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(54) Title: A DOWNHOLE PACKER APPARATUS PROMOTING RADIAL FLOW

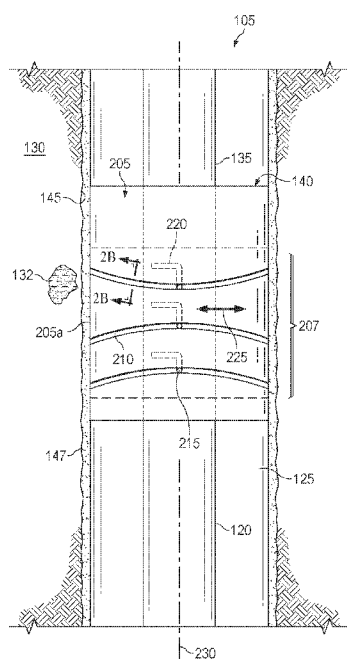


FIG. 2A

(57) Abstract: A downhole packer apparatus including a packer disposed along a downhole sampling tool, wherein an outer surface of the packer includes an uneven surface portion with one or more flow channels locatable between the outer surface of the one packer and a facing wellbore wall, the flow channels promoting radial flow of formation fluids to one or more surface conduits leading to flow lines located inside the one packer. A method of obtaining a formation sample using the downhole packer apparatus is also described.

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A DOWNHOLE PACKER APPARATUS PROMOTING RADIAL FLOW

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to U.S. Application Serial No. 18/483,328, filed by Christopher Michael Jones, *et al.* on October 9, 2023, entitled “A DOWNHOLE PACKER APPARATUS PROMOTING RADIAL FLOW,” which claims the benefit of U.S. Provisional Application Serial No. 63/508,209 filed by Christopher Michael Jones, *et al.* on June 14, 2023, entitled “A DOWNHOLE PACKER APPARATUS PROMOTING RADIAL FLOW,” commonly assigned with this application and incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] This application is directed, in general, to analyzing subterranean formations and, more specifically, to obtaining formation samples using a downhole packer apparatus and methods of use for formation sampling.

BACKGROUND

[0003] The infiltration drilling fluid into a formation can make the sampling of formation fluid from a wellbore problematic. Often, two expandable packers (packers) are placed in the wellbore around a sampling tool, to seal off and isolate a sampling zone of the formation. However, it can take longer than desired to clear the isolated sampling zone by removing mudcake (e.g., solid portions of drilling mud such as clay particles) from the well bore wall and pumping drilling fluid out of the sampling zone. Efforts to reduce the time to clear out the sampling zone include the use of a third central packer located in-between the two packers to reduce the volume of the sampling zone and move mudcake remnants.

BRIEF

[0004] FIG. 1 presents a schematic view of an embodiment of an example system for drilling operations that includes a downhole packer apparatus of the disclosure disposed in a borehole of a subterranean well;

[0005] FIG. 2A presents a schematic cross-sectional view of an embodiment of the packer apparatus of the disclosure;

[0006] FIG. 2B presents a detailed cross-sectional view of an embodiment of the packer along view line 2B—2B shown in FIG. 2A;

[0007] FIG. 2C presents a detailed cross-sectional view of another embodiment of the packer analogous to the view shown in FIG. 2B;

[0008] FIG. 2D presents a schematic cross-sectional view of an another embodiment of the packer apparatus analogous to the view shown in FIG. 2A;

[0009] FIG. 2E presents a schematic cross-sectional view of an another embodiment of the packer apparatus analogous to the view shown in FIG. 2A;

[0010] FIG. 3 presents a schematic cross-sectional view of an embodiment of the downhole packer apparatus of the disclosure disposed in a well as part of a downhole sampling tool of the disclosure;

[0011] FIG. 4 presents a schematic cross-sectional view of another embodiment of the packer apparatus of the disclosure analogous to the view shown in FIG. 3; and

[0012] FIG. 5 presents a flow diagram of an example method of obtaining a sample using the downhole packer apparatus of the disclosure.

DETAILED DESCRIPTION

[0013] As part of the present disclosure, we realized that the inflation of a central packer can cause the mudcake in a sampling zone to become compacted, which in turn, can deter the clearance of the sampling zone. Therefore, as further disclosed herein, in some embodiments, upper and bottom packers can be set, a flow of drilling fluids through the sampling zone can remove the mudcake off of the wellbore wall, and then a central packer, or distal portions of the same upper and lower packers, can be applied to volume exclude drilling fluid and sample formation fluid.

[0014] Further, the collection of sample formation fluids into a sampling tool can be facilitated by flowing formation fluids through uneven surface portions of a packer to thereby provide a flow channel located on an outer surface of the packer. As further disclosed herein, the flow channel, or channels, can be structured to promote radial flow of the formation fluids obtained from the sampling zone to one or more surface conduits leading to flow lines located inside the packer.

[0015] Additionally, for some embodiments of the downhole packer apparatus disclosed herein, it may not be necessary to have a third central packer. Rather, as further disclosed herein, the uneven surface portion to define the flow channel can be part of a first and/or a second packers (e.g., one or both upper and lower packers) used to define the sampling zone. For other embodiments, the first and/or a second packer can have a smooth or even surface and the third central packer or additional packers can have the uneven surface.

[0016] One embodiment of the disclosure is a downhole packer apparatus. FIG. 1 presents a schematic view of an embodiment of an example system 100 for drilling operations that includes a downhole packer apparatus 105 of the disclosure disposed or disposable in a subterranean well.

[0017] FIG. 1 further illustrates aspects of an example system 100 for drilling operations.

[0018] The system 100 includes a drilling rig 110 located at a surface 115 of a well. The drilling rig 110 provides support for a drill string 120. The drill string 120 penetrates a rotary table for drilling a borehole 125 through a subterranean formation 130 that includes formation fluids 132. A downhole sampling tool 135 may include any of a number of different types of device tools including measurement-while-drilling (MWD) tools, logging-while-drilling (LWD) tools, wireline tools etc. as familiar to those skilled in the pertinent art.

[0019] In some embodiments, the apparatus 105 may be mounted on a drill collar or wireline deployed. Thus, even though the apparatus 105 is shown as part of the drill string 120 and downhole sampling tool 135, some embodiments of the invention described below may be conveyed down borehole 125 via any drill string or wireline technology, as familiar to those skilled in the art. The downhole packer apparatus 105 includes a packer 140 facing a wellbore wall 145 and mudcake 147 thereon as further disclosed herein.

[0020] For example, as illustrated in FIG. 2A, the packer 140 can be disposed along the downhole sampling tool 135, where an outer surface 205 of the packer includes an uneven surface portion 207 with one or more flow channels 210 locatable between the outer surface (e.g., surface 205a) of the one packer 140 and a facing wellbore wall 145, the flow channels promoting radial flow of formation fluids 132 to one or more surface conduits 215 leading to sample flow lines 220 located inside the one packer, e.g., to route the fluid 132 to a testing tool of the sampling tool 135, as familiar to those skilled in the pertinent art.

[0021] The term uneven surface portion, as used herein, means that portion of the outer surface of the packer has material removed (e.g., to form groove 222, FIG. 2B), or, added (e.g., to form ridges 223, FIG. 2C) to provide the flow channel 210 for the formation fluids to substantially flow within. E.g., at least 80, 90, 99 % of the total fluid 132 volume flowing between the packer outer surface 205a against the wellbore wall 145, at a flow rate of at least about 1, 5, 10, 20, 50, or 100, cc/s in some embodiments, to provide a target formation fluid 132 sampling rate.

