



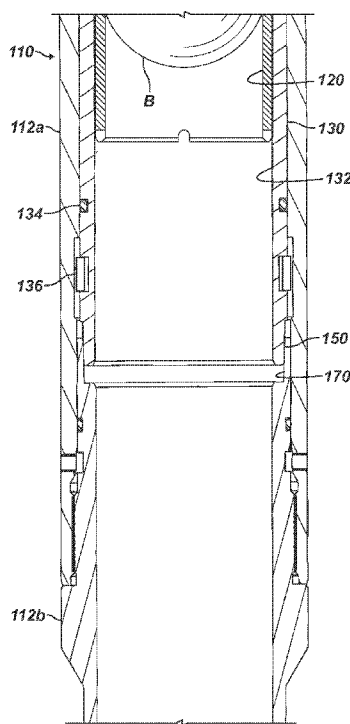
- (51) International Patent Classification:
E21B 34/14 (2006.01)
- (21) International Application Number:
PCT/US2014/022011
- (22) International Filing Date:
7 March 2014 (07.03.2014)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
13/789,984 8 March 2013 (08.03.2013) 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, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, 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, 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).

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(54) Title: ANTI-ROTATION ASSEMBLY FOR SLIDING SLEEVE



(57) Abstract: A sliding sleeve has an inner sleeve that moves in a housing. For example, the inner sleeve can move open relative to a port in the housing when a deployed ball engages a seat in the inner sleeve. Because the seat and the ball (if remaining) are preferably milled out of the inner sleeve after use, the inner sleeve preferably does not rotate in the housing during milling operations. To accomplish this, an anti-rotation clutch assembly in the sliding sleeve helps prevent the inner sleeve from rotating. A wedged cone is formed on a distal end of the inner sleeve and press fits into a cupped shoulder on the inside of the sleeve's housing.





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ANTI-ROTATION ASSEMBLY FOR SLIDING SLEEVE

BACKGROUND OF THE DISCLOSURE

[0001] In a staged fracturing operation, multiple zones of a formation need to be isolated sequentially for treatment. To achieve this, operators install a fracturing assembly down the wellbore, which typically has a top liner packer, open hole packers isolating the wellbore into zones, various sliding sleeves, and a wellbore isolation valve. When the zones do not need to be closed after opening, operators may use single shot sliding sleeves for the fracturing treatment. These types of sleeves are usually ball-actuated and lock open once actuated. Another type of sleeve is also ball-actuated, but can be shifted closed after opening.

[0002] Initially, operators run the fracturing assembly in the wellbore with all of the sliding sleeves closed and with the wellbore isolation valve open. Operators then deploy a setting ball to close the wellbore isolation valve. This seals off the tubing string of the assembly so the packers can be hydraulically set. At this point, operators rig up fracturing surface equipment and pump fluid down the wellbore to open a pressure actuated sleeve so a first zone can be treated.

[0003] As the operation continues, operators drop successively larger balls down the tubing string and pump fluid to treat the separate zones in stages. When a dropped ball meets its matching seat in a sliding sleeve, the pumped fluid forced against the seated ball shifts the sleeve open. In turn, the seated ball diverts the pumped fluid into the adjacent zone and prevents the fluid from passing to lower zones. By dropping successively increasing sized balls to actuate corresponding sleeves, operators can accurately treat each zone up the wellbore.

[0004] Figure 1A shows an example of a sliding sleeve 10 for a multi-zone fracturing system in partial cross-section in an opened state. This sliding sleeve 10 is similar to Weatherford's ZoneSelect MultiShift fracturing sliding sleeve and can be placed between isolation packers in a multi-zone completion. The sliding sleeve 10 includes a housing 20

defining a bore 25 and having upper and lower subs 22 and 24. An inner sleeve or insert 30 can be moved within the housing's bore 25 to open or close fluid flow through the housing's flow ports 26 based on the inner sleeve 30's position.

[0005] When initially run downhole, the inner sleeve 30 positions in the housing 20 in a closed state. A breakable retainer 38 initially holds the inner sleeve 30 toward the upper sub 22, and a locking ring or dog 36 on the sleeve 30 fits into an annular slot within the housing 20. Outer seals on the inner sleeve 30 engage the housing 20's inner wall above and below the flow ports 26 to seal them off.

