

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

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
30 June 2011 (30.06.2011)

(10) International Publication Number
WO 2011/079264 A2

PCT

(51) International Patent Classification:

E21B 23/06 (2006.01) *F16J 15/00* (2006.01)
E21B 33/12 (2006.01)

(21) International Application Number:

PCT/US2010/062004

(22) International Filing Date:

23 December 2010 (23.12.2010)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

12/646,421 23 December 2009 (23.12.2009) US

(71) Applicant (for all designated States except US): **BAKER HUGHES INCORPORATED** [US/US]; Po Box 4740, Houston, Texas 77210-4740 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **GAUDETTE, Sean L.** [US/US]; 23322 Dunhill Ct., Katy, Texas 77494 (US). **MICKEY, Clint E.** [US/US]; 8310 Everleaf, Spring, Texas 77379 (US). **LOUGHLIN, Michael J.** [US/US]; 4039 Villanova Street, Houston, Texas 77005 (US). **URBAN, Larry J.** [US/US]; 4 Prairie Oaks Drive, Santa Fe, Texas 77510 (US).

(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, 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, IS, JP, KE, KG, KM, 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, PE, PG, PH, PL, PT, RO, RS, RU, 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, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, 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, 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:

- without international search report and to be republished upon receipt of that report (Rule 48.2(g))

(54) Title: HIGH EXPANSION METALLIC SEAL

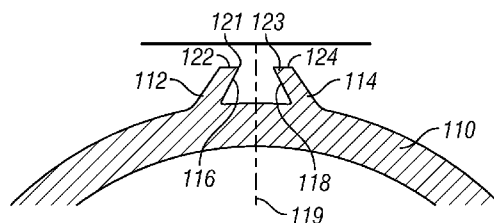


FIG. 3

(57) Abstract: A downhole seal includes a seal body; two or more pips extending in a direction from the seal body associated with an intended sealing surface, the two or more pips defining nonparallel facing surfaces when in a run in position.

WO 2011/079264 A2

HIGH EXPANSION METALLIC SEAL

CROSS REFERENCE TO RELATED APPLICATION

This application claims the benefit of the filing date of United States Patent Application Serial Number 12/646,421 filed December 23, 2009, for “HIGH EXPANSION METALLIC SEAL.”

BACKGROUND

[0001] In the downhole drilling and completion arts, sealing of various things such as an annulus between a mandrel or basepipe and a casing, for example is a common requirement. Many different types of seals have been developed and have used many different types of material and/or combinations of material. More recently, high expansion metal seals have become of interest to the industry yet while they suffer little from the deleterious effects of the downhole environment and relatively easily resist mechanical insults such as pressure inversions, extrusion, and the ravages of time, they present greater difficulty with regard to establishing a competent seal to begin with. Various means have been used to assist in the creating of the seal each having effective success to some degree.

[0002] None of the known solutions has proven a panacea in all situations and consequently, the art still seeks alternative solutions and well receives those proposed.

SUMMARY

[0003] A downhole seal includes a seal body; two or more pips extending in a direction from the seal body associated with an intended sealing surface, the two or more pips defining nonparallel facing surfaces when in a run in position.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] Referring now to the drawings wherein like elements are numbered alike in the several Figures:

[0005] Figure 1 is a schematic cross sectional representation of a prior art seal in a run in position;

[0006] Figure 2 is a schematic cross sectional representation of the same seal shown in Figure 1 but in a set position;

[0007] Figure 3 is a schematic cross sectional representation of a seal configuration as disclosed herein in a run in position;

[0008] Figure 4 is a schematic cross sectional representation of the same seal shown in Figure 3 but in a set position;

[0009] Figure 5 is a schematic cross sectional representation of another seal configuration as disclosed herein in a run in position;

[0010] Figure 6 is a schematic cross sectional representation of the same seal shown in Figure 5 but in a set position;

[0011] Figure 7 is a schematic cross sectional representation of another seal configuration as disclosed herein in a run in position;

[0012] Figure 8 is a schematic cross sectional representation of the same seal shown in Figure 7 but in a set position;

[0013] Figure 9 is a schematic cross sectional representation of another seal configuration as disclosed herein in a run in position;

[0014] Figure 10 is a schematic cross sectional representation of the same seal shown in Figure 9 but in a set position;

[0015] Figure 11 is a schematic cross sectional representation of the seal configuration shown in Figure 3 with an optional sleeve, as disclosed herein in a run in position;

[0016] Figure 12 is a schematic cross sectional representation of the same seal shown in Figure 11 but in a set position; and

[0017] Figures 13-20 are schematic cross sectional representations of alternate elastomer configurations for the seal embodiments of Figures 3-12.