[0022] The term radial flow, as used herein, means that an average direction of the formation fluid moving across the outer surface of the packer through the channel is in a circular direction

(e.g., direction 225, FIG. 2A) substantially perpendicular (e.g., 90 ± 45 degrees) to the longitudinal axis (e.g., axis 230, FIG. 2A) of the zone of the borehole 108 that the apparatus 105 is placed in (e.g., a sampling zone 150 of the formation 130, FIG. 1).

[0023] For instance, in some embodiments, the uneven surface portion 207 can include grooves 222 (e.g., FIG. 2B) in the outer surface 205 to thereby define the flow channel 210, or, the uneven surface portion 207 includes raised ridges 223 (e.g., FIG. 2C) on the outer surface 205 to thereby define the flow channel 210. In some embodiments, the one or more flow channel 210 can spiral around the uneven surface portion 207, e.g., the flow channel can define a spirally-shaped channel pattern 235 (e.g., FIG. 2D). As illustrated in FIG. 2A, in some embodiments, the one or more flow channels 210 can be non-intersecting and separated from each other along the uneven surface portion 207, while in other embodiments, at least two of flow channels 210 can intersect with each other.

[0024] In any such embodiments, the one or more flow channels 210 can be first channels (e.g., radially-oriented channels 210a, 210b, 210c, FIG. 2E) and the uneven surface portion 207 can further include second flow channels that promote substantially longitudinal flow of the formation fluids 132 between the first channels 210a, 210b (e.g., longitudinally-oriented channels 240a, 240b).

[0025] The term longitudinal flow, as used herein, means that an average direction of motion of the formation fluid across the outer surface of the packer through the second channel is substantially parallel (e.g., 0 ± 45 degrees) to the longitudinal axis 230 of the zone 150 of the borehole that the packer apparatus is placed in. The inclusion of such longitudinally oriented second flow channels 240a, 240b can advantageously help balance the fluid pressure between the radially oriented first channels 210a, 210b, and 210c and thereby help normalize the fluid pressure across the uneven surface portion 207.

[0026] Based on the present disclosure one of ordinary skill would appreciate that the flow channels 210 and optional second channels 240 of the uneven surface portion of the packer could have a variety of different shapes, sizes and/or patterns to promote a balanced radial flow and desired target sampling rate.

[0027] For instance, as non-limiting examples, in various embodiments, the grooves 222 can have a depth 250, or the ridges 223 can have a height 252, of 0.5, 1, 1.5, 2, 2.5, 3, or 4 cm and a groove width 254, or ridge-to-ridge separation 256, of 0.5, 1, 1.5, 2, 2.5, 3, or 4 cm. For

instance, the number grooves or ridges can be adjusted to provide 1, 2, 3, 4, 5, 10, 20 or 100 radially- or longitudinally-oriented flow channels across the uneven surface portion 207.

[0028] As illustrated in FIG. 3, in some embodiments of the apparatus 105, the packer 140 can be a first packer (e.g., one of an upper or lower packer) and the apparatus 105 can further include a second packer 305 (e.g., the other of a lower or upper packer) disposed along the downhole sampling tool 135 and the first and second packers are longitudinally spaced apart from each other (e.g., the separation can range from immediately adjacent to each other to meters apart).

[0029] In some such embodiments, the uneven surface portion 207 of the first packer 140 can be located proximate to the second packer 305, and the first packer 140 surface 205 can further include an even surface portion (e.g., portion 306) located distal to the second packer 305. The even surface portion 306 deters passage of the formation fluids 132 between the even surface portion and the facing wellbore wall (e.g., between the packer outer surface 205a against the wellbore wall 145).

[0030] In some embodiments, an outer surface 307 of the second packer 305 further includes a uneven surface portion 310 with one or more second channels (e.g., analogous to any embodiments of the radially-oriented or longitudinally-oriented flow channels 210, 240 disclosed in the context of FIGs. 2A-2E) locatable between the outer surface (e.g., surface 307a) of the second packer and the facing wellbore wall 145, the second flow channels promoting the radial flow of the formation fluids to one or more second surface conduits leading to second flow lines located inside the second packer (analogous to the conduits 215 and flow lines 220 discussed in the context of FIGs. 2A-2E)

[0031] As further illustrated in FIG. 3, the second uneven surface-portion 310 of the second packer 305 can be located proximate to the first packer 140, and the second packer 305 can further include an even surface portion 315 located distal to the first packer 140. The even surface portion 315 of the second packer 305 deters passage of the formation fluids between the second even surface portion and the facing wellbore wall, analogous to the even surface portion 306 of first packer 140.

[0032] The term even surface portion, as used herein, means that the even surface portion (e.g., portion 306 or 315) of the packer's outer surface (e.g., surface 205 or 307) is smooth and substantially free of flow channels such that the formation fluids 132 substantially do not flow over the even surface portion (e.g., a flow rate of less than about 0.9, 0.5, 0.2, 0.1, 0.05, or 0.01,

cc/s, in some embodiments) and thereby helps isolate or seal off the zone 150 of the wellbore through which formation sampling is conducted.

[0033] In some such embodiments, e.g., when the fluid flow rate through the uneven surface portion (e.g., portion 207 or 310) is high (e.g., 10, 20 or 50 cc/s) then a fluid flow rates through the even surface portion (e.g., portion 310 or 315) of higher than the 1 cc/s can be tolerated, but, the relative fluid flow rate is still low. For instance, in some embodiments, the relative fluid flow rates over the uneven surface portion versus over the even surface portion can at least 1.5:1, 2:1, 5:1, 10:1, 100:1 or 500:1.

[0034] As further illustrated in FIG. 3, one or both the first and second packers 140, 305 can each have a first interior chamber 320a, 320b, respectively, underlying the even surface portions (e.g., even portions 306, 315, respectively) and a second interior chamber 325a, 325b, respectively underlying the uneven surface portion (e.g., uneven portions 207, 310, respectively). The first and second interior chambers can be connected to each other by a pressure offset valve (e.g., valves 330a, 330b, respectively for the first and second packers 140, 305). The valve is set to prevent the second interior chamber (e.g., chambers 325a, 325b) from expanding until the first interior chamber (e.g., chambers 320a, 320b) have expanded to contact the facing wellbore wall 145. For instance, the pressure offset value can be a check valve or a manually actuated valve, e.g., set to open or opened when the pressure differential between first and second chambers reaches a certain preselected value.

[0035] In some embodiments, however, the second packer 305 can have only an even surface portion (e.g., portion 315) and serve only as part of isolating the sampling zone.

[0036] As illustrated in FIG. 4, in some embodiments of the apparatus 105, the packer 140 is a central packer and the apparatus further includes second and third packers 405, 410 (e.g., upper and lower packers) disposed along the downhole sampling tool 135, the second and third packers longitudinally spaced apart with the central packer 140 located there-between.

[0037] In some such embodiment, to increase fluid sampling flow rates, the uneven surface portion 207 of the central packers surface (surface 205 FIG. 2) can extend over an entire longitudinal length of the central packer 140 (e.g., from a side proximate to the second packer 405 to a side proximate to the third packer 410).

[0038] In other embodiments, however, the central packer's surface could include both uneven and even surface portions such as discussed in the context of FIGs 2A-3.

[0039] In some embodiments, to increase sampling zone isolation, the second and third packer surfaces 420, 425 can have even surface portions (e.g., portions 412, 415) that extend over entire longitudinal lengths of the second and third packers, respectively, to deter passage of the formation fluids between the even surface portion and the facing wellbore wall.

