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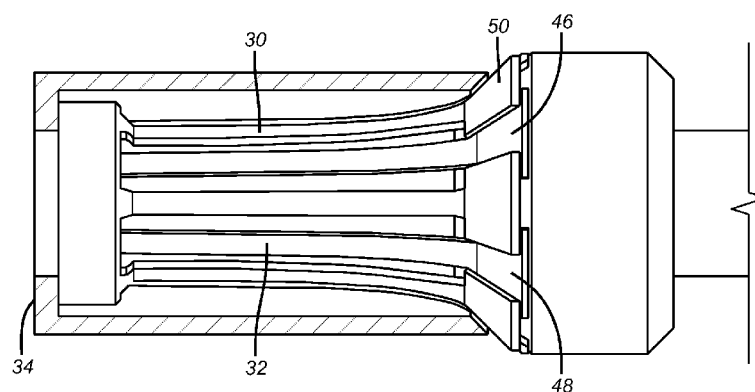


FIG. 3

(57) Abstract: A high expansion plug has multiple sealing elements and an extrusion barrier system that uses overlapping petals in a stack of rings. When setting the plug, the petals are elastically moved toward a surrounding tubular wall in an elastic deformation between a housing that surrounds the mandrel and a tapered ring on the mandrel. That sandwich controls the amount of deformation and allows a potential energy force to be stored in the petals that allows them to return toward their initial position when the set of the plug is released and the seals are allowed to relax and extend axially as they shrink radially. The plug can then be removed without milling. Expansions in the order of 25% of the initial seal dimension are contemplated.



RETRACTABLE PETAL COLLET BACKUP FOR A SUBTERRANEAN SEAL

Inventors: David S. Bishop and Dennis E Kroll

FIELD OF THE INVENTION

[0001] The field of the invention is high expansion packers and more particularly those that can be retrieved while using overlapping petals to form backup rings.

BACKGROUND OF THE INVENTION

[0002] 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 has 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.

[0003] The high expansion designs have focused on the need to prevent extrusion as a result of the combination of high expansion and differential pressure. The stack of backup rings were deformed against the surrounding tubular in a way that made the high expansion plug of the prior design removable by milling it apart. What has been needed in high expansion applications is a retrievable design that performs as needed to prevent element extrusion under pressure differentials typically seen for such plugs.

[0004] The present invention addresses this issue by using an overlapping petal design for the backup rings but disposing the rings in a manner where the assembly has a low profile for run in and that guides the flexing of the petals toward the surrounding tubular when in the set position. Support is offered to the petals by a housing on one side and a tapered guide ring on another side. As a result the petals elastically deform to act as a backup to the sealing elements and when the plug is unset and the sealing elements are able to release from the surrounding tubular using the stored potential energy from the elastic deformation that occurred when the plug was set. Mirror image orientations of sealing elements and backup rings address differential

pressures in opposed directions. Those skilled in the art will better understand 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 determined by the claims appended below.

SUMMARY OF THE INVENTION

[0005] A high expansion plug has multiple sealing elements and an extrusion barrier system that uses overlapping petals in a stack of rings. When setting the plug, the petals are elastically moved toward a surrounding tubular wall in an elastic deformation between a housing that surrounds the mandrel and a tapered ring on the mandrel. That sandwich controls the amount of deformation and allows a potential energy force to be stored in the petals that allows them to return toward their initial position when the set of the plug is released and the seals are allowed to relax and extend axially as they shrink radially. The plug can then be removed without milling. Expansions in the order of more than 25% of the initial seal dimension are contemplated.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] FIGS. 1a-1b show the plug in the run in position;

[0007] FIGS. 2a-2b show the plug in the set position;

[0008] FIG. 3 is an enlarged view showing the petal assembly extending into its supporting housing.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0009] FIG. 1a is the upper end of the plug **10** while FIG. 1b is the mirror image lower end of the plug **10**. A mandrel **12** extends into both parts of FIG. 1 and supports the sealing element **14**.