DETAILED DESCRIPTION

[0018] In order to enhance understanding of the invention disclosed herein initial reference will be made to the prior art, represented in Figures 1 and 2. A prior art seal 10 includes pips 12 and 14. The pips together define parallel facing surfaces 16 and 18. Once the seal 10 is set, the pips 12 and 14 are moved to a position illustrated in Figure 2, with the surfaces 16 and 18 moving to a splayed open position as shown. In the prior art this was considered a positive occurrence and hence is the state of the art.

[0019] Referring now to Figures 3 and 4, a first embodiment of the seal concept disclosed herein is illustrated. A seal body 110 comprises a relatively rigid material such as a metal material. In one embodiment the material is a steel alloy such as stainless steel or

inconel. The seal body 110 includes a set of depending pips 112 and 114 that extend radially relative to an axis of the seal body 110 and in one embodiment, as illustrated, extend radially outwardly. Significantly, the pips 112 and 114 each define nonparallel facing surfaces 116 and 118, respectively. These surfaces are oriented to generally oppose each other but they are not parallel to each other in the run in condition. Moreover, as can be appreciated from the Figures, the surfaces grow closer to one another as distance from the seal body 110 increases. The surfaces 116 to 118 form an acute angle with respect to a centerline 119 of the seal body as displayed in the Figures. Pips having angled surfaces, as illustrated, more reliably achieve metal-to-metal contact with a casing inside surface (casing ID) 120. Further the angled surfaces 116 and 118 help to minimize a radial extrusion gap between the pip 112 or 114 contact surface 122 or 124, respectively, and casing ID 120 than does the prior art seal shown in Figures 1 and 2. The acute angle of the pips also helps to self-energize the seal, in an embodiment where soft material filler 130 is included, with the application of differential pressure. The acute angle of the pips allows for a larger cross sectional area between the two pips for a given dimension between distal ends 121 and 123 of the pips, which will provide larger volume of soft material than the geometry of the prior art such as illustrated in Figure 1. The performance increase is due to the pips 112 and 114 having higher contact pressure against a casing ID 120 or to the pips 112 and 114 attaining a final set position in closer proximity to the casing. As can be appreciated in Figure 4, the orientation of the pips 112 and 114 creates an acute angle between surface 116 and 120 when measuring the angle toward the left side of the drawing and an acute angle between surface 118 and 120 when measuring the angle toward the right side of the drawing.

[0020] In another embodiment, referring to Figures 5 and 6, the configuration of Figures 3 and 4 is repeated except for the addition of an additional pip 126. The additional pip 126 is configured to contact the casing 120 as shown in Figure 6. The advantages to adding a center pip is that it offers the potential of a third metal-to-metal contact point or reduced extrusion gap and it controls the set volume of soft material 130, which prevents excessive squeeze.

[0021] In another embodiment, referring to Figures 7 and 8, the configuration of Figures 5 and 6 are repeated except the pips 128 and 131 have a reduced diameter (reduced prominence) that is less than the diameter of the center pip 126 (prominent pip). The advantage to reducing the diameter of the outer pips 128 and 131 is that metal-to-metal contact between the center pip 126 and the casing ID 120 is even more reliably achieved. The pips 128 and 131 still provide for soft material filler anchoring to help prevent washing

away of the soft material. In this embodiment however, the shorter pips encourage the soft material to flow between the pips and the casing ID 120. This helps with sealing small irregularities in the surface 120. Further, it is to be appreciated that in this embodiment the angled inner surfaces of the pips of the foregoing embodiments may be used but are permissive rather than required. Stated alternatively, in embodiments with reduced prominence pips, the pips need not have the angled surfaces 116 and 118 as in the foregoing embodiments but could be configured with surfaced 16 and 18 as in the prior art.