[0040] In other embodiments, however, one or both of the second and third packer surface could include both uneven and even surface portions, analogous to that discussed for the second packer in the context of FIG. 3.

[0041] For instance, to increase sampling rates, one or both of the second and third packers 405, 410 can include uneven portions having flow channels locatable between the outer surface of the one packer and a facing wellbore wall, the flow channels promoting radial flow of formation fluids to surface conduits leading to flow lines located inside the first and second packers, respectively, analogous to the surface conduits and flow lines discussed in the context of FIGs. 2A-2E.

[0042] For some such embodiments, the uneven surface portions of the second and third packers 405, 410 surface can be located proximate to the central packer 140 and the second and third even portions can be located distal to the central packer 140, analogous to that discussed in the context of FIGs. 2A-2E.

[0043] Another embodiment of the disclosure is a method of obtaining a formation sample using a downhole packer apparatus deployed within a borehole of a subterranean formation. FIG. 5 presents a flow diagram of an example method 500 of obtaining the formation sample in accordance with the present disclosure.

[0044] As illustrated, and with continuing reference to FIGs. 1-4 throughout, the method 500 includes a step 510 of obtaining a formation sample using a downhole packer apparatus 105 deployed within a borehole 125 of a subterranean formation 130.

[0045] Obtaining the sample (step 510) includes a step 515 of disposing the downhole packer apparatus 105 along a downhole sampling tool 135. The downhole packer apparatus includes any embodiments of the packer 140 disclosed in the context of FIGs. 1-4. E.g., an outer surface 205 of the packer includes an uneven surface portion 207 with one or more flow channels 210 locatable between the outer surface 205a of the one packer and a facing wellbore wall, the flow channels promoting radial flow of formation fluids 132 to one or more surface conduits 215 leading to sample flow lines 220 located inside the one packer.

[0046] Obtaining the sample (step 510) includes a step 520 of isolating a sampling zone 150 of the subterranean formation 130 adjacent to the borehole 125 to create a fluid seal between the downhole packer apparatus and a wall 145 of the borehole.

[0047] In some embodiments, isolating the sampling zone 150 (step 520) includes a step 522 of expanding upper and lower packers of the downhole packer apparatus 105 (e.g., second and third packers 405, 410 FIG. 4) and disposed along the downhole sampling tool, wherein the packer 140 is a central packer located between the upper and lower packers.

[0048] In some embodiments, isolating the sampling zone 150 (step 520) includes a step 525 of expanding a chamber 320a underlying an even surface portion 306 of the packer 140, wherein the packer is one of an upper or lower packer of the downhole packer apparatus 105 (e.g., packer 140, FIG. 3). Some such embodiments, can further include a step 527 of expanding a chamber 320b underlying an even surface portion 315 a second packer (e.g., packer 305, FIG. 3), wherein the second packer is the other of a lower or upper packer of the downhole packer apparatus 105 (e.g., packer 140, FIG. 3).

[0049] Obtaining the sample (step 510) can include a step 530 of collecting the formation fluids 132 into the one or more surface conduits 215 to provide the formation sample.

[0050] Some embodiments of the method 500 further include a step 540 of removing a mudcake 147 lining the wall of the sampling zone including flowing drilling fluids through the sampling zone and then inflating a chamber of the packer underlying the uneven surface portion, where the removing step 540 is before the step 525 of collecting the formation fluids 132 and after the step 520 of isolating of the sampling zone 150.

[0051] Some embodiments of the method 500 further include a step 550 of transferring the formation sample by the sample flow lines 220 to a measuring device of the downhole sampling tool (e.g., a sensor of a MWD or LWD tool).

[0052] Each of the foregoing embodiments may include one or more of the following elements singly or in combination, and neither the example embodiments or the following listed elements limit the disclosure, but are provided as examples of the various embodiments covered by the disclosure:

[0053] Element 1: A downhole packer apparatus comprising a packer disposed along a downhole sampling tool, wherein an outer surface of the packer includes an uneven surface portion with one or more flow channels locatable between the outer surface of the one packer and a facing

wellbore wall, the flow channels promoting radial flow of formation fluids to one or more surface conduits leading to flow lines located inside the one packer.

[0054] Element 2: wherein the uneven surface portion includes grooves in the outer surface to thereby define the flow channel.

[0055] Element 3: wherein the uneven surface portion includes raised ridges on the outer surface to thereby define the flow channel.

[0056] Element 4: wherein the one or more flow channel defines a spirally-shaped channel pattern along the uneven surface portion.

[0057] Element 5: wherein the one or more flow channels are non-intersecting and separated from each other along the uneven surface portion.

[0058] Element 6: wherein the one or more flow channel are first channels and the uneven surface portion further includes second flow channels that promote substantially longitudinal flow of the formation fluids between the first channels.

[0059] Element 7: wherein the packer is a first packer and the apparatus further includes a second packer disposed along the downhole sampling tool and the first and second packers are longitudinally spaced apart, and wherein: the uneven surface portion of the first packer is located proximate to the second packer, the first packer surface further includes an even surface portion located distal to the second packer, and the even surface portion deters passage of the formation fluids between the even surface portion and the facing wellbore wall.

[0060] Element 8: wherein an outer surface of the second packer further includes a uneven surface portion with one or more second channels locatable between the outer surface of the second packer and the facing wellbore wall, the second flow channels promoting the radial flow of the formation fluids to one or more second surface conduits leading to second flow lines located inside the second packer.

[0061] Element 9: wherein: the uneven surface portion of the second packer is located proximate to the first packer, the second packer further includes an second even surface portion distal to the first packer, and the second even surface portion deters passage of the formation fluids between the second even surface portion and the facing wellbore wall.

[0062] Element 10: The apparatus of claim 1, wherein the first and second packers each have a first interior chamber underlying the even surface portions and a second interior chamber underlying the uneven surface portion wherein the first and second interior chambers are

connected by a pressure offset valve, the pressure offset valve set to prevent the second interior chambers to expand until the first interior chambers have expanded to contact the facing wellbore wall.

[0063] Element 11: wherein the packer is a central packer and the apparatus further includes second and third packers disposed along the downhole sampling tool, the second and third packers longitudinally spaced apart with the central packer located there-between.

[0064] Element 12: wherein the uneven surface of the central packer extends over an entire longitudinal length of the central packer.

[0065] Element 13: wherein the second and third packers have even surface portions that extend over entire longitudinal lengths of the second and third packers.

[0066] Element 14: The apparatus of claim 11, wherein one or both of the second and third packers, include uneven surface portions having flow channels locatable between the outer surface of the one packer and a facing wellbore wall, the flow channels promoting radial flow of formation fluids to surface conduits leading to flow lines located inside the first and second packers.

[0067] Element 15: The apparatus of claim 1, wherein the downhole packer apparatus is included in a system for drilling operations of a subterranean formation.

[0068] Element 16: A method, comprising: obtaining a formation sample using a downhole packer apparatus deployed within a borehole of a system for drilling operations of a subterranean formation, including: disposing the downhole packer apparatus along a downhole sampling tool, wherein the downhole packer apparatus includes a packer, an outer surface of the packer includes an uneven surface portion with one or more flow channels locatable between the outer surface of the one packer and a facing wellbore wall, the flow channels promoting radial flow of formation fluids to one or more surface conduits leading to sample flow lines located inside the one packer; isolating a sampling zone of the subterranean formation adjacent to the borehole to create a fluid seal between the downhole packer apparatus and a wall of the borehole; and collecting the formation fluids into the one or more surface conduits to provide the formation sample.

