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— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

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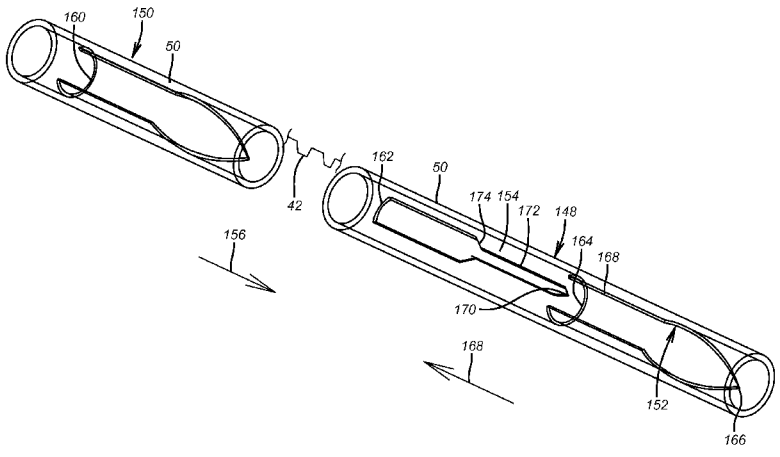
(54) Title: RESETTABLE SELECTIVE LOCKING DEVICE



(57) Abstract: A lock system works in combination with a mandrel to allow selective operation and disabling of a downhole tool. In the specific situation of a Smart Collet® the tool is locked from being able to find support when engaged to a mating profile as the tool is moved between landing locations. A lower housing features an external dog that in response to rotation takes with it a collet ring with circumferentially oriented fingers. An outer housing cams the collet heads into a respective groove in the mandrel. Reversal of such relative rotation between the upper and lower housings allows the collet heads to spring out of the mandrel groove for the unlocked position. The lock is adapted for use in a variety of tools. The rotation to unlock and then lock is accomplished by dog interaction with shaped internal profiles in a surrounding tubular assembly at strategic locations where needed.

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RESETTABLE SELECTIVE LOCKING DEVICE

Inventor: Robert S. O'Brien

FIELD OF THE INVENTION

[0001] The field of the invention is a selectively operated lock for a downhole tool and more particularly a selective lock for a Smart® Collet when used in multiple zone completions.

BACKGROUND OF THE INVENTION

[0002] The details of the assembly and operation of Smart® Collets is described in detail in USP 6,382,319 and 6,464,006. In essence the collet lands at predetermined support locations in an outer screen assembly and is part of an inner string. For example, in USP 6,382,319 FIG. 1 the support locations are 36, 37 and 38 and their spacing is known as a single zone is being treated. However in multiple zone completions the spacing of the support locations intended to operate with the Smart® Collet may be unknown or the large spacing between zones with the potential of other tools being in the assembly that present potential unintended support locations for the Smart® Collet present problems to surface personnel in determining if the inner string assembly in a gravel pack is properly aligned so that gravel delivered through the frac port in the inner string will properly cross over to the outer annular space of the zone that needs the gravel packing. What is needed as provided by the present invention is a way to selectively prevent the Smart® Collet from supporting any load until it comes in proximity of the shoulder on which it is intended that it will support a load. At this point the lock is defeated to allow the Smart® Collet to function normally for proper crossover support at the desired zone to selectively circulate or squeeze or reverse out in the known manner as described in the aforementioned patents. While the preferred application will be described as being for a Smart® Collet in a multi-zone gravel packing operation, those skilled in the art will appreciate that there are broader applications for locks that selectively unlock and reset to respectively unlock and lock an associated tool for multiple operations at spaced subterranean locations.

[0003] Sleeves have been used for location and orientation of keys to insure that a given collet system only latches at a desired profile location as described in US Publication 2003/0173089 A1. In a different application a

protective sleeve reduces the drift diameter to protect a release sleeve from catching a hold of the release sleeve inadvertently and moving it. A release tool is inserted through the release sleeve and into the protective sleeve inside diameter. The protective sleeve has an inner spline for the release tool to be able to get past the release sleeve and get a grip on the release sleeve to shift it. This device is described in US Application Number 13/142,552.

[0004] Downhole swivels involve a locking and unlocking feature for selective tandem or relative rotation of components that is accomplished with longitudinal component shifting to selectively engage a second pair of splines to another set of splines that are already meshed using a common shaft. Swivels of this type are shown in USP RE41, 759 and in a different application in USP 7,828,064 and 8,118,102.

[0005] What is needed and provided by the present invention is a simple lock and unlock feature for a subterranean tool that is located on a string delivering the tool that selectively allows the tool to operate as intended at predetermined locations and then locks the tool against operating as the tool is moved away from the desired location of operation. These and other aspects of the present invention will be more readily apparent to those skilled in the art 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 by the appended claims.

SUMMARY OF THE INVENTION

[0006] A lock system works in combination with a mandrel to allow selective operation and disabling of a downhole tool. In the specific situation of a Smart Collet® the tool is locked from being able to find support when engaged to a mating profile as the tool is moved between landing locations. A lower housing features an external dog that in response to rotation takes with it a collet ring with circumferentially oriented fingers. An outer housing cams the collet heads into a respective groove in the mandrel. Reversal of such relative rotation between the upper and lower housings allows the collet heads to spring out of the mandrel groove for the unlocked position. The lock is adapted for use in a variety of tools. The rotation to unlock and then lock is accomplished by dog interaction with shaped internal profiles in a surrounding tubular assembly at strategic locations where needed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] FIG. 1 is a section view of a known Smart® Collet with the selective lock feature shown at the right end;

[0008] FIG. 2 is an enlarged view of the lock feature at the right end of FIG. 1;

[0009] FIG. 3 shows a two zone gravel packing application of the lock system of the present invention with the Smart® Collet in the locked position;