[0006] The inner sleeve 30 defines a bore 35 having a seat 40 fixed therein. When an appropriately sized ball lands on the seat 40, the sliding sleeve 10 can be opened when tubing pressure is applied against the seated ball 40 to move the inner sleeve 30 open. To open the sliding sleeve 10 in a fracturing operation once the appropriate amount of proppant has been pumped into a lower formation's zone, for example, operators drop an appropriately sized ball B downhole and pump the ball B until it reaches the landing seat 40 disposed in the inner sleeve 30.

[0007] Once the ball B is seated, built up pressure forces against the inner sleeve 30 in the housing 20, shearing the breakable retainer 38 and freeing the lock ring or dog 36 from the housing's annular slot so the inner sleeve 30 can slide downward. As it slides, the inner sleeve 30 uncovers the flow ports 26 so flow can be diverted to the surrounding formation. The shear values required to open the sliding sleeves 10 can range generally from 1,000 to 4,000 psi (6.9 to 27.6 MPa).

[0008] Once the sleeve 10 is open, operators can then pump proppant at high pressure down the tubing string to the open sleeve 10. The proppant and high pressure fluid flows out of the open flow ports 26 as the seated ball B prevents fluid and proppant from communicating further down the tubing string. The pressures used in the fracturing operation can reach as high as 15,000-psi.

[0009] After the fracturing job, the well is typically flowed clean, and the ball B is floated to the surface. Then, the ball seat 40 (and the ball B if remaining) is milled out. The ball seat 40 can be constructed from cast iron to facilitate milling, and the ball B can be composed of aluminum or a non-metallic material, such as a composite. Once milling is complete, the inner sleeve 30 can be closed or opened with a standard “B” shifting tool on the tool profiles 32 and 34 in the inner sleeve 30 so the sliding sleeve 10 can then function like any conventional sliding sleeve shifting with a “B” tool. The ability to selectively open and close the sliding sleeve 10 enables operators to isolate the particular section of the assembly.

[0010] When aluminum balls B are used, more sliding sleeves 10 can be used due to the close tolerances that can be used between the diameters of the aluminum balls B and iron seats 40. For example, forty different increments can be used for sliding sleeves 10 having solid seats 40 used to engage aluminum balls B. However, an aluminum ball B engaged in a seat 40 can be significantly deformed when high pressure is applied against it. Any variations in pressuring up and down that allow the aluminum ball B to seat and to then float the ball B may alter the shape of the ball B compromising its seating ability. Additionally, aluminum balls B can be particularly difficult to mill out of the sliding sleeve 10 due to their tendency of rotating during the milling operation. For this reason, composite balls B are preferred.

[0011] The subject matter of the present disclosure is directed to overcoming, or at least reducing the effects of, one or more of the problems set forth above.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] Fig. 1A illustrates a sliding sleeve having a ball engaged with a seat to open the sliding sleeve according to the prior art.

[0013] Fig. 1B illustrates a close up view of the sliding sleeve in Fig. 1B.

[0014] Fig. 2A illustrates a cross-sectional view of a sliding sleeve according to the present disclosure.

[0015] Fig. 2B illustrates a detailed view of the sliding sleeve in Fig. 2A.

[0016] Figs. 3A-3D respectively illustrate a cross-sectional view, an end view, a perspective view, and a detailed view of the inner sleeve of the disclosed sliding sleeve.

[0017] Fig. 4 illustrates a cross-sectional view of the upper housing section of the disclosed sliding sleeve.

[0018] Figs. 5A-5B respectively illustrate a cross-sectional view and a detailed view of the lower housing section of the disclosed sliding sleeve.

DETAILED DESCRIPTION OF THE DISCLOSURE

[0019] Fig. 2A illustrates a cross-sectional view of a sliding sleeve 100 according to the present disclosure. The sliding sleeve 100 has a housing 110 comprised of upper and lower housing sections 112a-b that couple together for assembly. Inside the bore 114 of the housing 110, the sleeve 100 has an inner sleeve 130 that is moveable therein between an upper position (not shown) and a lower position (shown).