[0022] In another embodiment, referring to Figures 9 and 10, the configuration of Figures 3 and 4 is repeated except a span surface 134 between pips 112 and 114 is not perpendicular to the centerline 119 of the seal but rather has a concave shape with respect to the centerline of the seal as illustrated. The concavity of span surface 134 alters the set volume of the seal 110 and allows for greater selection in soft material volume. It is to be understood however, that the volume of the area defined by the pips, surface 134 and casing surface 120 will change during setting of the seal 110 and therefore consideration of the amount of soft material is important to ensure that it does not prevent metal to metal contact of the seal with the casing 120, something that can occur as a result of excessive squeezing of the soft material.

[0023] In all embodiments Figures 3-10, an additional optional sleeve 136 is contemplated. Referring to Figures 11 and 12, an illustration of a seal configuration like that of Figures 3 and 4 is used to illustrate the sleeve 136. The illustration is certainly by way of illustration rather than limitation since the sleeve may be used on any of the embodiments disclosed herein or others. In one embodiment the sleeve 136 comprises non-metallic material although metallic material having appropriate structural characteristics could be substituted. Structural characteristics that are desired include toughness to resist borehole impacts during running and softness to promote sealing at pip contact surfaces 122 and 124. The sealing function of the sleeve 136 occurs similarly to that of the soft material 130 in that it flows into small irregularities at casing surface 120 but is located at the pips as opposed to between the pips.

[0024] As has been alluded to hereinabove, each of the embodiments disclosed may be used with or without a soft material 130. Each of the foregoing seal configurations used alone will create a reliable seal. These configurations when endowed with a softer material 130 (see Figures 13-20) than the material from which the seal itself is constructed, that softer material being positioned between pip 112 and pip 114 or 128 and 130 exhibit different sealing properties that may be helpful in tubular structures having a pitted surface, for

example. Softer materials contemplated include but are not limited to nonmetallic materials such as polytetrafluoroethylene, rubber, plastic, and soft metallic materials such as lead, gold, silver, etc. Each of these materials tends to flow relatively easily under stress. They are therefore helpful in ensuring sealing in smaller discontinuities of the sealing surface. The configurations of the pips as described above enhance the utility and reliability of these softer materials by helping to keep them contained between the pips rather than to allow the material to flow to a position where it is between the pips and the casing 120, where it can have a detrimental affect on sealing. Reference is made to a number of embodiments of soft material 130. The embodiments are self explanatory, each of which being configured to provide for good sealing characteristics while exhibiting an unstressed shape that allows space into which the stressed material 120 may flow to avoid flow of that material between the pips 112 and 114 and the casing 120. It is to be appreciated that in some illustrated embodiments the material is a single piece of material (Figures 13, 17, 18 and 19) while in other embodiments the material 130 is configured as more than one piece of material (Figures 14, 15, 16, and 20). It is further to be appreciated that in Figure 20, O-rings are illustrated having different cross sectional diameters. O-rings with the same cross sectional diameters can also be used as well as different numbers of O-rings. All of the configurations shown Figures 13-20 may have soft material that is molded into a separate ring and placed onto the seal body or molded and bonded directly onto the seal body.

[0025] While one or more embodiments have been shown and described, modifications and substitutions may be made thereto without departing from the spirit and scope of the invention. Accordingly, it is to be understood that the present invention has been described by way of illustrations and not limitation.

CLAIMS

1. A downhole seal comprising:
a seal body;
two or more pips extending in a direction from the seal body associated with an intended sealing surface, the two or more pips defining nonparallel facing surfaces when in a run in position.
2. A downhole seal as claimed in claim 1 wherein the nonparallel facing surfaces define a dimension therebetween that diminishes with increasing distance from the seal body.
3. A downhole seal as claimed in claim 1 wherein the two or more pips nonparallel facing surfaces each define acute angles with a surface of a tubular in which the seal is installed.
4. A downhole seal as claimed in claim 1 wherein the two or more pips each include a selected contact surface.
5. A downhole seal as claimed in claim 4 wherein the contact surface has an angle relative to an axis of the seal body.
6. A downhole seal as claimed in claim 1 further comprising an additional pip located between the two or more pips.
7. A downhole seal as claimed in claim 6 wherein the additional pip is of symmetrical geometry relative to an annular path along which it extends.
8. A downhole seal as claimed in claim 1 further comprising a soft material disposed between the two or more pips.
9. A downhole seal as claimed in claim 8 wherein the soft material is a nonmetal material.
10. A downhole seal as claimed in claim 8 wherein the soft material is a metallic material.
11. A downhole seal as claimed in claim 8 wherein the soft material is configured in a single piece.
12. A downhole seal as claimed in claim 11 wherein the single piece is bonded directly to the seal body.
13. A downhole seal as claimed in claim 8 wherein the soft material is configured in a plurality of pieces.
14. A downhole seal as claimed in claim 13 wherein the plurality of pieces are bonded directly to the seal body.