[0010] FIG. 4 is the view of FIG. 3with the Smart® Collet unlocked and supporting a crossover in a profile so that the frac port aligns with the port above the screens to the outer annulus of the lower zone;

[0011] FIG. 5 is the view of FIG. 4 after the lower zone is completed with the Smart® Collet locked for movement to the next zone uphole;

FIG. 6 is a perspective view of the upper housing seen through the lower lousing;

[0012] FIG. 7 is a perspective view of the collet type lock ring;

[0013] FIG. 8is a perspective view of the collet type lock ring in the unlocked position;

[0014] FIG. 9 is the view of FIG. 8 with the collet type lock ring in the locked position;

[0015] FIG. 10 is an interior view of a part of the outer housing adjacent an associated landing location for a Smart Collet® that selectively allows unlocking and relocking; and

[0016] FIG. 11 is a section view showing the unlocked position of the collet type lock ring with respect to an adjacent mandrel groove.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0017] Referring to FIG. 1 the Smart® Collet **10** is of a type known in the art and described in detail in USP 6,382,319 and 6,464,006. In operation, greatly simplified, the collet assembly is a movable member **10** that moves radially and relatively axially with respect to the mandrel **12** so that the collet assembly **10** can snap into profile **14** in the surrounding tubular **16**. Once there is such engagement the mandrel **12** can be axially manipulated with respect to the collet assembly **10** now supported in profile **14**. This relative axial motion can place support **18** in line with inner ring **20** on the collet assembly **10** to lock the collet assembly **10** in the profile **14**. There are generally several such

profiles **14** in spaced locations for a given zone to gravel pack to support the circulate, squeeze and reverse out positions of the crossover (not shown) that supports the collet assembly **10** through the mandrel **12** support **18** misaligned with ring **20** to then allow the collet assembly **10** to radially collapse and move out of the profile **14**. The lock assembly **22** is supported by mandrel **12** and is designed to selectively permit or prevent relative axial movement between the mandrel **12** and the collet assembly **10**. In the locked position the support **18** is held offset to ring **20** so that the collet assembly **10** cannot find support in any profile such as **14**. When lock assembly **22** is released, the collet assembly **10** works as a known Smart® Collet.

[0018] An assembly for two zones **24** and **26** is illustrated in FIG. 3. Zone **24** is between packers **28** and **30** and zone **26** is between packers **30** and **32**. Screens **34** are in zone **24** and screens **36** are in zone **26**. The screens **34** and **36** respectively have openings **38** and **40** above to allow gravel slurry or other fluids to pass into the outer annulus in the borehole that reaches the zones **24** and **26** by going through the outer assembly **50**. The collet assembly **10** engages profile **42** in zone **24** or profile **44** in zone **26** in a known manner. FIG. 3 shows profile **46** for example in section and FIG. 4 shows the inside view showing the adjacent and alternating peaks **52** and valleys **54**. Preferably there is a constant pitch to the pattern. The patterns at profiles **46** and **48** can be identical or the pitch on one can be the reverse of the pitch on the other.

[0019] When relative axial movement is permitted between the mandrel **12** and the collet assembly **10** it allows normal Smart® Collet operation in zone **24** just as the collet assembly **10** comes into the vicinity of the support locations **42** in zone **24**. This normal operation is shown illustratively in FIG. 4 for the lower zone **26** which would normally be treated first. The same process occurs in zone **24**. FIG. 5 shows the inner string of mandrel **12**, collet assembly **10** and lock assembly **22** moving sufficiently to lock the Smart Collet ® until zone **24** is reached.

[0020] The lock assembly **22** serves to permit or prevent the support **18** to align with the ring **20** so that the Smart Collet® **10** selectively enabled to latch into a given profile or just snaps in and right back out due to the inability of support **18** to get aligned with ring **20**. It is this relative movement that the locking assembly permits or prevents. The locking assembly **22** is selectively

movable with respect to a mandrel **100**. Mandrel **100** has a groove or grooves **102** as best seen in FIG. 11. A collet ring **104** is seen in section in FIG. 11 and in perspective in FIG. 7. There is a base ring structure **106** that has circumferential wire EDM cuts **108** and **110** made parallel to each other with a collet head **112** at the free end so that the heads **112** at the end of each finger **114** can flex in a radial direction either toward or away from a corresponding groove **102** in the mandrel **100**. The is a leading ramp **114** on each collet head **112** that interacts with ramp **116** on top housing **118** as best seen in FIG. 7. Rotation of mandrel **100** is in tandem with rotation of the lower housing **120** seen in FIG. 6. Ring **104** has alternating peaks **122** and valleys **124** into which the top of the lower housing **120** mesh. Lower housing **120** has a radially biased dog **126** that has end ramps **128** and **130** near the top end **132** as well as opposed side ramp pairs **134** and **136**. The biasing is by one or more springs that are not shown and are between the dog **126** and the sleeve **138** that supports dog **126**. Thus rotational force acting on dog **126** will rotate the lower housing **120** and take with it the ring **104**. As a result ramp **114** will ride on ramp **116** and then on the inside diameter **140** of the upper housing **118** so that the heads **112** are radially part within the ring structure **106** and part within groove **102** for the axially locked position of FIG. 9. Either rotating the ring **104** in the opposite direction or further in the same direction will allow the heads **112** to move radially outwardly into an adjacent slot **142** that has the shape of a head **112** allowing the spring in the fingers **114** to snap the heads **112** into slot **142** for the unlocked position. Note that the upper housing **118** and the lower housing **120** are secured together at **142** as seen in FIG. 11 but can relatively rotate about the snap ring **144**. Thus with the heads **112** in groove **102** the upper housing **118** and lower housing **120** are in such a position the Smart Collet ® cannot find support by alignment of **18** with **20** even if collet **10** snaps into profiles **42** or **44**. However, the mandrel **100** with the housings **118** and **120** can still move relative to the outer assembly **50** so that the profiles in FIG. 10 that are part of the outer assembly come into play.

