. Curing normally occurs via cyclotrimerization (an addition process) of three CN groups to form three-dimensional networks comprising triazine rings.

[0032] The polyester may be formed by the reaction of a dibasic organic acid and a dihydric alcohol. Orthophthalic polyesters are made by phthalic anhydride with either maleic

anhydride or fumaric acid. Isophthalic polyesters are made from isophthalic acid or terephthalic acid. Isophthalic polyesters are preferred due to the improved corrosion resistance and mechanical properties.

[0033] Use of energetic materials disclosed herein is advantageous as these energetic materials are stable at wellbore temperatures but may undergo a self-sustained and self-propagated reaction that is not affected by downhole fluid or hydrostatic pressure. In addition, the energetic material may react without the need for environmental oxygen supply. The self-sustained and self-propagated reaction generates heat, which facilitates the chemical decomposition of the polymer in the polymer matrix.

[0034] The energetic material includes, for example, a reducing agent such as a metal powder and an oxidizing agent such as a metal oxide or a polymer that produces an exothermic oxidation-reduction reaction known as a thermite reaction. Choices for a reducing agent include at least one of aluminum, magnesium, calcium, titanium, zinc, silicon, or boron, for example, while choices for an oxidizing agent include at least one of boron oxide, silicon oxide, chromium oxide, manganese oxide, iron oxide, copper oxide, nickel oxide, silver oxide, lead oxide, or polytetrafluoroethylene (PTFE), for example.

[0035] The amount and the composition of the energetic material are selected that the energetic material does not result in an explosion, rather the heat generated by the energetic material is used to facilitate the chemical decomposition of the polymer in the polymer matrix, not to physically destroy the matrix such as by explosion. A weight ratio of the polymer matrix to the energetic material is about 1:7 to about 1:1, preferably about 1:6 to about 1:2, more preferably about 1:5 to about 1:3.

[0036] The reinforcing fiber is used to increase the tensile strength and the compressive strength of the shell 14. The reinforcing fiber comprises at least one of carbon fiber, glass fiber, polyethylene fiber, or aramid fiber. The form of the reinforcing fiber is not particularly limited, and may include fiber filaments; fiber rovings; fiber yarns; fiber tows; fiber tapes; fiber ribbons; fiber meshes; fiber tubes; fiber films; fiber braids; woven fibers; non-woven fibers; or fiber mats. The reinforcing fiber may include at least one of continuous fibers or short fibers. Continuous fibers may be disposed within the energetic disintegrable material along a reinforcing direction, providing a continuous path for load bearing, while short fibers may be blended into the polymer matrix in a random or semi-random orientation. Short fibers may include staple fibers, chopped fibers, or whiskers. Staple fibers typically have a lengths of about 10 to about 400 mm. Chopped fibers may have a lengths of about 3 to about 50 mm

while whiskers are a few millimeters length. Combinations of the fibers in different forms and different compositions may be used.

[0037] Depending on the desired mechanical strength, a ratio of a total weight of the polymer matrix and the energetic material relative to a weight of the reinforcing fiber may be about 40:1 to about 5:1, preferably about 30:1 to about 10:1.

[0038] The energetic disintegrable material may comprise a filler. Examples of the filler include at least one of carbon black, mica, clay, a ceramic material, a metal, or a metal alloy. Ceramic materials include SiC, Si₃N₄, SiO₂, BN, and the like. Examples of the metal or metal alloy may include at least one of lightweight aluminum alloys, magnesium alloys, or titanium alloys. The metal or metal alloy may also be the excess metal/metal alloy in the energetic material that does not participate in an oxidation-reduction reaction. The filler may be present in an amount of about 0.5 to about 10 wt. %, or about 1 to about 8% based on the total weight of the energetic disintegrable material.

[0039] The reinforcing fiber, the filler, and the energetic material may be randomly distributed in the polymer matrix. Alternatively, the energetic disintegrable materials may have a layered structure and comprise a first layer and a second layer disposed on the first layer, wherein the first layer contains the reinforcing fiber described herein and the second layer comprises the polymer and the energetic material described herein.

[0040] It is to be appreciated that the energetic disintegrable material may have more than one first layer and more than one second layer. For example, the energetic disintegrable material may include alternating first and second layers. The thicknesses of the first and second layers are not particularly limited. In an aspect, the thickness of the first layer relative to the thickness of the second layer is about 10:1 to about 1:10 or about 5:1 to about 1:5, or about 2:1 to about 1:2.