[0010] A backup ring **20** that is preferably PTFE or Amadil® is adjacent to a ramp ring **22**. Both rings are mounted over the mandrel **12** and are slidably mounted with respect to the mandrel **12**. Ring **21** sits on the mandrel **12** and is preferably made of PEEK. It is there to resist extrusion of the element **14** along the mandrel **12** as shown in FIG. 2. Together they present a barrier for the rubber element **14** to prevent extrusion under and between the petal rings **30** and **32**. As seen in FIG. 3 the petal rings **30** and **32** are formed from elongated flat steel members that in each ring overlap an adjacent petal. As between rings the spacing is circumferentially staggered so

that the petals of one ring are not in alignment with petals of an adjacent ring. While two overlapping rings are shown, other numbers of rings can be used without departing from the invention. The rings of elongated petals are fixed at one end to a base **34** that is disposed inside an annular space **28** defined between a sleeve **26** and the mandrel **12**. Sleeve **26** has a taper **27** that selectively contacts the stacked rings **30** and **32** in the FIG. 2 set position on the opposite side from ramp surface **24**. The sleeve **26** has an opening **36** through which the mandrel **12** extends so that both the sleeve **26** and the base **34** and the elongated petal rings **30** and **32** that are supported with the base **34** can all be moved when the plug **10** is set by holding the mandrel **12** and using a setting sleeve that is schematically represented as arrow **38** in FIG. 1a. In essence, FIG. 1a is the mirror image of FIG. 1b as between the seal **14** and the associated sleeve **40**. With this arrangement the seal **14** can be retractably set with expansion ratio of over 25%.

[0011] In the set position of FIG. 2 the petal rings **30** and **32** are up against the casing or tubular **42** with the end **44** of the sleeve **40** against the stacked rings **30** and **32** on one side and the seal **14** on the other side. The same goes on at the opposite hand where the ring stacks **30** and **32** are up against the sleeve **26** on one side and the seal **14** on the other side. What has happened as a result of the relative motion created by the setting tool, schematically illustrated as **38** pushing all the parts against a travel stop schematically represented by arrow **18**, is that the stacked rings that extend beyond the respective sleeves **26** or **40** have been elastically deflected to contact the surrounding tubular **42** to function as a backup to the adjacent respective seal while at the same time the rings **30** and **32** have been provided with sufficient support from opposing sides to keep them against the tubular **42** in the set position while still allowing the rings to retract if the plug **10** is unset. The reason this happens is that the portion of the overlapping rings **30** and **32** that extend from the respective sleeves is simply elastically bent so that springing back is still possible. The support provided from opposed ends to the petal rings gives them the strength to serve as extrusion barriers in the set position while still being retractable.

[0012] FIG. 3 shows two adjacent overlapping petals **46** and **48** from one ring and another petal **50** from an adjacent ring that is offset from both petals **46** and **48** to illustrate the juxtaposition of the adjacent rings of petals. The petals themselves are elongated preferably metallic structures that can have parallel sides or can flare toward the end extending from the adjacent sleeve. The sleeves can be secured for run in with shear pins or other breakable retainers. While mirror image configurations are preferred, other options are envisioned such as using only as single seal with the petal type backup to resist differential in a single direction rather than in the opposed directions as described above. Alternatively, there can be more than a single seal with the associated backup as described above that resists pressure differential in a given direction.

[0013] 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.

We claim:

1. A high expansion retrievable plug for subterranean use, comprising:
a mandrel supporting at least one sealing element set by compression to selectively seal against and release from a surrounding wall at a subterranean location;
at least one backup ring extending from a support, said ring disposed between said seal and said support, whereupon compression of said seal said ring flexes elastically to contact said wall.
2. The plug of claim 1, wherein:
said support is movable with respect to said mandrel into contact with said ring when said seal is compressed.
3. The plug of claim 2, wherein:
said ring is compressed on opposing sides by said seal and said support when said support moves relative to said mandrel.
4. The plug of claim 3, wherein:
said ring retracts from the wall when said compressive force acting on said seal is removed.
5. The plug of claim 4, wherein:
said support further comprises a ramped member facing said ring for selective contact therewith.
6. The plug of claim 5, wherein:
said support comprising a taper for selective contact with said ring on the opposite side from said ramped member.
7. The plug of claim 6, wherein:
said support comprises an annular shape surrounding said mandrel to define an annular space therebetween;
said taper disposed at an open end of said support.
8. The plug of claim 7, wherein:
said ring comprising a plurality of overlapping petals that extend beyond said taper and having a base within said annular space.
9. The plug of claim 8, wherein:
said at least one backup ring comprises a plurality of backup rings each having a plurality of overlapping petals with the petals of one ring

circumferentially offset from the petals in an adjacent ring so that petal side surfaces are not in alignment.

10. The plug of claim **9**, wherein:

said at least one seal comprises a plurality of seals each with an associated backup ring, wherein at least two backup rings are oriented in mirror image.

