

(19) World Intellectual Property
Organization
International Bureau



(43) International Publication Date
16 December 2004 (16.12.2004)

PCT

(10) International Publication Number
WO 2004/109055 A1

(51) International Patent Classification⁷: **E21B 33/12**,
43/10

(21) International Application Number:
PCT/US2004/016576

(22) International Filing Date: 27 May 2004 (27.05.2004)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/474,486 30 May 2003 (30.05.2003) US

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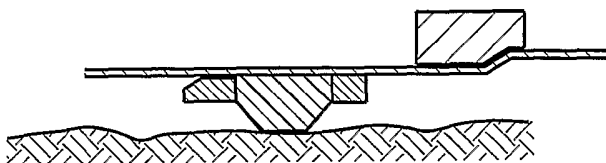
(81) Designated States (unless otherwise indicated, for every
kind of national protection available): AE, AG, AL, AM,
AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN,
CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI,
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KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD,
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TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM,
ZW.

(84) Designated States (unless otherwise indicated, for every
kind of regional protection available): ARIPO (BW, GH,
GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM,
ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),
European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI,
FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI,
SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ,
GW, ML, MR, NE, SN, TD, TG).

Published:
— with international search report

*For two-letter codes and other abbreviations, refer to the "Guid-
ance Notes on Codes and Abbreviations" appearing at the begin-
ning of each regular issue of the PCT Gazette.*

(54) Title: EXPANSION SET PACKER



ing its length. Preferably, an advancing swage triggers the release to allow the element to expand as much as it can go or to the maximum relaxed diameter, whichever is larger. The swage then, preferably, drives the relaxed element toward the borehole wall or the casing.

(57) Abstract: A packer element has a biasing member in-
corporated with it. The element is either fabricated with the
biasing element in a relaxed condition and then the element
is stretched prior to insertion downhole or the element is cre-
ated around the stressed biasing member and is held in that
position until allowed to relax downhole. In either event the
release of the element increases its diameter while shorten-

APPLICATION FOR PATENT

Title: **EXPANSION SET PACKER**

FIELD OF THE INVENTION

[0001] The field of this invention is downhole packers and more particularly those that are set with expansion force and finally those that use a bias to increase diameter independently of the applied expansion force.

BACKGROUND OF THE INVENTION

[0002] Annular spaces downhole are typically sealed with packers. Packers can be used in cased or open hole. One type of packer involves an element mounted to a mandrel, where the element is made of an elastomer. The packer is placed downhole and can be set by mechanical compression of the element. The longitudinal mechanical compression increases the diameter. Another technique has been to simply expand the mandrel to increase the outside diameter of the annularly shaped element. One such technique is the Poroflex® product from Halliburton, which uses a solid ribbed elastomer sleeve that is longitudinally compressed by an advancing swage. The driving of the swage also increases the mandrel diameter. The ribbing allows part of the sleeve to collapse on itself in a series of accordion folds. The forming of the folds is claimed to bridge the annular gap around the mandrel. The swage is sized so as not to collapse the accordion folds of the collapsed elastomer sleeve. This product is advertised for cased hole applications and appears unsuitable for open hole applications. It also has some uncertainties as to how well it will seal. Longitudinal compression will not always assure that the sleeve will collapse uniformly over the ribbed length. The sealing occurs by end contact of each accordion fold with the casing wall. The number of such ends in contact with the casing wall due to collapse and expansion is uncertain. The possibility, even in cased hole, exists for channeling between the fold ends and the casing wall. The element is not pre-stretched to reduce its run in diameter and therefore can get thinner after swaging to the point where the sealing integrity may be in question. Accordingly, a design is

needed that can better address the above described sealing problems in cased hole and that has the ability to seal effectively in open hole.

[0003] The present invention employs an annular sleeve as the sealing element and mounts a biasing element with it. The biasing element stores a force, which is liberated downhole to longitudinally compress the element and increase its diameter. In a preferred embodiment the advancing swage liberates a stored force to allow the element diameter to grow to its relaxed dimension. Preferably, the advancing swage liberates this force and increases the mandrel dimension when the element is already at its relaxed diameter forcing the element into the borehole wall or the casing. How this is accomplished, so that those skilled in the art will readily appreciate the scope of the invention, will be explained more fully in the detailed description of the preferred embodiment and the claims, which appear below.