[0069] Element 17: further including removing a mudcake lining the wall of the sampling zone including flowing drilling fluids through the sampling zone and then inflating a chamber of the

packer underlying the uneven surface portion, wherein the removing is before collecting the formation fluids and after the isolating of the sampling zone.

[0070] Element 18: wherein isolating the sampling zone includes expanding upper and lower packers of the downhole packer apparatus and disposed along the downhole sampling tool, wherein the packer is a central packer located between the upper and lower packers.

[0071] Element 19: wherein isolating the sampling zone includes expanding a chamber underlying an even surface portion of the packer, wherein the packer is one of an upper or lower packer of the downhole packer apparatus.

[0072] Element 20: wherein isolating the sampling zone includes expanding a chamber underlying an even surface portion a second packer, wherein the second packer is the other of a lower or upper packer of the downhole packer apparatus.

[0073] The foregoing listed embodiments and elements do not limit the disclosure to just those listed above, and those skilled in the art to which this application relates will appreciate that other and further additions, deletions, substitutions and modifications may be made to the described embodiments.

WHAT IS CLAIMED IS:

1. A downhole packer apparatus, comprising:
a packer disposed along a downhole sampling tool, wherein an outer surface of the packer includes an uneven surface portion with one or more flow channels locatable between the outer surface of the one packer and a facing wellbore wall, the flow channels promoting radial flow of formation fluids to one or more surface conduits leading to flow lines located inside the one packer.
2. The apparatus of claim 1, wherein the uneven surface portion includes grooves in the outer surface to thereby define the flow channel.
3. The apparatus of claim 1, wherein the uneven surface portion includes raised ridges on the outer surface to thereby define the flow channel.
4. The apparatus of claim 1, wherein the one or more flow channel defines a spirally-shaped channel pattern along the uneven surface portion.
5. The apparatus of claim 1, wherein the one or more flow channels are non-intersecting and separated from each other along the uneven surface portion.
6. The apparatus of claim 1, wherein the one or more flow channel are first channels and the uneven surface portion further includes second flow channels that promote substantially longitudinal flow of the formation fluids between the first channels.
7. The apparatus of claim 1, wherein the packer is a first packer and the apparatus further includes a second packer disposed along the downhole sampling tool and the first and second packers are longitudinally spaced apart, and wherein:
the uneven surface portion of the first packer is located proximate to the second packer,
the first packer surface further includes an even surface portion located distal to the second packer, and
the even surface portion deters passage of the formation fluids between the even surface portion and the facing wellbore wall.
8. The apparatus of claim 7, wherein an outer surface of the second packer further includes a uneven surface portion with one or more second channels locatable between the outer surface of the second packer and the facing wellbore wall, the second flow channels promoting

the radial flow of the formation fluids to one or more second surface conduits leading to second flow lines located inside the second packer.

9. The apparatus of claim 8, wherein:

the uneven surface portion of the second packer is located proximate to the first packer,

the second packer further includes an second even surface portion distal to the first packer, and

the second even surface portion deters passage of the formation fluids between the second even surface portion and the facing wellbore wall.

10. The apparatus of claim 1, wherein the first and second packers each have a first interior chamber underlying the even surface portions and a second interior chamber underlying the uneven surface portion wherein the first and second interior chambers are connected by a pressure offset valve, the pressure offset valve set to prevent the second interior chambers to expand until the first interior chambers have expanded to contact the facing wellbore wall.

11. The apparatus of claim 1, wherein the packer is a central packer and the apparatus further includes second and third packers disposed along the downhole sampling tool, the second and third packers longitudinally spaced apart with the central packer located there-between.

12. The apparatus of claim 11, wherein the uneven surface of the central packer extends over an entire longitudinal length of the central packer.

13. The apparatus of claim 11, wherein the second and third packers have even surface portions that extend over entire longitudinal lengths of the second and third packers.

14. The apparatus of claim 11, wherein one or both of the second and third packers, include uneven surface portions having flow channels locatable between the outer surface of the one packer and a facing wellbore wall, the flow channels promoting radial flow of formation fluids to surface conduits leading to flow lines located inside the first and second packers.

15. The apparatus of claim 1, wherein the downhole packer apparatus is included in a system for drilling operations of a subterranean formation.

16. A method, comprising:

obtaining a formation sample using a downhole packer apparatus deployed within a borehole of a system for drilling operations of a subterranean formation, including:

disposing the downhole packer apparatus along a downhole sampling tool, wherein the downhole packer apparatus includes a packer, an outer surface of the packer

includes an uneven surface portion with one or more flow channels locatable between the outer surface of the one packer and a facing wellbore wall, the flow channels promoting radial flow of formation fluids to one or more surface conduits leading to sample flow lines located inside the one packer;

isolating a sampling zone of the subterranean formation adjacent to the borehole to create a fluid seal between the downhole packer apparatus and a wall of the borehole; and

collecting the formation fluids into the one or more surface conduits to provide the formation sample.

17. The method of claim 16, further including removing a mudcake lining the wall of the sampling zone including flowing drilling fluids through the sampling zone and then inflating a chamber of the packer underlying the uneven surface portion, wherein the removing is before collecting the formation fluids and after the isolating of the sampling zone.

18. The method of claim 16, wherein isolating the sampling zone includes expanding upper and lower packers of the downhole packer apparatus and disposed along the downhole sampling tool, wherein the packer is a central packer located between the upper and lower packers.

19. The method of claim 16, wherein isolating the sampling zone includes expanding a chamber underlying an even surface portion of the packer, wherein the packer is one of an upper or lower packer of the downhole packer apparatus.

20. The method of claim 16, wherein isolating the sampling zone includes expanding a chamber underlying an even surface portion a second packer, wherein the second packer is the other of a lower or upper packer of the downhole packer apparatus.