11. The plug of claim **10**, wherein:

said seals expand over 25% to contact the wall in the set position.

12. The plug of claim **1**, wherein:

said ring comprising a plurality of overlapping petals that extend beyond said support.

13. The plug of claim **12**, wherein:

said at least one backup ring comprises a plurality of backup rings each having a plurality of overlapping petals with the petals of one ring circumferentially offset from the petals in an adjacent ring so that petal side surfaces are not in alignment.

14. The plug of claim **12**, wherein:

said petals are elastically deformed to contact the wall and supported when contacting said wall by a tapered member located between said petals and said seal on one side and said support on the opposite side of said petals.

15. The plug of claim **14**, wherein:

said support is selectively movable with respect to said mandrel and has a leading taper to contact said petals.

16. The plug of claim **15**, wherein:

said support comprises an annular shape surrounding said mandrel to define an annular space therebetween;

said taper disposed at an open end of said support.

17. The plug of claim **16**, wherein:

said overlapping petals extend beyond said taper and having a base within said annular space.

18. The plug of claim **17**, wherein:

said petals move away from said wall when compression on said seal is released.

19. The plug of claim **18**, wherein:
said seals expand over 25% to contact the wall in the set position.
20. The plug of claim **13**, wherein:
said petals comprise elongated flat metallic members with parallel or tapered side surfaces.