[0004] Relevant to the general area of sealing devices, with some illustrating downhole applications are U.S. Patents: 2,449,514; 4,545,433; 5,062,482; 6,543,780 B1 and Re. 32,831.

SUMMARY OF THE INVENTION

[0005] A packer element has a biasing member incorporated with it. The element is either fabricated with the biasing element in a relaxed condition and then the element is stretched prior to insertion downhole or the element is created around the stressed biasing member and is held in that position until allowed to relax downhole. In either event the release of the element increases its diameter while shortening its length. Preferably, an advancing swage triggers the release to allow the element to expand as much as it can go or to the maximum relaxed diameter, whichever is larger. The swage then, preferably, drives the relaxed element toward the borehole wall or the casing.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] Figure 1 is a run in cross-section of a coiled spring embodiment shown in an open hole application;

[0007] Figure 2 is the view of Figure 1 showing the coiled spring allowed to relax to expand the diameter of the element;

[0008] Figure 3 is the view of Figure 2 showing the swage advanced to expand the mandrel under the already diametrically enlarged element;

[0009] Figure 4 is an alternate embodiment to Figure 1 using a leaf spring and shown in the run in position;

[0010] Figure 5 is the view of Figure 4 in the spring-relaxed position where the diameter of the element has enlarged;

[0011] Figure 6 is the view of Figure 5 after expansion of the mandrel with a swage;

[0012] Figure 7 is an alternative to Figure 1 without any biasing and where the element is stretched to reduce its run-in diameter;

[0013] Figure 8 is the view of Figure 7 with the element in a relaxed position;

[0014] Figure 9 is the view of Figure 8 after the mandrel is swaged;

[0015] Figure 10 is a detailed view of the latch at run in;

[0016] Figure 11 is the view of Figure 10 with expansion releasing the latch to allow the element to shrink in length and expand in diameter;

[0017] Figures 12-16 are a sequential view showing how the advancing swage releases the latch and passes through to finish the expansion.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0018] Figure 1 shows a mandrel **10** with an element **12** that has a biasing element **14**, which, in this Figure happens to be a coiled spring. Those skilled in the art will recognize that other types of biasing elements are contemplated, such as: leaf springs (see Figures 4-6), Belleville washers or even no biasing element at all (see Figures 7-9). The advantage of pre-stretching is that the initial outside diameter is

reduced. For example, in a monobore application, the mandrel **10** and the element **12** must fit through the casing **16** and after expansion in open hole **18**, assume an inside diameter **20** (see Figure 3) approximating that of the casing **16**. Without pre-stretching to reduce the outside diameter of the element **12** the element thickness has to be reduced for a given mandrel diameter. Later when expansion takes place in open hole, the element may not make sealing contact with the borehole wall **18**.

[0019] The present invention, as shown in Figure 1, involves building a relaxed spring into the un-stretched element **12** and then stretching the assembly and holding it in that position for run in. Preferably, retainer **22** is fixed to mandrel **10** while retainer **24** is temporarily secured by a latch or another equivalent device shown schematically as **26**. Advancing the swage **28** releases the latch **26** and allows the element **12** to shorten in length and to grow in diameter, aided by the stored force in spring **14**. Spring **14** wants to get shorter when latch **26** is tripped. Now, as shown in Figure 2 element **12** has shrunk in length and grown in diameter so that its outside diameter is substantially larger than during the run in. Now, when the swage **28** advances under the element **12** there is a better assurance that the element **12** will seal against the borehole wall **18**. Those skilled in the art will appreciate that the illustrated embodiments of the device can be used in cased as well as in open hole.

[0020] An alternative way to make the device in Figure 1 is to build an element **12** over an extended spring **14** and hold the element against shrinkage until it is delivered through casing **16**. When the swage **28** is advanced and latch **26** is released, the spring **14** can relax and shorten the element **12** to make its diameter increase before the swage **28** expands the mandrel **10** under the element **12**.

[0021] The spring **14** may be bonded to element **12**, which is preferably a cured elastomer. The bonding may be total or partial. Alternatively, there may be no bonding at all. The spring **14** can be totally imbedded in the element **12** or it may be partially embedded or mounted externally in a manner that its relaxation will reduce the length and increase the diameter of the element **12**.