[0021] FIG. 10 shows one way to rotate heads **112** between the locked position of FIG. 9 and the unlocked position of FIG. 8. Again, in the unlocked position mandrel **100** can move enough to align **18** with **20** so that the collet **10** can find support in a profile such as **42** or **44**. In the locked position of FIG.

9 **18** and **20** can't align so that the collet **10** just snaps in and right out of profiles such as **42** and **44**. In either case, the mandrel **110** can move axially with housings **118** and 120 so that dogs **126** and **146** can interact with internal profiles **148** and **150** that are part of the outer assembly **50**. Profile **148** has two components **152** and **154** that interact with dogs **126** and **146**.

[0022] Mandrel **100** movement in the direction of arrow **156** acts only to compress the dogs **126** and **146** radially inwardly against an opposing spring bias from internal springs to those dogs that are not shown. In essence the top tapers **128** and **158** of dogs **126** and **146** respectively facilitate the radially inward movement of both dogs past blunt surface transitions **160**, **162** and **164**. Whether the tool was locked as in FIG. 9 or unlocked as in FIG. 8 does not change with movement of dogs **126** and **146** in the direction of arrow **156**. After dog **146** passes lower point **166** and snaps radially out the movement of the mandrel **100** is reversed to the direction of arrow **168**. As movement continues the dog **146** is pushed left or right by point **166**. Further movement in the direction of arrow **168** by the mandrel **100** brings dog **146** into wide slot **168** as dog **126** reaches the point **166** and is deflected left or right into alignment with wide slot **168**. At point **170** the dog **146** will be on one side of point **170** and dog **126** will be on the other side of the barrier **172**. Then ramp **174** relatively rotates the dogs **126** and **146** so that the unlocked orientation of FIG. 8 is accomplished. At that point the collet **10** can find profile such as **42** and lock to it as **18** lines up with **20**. When the operation there is completed the mandrel **100** can be further picked up and the direction of relative rotation that unlocked is reversed so that the locked position of FIG. 9 is assumed. After that the collet **10** can be safely moved to the next profile where another structure such as FIG. 10 is to be found and movement through profiles **152** and then **154** will again resume the unlocked position of FIG. 8 so that the collet **10** can be landed and supported in the normal manner.

[0023] Those skilled in the art will appreciate that there are variations that could be employed in the number of mandrel grooves **102** and collets oriented circumferentially on the ring **104** for engagement. Movement between the locked and unlocked positions can be with rotation in a single direction or rotation in equal measure in opposed directions. The profiles in FIG. 10 induce relative rotation between the lower housing **120** and ring **104** on one hand and

the upper housing **118** on the other hand so that the circumferentially oriented heads **112** get pushed into the grooves **102** for the locked position while reverse relative rotation allows the heads **112** to snap out into grooves **176** as shown in FIG. 8 for the unlocked position. While the preferred application is for a collet such as **10** the described locking and unlocking mechanism can be used in a variety of downhole applications where certain relative movements are to be prevented at a desired time and then subsequently enabled. In the preferred embodiment the locked position of FIG. 9 interacts with the Smart Collet ® components to prevent aligning **18** with **20** so that the collet **10** can be supported. In the unlocked position of FIG. 8 different mandrel movement becomes possible and the collet **10** can be supported with **18** aligning with **20** to selectively lock the collet **10** in the known manner.

[0024] Those skilled in the art will appreciate that the invention seeks to keep a tool in a locked position when being moved past areas where premature operation is not desirable. The lock system can unlock and relock to allow normal tool operation in a desired zone while preventing operation for any reason when away from desired zones of operation. It is particularly adept at dealing with multiple completion zones where a crossover has to take several positions in a particular zone to accomplish the circulation, squeeze and/or reverse out positions. Mere axial movement is automatically converted to rotation that selectively locks or unlocks the associated tool, which in the preferred embodiment is the Smart® Collet. The benefit of the present invention is the simplicity and the automatic nature of the operation so that that a problem of the Smart® Collet getting a support where it is not desired are eliminated. In essence the lock assembly **22** in a movement of the inner string with the Smart® Collet respectively enables normal operation and then disables normal operation by locking the collet assembly **10** to the mandrel **12** to prevent unintended operation at anywhere but the intended support locations such as at multiple zones **24** and **26**. Those zones can be far apart with several radial surfaces in between where the Smart® Collet could otherwise be engaged to find support for the inner string but for the presence of the lock assembly **22** of the present invention.

[0025] 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. A lock assembly for a subterranean tool operably positioned in a surrounding tubular, comprising:

a mandrel operatively associated with a subterranean tool such that relative movement therebetween enables and disables said tool from operating;

a lock assembly supported by said tool and mounted to said mandrel for selective engagement to said mandrel for a locked position for said tool and selective release from said mandrel for the operating position for said tool, said lock assembly comprising housing components whose relative rotation selectively engages and releases said lock assembly with said mandrel.

2. The assembly of claim **1**, wherein:

said relative rotation in a first direction selectively drives at least one collet into an associated groove in said mandrel.

3. The assembly of claim **1**, wherein:

said relative rotation is created with axial movement of said mandrel.

4. The assembly of claim **1**, wherein:

said relative rotation is in opposed directions responsive to mandrel axial movement in opposed directions.

5. The assembly of claim **2**, wherein:

relative rotation in a second direction opposite said first direction aligns a recess of one of said housing components over said collet to allow said collet to exit said groove.

6. The assembly of claim **5**, wherein:

said collet is configured with a bias to move out of said groove.