15. A downhole seal as claimed in claim 8 wherein the soft material is one or more O-rings.

16. A downhole seal as claimed in claim 6 wherein the two or more pips are of lesser prominence than the additional pip.

17. A downhole seal as claimed in claim 1 wherein the seal further comprises a sleeve disposed about the seal body.

18. A downhole seal as claimed in claim 17 wherein the sleeve comprises tough soft material.

19. A downhole seal as claimed in claim 17 wherein the sleeve facilitates sealing at a contact surface of each pip.

20. A downhole seal as claimed in claim 1 wherein the seal body further includes a concave span surface between the two or more pips.

1/5

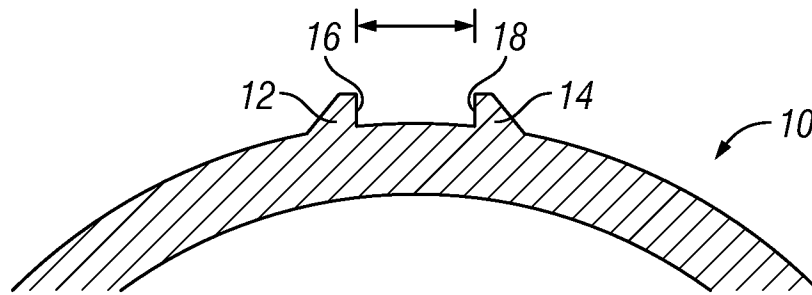


FIG. 1
(Prior Art)

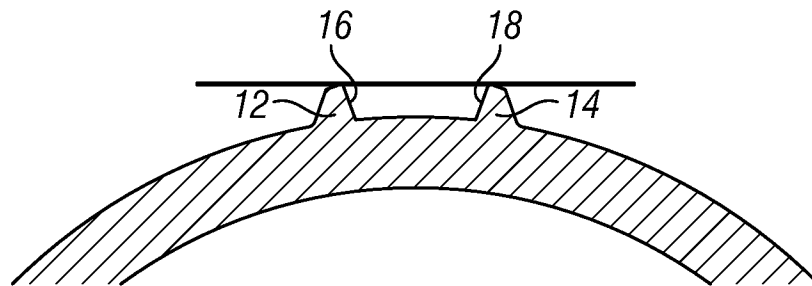


FIG. 2
(Prior Art)