[0022] Figures 4-6 operate identically to Figures 1-3 and may be manufactured in the two ways described above for Figures 1-3. The difference is that the spring is a leaf spring **30** that collapses on itself when latch **26'** is released. Those

skilled in the art will appreciate that the leaf spring **30** may be composed of segments that are independent or tied together or a solid ring. Similarly, spring **14** can be one or more springs which could be stacked or nested. Each coil spring can have a constant or variable diameter or a constant or a plurality of pitches. The wire diameter can vary, as can the materials of construction even within a single spring. If Belleville washers are used, they can be stacked in one direction or stacked in more than one direction and can incorporate material and dimensional variations to obtain the desired performance.

[0023] Ideally, after the element **12** or **12'** has attained its relaxed large diameter shown in Figures 2 and 5, the expansion of mandrel **10** or **10'** will ensure that there is tight sealing contact with the borehole wall. Since expansion of mandrel **10** can further reduce its length, there is an added force created on the element **12** tending to longitudinally compress it. The element **12** makes contact with the borehole **18** over a substantial portion of its length, as compared with the contact of the accordion folded ends of the Halliburton product.

[0024] Figures 7-9 illustrate the same element **12''** that now is without any associated biasing structure. It is simply initially stretched to reduce its outer dimension for run in. Advancing the swage **28''** will allow it to shrink in length and expand in diameter. The mandrel **10''** can then be expanded to get the element **12''** up against the borehole wall **18''**. Here again, expansion of the mandrel past retainer **24''** will result in a further compression of element **12''** that is trapped between retainer **24''**, now fixed to mandrel **10''** due to expansion and retainer **22''** that was initially connected to mandrel **10''**. This is because diametral expansion results in a shortening of length of the mandrel **10''**. Alternatively, the swage **28''** can actually drive the retainer **24''** along mandrel **10''** so that the element **12''** is compressed against retainer **22''**.

[0025] Figures 10 and 11 show respectively, the latch mechanism **26** which is preferably a ring **32** that shears on movement of the swage **28** to allow the element **12** to shrink, shown in the run in and released position. Other devices that release on mandrel expansion are within the scope of the invention. Figure 10 shows ring **24** having a hook **40** that is retained by ring **32**. Ring **32** can be assembled in pieces that are held to each other by a breakable member **42**. Ring **32** is held from moving

longitudinally by retaining rings **44** and **46** that are mounted on either side of it. Rings **44** and **46** can be overlapping open rings that simply grow in diameter when the swage **28**, see Figure 11, breaks the breakable member **42** to release the hook **40** to allow the spring **14**, if used, to draw up ring **24** while the element **12** shrinks in length and grows in diameter. Figures 12-16 show in sequence the latch release procedure just described as seen from a larger perspective. In Figures 12 and 13, the swage **28** approaches the latch mechanism **26**. In Figure 14 the latch mechanism **26** is released. Figure 15 shows that on further advance of the swage **28**, the latch mechanism **26** has shifted because the mandrel **10** has shrunk in length due to the expansion. Figure 16 shows the swage **28** passing under the element **12**, which is now pressed firmly against the casing wall **18**.

[0026] Those skilled in the art will appreciate that the present invention reduces the element thickness by stretching it. It can then pass through casing into open hole and be released. If a biasing member is used, it will aid in the longitudinal shrinking and the radial expanding of the element. The swage can be the trigger for the release of the element and ultimately the device that expands the mandrel to force the already relaxed and larger in diameter element against the borehole wall.

[0027] The foregoing disclosure and description of the invention are illustrative and explanatory thereof, and various changes in the size, shape and materials, as well as in the details of the illustrated construction, may be made without departing from the spirit of the invention.