7. The assembly of claim **2**, wherein:

said collet is ramped into said groove by a stationary upper housing of said housing members.

8. The assembly of claim **7**, wherein:

said collet extends circumferentially, in a transverse plane to a longitudinal axis of said mandrel, from a ring that rotates with a lower housing of said housing members.

9. The assembly of claim **8**, wherein:

said upper and lower housings further comprise an upper dog and a lower dog respectively, said dogs biased in a direction away from said longitudinal axis of said mandrel.

10. The assembly of claim **9**, further comprising:

profile assemblies on the surrounding tubular that interact with said dogs in a manner to create said relative rotation between said upper and lower housing components.

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

said profile assemblies comprise discrete spaced profiles with each profile having a blunt upper end such that movement of said dogs in a downhole direction over said blunt ends retracts said dogs against the bias acting on said dogs without causing relative rotation of said upper and lower housings.

12. The assembly of claim **10**, wherein:

said profile assemblies straddle at least one location where said tool is to be operated with an upper profile assembly and a lower profile assembly.

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

movement of said dogs past said lower profile assembly to the location where the tool is to be operated releases said collet from said groove in said mandrel.

14. The assembly of claim **13**, wherein:

further movement of said dogs away from said lower profile assembly and toward said upper profile assembly after operation of said tool engages said collet in said groove to allow mandrel movement with said tool locked against actuation.

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

said lower profile assembly comprises a first lower profile with tapered guide surfaces to orient said upper and lower dogs with an elongated slot;

said elongated slot aligns with a second lower profile comprising a longitudinal component positioned so that said upper and lower dogs advance on opposed sides thereof;

said longitudinal component comprising a taper that causes relative rotation between said dogs moving said dogs apart for removal of said collet from said groove in said mandrel.

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

said upper profile comprises tapered guide surfaces to orient said upper and lower dogs with a second elongated slot and creating relative rotation as said dogs are brought together circumferentially to pass through said second elongated slot to move said collet into said groove in said mandrel, thereby allowing further transport of said tool in said locked position of said tool.

17. The assembly of claim **2**, wherein:

said at least one collet comprises a plurality of collets integrally formed using spaced parallel cuts in a ring in a plane substantially perpendicular to an axis of said mandrel;

said mandrel comprising an associated groove for each said collets;

said housing components comprising and upper and lower housing components;

said collets comprising ramped heads that selectively engage corresponding upper housing ramps for selective movement into a respective said groove.

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

said ring moves in tandem with said lower housing component in response to interaction of a lower housing biased dog with a profile assembly on the surrounding tubular;

said upper housing comprising an upper housing spring loaded dog;

said profile assembly moving said dogs circumferentially apart and subsequently circumferentially together as said mandrel is moved in a single axial direction.

19. The assembly of claim **1**, further comprising:

profile assemblies on the surrounding tubular that interact with said housing components in a manner to create said relative rotation therebetween.

20. The assembly of claim **19**, further comprising:

said profile assembly moving said housing components relatively rotationally in a first direction and subsequently relatively rotationally in an

opposite direction to said first direction as said mandrel is moved in a single axial direction.