[0020] As discussed previously, the sliding sleeve 100 can have a ball seat 120 disposed in the bore 132 of the inner sleeve 130 to engage a ball B. Moreover, the housing 110 may define flow ports 116 for passage of fluid out of the sleeve 100 when the inner sleeve 130 is moved to its lower position. The sliding sleeve 100 also includes various seals 134, shear screws (not shown), lock ring (136), and other common components, which may not be depicted but would be present as will be appreciated.

[0021] As discussed previously, sometimes the ball B and seat 120 in the inner sleeve 130 need to be milled out. For example, the ball B may not dislodge from the seat 120 to be floated to the surface. In any event, a milling operation mills out the seat 120 and the ball B (if present) from the inner sleeve 130 so the sliding sleeve defines full bore 132 for operations. To facilitate this milling procedure, the inner sleeve 130 preferably does not rotate or at least inhibits its rotation so that the rotating drill bit used in

the milling operation can be applied more directly to the seat 120 and ball B (if any).

[0022] As best shown in Figure 2B, the sliding sleeve 100 has an anti-rotation clutch assembly that helps prevent the inner sleeve 130 from rotating. In particular, the distal end of the inner sleeve 130 defines a wedged cone 150. When the inner sleeve 130 is moved to its lower position shown in Figures 2A-2B and is forced further downward by any pressure build-up or other force, the wedged cone 150 engages in a deepening press fit into a cupped shoulder 170 defines on the lower housing section 112b.

[0023] Details of the inner sleeve 130 and its wedged cone 150 are further shown in Figures 3A-3D, which respectively illustrate the inner sleeve 130 in cross-sectional, end, perspective, and detailed views. The wedged cone 150 on the distal end of the inner sleeve 130 angles inward by an angle (α). The angle (α) may be about 1.5-degrees ($\pm$ 0.5-degrees), and the wedged cone 150 may extend a distance of about 1-in. when the inner sleeve 130 is about 13-in. long and defines an inner dimension of about 4-in. In fact, the cone 150 can have a 1-in. Morse taper #0. Other values can be provided for different implementations.

[0024] Scores 152 are defined at locations around the circumference of the wedged cone 150 and run along the length of the wedged cone 150. As shown, eight such scores 152 may be provided, but more or less may be used. The scores 152 can facilitate the press fit of the wedged cone 150 into the cupped shoulder (170) of the lower housing section (112b), as disclosed herein. Other than or in addition to the scores 152, the cone 150 can have knurled surfacing or other modifications to facilitate the press fit.

[0025] Figure 4 illustrates a cross-sectional view of the upper housing section 112a. Features of this section 112a may be similar to those conventionally used. However, further details of the lower housing section 112b are provided in Figures 5A-5B, which respectively illustrate cross-sectional and detailed views of the lower housing section 112b. The

cupped shoulder 170 has an inner surface 172 that is relatively perpendicular to a stopping shoulder 174.

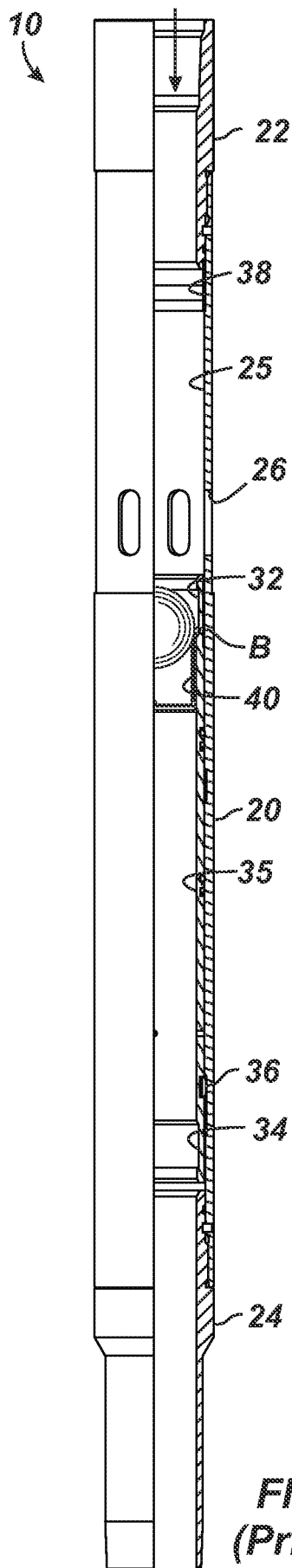
[0026] The inner surface 172 defines an angle (β) and press fits around the wedged cone (150) of the inner sleeve (130). The angle (β) may be about 1.5-degrees ($\pm$ 0.5-degrees), and the sidewall 172 may extend a distance of about 1-in. when the inner sleeve 130 is about 13-in. long. In fact, the sidewall 172 can have a 1-in. Morse taper #0. Other values can be provided for different implementations.