[0041] The microstructures of the energetic disintegrable materials are illustrated in FIGS. 4A, 4B, and 5. Referring to FIGS. 4A and 4B, the energetic disintegrable material includes alternating layers A and B, where layer A contains a reinforcing fiber 30 and layer B contains an energetic material 40 and a polymer matrix 50. Referring to FIG. 4, the energetic disintegrable material includes an energetic material 62, 64 and a reinforcing fiber 30 randomly disposed in the polymer matrix 50.

[0042] The polymer, the energetic material, and at least one of the reinforcing fiber or filler may form a composite. When the composite includes a continuous fiber (also referred to as continuous fiber composite), the composite may have a greater tensile strength than compressive strength. For example, the continuous fiber composite may have a tensile strength

of about 40 to about 50 kilopound per square inch (ksi), determined in accordance with ASTM D3039. The continuous fiber composite may have a compressive strength of about 14 to about 33 ksi, determined in accordance with ASTM D6641. A ductility of the continuous fiber composite may be about 1 to about 4%.

[0043] When the composite comprises a short fiber (also referred to as “short fiber composite”), the composite may have a greater compressive strength than tensile strength. For example, the short fiber composite may have a tensile strength of about 10 to about 15 ksi, determined in accordance with ASTM D3039, and a compressive strength of about 25 to about 40 ksi, determined in accordance with ASTM D6641 or ASTM D695. A ductility of the short fiber composite may be about 5 to about 10%.

[0044] The energetic disintegrable material comprises the composite and may be manufactured from the polymer, the energetic material, and at least one of the reinforcing fiber or the filler. In an aspect, a mold is alternately loaded with a reinforcing fiber, for example a reinforcing fiber layer or reinforcing fiber mesh and a combination comprising an energetic material and a polymer to provide a reinforced composition. The reinforced composition is then molded to form an energetic disintegrable material. Alternatively, at least one of the reinforced fiber or a filler, the energetic material and the polymer may be mixed and then molded to form an energetic disintegrable material. The energetic disintegrable material may be further machined or shaped to form an energetic disintegrable material having the desired structure.

[0045] To receive and process a signal to activate an energetic material, the trigger 18 may include a receiver as noted above to receive a disintegration instruction or signal, the trigger then generating an electric current applied to the shell 14. The trigger 18 may use batteries or other electronic components. As noted above, the disintegration signal may be obtained from the surface of a wellbore or from a signal source in the well, for example, from a signal source in the well close to the energetic disintegrable material.

[0046] When the polymer in the polymer matrix is exposed to the heat generated by the self-propagation reaction of the energetic material, the polymer chemically decomposes producing a decomposed product containing at a small molecule that may exhibit a supercritical state.

[0047] As used herein, a small molecule refers to a compound having less than 16, less than 10, or less than 8 carbon atoms. Examples of the small molecules include at least one of acetylene, ethylene, methane, carbon dioxide, carbon monoxide, formaldehyde, a phenol, a bisphenol, or water. The produced small molecules are subject to an elevated temperature and

a super-atmospheric pressure. When the elevated temperature and super-atmospheric pressure exceed a supercritical temperature and a supercritical pressure of the small molecule, the small molecule exhibits a supercritical state. The elevated temperature may be provided by the heat generated by the self-propagation reaction of the energetic material. The super-atmospheric pressure applied to the small molecule may be provided by a downhole environment. Because there is no boundary between liquid and gas for compounds in a supercritical state, decomposing the polymer may result in a minimal pressure increase, which avoids explosion, or choking of the self-propagation reaction of the energetic material, or otherwise uncontrolled disintegration of the shell 14. In an aspect, chemically decomposing the polymer as described herein may result in a pressure increase of less than about 100 psi or less than about 80 psi under a hydrostatic pressure of 400 to 1500 psi in a downhole environment.

[0048] Advantageously, the decomposition of the polymer is not affected or counteracted by the downhole hydrostatic pressure. The shell 14 may disintegrate in tens of seconds or even 10 seconds as noted above regardless of direct contact with downhole fluid under hydrostatic pressures once the energetic material is activated. The disintegration of the shell 14 is safe for the sensor 12 and for other adjacent tools including seal elements as the decomposition of the polymer results in minimal pressure and temperature increase. In addition, there is no explosion or flame during the disintegration of the shell 14, and the disintegration does not create projectiles or shock waves which may have undesirable consequences.

[0049] The energetic disintegrable material and method of use are further illustrated in the example.

Example

[0050] A test coupon was made of a composite of an epoxy matrix, an energetic material, and a fiber with a weight ratio of 22:66:5. The epoxy resin comprised 60-80 wt% bisphenol A diglycidyl ether (CAS # 1675-54-3) and the balance being phenol-formaldehyde polymer glycidyl ether (CAS # 28064-14-4) and 1,4-butane diglycidyl ether (CAS # 2425-78-8).

