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AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY,
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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,
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Declarations under Rule 4.17:

- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(H))
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(in))

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(54) **Title:** CONTINUOUS BACKUP ASSEMBLY FOR HIGH PRESSURE SEALS

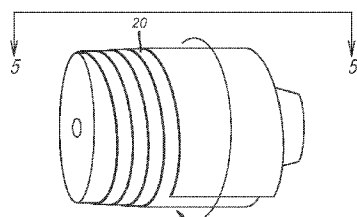


FIG. 4

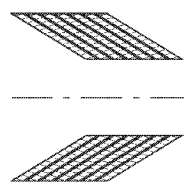


FIG. 5

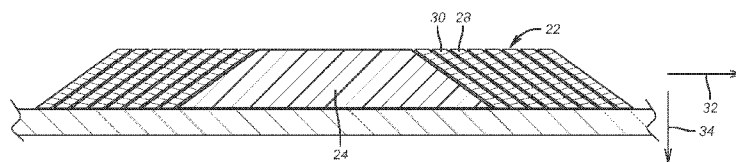


FIG. 6

(57) **Abstract:** An extrusion barrier assembly for high pressure and temperature applications for a sealing element incorporates a backing member between the sealing element and a multi-row petal type backup ring assembly. The surface irregularities of the off-set petals are distributed through the backing member so that stress concentration locations at the petal transitions between rows are diffused through the backing member to avoid or minimize the tendency of the petals to stress crack at row to row transitions. The backing member is formed from spirally wound strip of sheet material that can be coated to promote relative sliding of overlapping layers. The assembly can be temporarily bonded to retain its shape with adhesive that releases under expected well conditions when the packer or bridge plug is set.

CONTINUOUS BACKUP ASSEMBLY FOR HIGH PRESSURE SEALS

Inventor: Edward J. O'Malley

FIELD OF THE INVENTION

[0001] The field of the invention is anti-extrusion assemblies for subterranean seals in high differential pressure and high temperature environments and more particularly to intermediate structures between a sealing element and a backup ring assembly to control stress at said backup ring assembly.

BACKGROUND OF THE INVENTION

[0002] High pressure elastomer seals often require the use of a backup system to prevent extrusion failure of the seal material. Backup systems may be comprised of multiple components with different design intents. Petal backups are employed as means of mechanically reinforcing an elastomer seal against applied pressures. Petal backups are so named due to their resemblance to a flower - typically a thin metallic cup-shape with slots cut into the sidewalls to reduce the amount of force required to expand the part during setting. One such design is shown in FIG. 1.

[0003] In use, when the petal backups expand and are set, a gap is generated between adjacent petals, which would cause seal failure if only one backup were present. As a result, petal backups are staggered and stacked, so that when the complete backup system is assembled the gaps of one backup are against the centers of the petals of the next backup. A disadvantage to this approach is that a discontinuous surface will exist within a set seal stack, and as temperature and pressure increase, that discontinuous surface becomes an increasingly risky potential failure point.

[0004] High expansion packers are used in through tubing applications where the packer or plug is then set in casing below the tubing through which it was delivered. Some designs provided cup shaped backup ring stacks that have staggered slots as between layers as an extrusion barrier in expansion ranges up to 25%. USP 6,827,150 is an illustration of one such design. Others are USP 7,128,145; US Publication 2004/0149429 and 2005/0115720. Other high expansion packer designs are US Re 32,831; 6,311,778; 6,318,461 and 6,164,375.

[0005] Another design is revealed in US Publication 2008/0251250 where a series of overlapping petals 310 are initially retained by a band 314. The petals are connected to tubular 312 that is expanded. The band breaks with expansion of the tubular. The petals can be in a single row but are stated to be preferably in multiple rows. The main issue with this design is the dependency for sealing on petal overlap which can be problematic if the petals do not all move out radially in a uniform fashion.

[0006] In extreme pressure differential applications the surface irregularity presented with the offset gaps among the petal layers becomes a stress concentration location and the end result can be cracking where a gap in the innermost row that is up against the sealing element is backed by the middle of another petal in an adjacent row. Once the petal ring assembly develops stress cracks the seal can be lost as portions of the sealing element begin to flow and extrude through such newly formed cracks. Situations where there are high temperatures aggravate these types of potential failures.