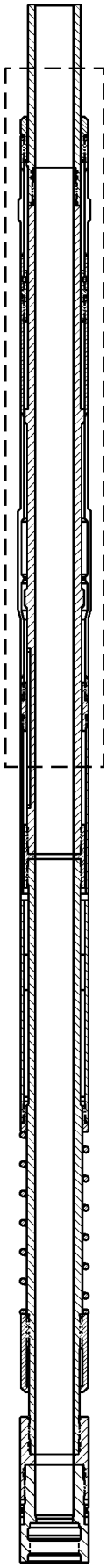

FIG. 1

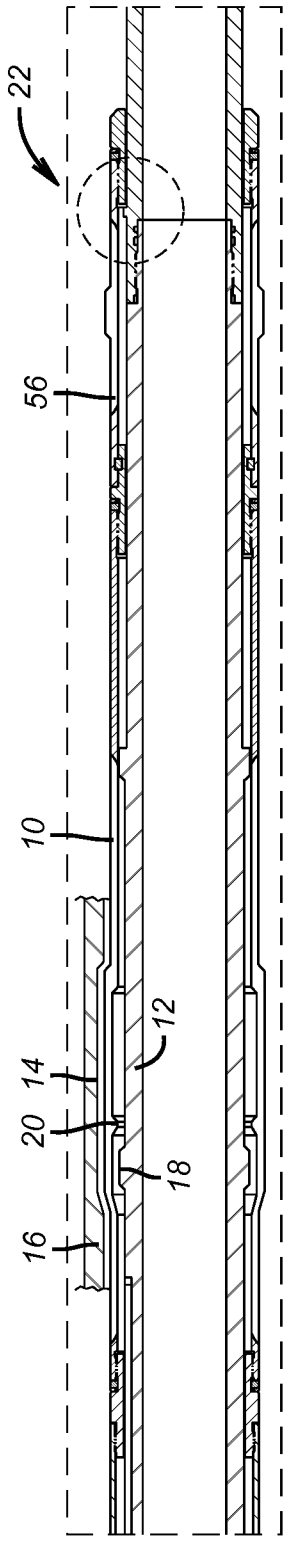

FIG. 2

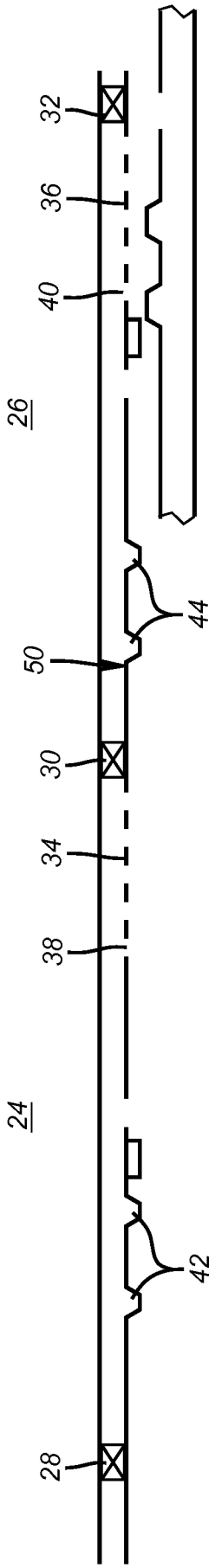

FIG. 3

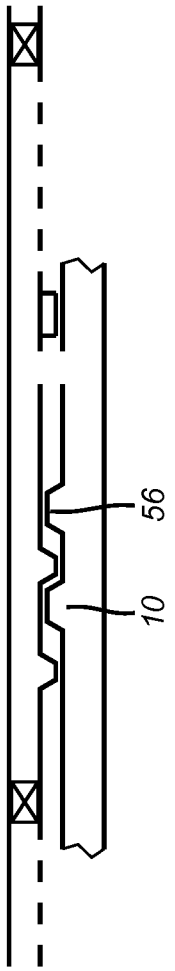

FIG. 4

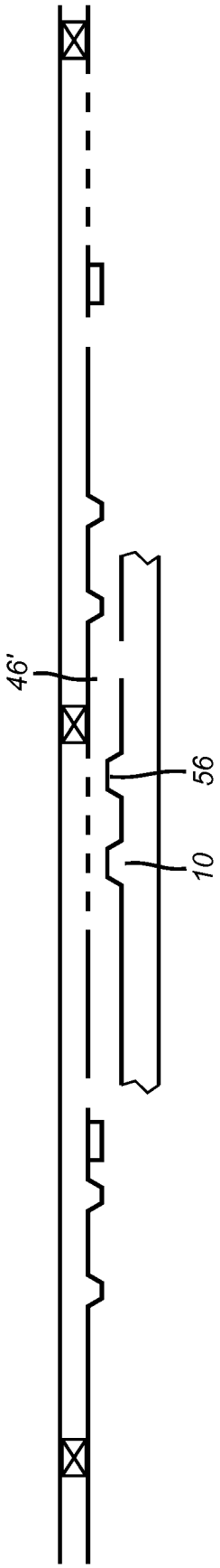

FIG. 5

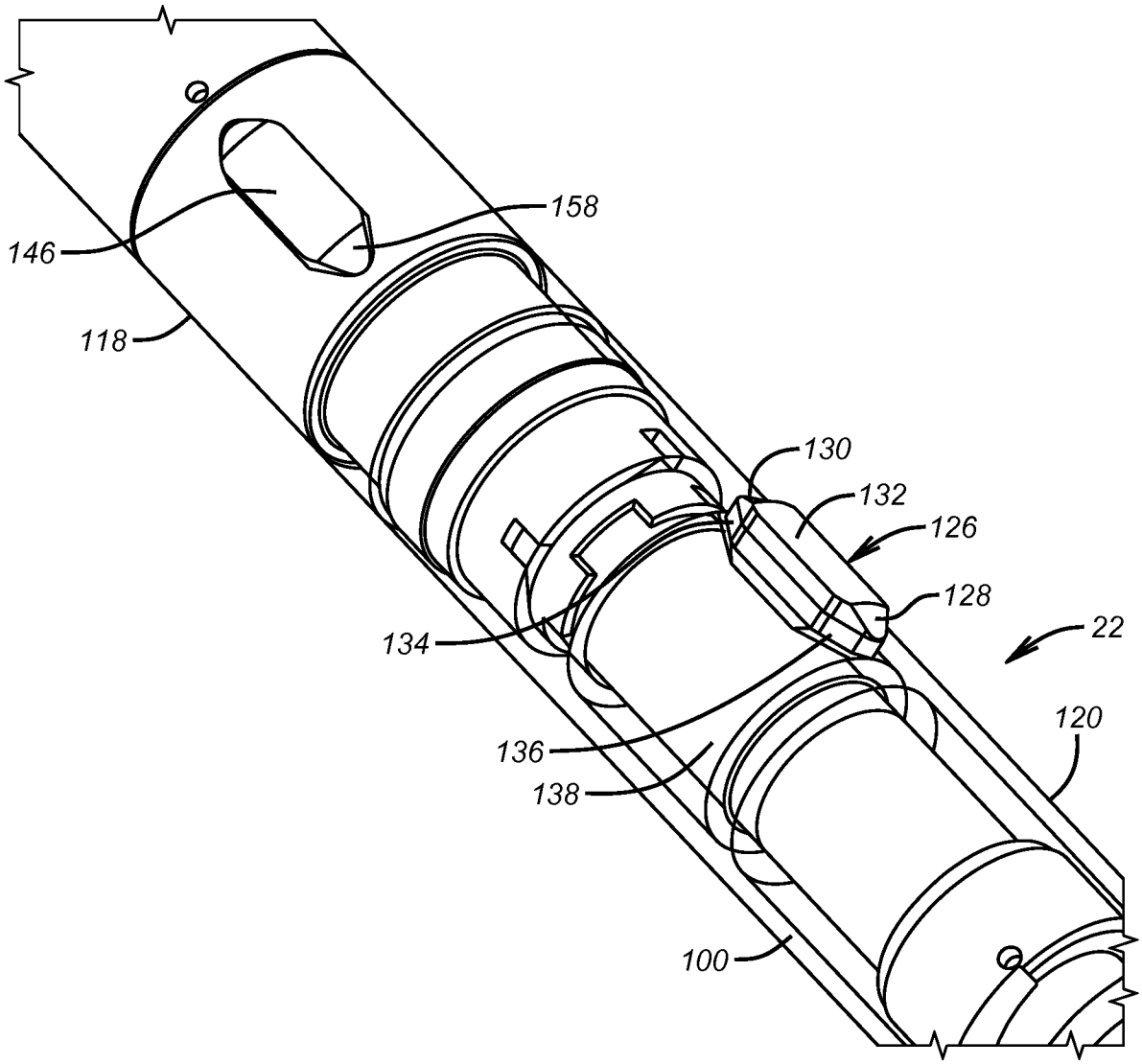

FIG. 6

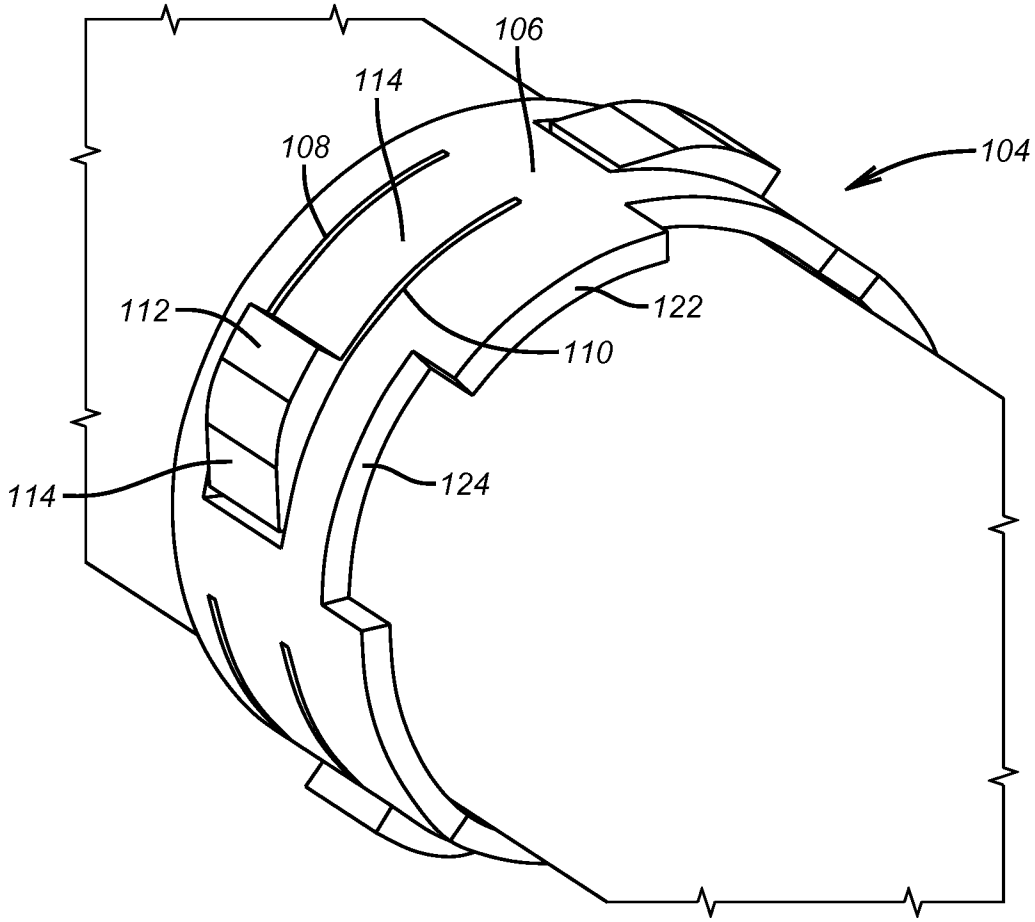

FIG. 7

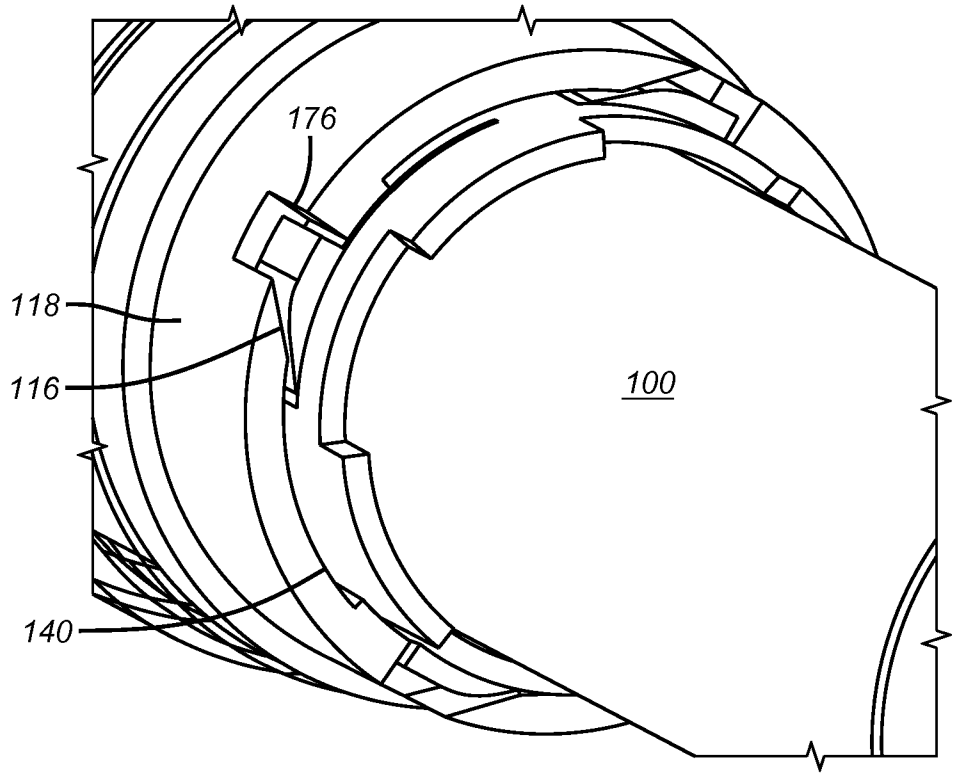

FIG. 8

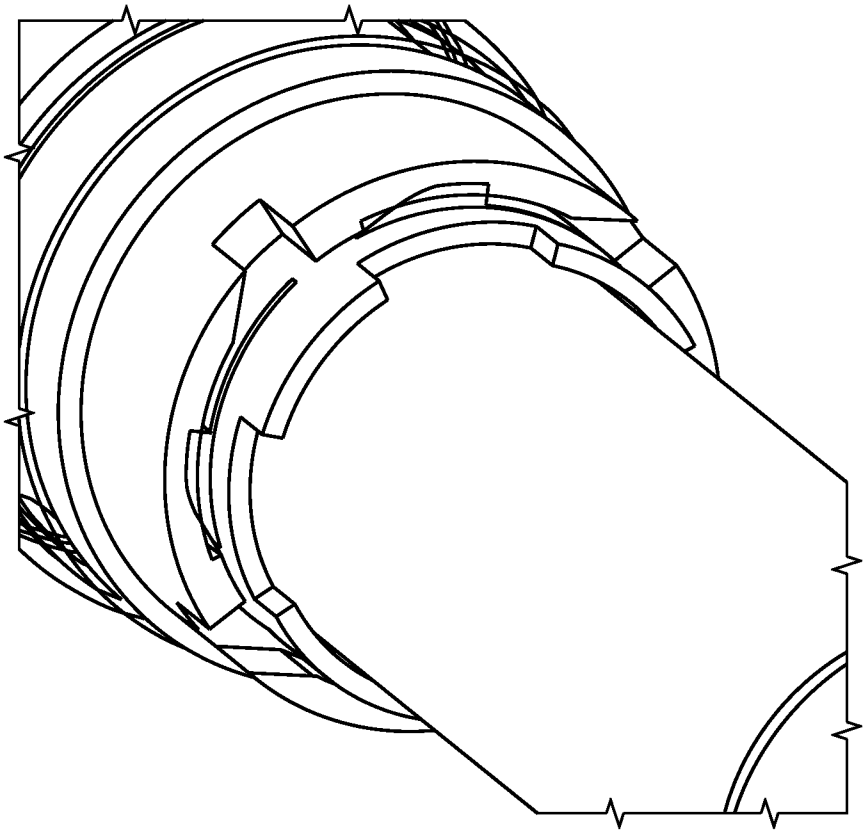

FIG. 9

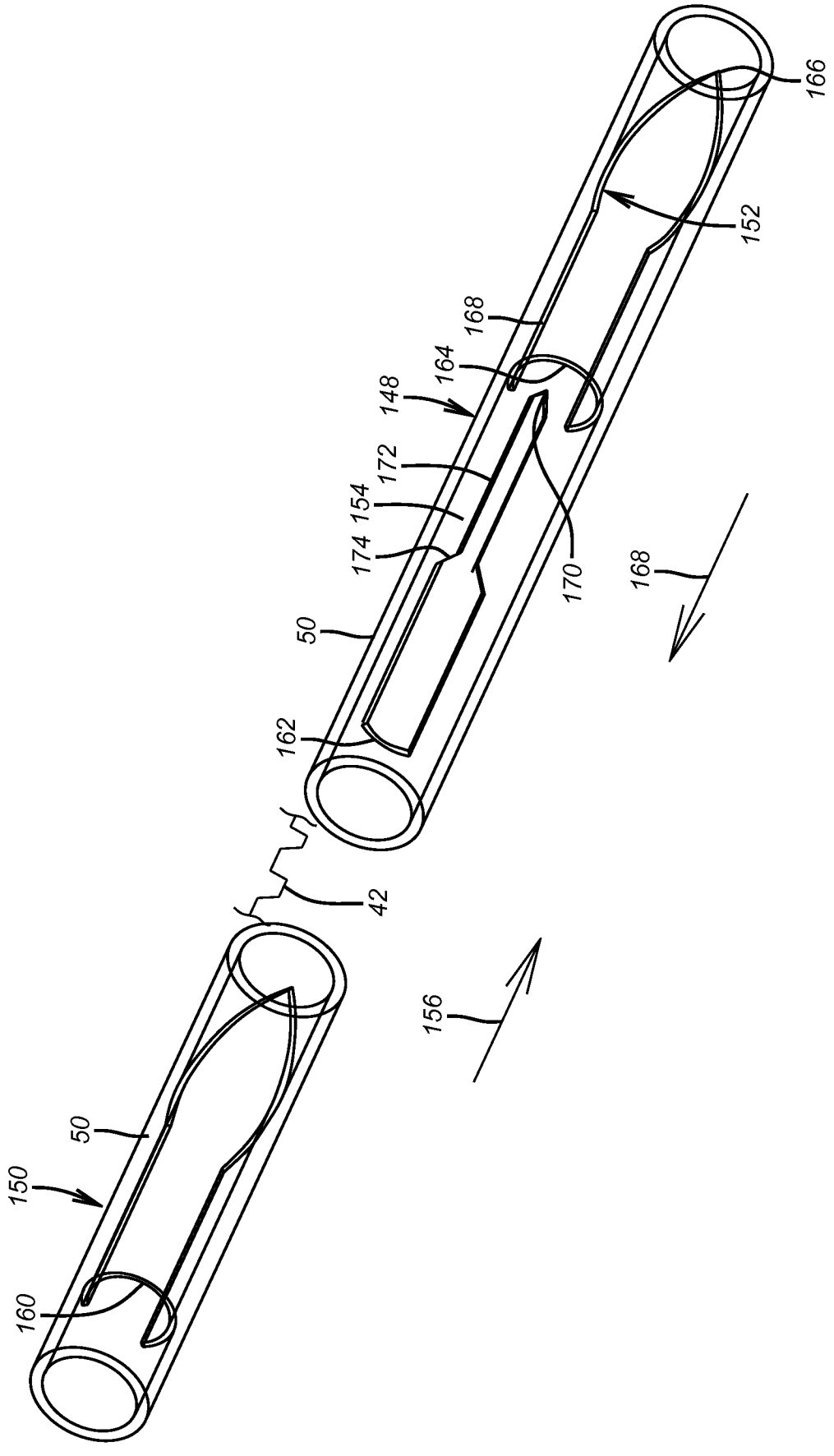