[0051] The composite had a tensile strength of about 45 ksi, determined in accordance with ASTM D3039; and a compressive strength of about 18 ksi, determined in accordance with ASTM D6641. The composite also had a ductility of about 2%.

[0052] Fig. 6A is a coupon with a watertight trigger sealed and embedded inside the coupon. A ceramic crucible wrapped and covered with steel mesh was placed outside the coupon to restrict the coupon remaining submerged during the test. Then the coupon was

submerged under a test fluid in an autoclave (high pressure vessel). And then the autoclave was closed and pressurized with compressed gas to test the hydrostatic pressure effect under downhole conditions. The trigger was then activated, and after the test, the coupon was completely disintegrated into small pieces as shown in FIG. 6B. The decomposed pieces do not have the strength of the coupon and may be readily pulverized. FIG. 7 shows that a pressure increase (ΔH) resulted from the decomposition of the polymer is about 50 psi under high hydrostatic pressures from 400 to 1500 psi. A peak temperature rise of about 55 °F was recorded near the test coupon.

[0053] Referring to Figure 8, a borehole system 70 is illustrated. The system 70 comprises a borehole 72 in a subsurface formation 74. A feature 76 is disposed within the borehole 72. The object 10, as disclosed herein, is disposed on the feature 76.

[0054] Set forth below are some embodiments of the foregoing disclosure:

[0055] Embodiment 1: A tripping object, including a sensor, and a disappear on demand material shell surrounding the sensor.

[0056] Embodiment 2: The object as in any prior embodiment, wherein the sensor is connected to a power source within the shell.

[0057] Embodiment 3: The object as in any prior embodiment, wherein the power source is a battery.

[0058] Embodiment 4: The object as in any prior embodiment, further including a core material within which the sensor is mounted.

[0059] Embodiment 5: The object as in any prior embodiment, wherein the core material is of a density lower than a downhole fluid to which the core will be exposed during use.

[0060] Embodiment 6: The object as in any prior embodiment, further including a trigger in operable communication with the material.

[0061] Embodiment 7: The object as in any prior embodiment, wherein the trigger is embedded in the material.

[0062] Embodiment 8: The object as in any prior embodiment, wherein the trigger is surrounded by the material.

[0063] Embodiment 9: The object as in any prior embodiment, wherein the trigger is responsive to one or more of temperature, pressure, vibrational signal, or electromagnetic signal.

[0064] Embodiment 10: The object as in any prior embodiment, wherein the sensor is one or more sensors and configured to sense one or more of temperature, pressure, or pH.

[0065] Embodiment 11: The object as in any prior embodiment, wherein the object is a ball or a dart.

[0066] Embodiment 12: The object as in any prior embodiment, wherein the object includes a selective profile.

[0067] Embodiment 13: A tool for a borehole environment, including an activator comprising a disappear on demand material, a data collector disposed in contact with the activator.

[0068] Embodiment 14: The tool as in any prior embodiment, wherein the data collector is inoperative while the activator is in an initial condition.

[0069] Embodiment 15: A method for taking an action in a borehole and immediately collecting data, including conveying an object as in any prior embodiment to a feature in a borehole, engaging the feature with the object causing a change based upon the object engaging the feature, disappearing the shell, and collecting data with the sensor.

[0070] Embodiment 16: The method as in any prior embodiment, wherein the causing a change is by pressuring against the object engaged with the feature.

[0071] Embodiment 17: The method as in any prior embodiment, further including conveying the sensor back to surface while recording data.

[0072] Embodiment 18: The method as in any prior embodiment, wherein the conveying is floating.

[0073] Embodiment 19: A borehole system, including a borehole in a subsurface formation, a feature in the borehole, an object as in any prior embodiment disposed on the feature.

[0074] 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 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 terms “about”, “substantially” and “generally” are intended to include the degree of error associated with measurement of the particular quantity based upon the equipment available at the time of filing the application. For example, “about” and/or “substantially” and/or “generally” can include a range of $\pm 8\%$ a given value.

[0075] 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 borehole, and / or equipment in the borehole, 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, hydraulic fracturing, stimulation, tracer injection, cleaning, acidizing, steam injection, water flooding, cementing, etc.