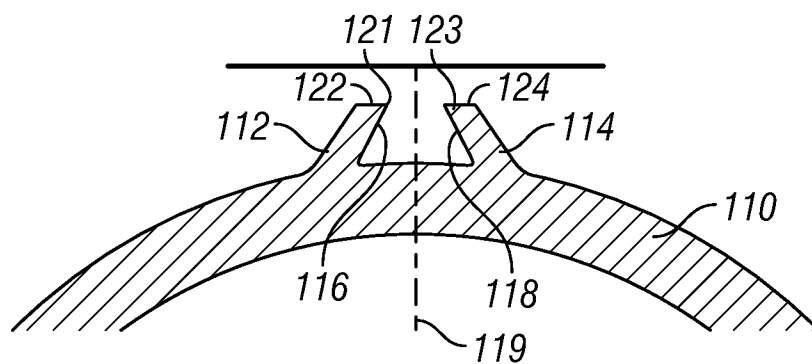


FIG. 3

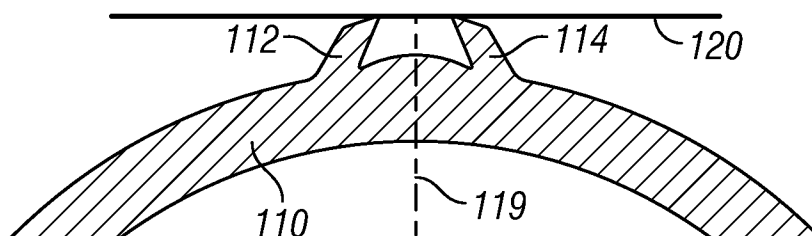


FIG. 4

2/5

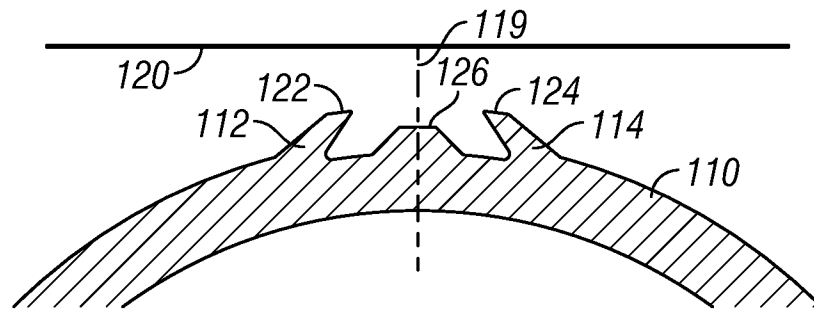


FIG. 5

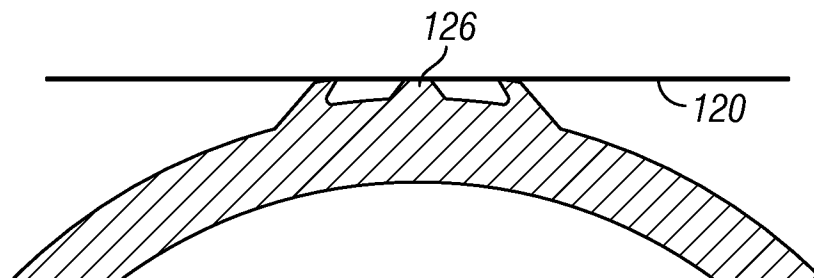


FIG. 6

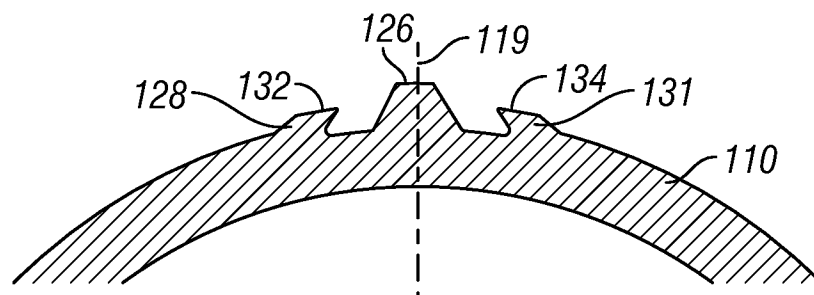


FIG. 7

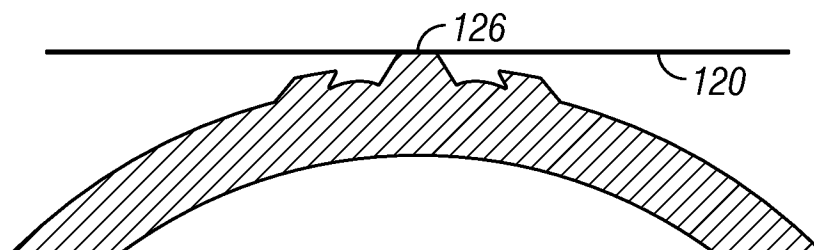


FIG. 8

3/5