[0027] The foregoing description of preferred and other embodiments is not intended to limit or restrict the scope or applicability of the inventive concepts conceived of by the Applicants. It will be appreciated with the benefit of the present disclosure that features described above in accordance with any embodiment or aspect of the disclosed subject matter can be utilized, either alone or in combination, with any other described feature, in any other embodiment or aspect of the disclosed subject matter. Accordingly, features and materials disclosed with reference to one embodiment herein can be used with features and materials disclosed with reference to any other embodiment.

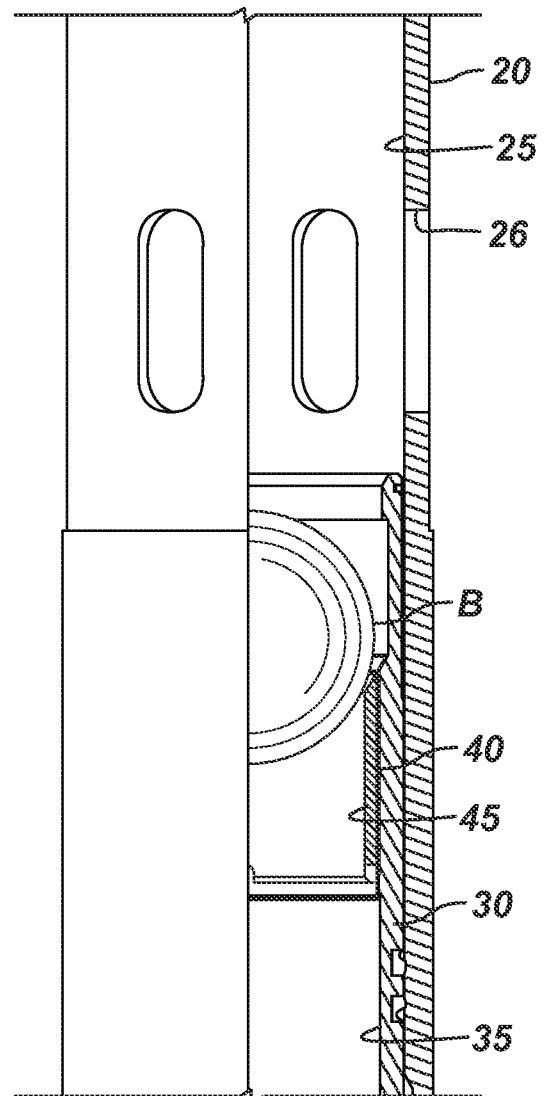
[0028] In exchange for disclosing the inventive concepts contained herein, the Applicants desire all patent rights afforded by the appended claims. Therefore, it is intended that the appended claims include all modifications and alterations to the full extent that they come within the scope of the following claims or the equivalents thereof.