We claim:

1. A method of placing a packer downhole, comprising:
placing a longitudinally stretched element over a mandrel;
running said mandrel into the well;
allowing said element to assume a relaxed position; and
expanding the mandrel to make sealing contact downhole with said element.
2. The method of claim 1, comprising:
initiating movement of said element to said relaxed position by said
expanding.
3. The method of claim 1, comprising:
latching said element in said stretched position;
defeating said latch with said expanding.
4. The method of claim 1, comprising:
using a biasing member to create a bias force on said element toward said
relaxed position.
5. The method of claim 4, comprising:
releasing said bias force by said expanding.
6. The method of claim 4, comprising:
creating said bias force by said pre-stretching of said element.
7. The method of claim 4, comprising:
securing said biasing member to said element when said biasing member
stores a bias force;
selectively restraining said element from longitudinal collapse against said
bias force.
8. The method of claim 4, comprising:

using at least one coiled spring as said biasing member

9. The method of claim 4, comprising:
at least partially embedding said biasing member in said element.
10. The method of claim 4, comprising:
using at least one leaf spring as said biasing member.
11. The method of claim 4, comprising:
using at least one Belleville washer as said biasing member.
12. The method of claim 1, comprising:
shrinking said mandrel longitudinally from said expanding;
using said shrinking to compress said element longitudinally.
13. The method of claim 4, comprising:
shrinking said mandrel longitudinally from said expanding;
using said shrinking to compress said element longitudinally apart from said bias force.
14. The method of claim 3, comprising:
retaining a collar connected to said element by a ring that is selectively secured to said mandrel;
breaking said ring to release said collar.
15. The method of claim 14, comprising:
using said expanding of said mandrel to break said ring.
16. The method of claim 15, comprising:
retaining said ring against shifting longitudinally along said mandrel during at least a portion of said expanding thereof.
17. The method of claim 14, comprising:

moving said collar longitudinally along said mandrel to compress said element as said mandrel is being expanded.

18. The method of claim **4**, comprising:

initiating movement of said element to said relaxed position by said expanding.

19. The method of claim **18**, comprising:

latching said element in said stretched position;

defeating said latch with said expanding.

20. The method of claim **19**, comprising:

retaining a collar connected to said element by a ring that is selectively secured to said mandrel;

breaking said ring to release said collar.

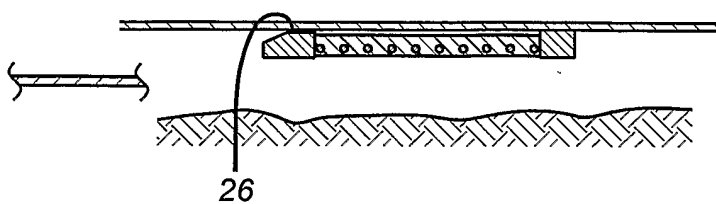
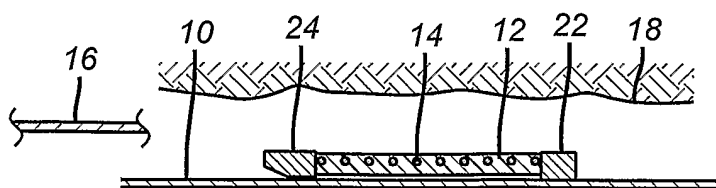
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FIG. 1