[0076] 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 tripping object (10), characterized by:
a sensor (12); and
a disappear on demand material shell (14) surrounding the sensor (12).
2. The object (10) as claimed in claim 1, wherein the sensor (12) is connected to a power source (16) within the shell (14).
3. The object (10) as claimed in claim 1, further including a core material (20) within which the sensor (12) is mounted.
4. The object (10) as claimed in claim 3, wherein the core material (20) is of a density lower than a downhole fluid to which the core will be exposed during use.
5. The object (10) as claimed in claim 1, further including a trigger (18) in operable communication with the material (20).
6. The object (10) as claimed in claim 5, wherein the trigger (18) is embedded in the material (20).
7. The object (10) as claimed in claim 6, wherein the trigger (18) is surrounded by the material (20).
8. The object (10) as claimed in claim 6, wherein the trigger (18) is responsive to one or more of temperature, pressure, vibrational signal, or electromagnetic signal.
9. The object (10) as claimed in claim 1, wherein the object (10) includes a selective profile.
10. A tool for a borehole environment, characterized by:
an activator comprising a disappear on demand material;
a data collector disposed in contact with the activator.
11. The tool as claimed in claim 10, wherein the data collector is inoperative while the activator is in an initial condition.
12. A method for taking an action in a borehole (72) and immediately collecting data, characterized by:
conveying an object (10) as claimed in claim 1 to a feature in a borehole (72);
engaging the feature (22) with the object (10);
causing a change based upon the object (10) engaging the feature (22);
disappearing the shell (14); and
collecting data with the sensor (12).

13. The method as claimed in claim 12, wherein the causing a change is by pressuring against the object (10) engaged with the feature (22).

14. The method as claimed in claim 12, further including conveying the sensor (12) back to surface while recording data.

15. A borehole system (70), characterized by:

a borehole (72) in a subsurface formation (74);

a feature (76) in the borehole (72);

an object (10) as claimed in claim 1 disposed on the feature (76).