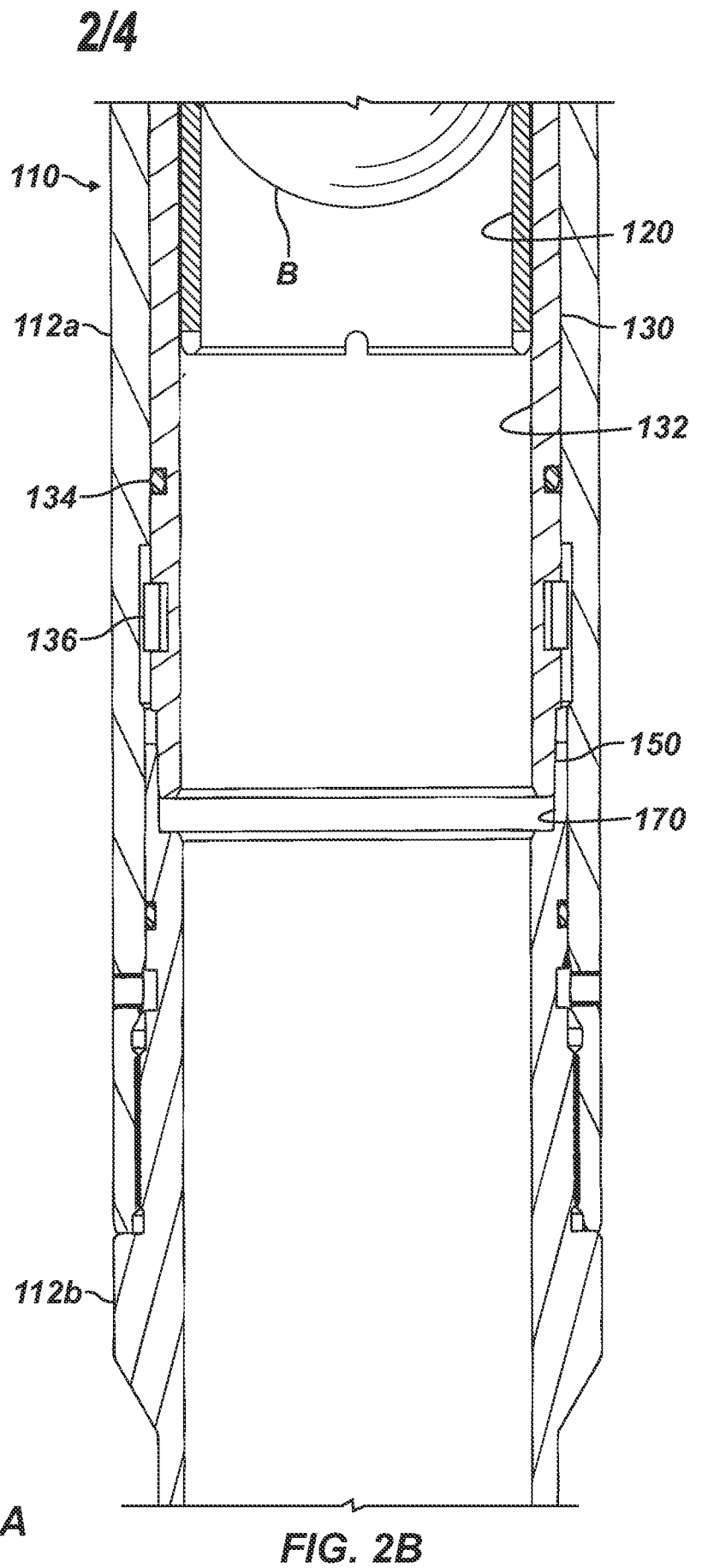
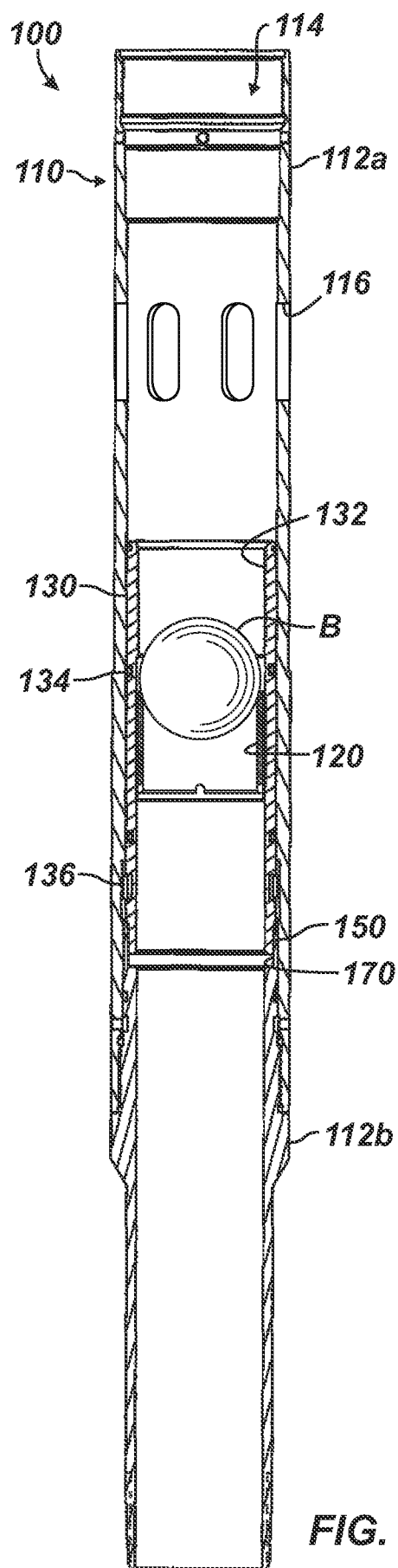
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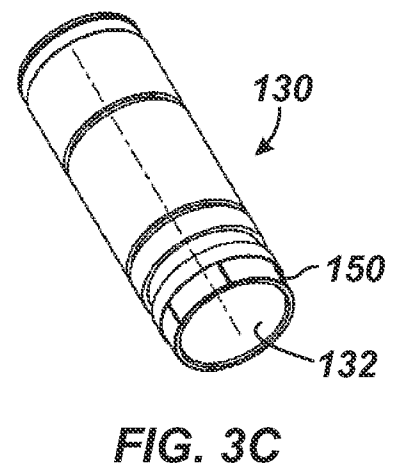
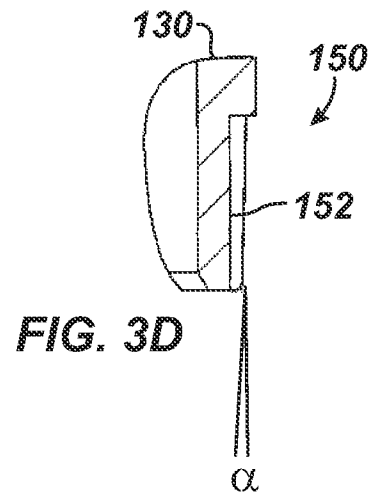
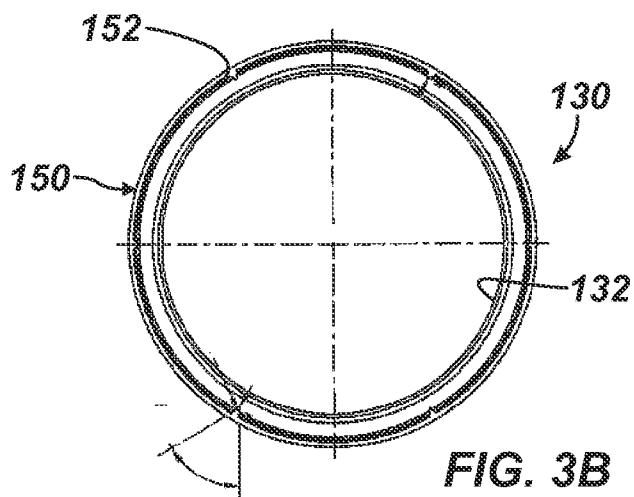
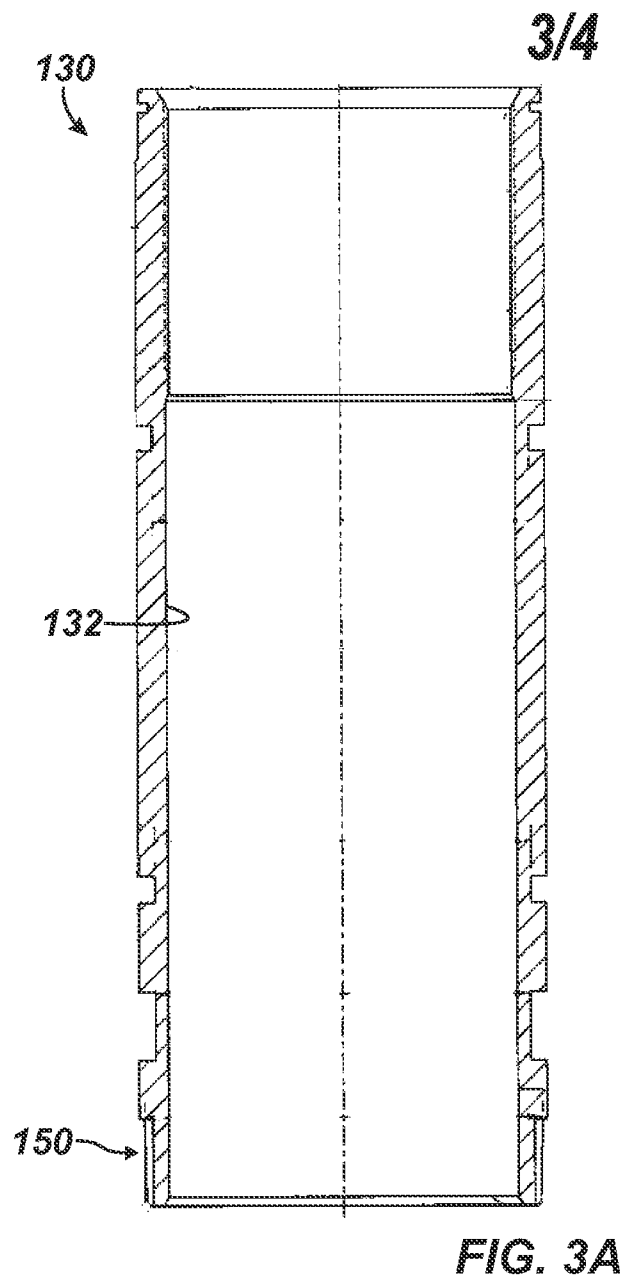
1. A sliding sleeve, comprising:
a housing defining a bore and defining a cupped shoulder therein;
an inner sleeve movably disposed in the bore from a first position to
a second position,
the inner sleeve having a wedged cone formed on a distal end of
the inner sleeve,
the wedged cone press fitting in the cupped shoulder of the housing
and inhibiting rotation of the inner sleeve while in the second
position.
2. The sliding sleeve of claim 1, wherein the wedged cone defines a
plurality of axial scores defined about a circumference of the wedged
cone.
3. The sliding sleeve of claim 1, wherein the cupped shoulder defines
an inner wall disposed about a circumference of the bore and being
substantially parallel to the axis of the sliding sleeve.
4. The sliding sleeve of claim 3, wherein the cupped shoulder defines
a stopping surface perpendicular to the inner wall.
5. The sliding sleeve of claim 1, wherein the inner sleeve comprises a
ball seat disposed therein.
6. The sliding sleeve of claim 1, wherein the inner sleeve in the first
position closes a port defined in the housing, and wherein the inner
sleeve in the second position opens the port to the bore of the housing.