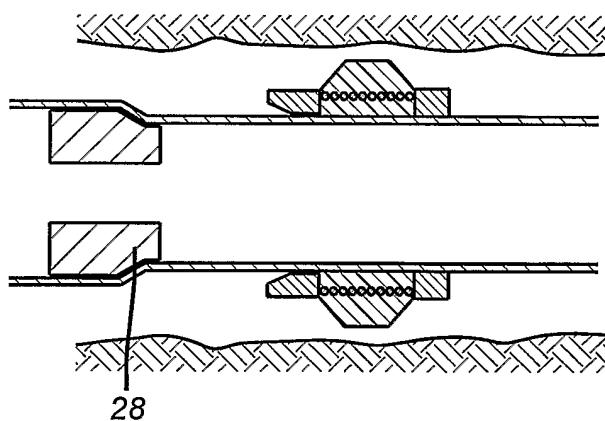


FIG. 2

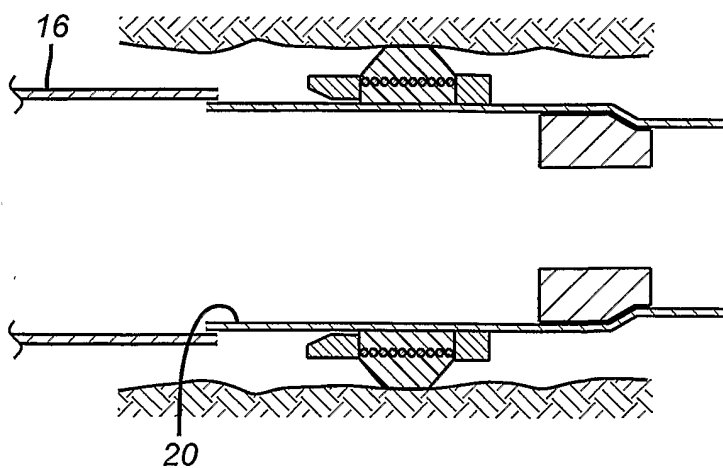


FIG. 3

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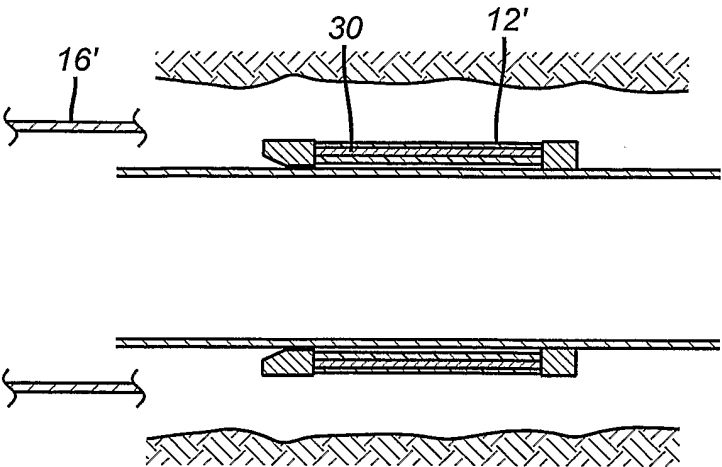