FIG. 10

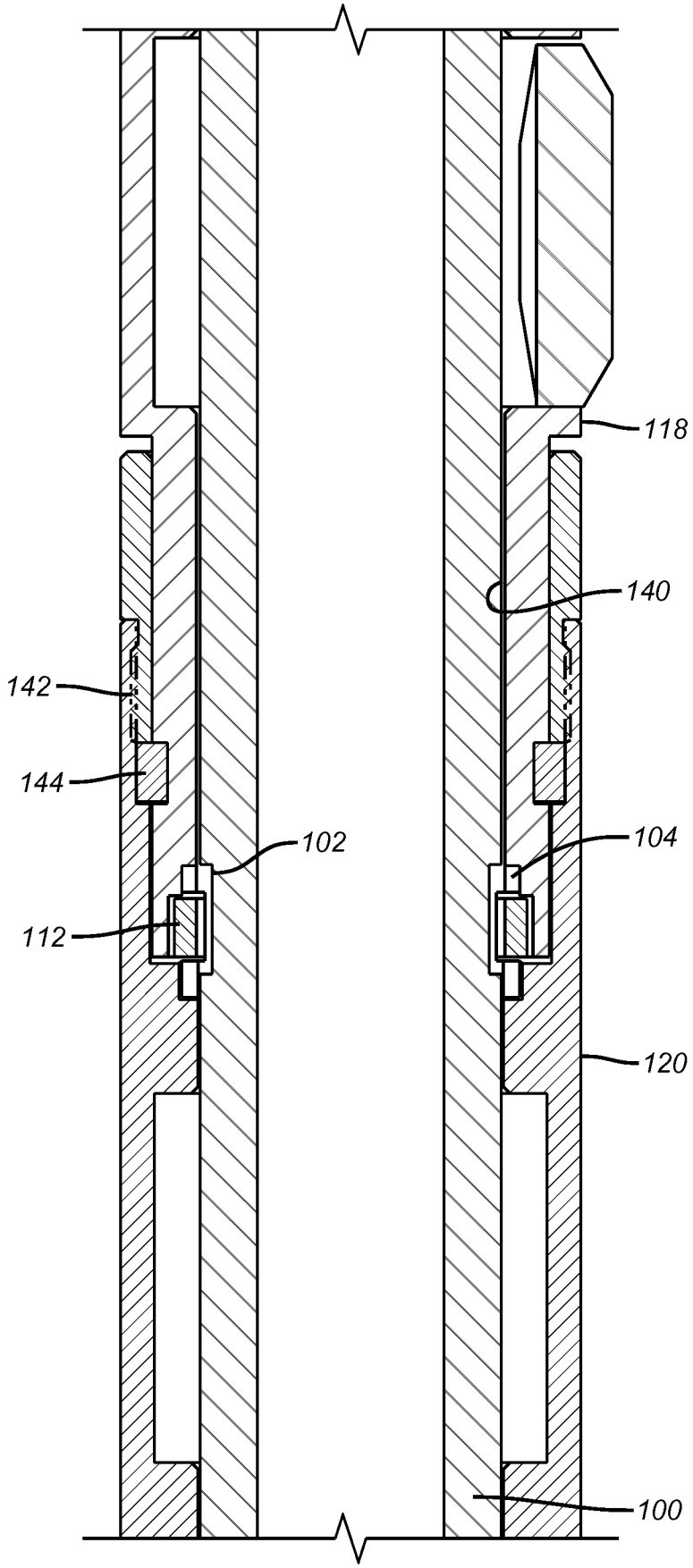

FIG. 11

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/067290

A. CLASSIFICATION OF SUBJECT MATTER

E21B 17/046(2006.01)i, E21B 19/16(2006.01)i

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 17/046; E21B 33/10; E21B 34/00; E21B 33/12; E21B 34/10; E21B 19/16

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: release, rotation, mandrel, collet, sleeve, and lock

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2011-0209867 A1 (NEVELS et al.) 01 September 2011 See abstract, paragraph [0012], and figure 1a.	1,3-4,19-20
A		2,5-18
Y	US 6634424 B2 (KNOWLES, DAVID GEORGE) 21 October 2003 See abstract, column 3, lines 1-13, claims 1-2, and figures 1-2,6.	1,3-4,19-20
A	US 2009-0065214 A1 (PURKIS, DANIEL) 12 March 2009 See abstract, paragraphs [0071]-[0075], and figure 10.	1-20
A	US 2011-0114325 A1 (COGHILL et al.) 19 May 2011 See abstract, paragraph [0018], and figure 3a.	1-20
A	US 5826657 A (RINGGENBERG, PAUL D.) 27 October 1998 See abstract, column 4, line 53 - column 5, line 34, and figures 2A-3C.	1-20

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:
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Date of the actual completion of the international search	Date of mailing of the international search report
14 February 2014 (14.02.2014)	**17 February 2014 (17.02.2014)**

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/US2013/067290

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