[0007] To help limit the risk, a new backup is proposed. In the simplest embodiment, the backup would be constructed from a spool of sheet material that would be wrapped onto a mandrel of the desired shape. Material type and thickness would be determined by the application. In operation, the helically wrapped backup would be part of a seal stack that might include one or more elastic elements, non-elastic elements, and other metallic backup components included for strength. In use, the layers of the backup should slide relative to one another fairly easily until compressive forces become large, allowing the part to conform to a desired shape. Because the layers are fairly thin, a smooth surface remains in the load path against the seal, limiting non-uniform loading of the seal, and ultimately reducing the risk of failure. Applying a coating on the sheet material as the part is wrapped may ease the force required to set the backup. A temporary adhesive might also be useful to hold the wrapped component together until use. The adhesive is chosen in such a way that a slight application of force or exposure to wellbore fluid would disable it. Shear or other temporary mechanical means might also be used.

[0008] Those skilled in the art will more readily understand these and other aspects of the invention from a review of the description of the preferred

embodiment and the associated drawings while recognizing that the full scope of the invention is to be determined from the appended claims.

SUMMARY OF THE INVENTION

[0009] An extrusion barrier assembly for high pressure and temperature applications for a sealing element incorporates a backing member between the sealing element and a multi-row petal type backup ring assembly. The surface irregularities of the offset petals are distributed through the backing member so that stress concentration locations at the petal transitions between rows are diffused through the backing member to avoid or minimize the tendency of the petals to stress crack at row to row transitions. The backing member is formed from spirally wound strip of sheet material that can be coated to promote relative sliding of overlapping layers. The assembly can be temporarily bonded to retain its shape with adhesive that releases under expected well conditions when the packer or bridge plug is set.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. 1 is an elevation view in section of a prior art petal type multi-layer backup ring assembly that can be used with the present invention;

[0011] FIG. 2 shows a mandrel on which the backing member of the present invention is produced;

[0012] FIG. 3 shows a roll of sheet material before it is wrapped onto the mandrel of FIG. 2;

[0013] FIG. 4 shows the sheet material of FIG. 3 wrapped around the mandrel of FIG. 2;

[0014] FIG. 5 is a section view along lines 5-5 in FIG. 4 with the mandrel removed;

[0015] FIG. 6 shows the backing member of the present invention on a sealing element with the petal type backing member removed.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0016] Mandrel **10** has a taper **12** and a cylindrical portion **14** that is used to support the mandrel **10** as the sheet **16** comes off the roll **18** and is spirally wound beginning with the cylindrical portion **14** and then continuing to the taper **12**. The spiral winding leaves a portion **20** of the previous winding exposed as another winding is made. As a result when the mandrel **10** is removed and portions wound on the cylindrical portion **14** are trimmed off the

resulting shape shown in section is a chevron shape or a frusto-conical shape illustrated in FIG. 5. As shown in FIG. 6 the backup member 22 conforms to the shape of the end of the sealing element 24. With the petal type backup assembly 26 shown in FIG. 1 and fitted over the backup member 22 an applied axial force causes the overlapping layers such as 28 and 30 to slide over each other as they get axially compressed in the direction of arrow 34 while growing radially in the direction of arrow 32 against the surrounding tubular or wellbore surface for a sealing contact.

[0017] The backup member 22 is not intended to be structural and is combined with the petal ring assembly 26 for the strength of the assembly 26 combined with a layered petal assembly having the ability to be axially compressed and to extend radially while serving as an extrusion barrier. The addition of backup member 22 that is a thin multi-layer spiral structure preferably shaped to conform to the end of the sealing element 24 serves the purpose of distributing compressive loading when the assembly is set about the petal ring assembly 26. Referring to FIG. 1 petals 36 and 38 of one row of petals are backed by petal 40 in the adjacent row so as to create two ledge surfaces 42 and 44 that move apart during compressive loading to allow the ring assembly 26 to flatten out while growing radially and still not have open gaps between the petals. While there are no open gaps such as between petals 36 and 38 there are step transitions 42 and 44 that under high differential pressure loading will be lines of stress concentration. Cracking can occur at or adjacent transitions 42 and 44 and the presence of backup member 22 that overlays these step transitions 42 and 44 reduces the localized stresses at these locations by being flexible enough to distribute loading over a ring of petal shapes in ring assembly 26.