FIG. 4

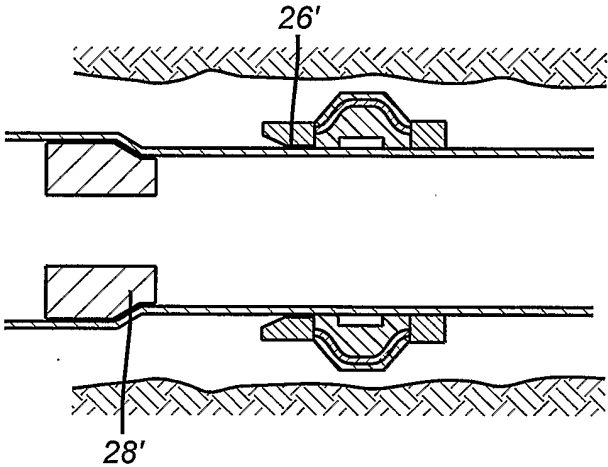


FIG. 5

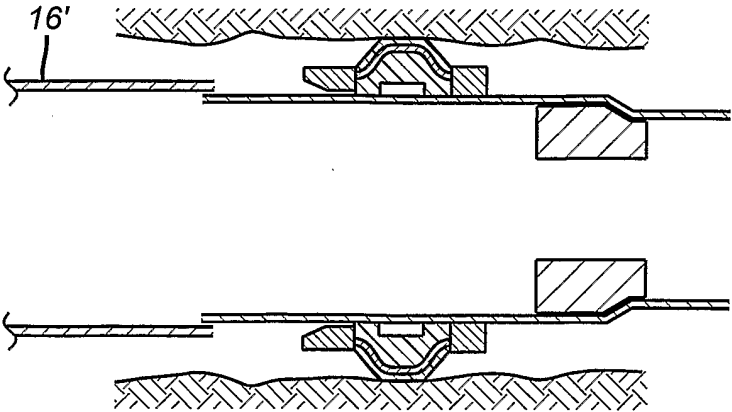


FIG. 6

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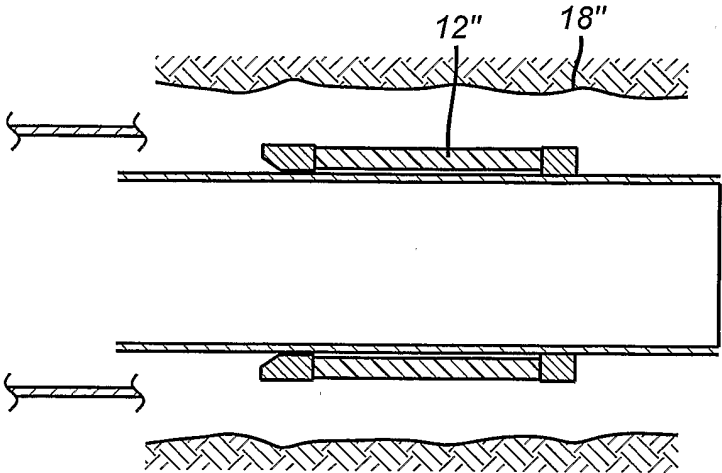