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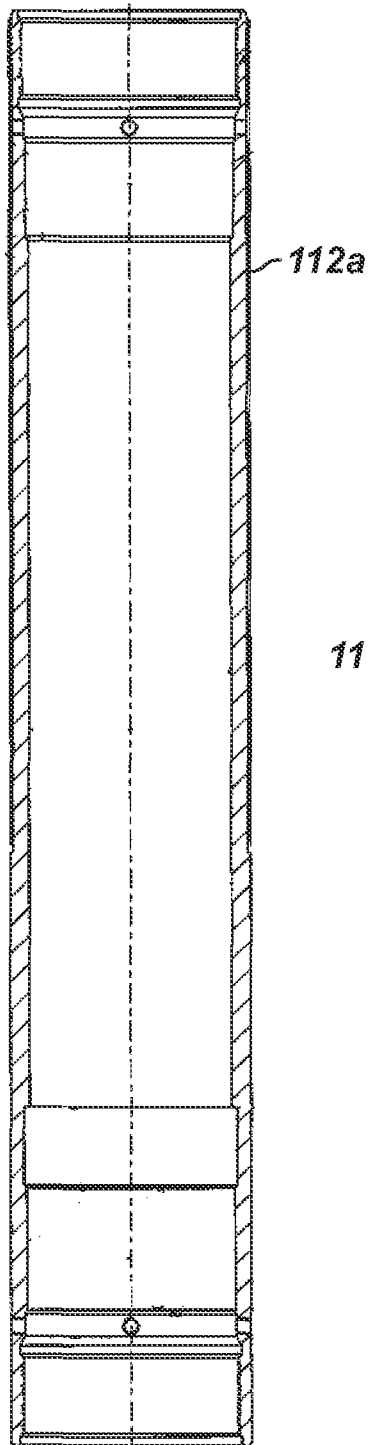