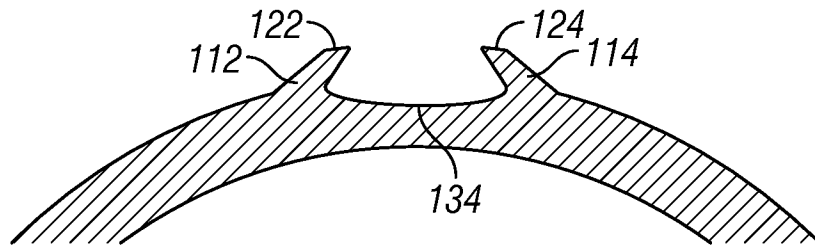


FIG. 9

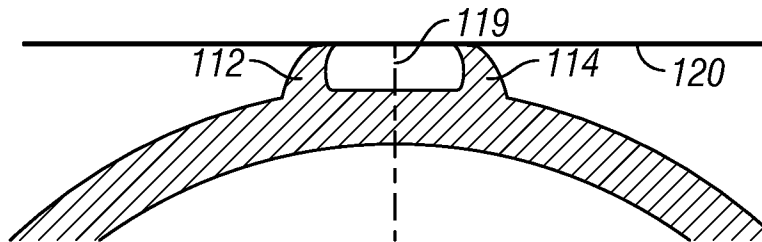


FIG. 10

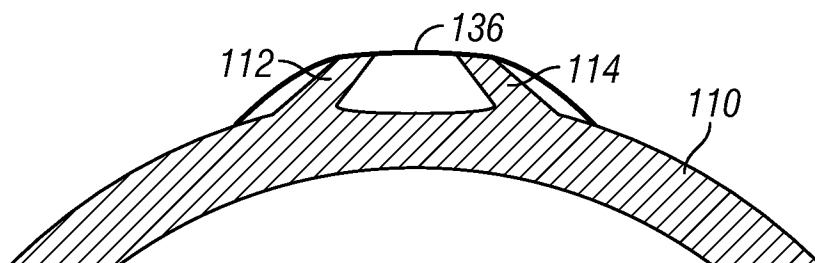


FIG. 11

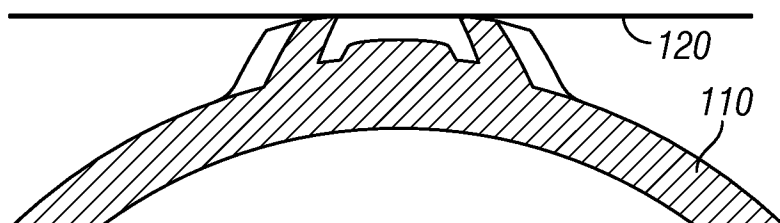


FIG. 12

4/5

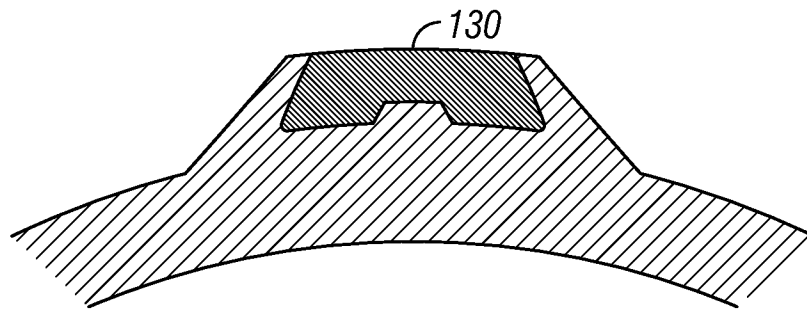


FIG. 13

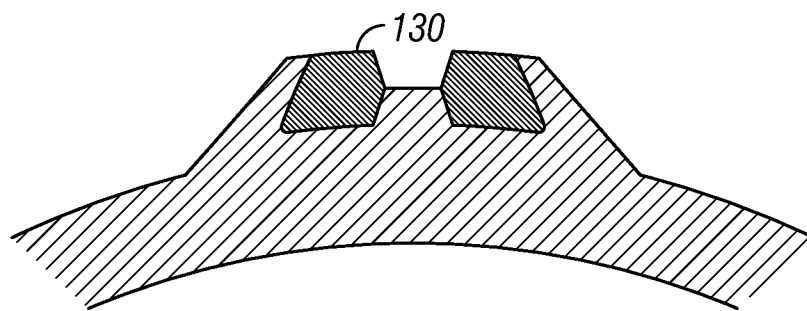


FIG. 14

