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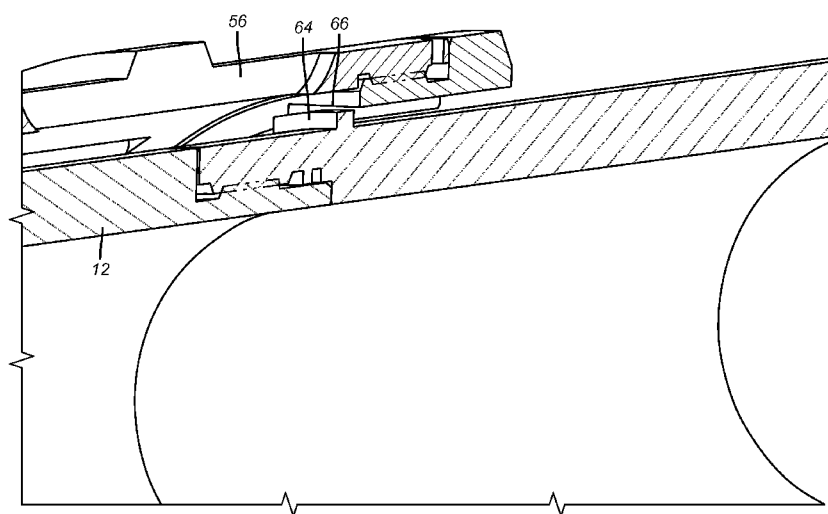
Declarations under Rule 4.17:

- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))
- 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 collet system is disabled from gaining profile support when moved between profiles that will be used ultimately to support an inner string at a desired plurality of locations. It is when the collet reaches a desired location that it is unlocked by virtue of inner string movement so that a profile on the outer assembly is engaged by a sleeve to induce relative rotation of the sleeve with respect to the mandrel that supports the sleeve. The relative rotation moves a tab into alignment with a slot to permit relative axial movement between the mandrel and the tool so that the tool can function as intended. The sleeve is engaged by another profile for further relative rotation to misalign the tab and the slot to lock the tool. The tool is preferably a support collet for a crossover in a multi-zone gravel pack.



RESETTABLE SELECTIVE LOCKING DEVICE

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 13/012,552.

[0004] 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

[0005] A collet system is disabled from gaining profile support when moved between profiles that will be used ultimately to support an inner string at a desired plurality of locations. It is when the collet reaches a desired location that it is unlocked by virtue of inner string movement so that a profile on the outer assembly is engaged by a sleeve to induce relative rotation of the sleeve with respect to the mandrel that supports the sleeve. The relative rotation moves a tab into alignment with a slot to permit relative axial movement between the mandrel and the tool so that the tool can function as intended. The sleeve is engaged by another profile for further relative rotation to misalign the tab and the slot to lock the tool. The tool is preferably a support collet for a crossover in a multi-zone gravel pack.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] FIG. 1 is a section view of a known Smart® Collet with the selective lock feature shown at the right end;

[0007] FIG. 2 is an enlarged view of the lock feature at the right end of FIG. 1;

[0008] FIG. 3 is an enlarged view of the lock of FIG. 2 showing the tab that selectively advances axially when aligned with a slot for normal Smart® Collet operation;

[0009] FIG. 4 shows a perspective of the rotating sleeve assembly that puts an axial slot into or out of alignment with the tab shown in FIG. 3;

[0010] FIG. 5 shows an aligned tab and axial slot;

[0011] FIG. 6 shows a misaligned tab and axial slot;

[0012] FIG. 7 is a section view of the extending helical profile of the rotating sleeve;

[0013] FIG. 8 is the exterior view of the helical profile on the rotating sleeve;

[0014] FIG. 9 is a section view of a surrounding tubular profile that is engaged by the extending helical profile of FIG. 7;

[0015] FIG. 10 is the interior view of the surrounding tubular profile shown in FIG. 9;

[0016] FIG. 11 shows a two zone gravel packing application of the lock system of the present invention with the Smart® Collet in the locked position;

[0017] FIG. 12 is the view of FIG. 11 with 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;

[0018] FIG. 13 is the view of FIG. 12 after the lower zone is completed with the Smart® Collet locked for movement to the next zone uphole.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0019] 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.

[0020] An assembly for two zones 24 and 26 is illustrated in FIG. 11. 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. The collet assembly 10 engages profile 42 in zone 24 or profile 44 in zone 26 in a known manner. However, above and below profile 42 are spiral profiles 46 and 48 on the outer assembly 50. FIG. 11 shows profile 46 for example in section and FIG. 12 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. As shown in FIGS. 1, 7 and 8, a rotating sleeve 56 is mounted to mandrel 12 and has alternating peaks 58 and valleys 60 on profile 62 that can have the same pitch as profile 46 or 48 or both. If the pitch on profiles 46 and 48 is in the same direction then movement of the sleeve 56 in the same direction past profiles 46 and 48 will turn sleeve 56 in the same direction as profile 62 engages them. Alternatively if the pitch on profiles 46 and 48 are opposite hand then movement of mandrel 12 in the same direction past profile 46 will see initial rotation in a first direction of the sleeve 56 due to engagement of profile 62 followed by a reversal of direction for rotation back to the initial position when profile 62 engages profile 48. Preferably the pattern in zone 26 is identical to the pattern in zone 24.