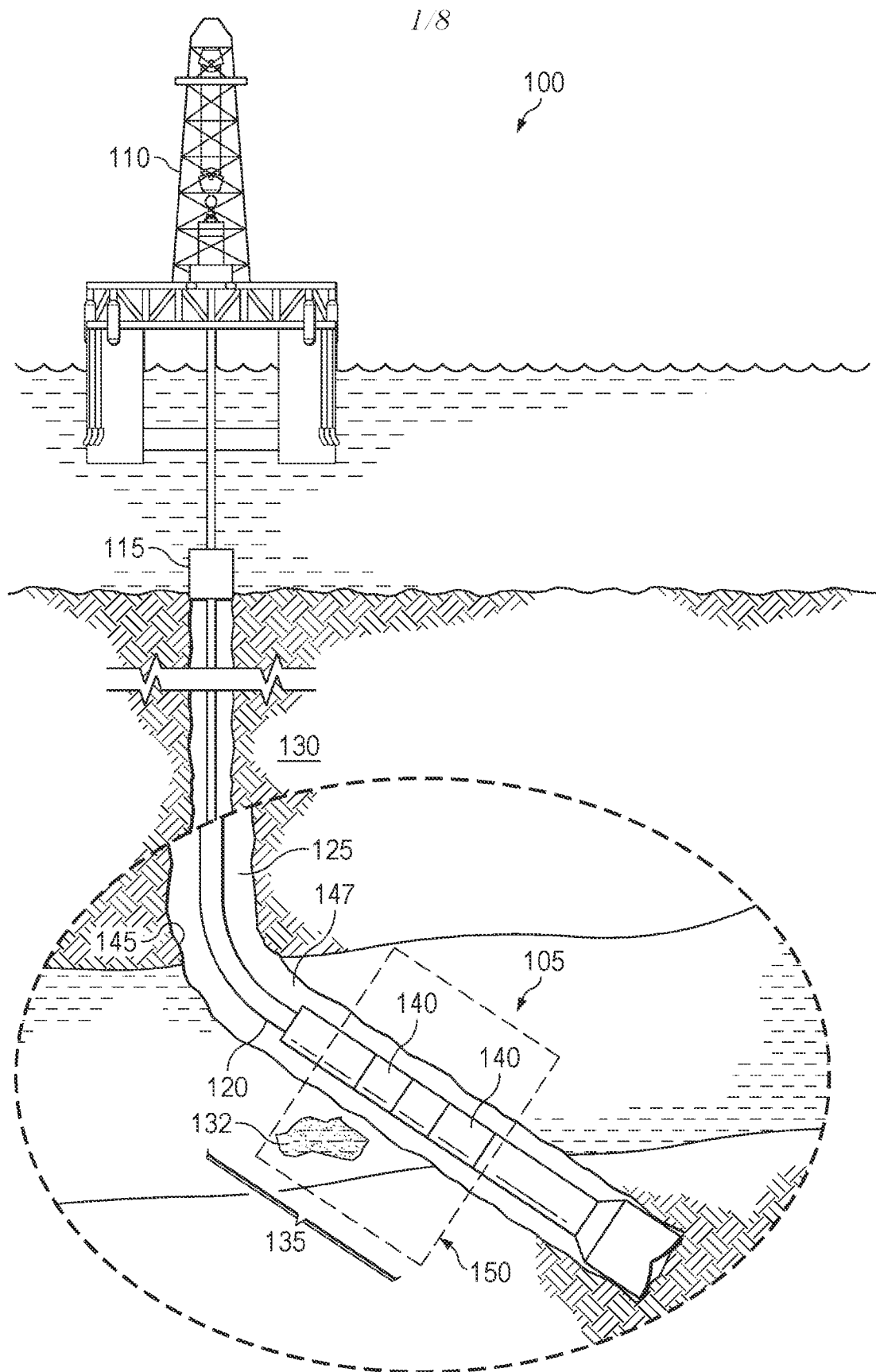


FIG. 1

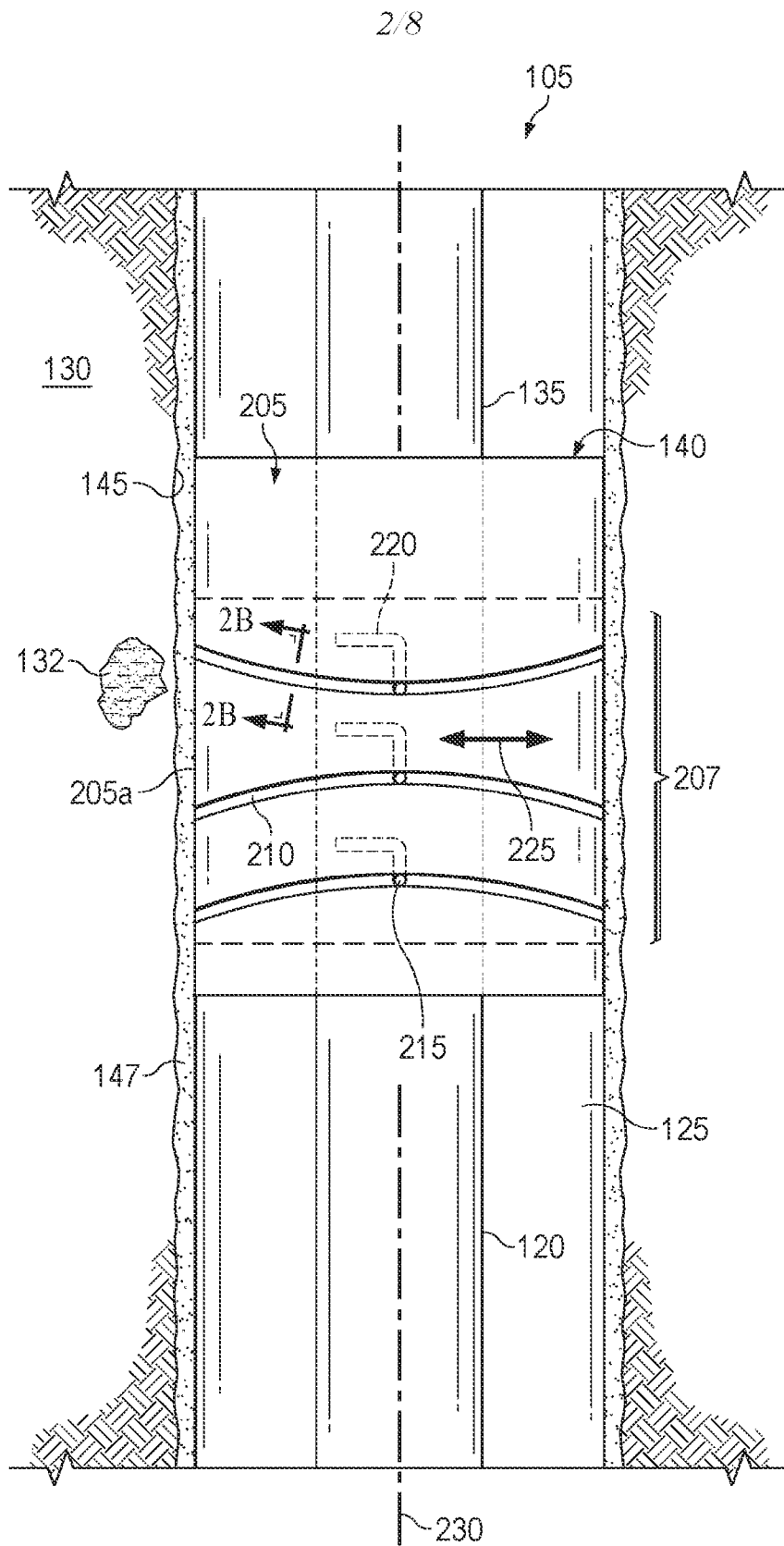


FIG. 2A

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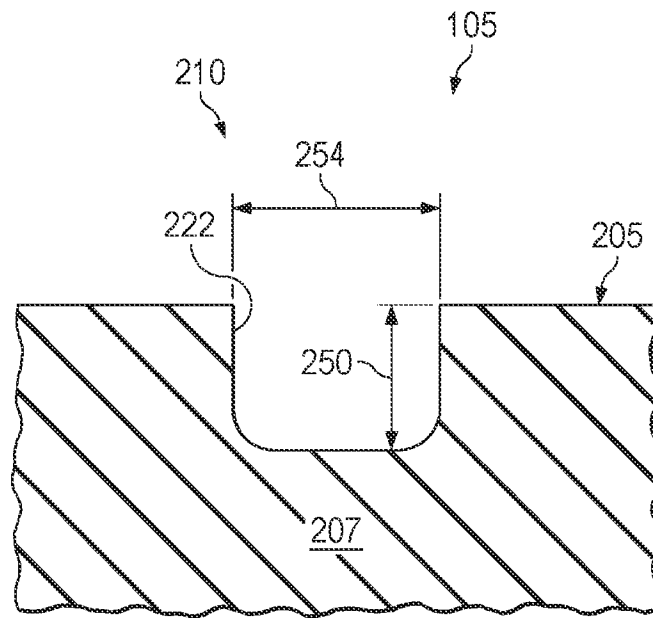