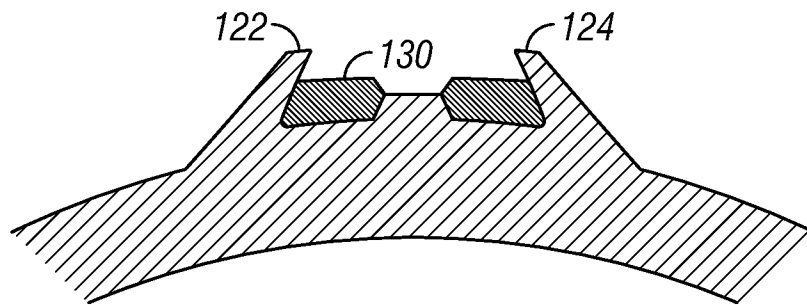


FIG. 15

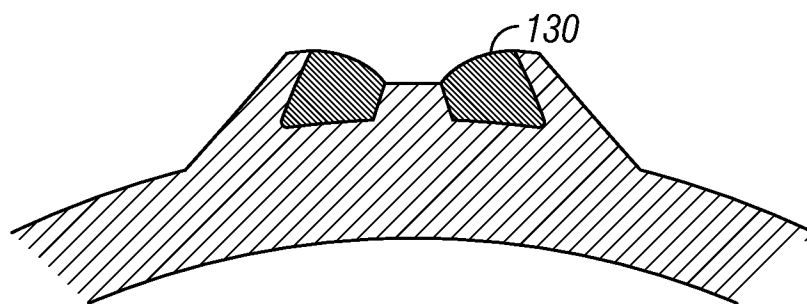


FIG. 16

5/5

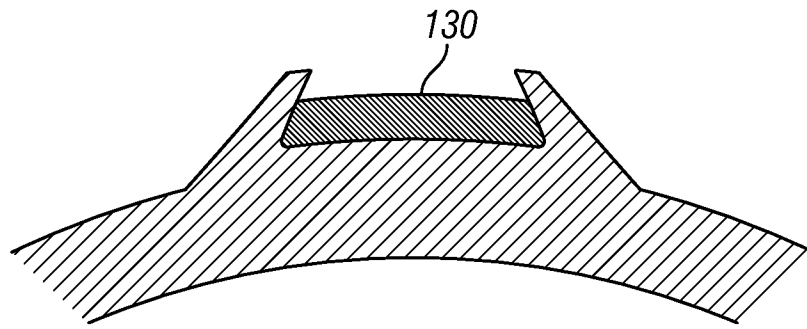


FIG. 17

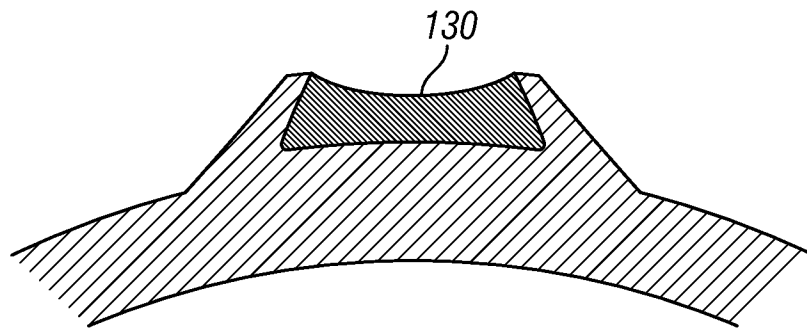


FIG. 18

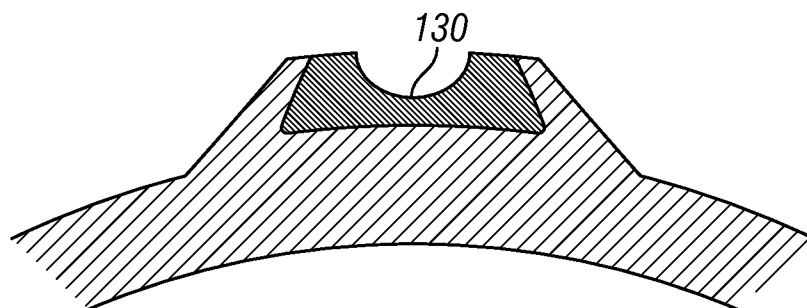


FIG. 19

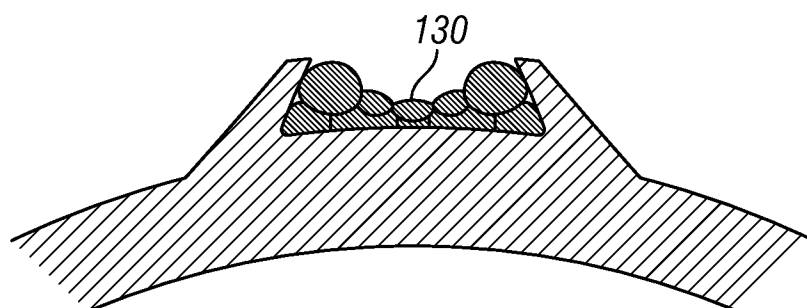


FIG. 20