FIG. 7

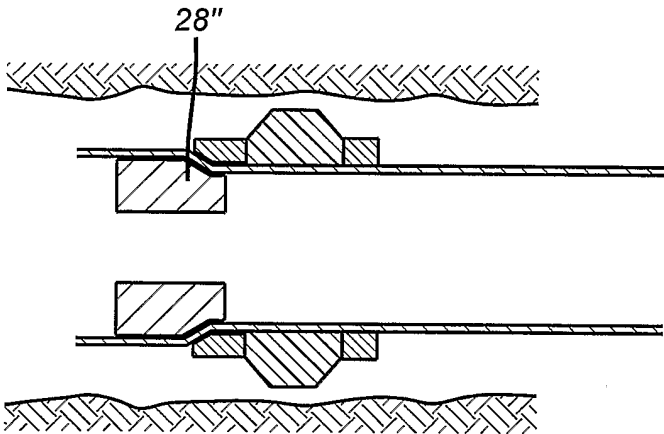


FIG. 8

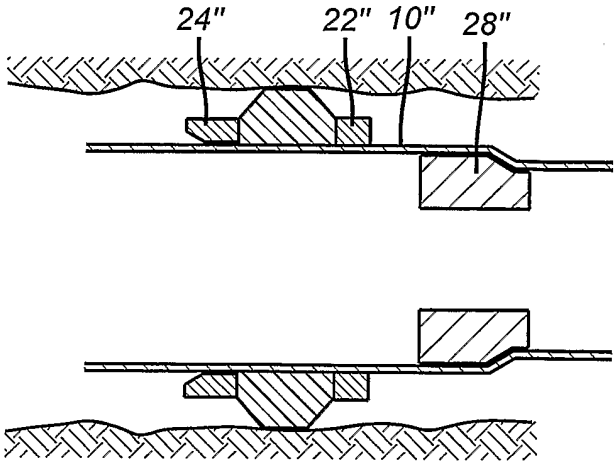


FIG. 9

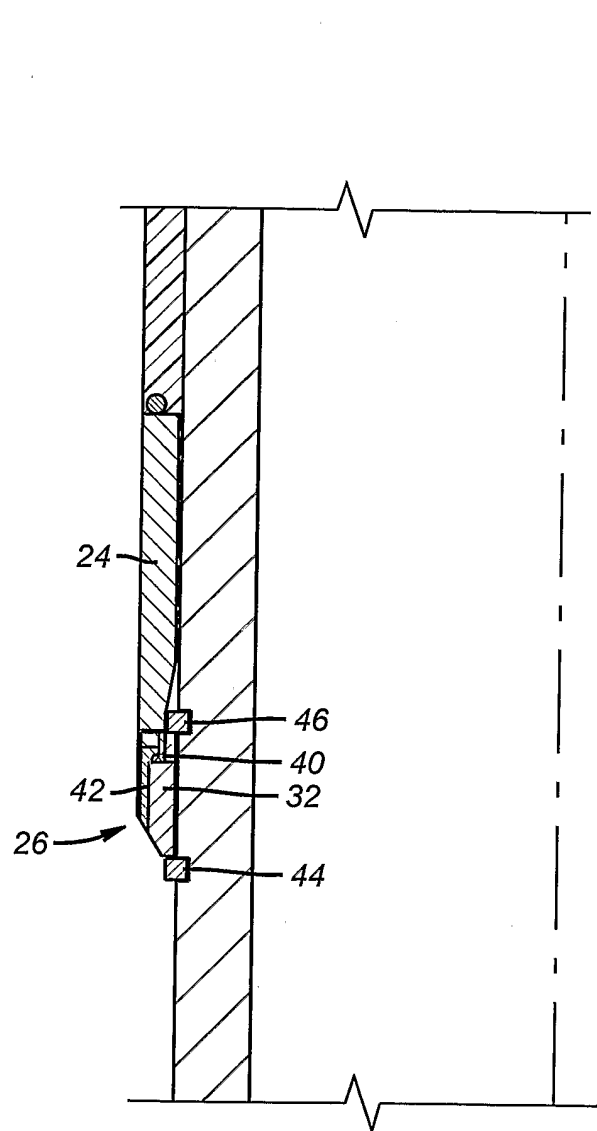


FIG. 10

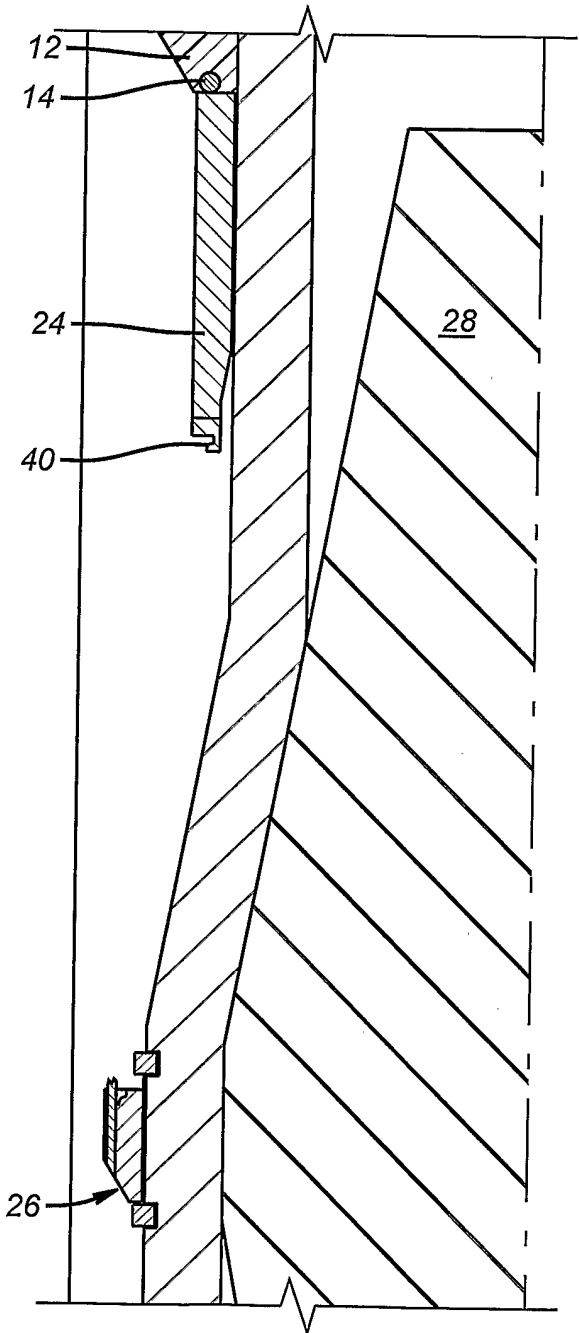


FIG. 11

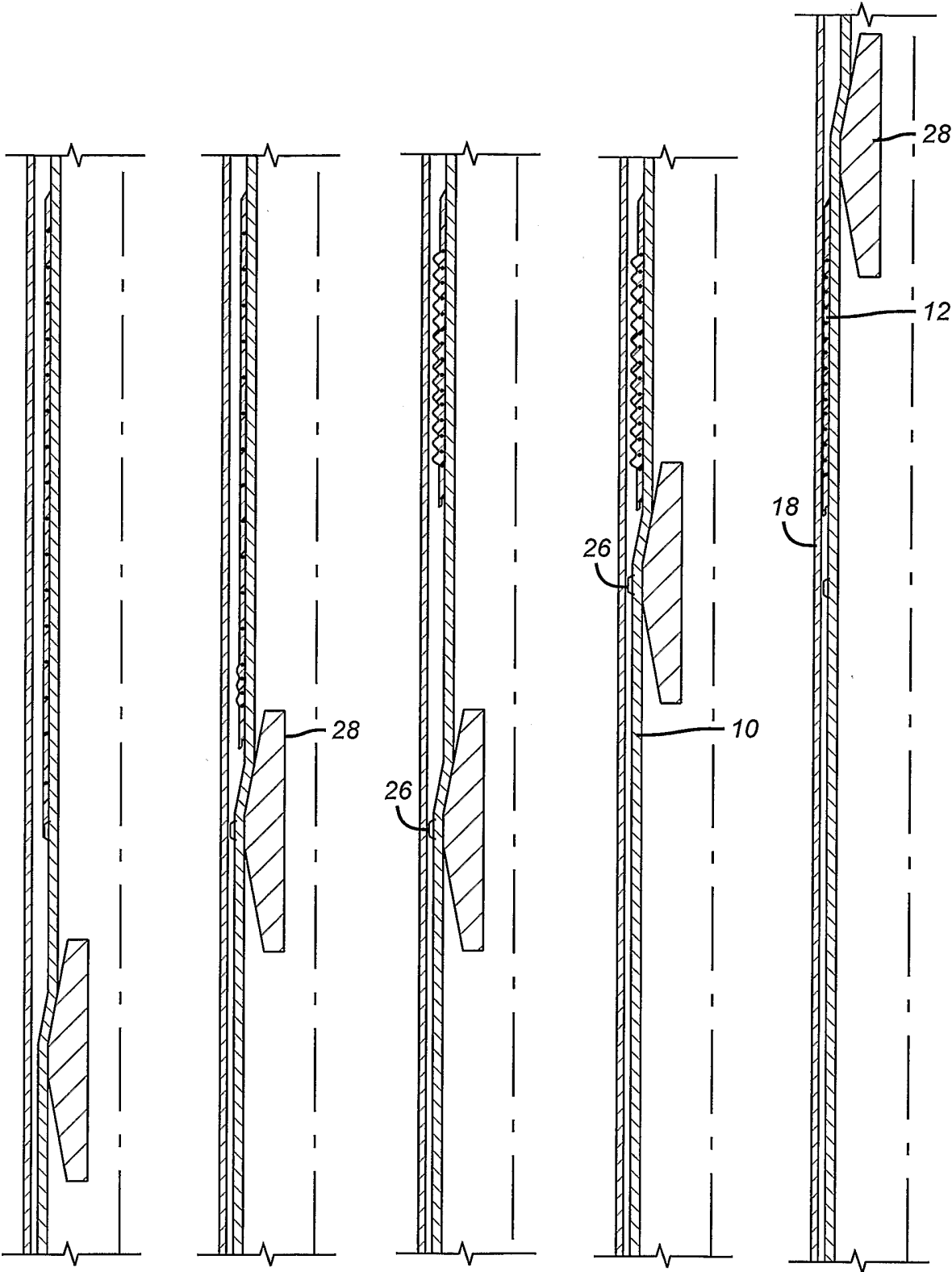


FIG. 12 FIG. 13 FIG. 14 FIG. 15 FIG. 16

INTERNATIONAL SEARCH REPORT

International Application No

PCT/US2004/016576

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 E21B33/12 E21B43/10

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)

IPC 7 E21B

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 03/008760 A (SHELL CANADA LTD ; BOSMA MARTIN GERARD RENE (NL); CORNELISSEN ERIK KER) 30 January 2003 (2003-01-30) page 3, lines 17-28 page 6, line 5 - page 7, line 24 figure 1	1
A	WO 03/008756 A (SHELL CANADA LTD ; BOSMA MARTIN GERARD RENE (NL); CORNELISSEN ERIK KER) 30 January 2003 (2003-01-30) abstract	1
A	US 6 431 282 B1 (BOSMA MARTIN GERARDS RENE ET AL) 13 August 2002 (2002-08-13) abstract	1

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☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

20 August 2004

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Schouten, A

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US2004/016576

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