FIG. 4

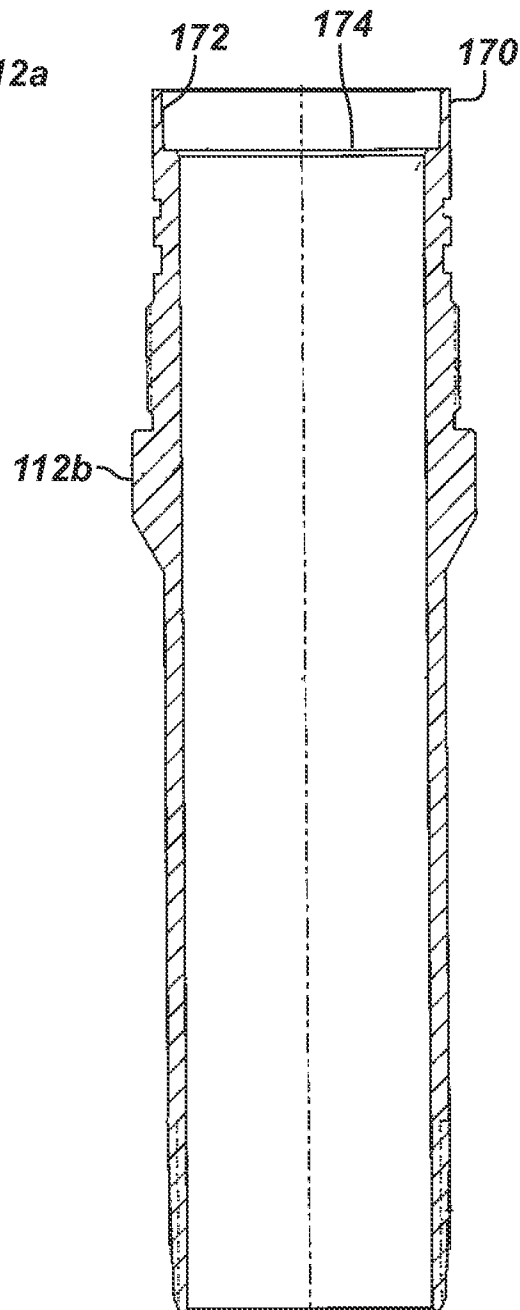


FIG. 5A

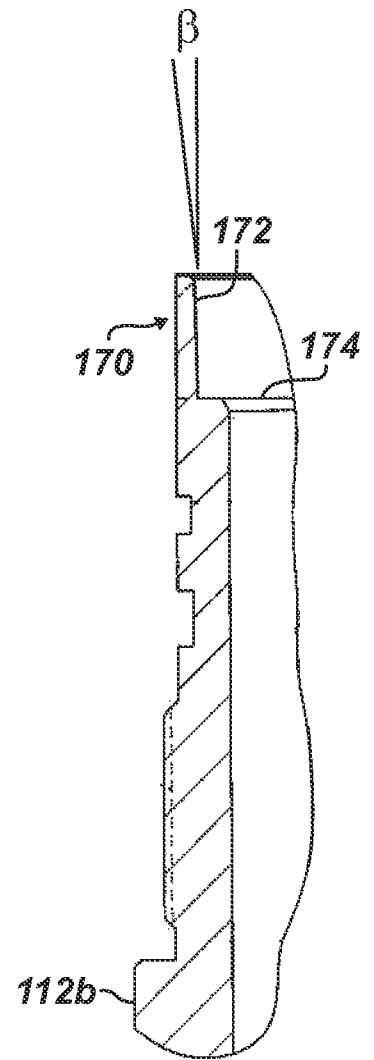


FIG. 5B