[0018] The petal ring assembly 26 of FIG. 1 is a preferred barrier to be used with the backup member 22 of the present invention and other barrier configurations with comparable performance can be used in conjunction with backup member 22. Any stack of ring members with circumferentially offset splits are contemplated such as split rings that have offset gaps, for example. Even a single ring with abrupt surface transitions can be used instead of the FIG. 1 design with the backup member 22.

[0019] The initial shape shown in FIG. 5 can be maintained by addition of adhesive as the shape is formed on the mandrel **10**. The adhesive can hold the shape intact as the mandrel is removed to produce the chevron shape shown in FIG. 5. Once the backups **22** and **26** are assembled to the sealing element **24** and run to a subterranean location it is desirable for the adhesive to release to allow sliding among the windings to promote the setting process where movement in the directions of arrows **32** and **34** are contemplated. Normally the high temperatures, on the order of 450° F, anticipated in the high pressure applications of over 10,000 PSI for the present invention should be an aid in the breakdown of the adhesive. Also beneficial to relative sliding between winding as occurs when the backup member **22** is forced to move in the directions of arrows **32** and **34** can be a coating on one or both sides of the strip to reduce friction and promote relative sliding movement that occurs when the backup member is flattened and moves in the directions of arrows **32** and **34**. The nature of the material selected for the strip **16** can provide a desired low coefficient of friction or/and a coating can be added or both. Softer metals that can tolerate the well conditions such as brass provide an added load spreading benefit. Coatings such as PTFE or other materials compatible with the well fluids and operating temperatures can also be used. The chevron shape promotes the relative sliding that allows the overall shape to move under compressive loading in directions of arrows **32** and **34**. The strip **16** can be metallic, composite or other material that can be fabricated in thin continuous strip for rolling on a mandrel. The taper angle of taper **12** can vary between 5-60° measured from the axis of the mandrel **10**.

[0020] The above description is illustrative of the preferred embodiment and many modifications may be made by those skilled in the art without departing from the invention whose scope is to be determined from the literal and equivalent scope of the claims below:

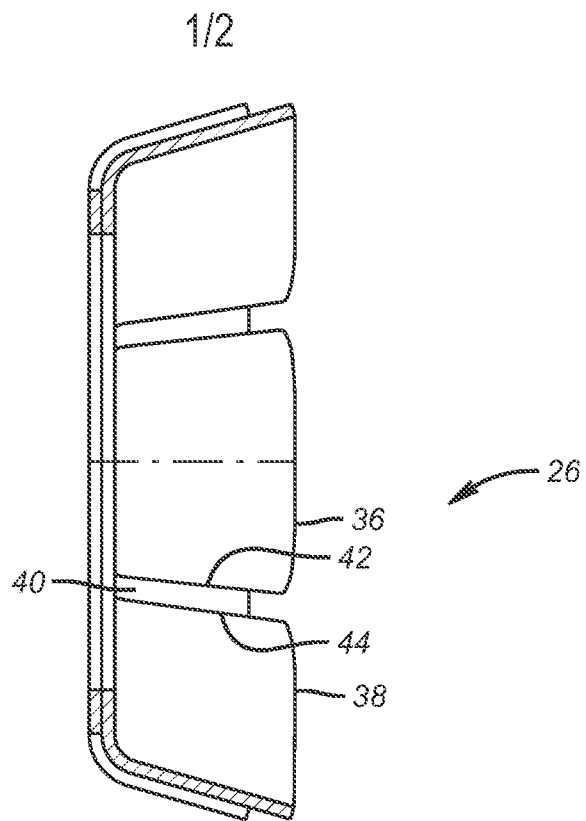
I claim:

1. An extrusion barrier assembly for a subterranean seal, comprising:
a seal element having a longitudinal axis;
a backup ring assembly located adjacent at least one end of said seal element;
a backup member disposed between said backup ring assembly and said seal element and formed from an elongated strip rolled into overlapping layers.
2. The assembly of claim 1, wherein:
said strip is spirally wound so that adjacent layers are offset from each other.
3. The assembly of claim 1, wherein:
said layers slide relatively upon compressive loading of said seal element along the longitudinal axis of said element.
4. The assembly of claim 1, wherein:
said layers are initially secured to each other with an adhesive.
5. The assembly of claim 1, wherein:
said layers have a coating in between that reduces friction to promote relative sliding between said layers.
6. The assembly of claim 1, wherein:
said backup member conforms to the shape of said petal backup ring at a contact location.
7. The assembly of claim 1, wherein:
said petal backup ring provides structural support for said backup member.
8. The assembly of claim 1, wherein:
said strip is continuous throughout said layers.
9. The assembly of claim 1, wherein:
said backup member has a frusto-conical shape.
10. The assembly of claim 9, wherein:
said shape comprising an axis and a taper slope angle of 5-60° with respect to said axis.