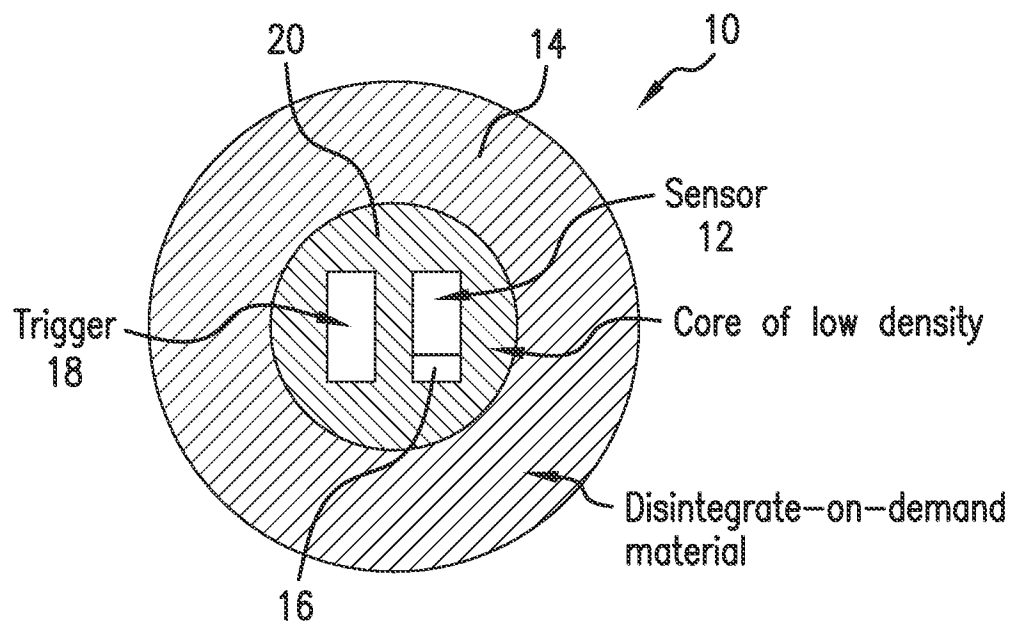


FIG. 1

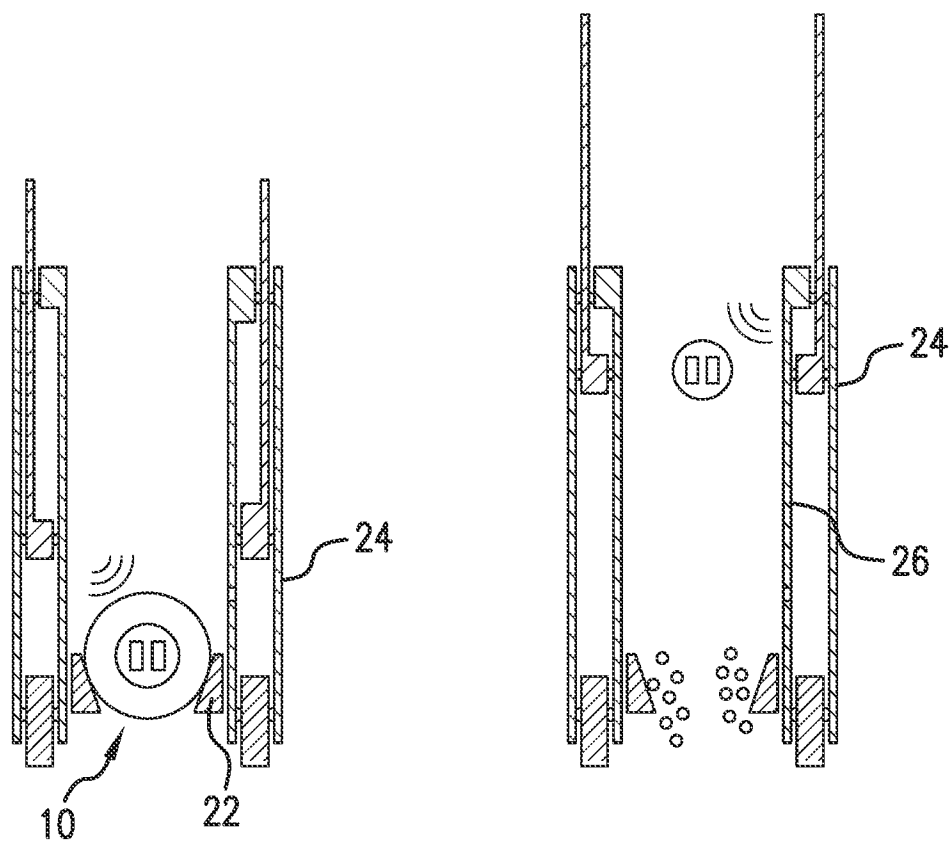


FIG. 2

FIG. 3

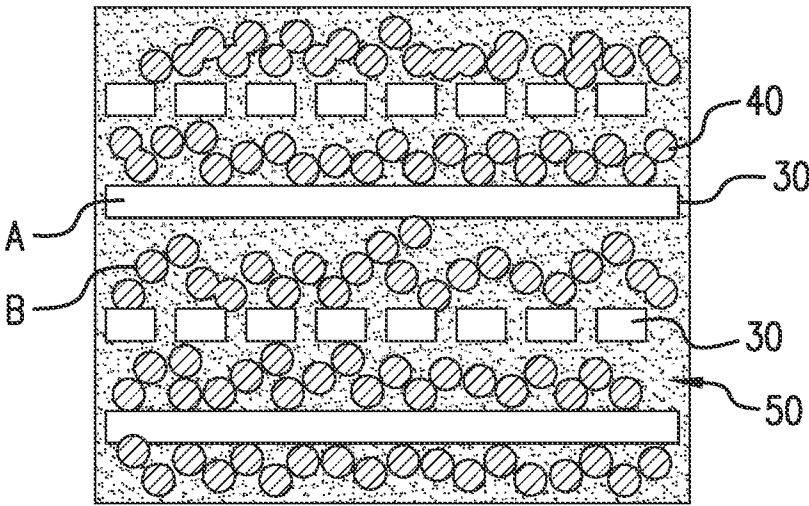


FIG.4A

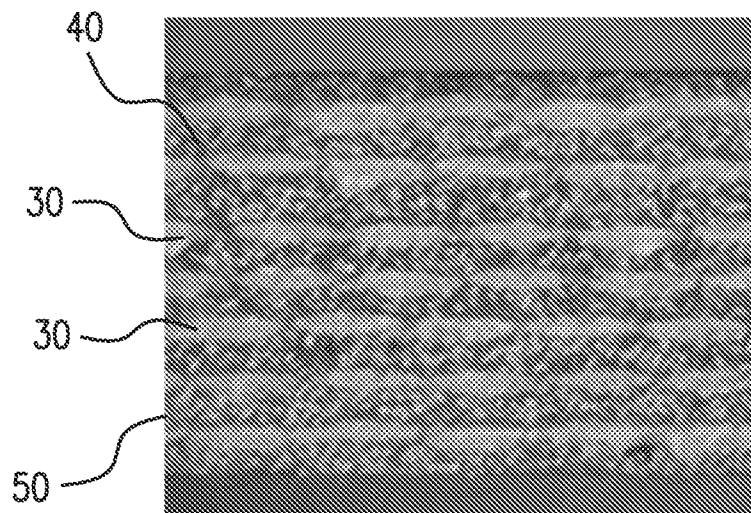


FIG.4B

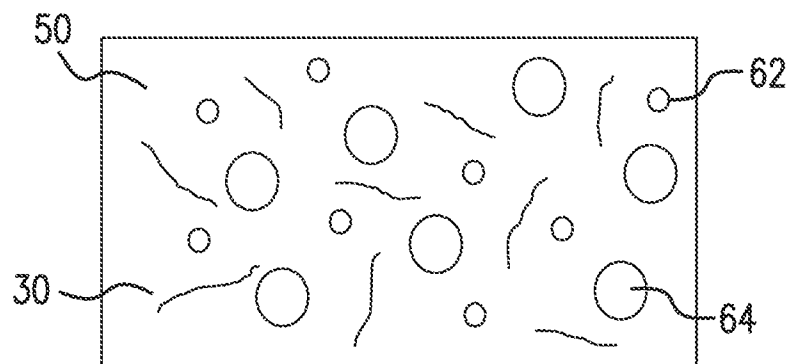


FIG.5

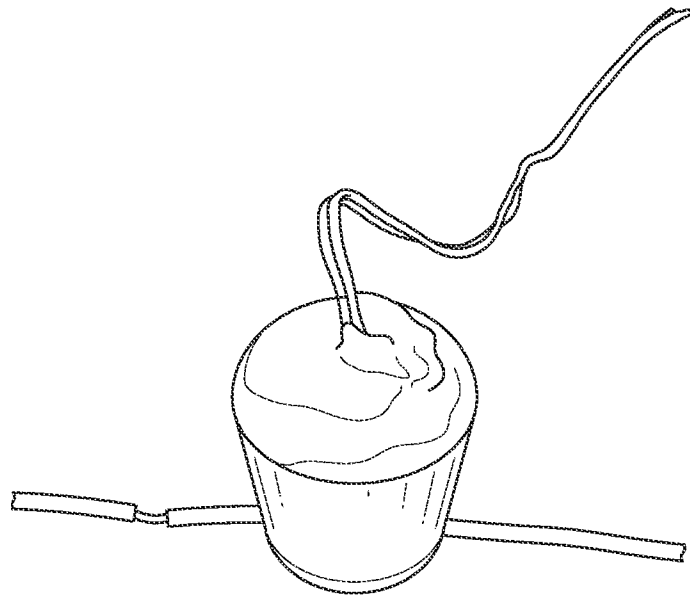


FIG.6A

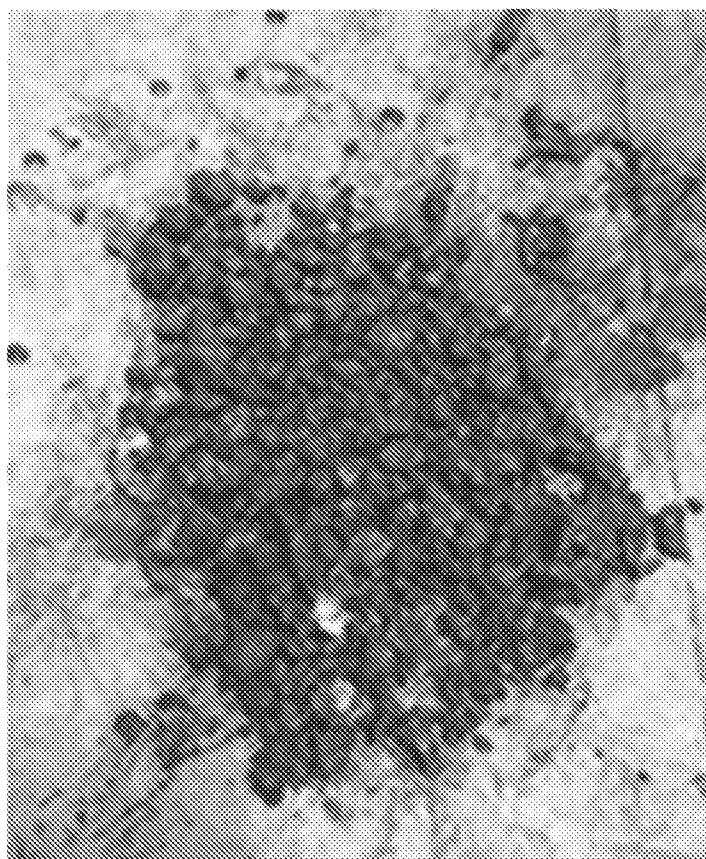


FIG.6B

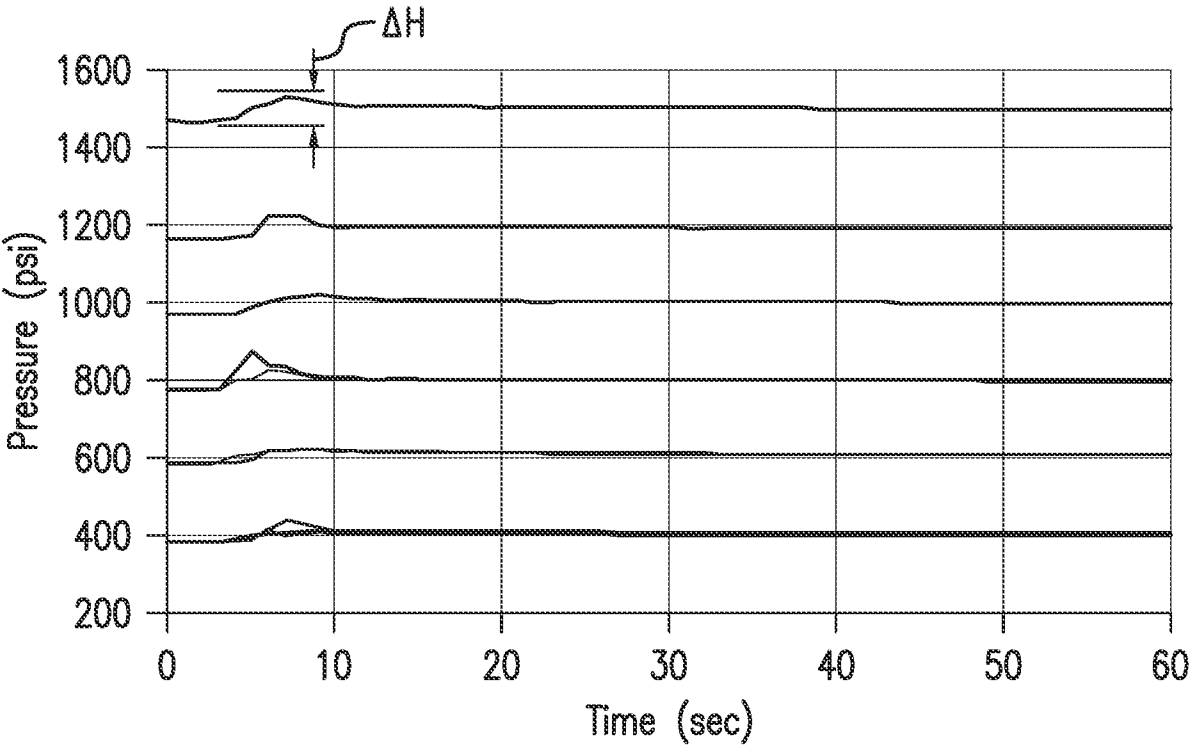


FIG. 7

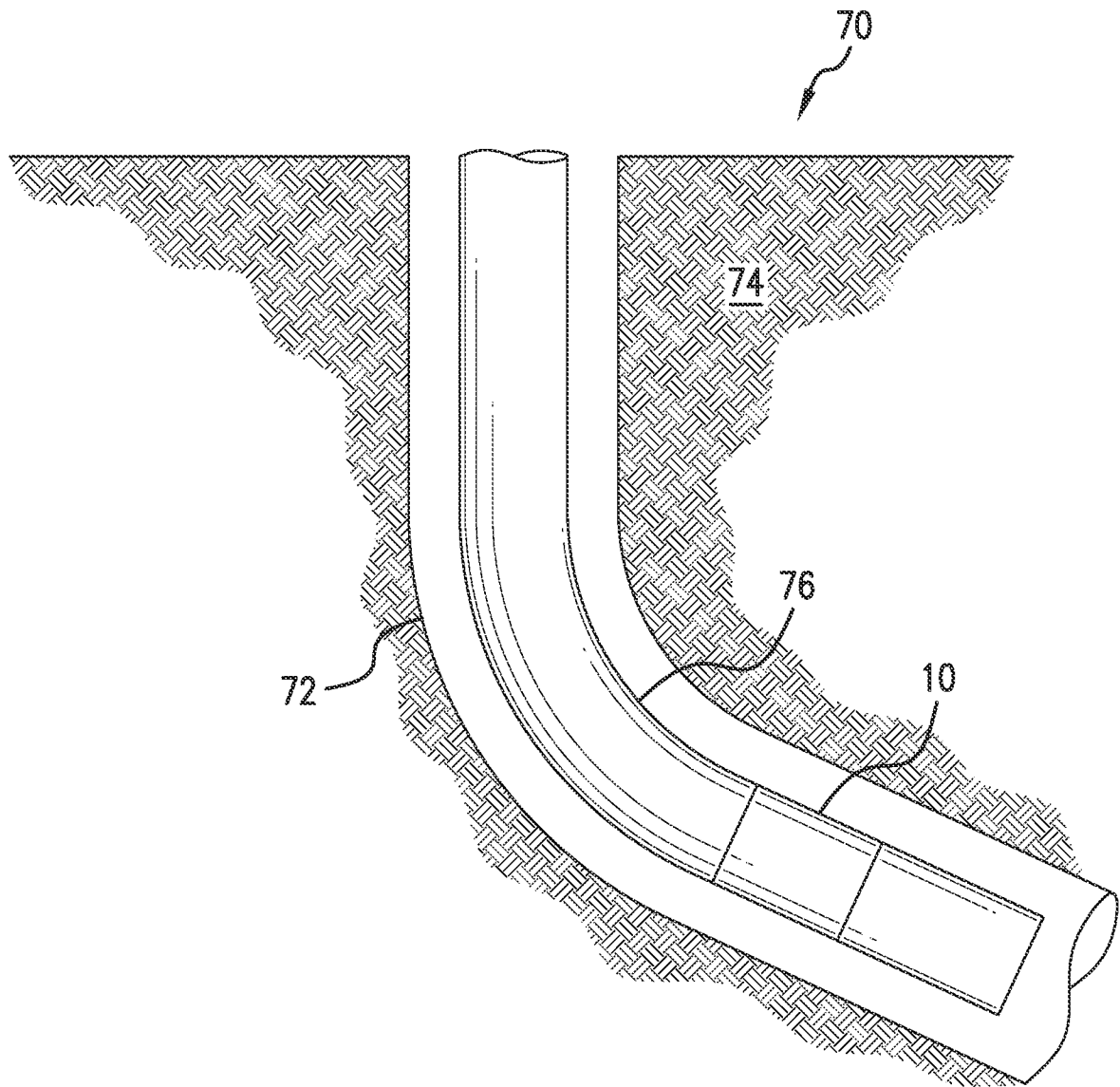


FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2024/031241

A. CLASSIFICATION OF SUBJECT MATTER**E21B 34/14(2006.01)i; E21B 47/13(2012.01)i; E21B 47/06(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 34/14(2006.01); E21B 33/12(2006.01); E21B 34/06(2006.01); E21B 43/26(2006.01); E21B 47/01(2006.01);