FIG. 2B

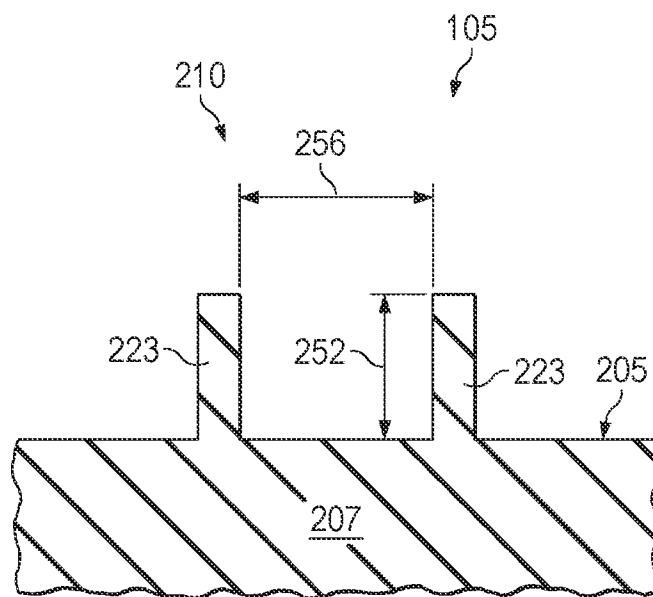


FIG. 2C

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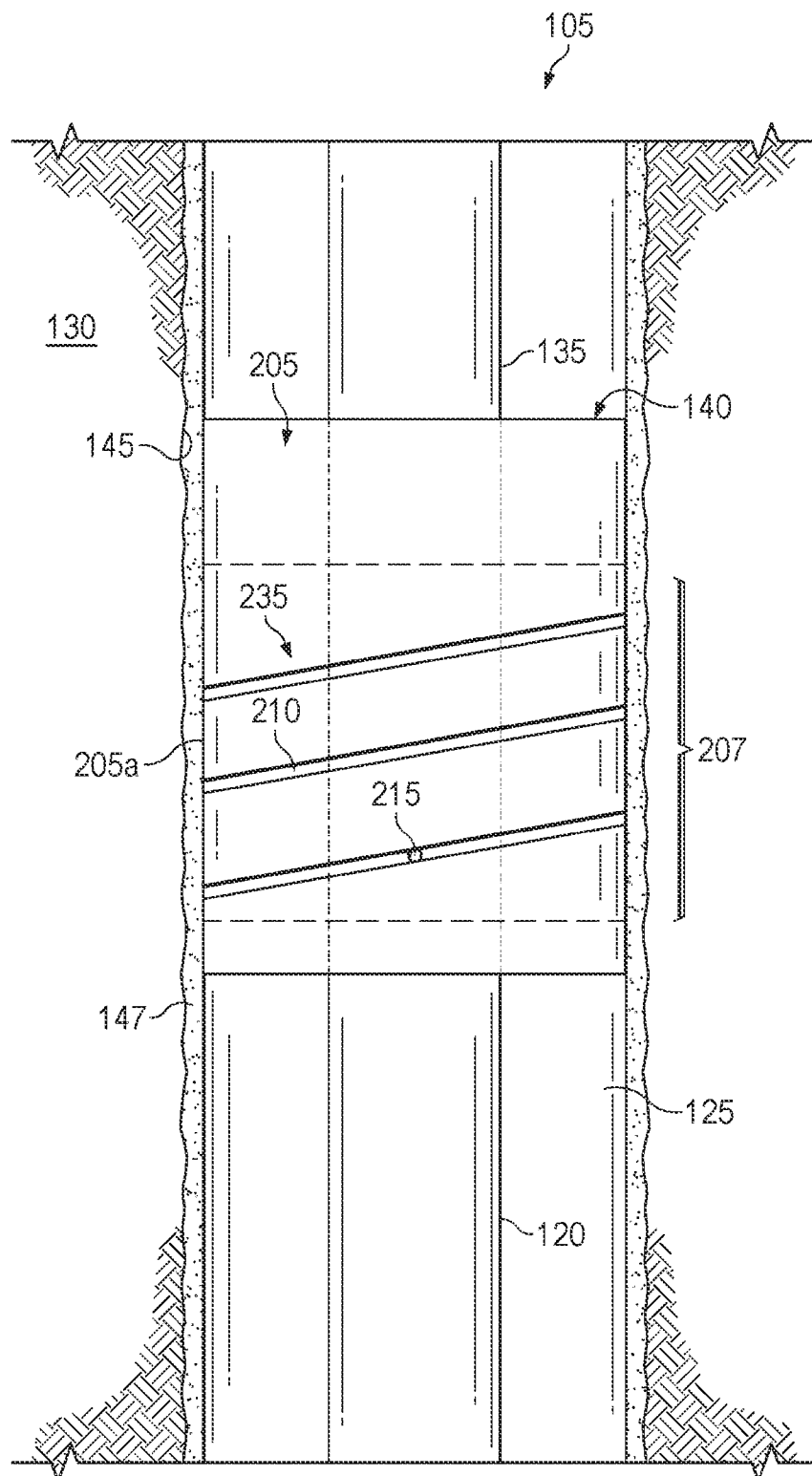


FIG. 2D

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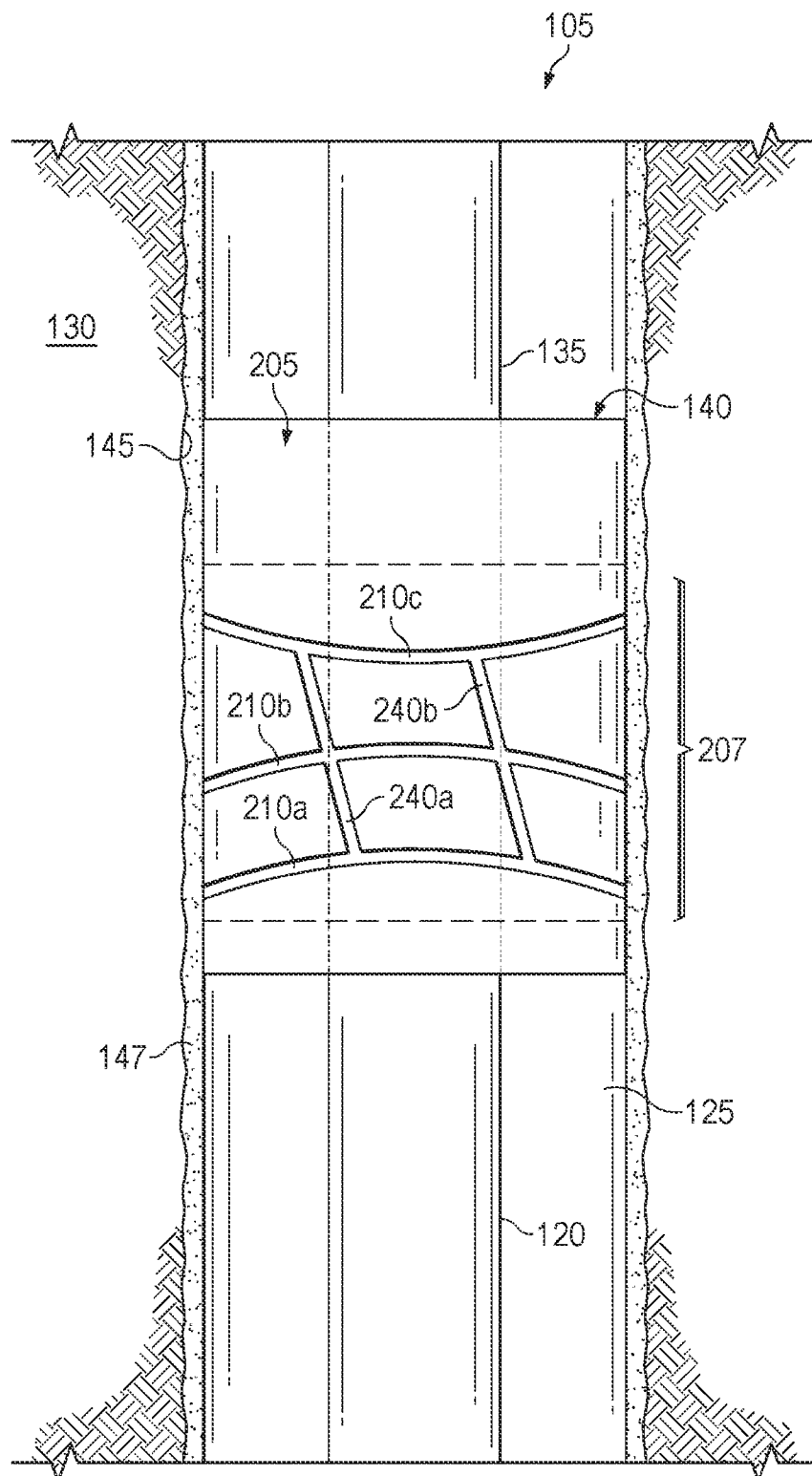