11. The assembly of claim 1, wherein:
spaced petal pairs in one row of said petal backup ring are backed by another petal in an adjacent row to define step transitions at adjacent edges of said spaced petals;
said backup member spanning said step transitions of said spaced petal pairs to reduce stress at said step transitions from compressive loading in a direction of said longitudinal axis of said sealing element.
12. The assembly of claim 2, wherein:
said layers slide relatively upon compressive loading of said seal element along the longitudinal axis of said element.
13. The assembly of claim 12, wherein:
said strip is continuous throughout said layers.
14. The assembly of claim 13, wherein:
said backup member has a frusto-conical shape.
15. The assembly of claim 14, wherein:
spaced petal pairs in one row of said petal backup ring are backed by another petal in an adjacent row to define step transitions at adjacent edges of said spaced petals;
said backup member spanning said step transitions of said spaced petal pairs to reduce stress at said step transitions from compressive loading in a direction of said longitudinal axis of said sealing element.
16. The assembly of claim 15, wherein:
said layers are initially secured to each other with an adhesive.
17. The assembly of claim 16, wherein:
said layers have a coating in between that reduces friction to promote relative sliding between said layers.
18. The assembly of claim 17, wherein:
said backup member conforms to the shape of said petal backup ring at a contact location.
19. The assembly of claim 18, wherein:
said petal backup ring provides structural support for said backup member.

20. The assembly of claim 19, wherein:
said shape comprising a axis and a taper slope angle of 5-60° with respect to said axis.
21. The assembly of claim 1, wherein:
said backup ring assembly comprises a petal backup ring assembly further comprising at least two rows of circumferentially offset petals and located adjacent at least one end of said seal element.
22. The assembly of claim 1, wherein:
said backup ring assembly comprises at least one ring with abrupt surface transitions.
23. The assembly of claim 1, wherein:
said backup ring assembly comprises a plurality of split rings with circumferentially spaced splits.