E21B 47/06(2006.01); E21B 47/10(2006.01); E21B 47/18(2006.01); G01V 9/02(2006.01)

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: disappear material, shell, sensor, floating, and trigger

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2019-0316459 A1 (WELL DIVER) 17 October 2019 (2019-10-17) paragraphs [0014], [0022], [0023], [0026]; claims 1, 8, 10, 11; and figures 1-4, 7	1,3,4,9-15
Y		2,5-8
Y	US 2021-0238982 A1 (HIGH RESOLUTION DATA, LLC) 05 August 2021 (2021-08-05) paragraphs [0060]-[0064] and figure 2	2
Y	US 2016-0130906 A1 (ENSIGN-BICKFORD AEROSPACE & DEFENSE COMPANY) 12 May 2016 (2016-05-12) paragraphs [0043]-[0051], [0060] and figures 8-10	5-8
A	US 2021-0317724 A1 (EXXONMOBIL UPSTREAM RESEARCH COMPANY) 14 October 2021 (2021-10-14) paragraphs [0074]-[0076] and figures 1-3	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

“D” document cited by the applicant in the international application

“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

06 September 2024

Date of mailing of the international search report

06 September 2024

Name and mailing address of the ISA/KR

**Korean Intellectual Property Office
189 Cheongsa-ro, Seo-gu, Daejeon
35208, Republic of Korea**Facsimile No. **+82-42-481-8578**

Authorized officer

PARK, Tae WookTelephone No. **+82-42-481-3405**

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2024/031241

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2020-0131899 A1 (WELLDIVER LLC) 30 April 2020 (2020-04-30) paragraphs [0017]-[0019] and figures 1-3B	1-15

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/US2024/031241

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
US	2019-0316459	A1	17 October 2019	None			
US	2021-0238982	A1	05 August 2021	US	11668186	B2	06 June 2023
US	2016-0130906	A1	12 May 2016	None			
US	2021-0317724	A1	14 October 2021	US	11555378	B2	17 January 2023
US	2020-0131899	A1	30 April 2020	None			