FIG. 2E

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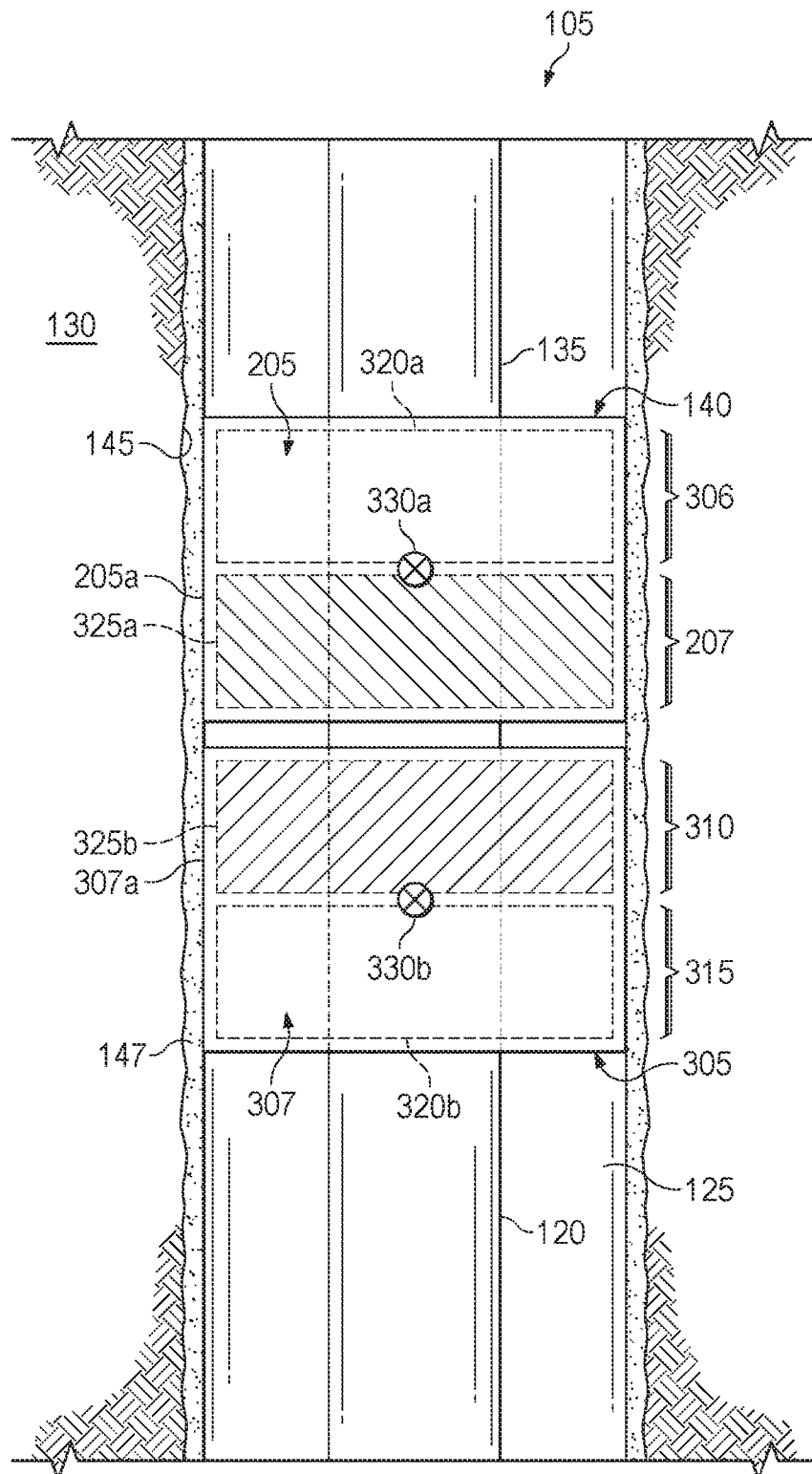


FIG. 3

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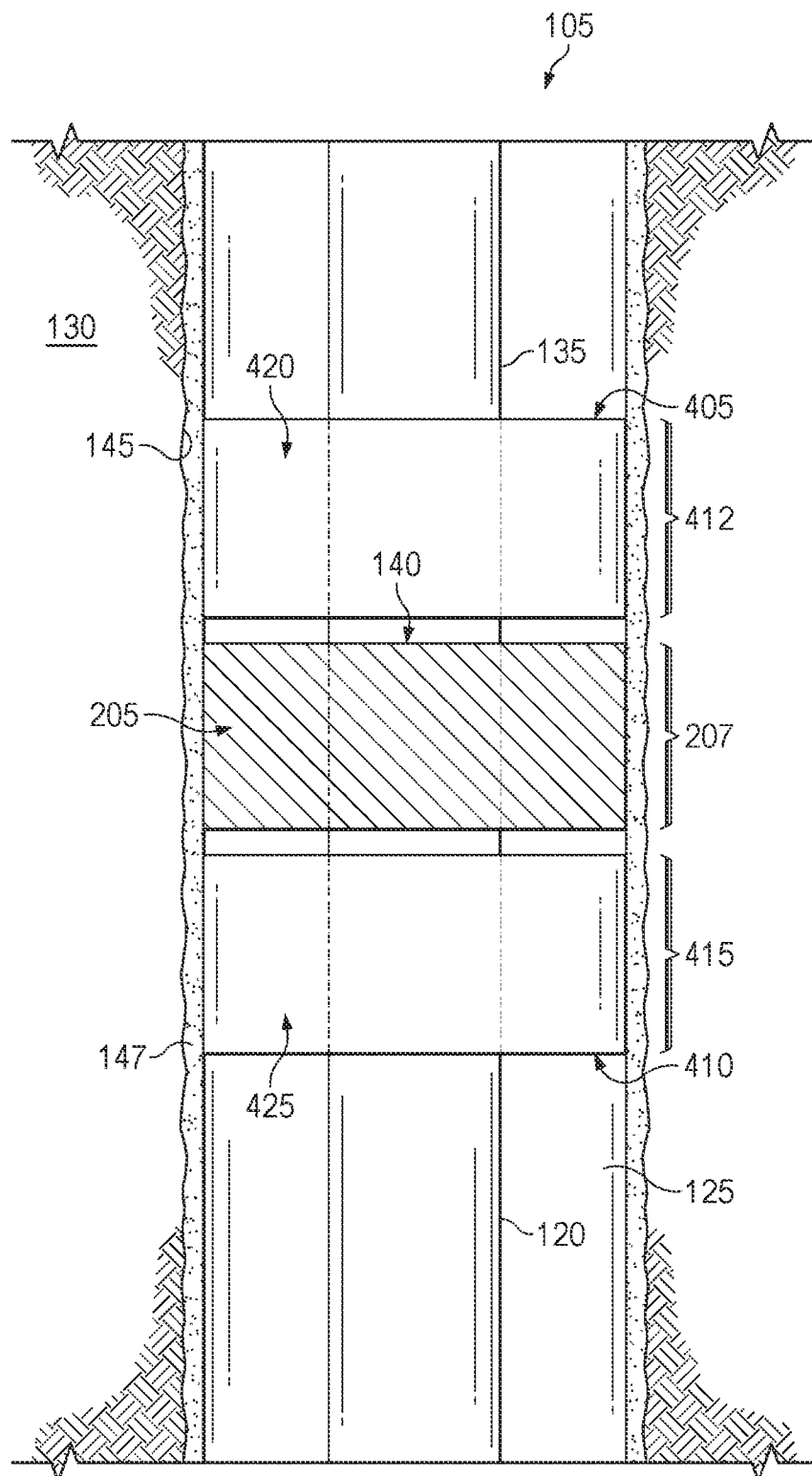