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(PRIOR ART)
FIG. 1

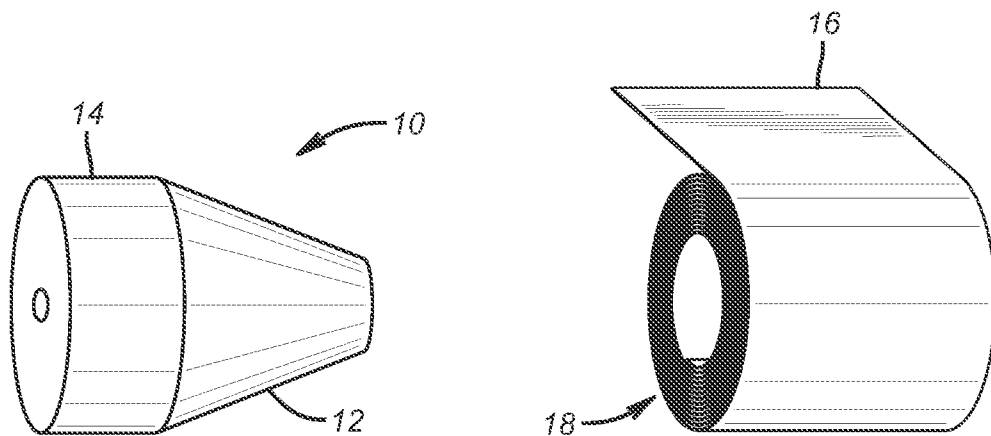


FIG. 2

FIG. 3

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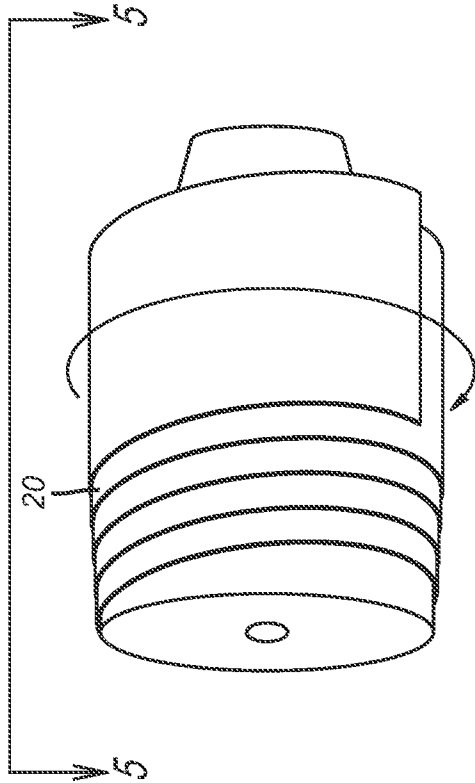


FIG. 4

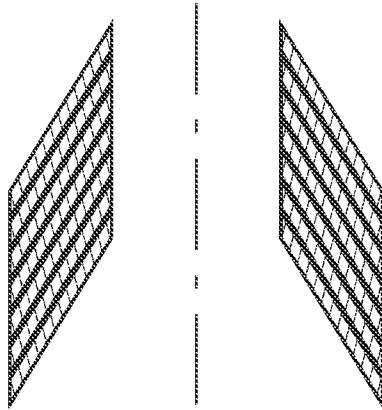


FIG. 5

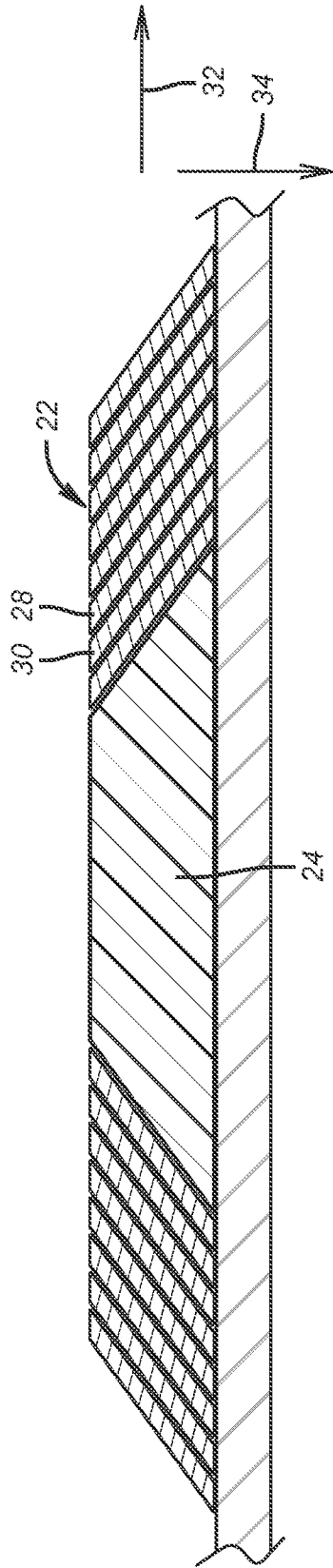


FIG. 6

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2012/064151**A. CLASSIFICATION OF SUBJECT MATTER****E21B 33/129(2006.01)i, E21B 33/12(2006.01)1**

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 33/129; E21B 23/06; E21B 33/128; E21B 33/12; E21B 33/129; E21B 23/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords: packer, backup ring, strip

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6827150 B2 (LUKE, MIKE A.) 07 December 2004 See abstract, column 3 line 54 - column 5 line 30, and figures 1 and 2.	1-23
A	US 2006-0219415 A1 (ZHENG, XU) 05 October 2006 See abstract, paragraphs [0024]-[0029], and figures 1-3.	1-23
A	US 7128145 B2 (CLINT, E. MICKEY) 31 October 2006 See abstract, column 2 line 41 - column 3 line 39, and figure 4.	1-23
A	US 2004-0149429 A1 (HALIT, DILBER et al.) 05 August 2004 See abstract, paragraphs [0016]-[0021], and figures 4 and 5.	1-23

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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"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

25 MARCH 2013 (25.03.2013)

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

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Information on patent family members

International application No.

PCT/US2012/064151

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