1/3

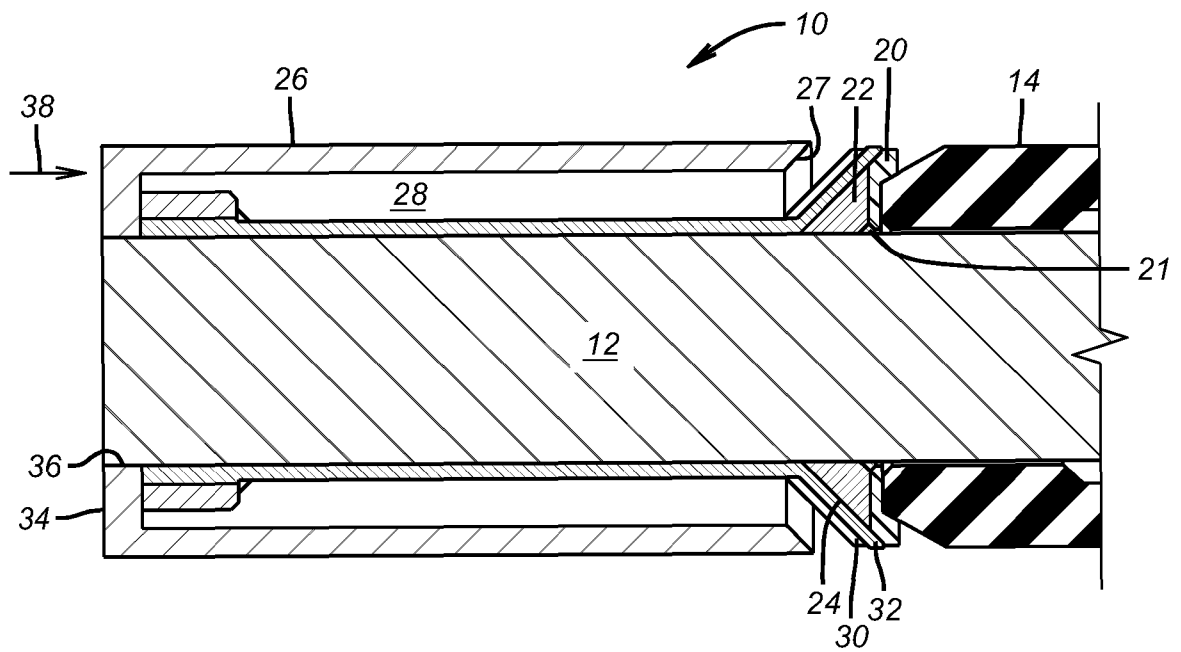


FIG. 1a

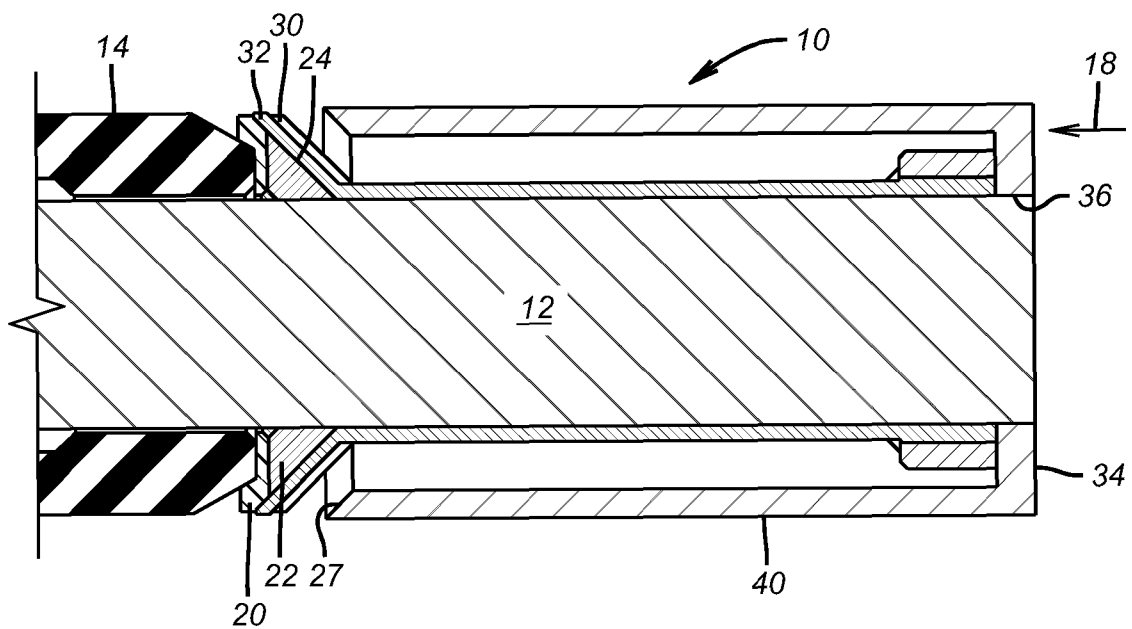


FIG. 1b

2/3

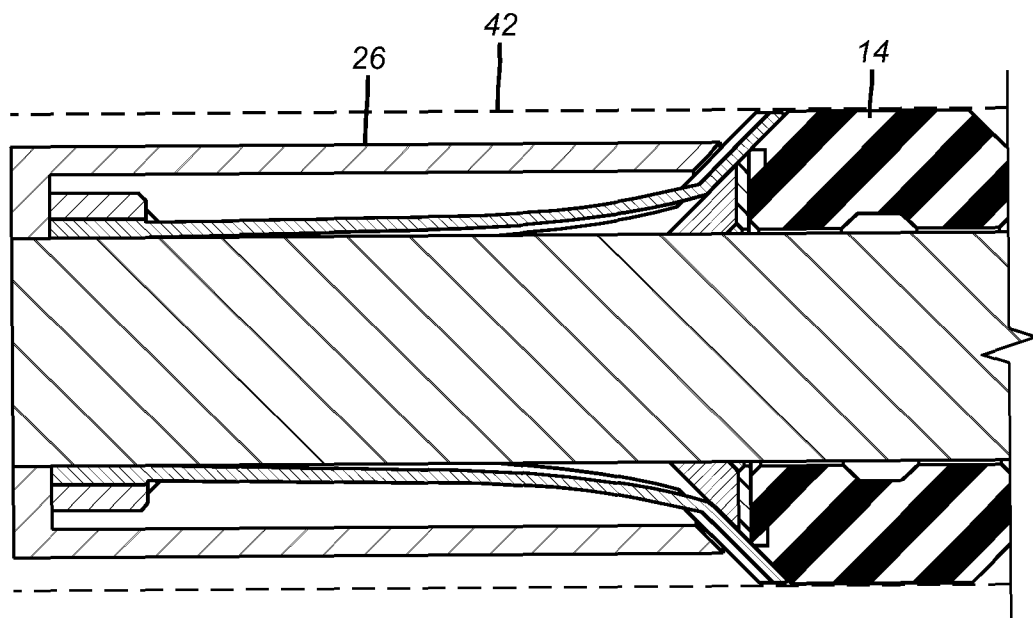