FIG. 4

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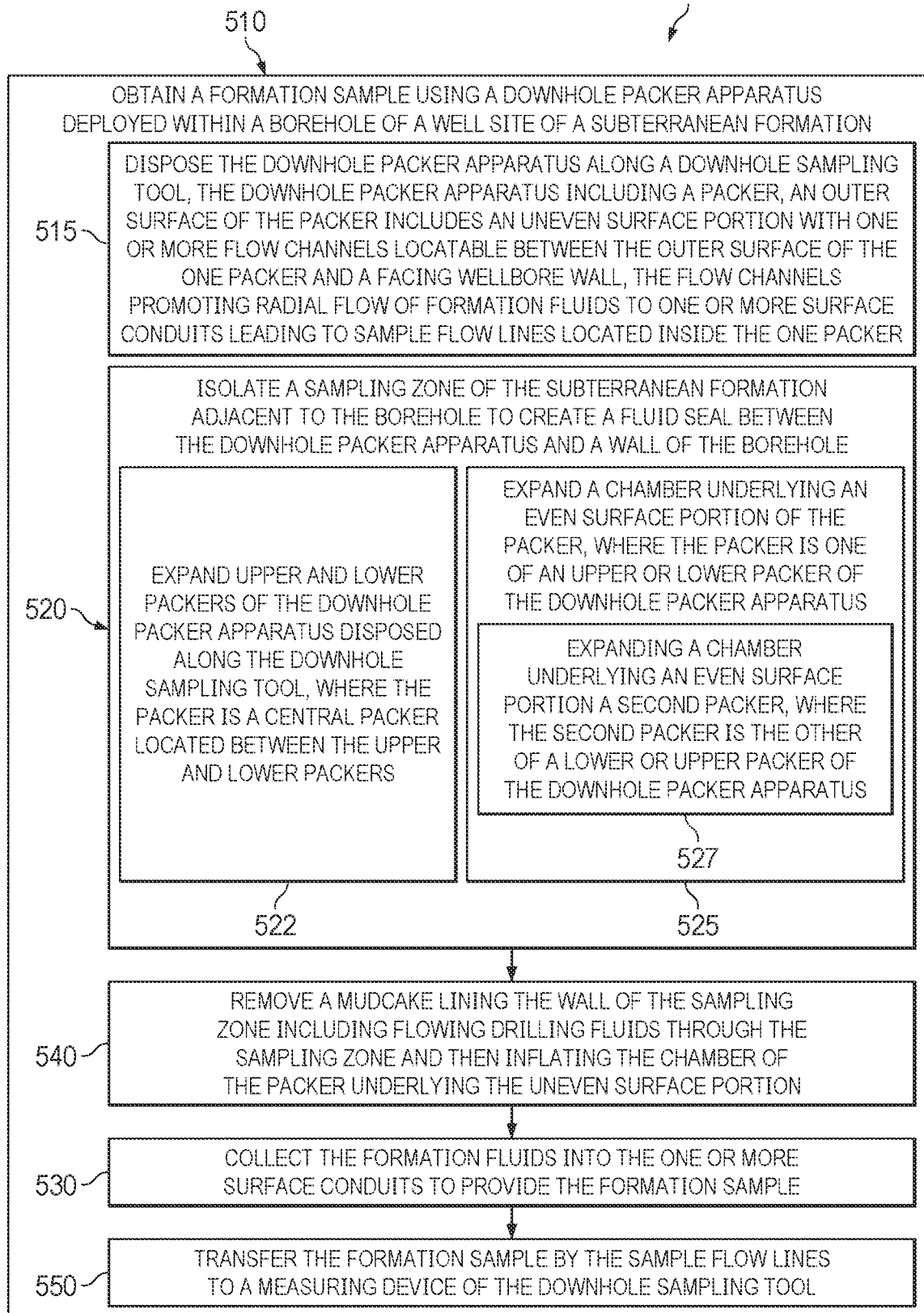


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2023/076469

A. CLASSIFICATION OF SUBJECT MATTER		
E21B 49/02(2006.01)i; E21B 49/10(2006.01)i; E21B 33/12(2006.01)i; E21B 33/127(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 49/02(2006.01); E21B 33/127(2006.01); E21B 36/00(2006.01); E21B 43/04(2006.01); E21B 43/16(2006.01); E21B 43/24(2006.01); E21B 43/26(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: packer, uneven surface, flow channel, flow line, conduit		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2008-0179055 A1 (BASKI, HENRY A.) 31 July 2008 (2008-07-31) paragraphs [0002], [0009], [0040]-[0053], [0072] and figures 1-2C, 6C	1-2,5-6,15-17
Y		3-4,7-14,18-20
Y	US 8833440 B1 (DICKINSON DOUGLAS RAY) 16 September 2014 (2014-09-16) column 7, lines 44-59 and figures 1C-1, 1C-2	3-4
Y	US 2978046 A1 (JERSEY PRODUCTION RESEARCH COMPANY) 04 April 1961 (1961-04-04) column 2, lines 50 – 64 and figures 1-3	7-10
Y	US 2015-0096756 A1 (THE BOARD OF REGENTS OF THE UNIVERSITY OF TEXAS SYSTEM) 09 April 2015 (2015-04-09) paragraph [0066] and figure 1	11-14,18-20
A	US 4995456 A (CORNETTE et al.) 26 February 1991 (1991-02-26) claims 1-2 and figures 1-4	1-20
☐ 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 05 March 2024		Date of mailing of the international search report 05 March 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 Wook Telephone No. +82-42-481-3405

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/US2023/076469

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)		Publication date (day/month/year)
US	2008-0179055	A1	31 July 2008	US	7721799 B2	25 May 2010
US	8833440	B1	16 September 2014	None		
US	2978046	A1	04 April 1961	None		
US	2015-0096756	A1	09 April 2015	US	9562422 B2	07 February 2017
				WO	2013-159007 A1	24 October 2013
US	4995456	A	26 February 1991	None		