FIG. 2a

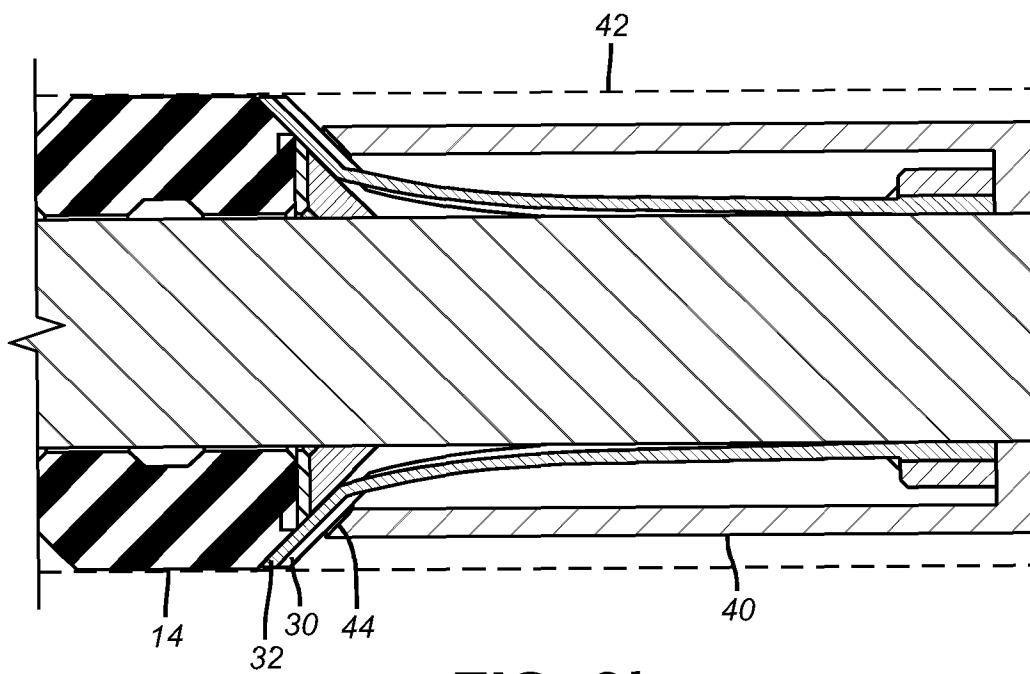


FIG. 2b

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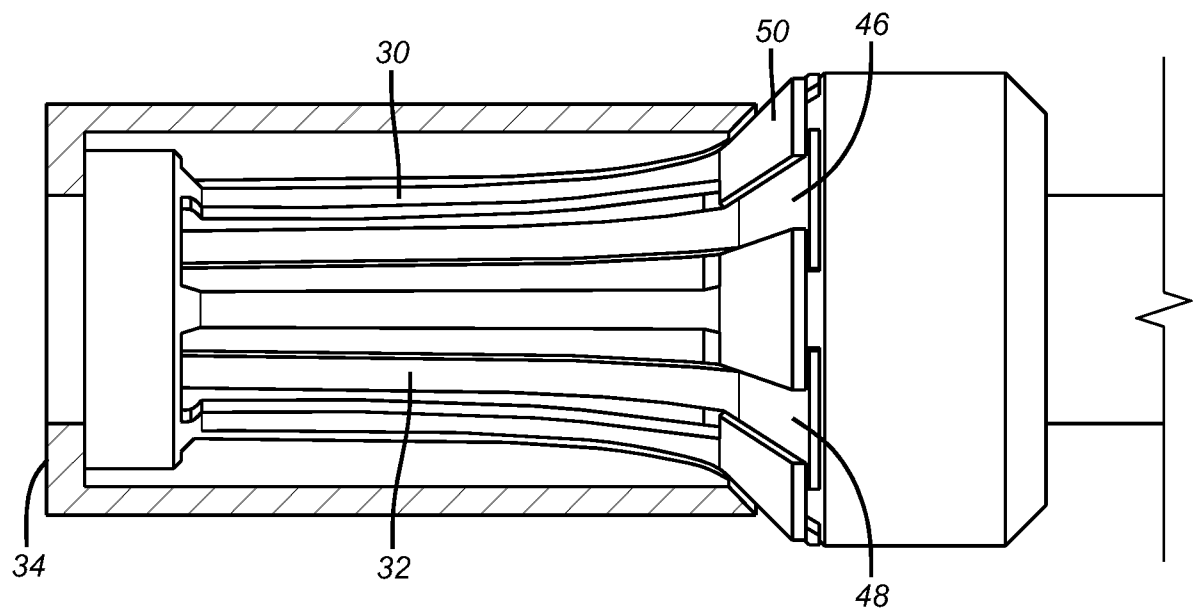


FIG. 3