[0021] FIG. 4 shows the rotating sleeve **56** that is axially retained on the mandrel **12**. Mandrel **12** has an exterior tab **64**. Axial movement of the mandrel **12** to bring profile **62** into contact with profile **48** brings a slot **66** into alignment with tab **64** to in turn permit relative axial movement between the mandrel **12** and the collet assembly **10** to allow 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. 12 for the lower zone **26** which would normally be treated first. The same process occurs in zone **24**. FIG. 13 shows the inner string of mandrel **12**, collet assembly **10** and lock assembly **22** moving sufficiently to get sleeve **56** with its profile **62** past the profile **48'** to turn the sleeve **56** either in the same direction as engagement with profile **46'** had caused earlier or back in the opposite direction for the same amount of rotation. Regardless of the direction of the second rotation of sleeve **56** in a given zone the desired result is to get tab **64** misaligned with slot **66** as in FIG. 6. FIG. 5 shows alignment of tab **64** with slot **66** for normal Smart® Collet operation. Since there can be multiple slots **66** sleeve rotation in the same direction will alternately bring alignment of tab **64** with different slots **66**. If in a given zone the sleeve **56** rotates one way for alignment and in reverse for misalignment then only one slot **66** is necessary. Thus for movement between zones **24** and **26**, the FIG. 6 position prevents the collet assembly **10** of the smart collet from getting a supporting grip on any profile or radial surface along the way. It is not until another spiral profile such as **48** in the upper zone **24** is engaged that the collet assembly **10** is able to find support as relative movement between the mandrel **12** and the collet assembly **10** again makes possible alignment of support **18** with inner ring **20**.

[0022] 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 with sleeve rotation in the same or in opposite hand rotation. While the preferred way to accomplish the rotation is with spirally meshing splines is preferred other ways are contemplated such as a j-slot for example. 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 a pair of activating profiles such as **48** and **46** in a movement of the inner string with the Smart® Collet respectively enable normal operation and then disable 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.

[0023] 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 to enable operation of said tool at one or more desired subterranean locations and to prevent operation of said tool during movement outside said one or more subterranean locations, comprising:

at least one first and second actuation profiles associated with at least one desired subterranean location and straddling opposed ends thereof;

said first actuation profile enables operation of said tool as said tool engages said first actuation profile to allow said tool to operate between said profiles;

said second actuation profile preventing said tool from operating as said tool engages said second actuation profile so that said tool can be relocated to another desired subterranean location for further operation of said tool in a like manner or to a surface location in a locked condition that prevents further operation of said tool.

2. The assembly of claim 1, wherein:

said first actuation profile enables relative movement in said tool and said second actuation profile disables relative movement in said tool.

3. The assembly of claim 2, wherein:

said relative movement occurs between a mandrel of said tool and a movable member mounted to said mandrel.

4. The assembly of claim 3, wherein:

said relative movement is axial.

5. The assembly of claim 4, wherein:

said relative axial movement occurs with mandrel movement while said movable member is externally supported in a subterranean location.

6. The assembly of claim 5, further comprising:

a rotatably mounted sleeve mounted over said mandrel and supported from said movable member, one of said sleeve and said mandrel having at least one axial slot and the other of said sleeve and said mandrel having at least one tab, whereupon selective alignment of said tab and said slot allows said tool to function by enabling said axial relative movement.

7. The assembly of claim 6, wherein:
said sleeve is rotated by contact with said first and second actuation profiles.
8. The assembly of claim 7, wherein:
said rotation upon contact with said first and second actuation profiles is in the same or opposite direction.
9. The assembly of claim 7, wherein:
said rotation is caused by meshing helical splines on said sleeve on one hand and on said first or second actuation profiles on the other hand.
10. The assembly of claim 6, wherein:
said tab is mounted to said mandrel and said sleeve has said at least one axial slot.
11. The assembly of claim 9, wherein:
said movable member comprises a collet for selective support of said mandrel for support of a crossover from which said mandrel extends into an outer screen assembly for gravel packing a desired subterranean location where said screen assembly is located.
12. The assembly of claim 11, wherein:
alignment of said tab and said slot allows mandrel axial movement to support said collet at multiple locations on support surfaces in said outer screen assembly in one or more desired subterranean locations, while misalignment of said tab and slot prevents relative axial movement between said mandrel and said collet to prevent said collet from supporting said mandrel outside of said desired subterranean locations.
13. The assembly of claim 1, wherein:
a sleeve rotatably mounted to said tool for selective engagement with said at least one first and second actuation profiles such that sleeve rotation both enables and disables actuation of said tool.
14. The assembly of claim 13, wherein:
said sleeve and said at least one first and second actuation profiles comprise helical splines to rotate said sleeve as said tool moves axially.

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

said tool comprises a mandrel and said sleeve mounted over said mandrel;

one of said sleeve and said mandrel having at least one axial slot and the other of said sleeve and said mandrel having at least one tab, whereupon selective alignment of said tab and said slot allows said tool to function, while misalignment of said at least one slot and said at least one tab prevents operation of the tool.

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

said tool comprises a movable member mounted to said mandrel, said movable member supports said sleeve for relative mandrel movement when said movable member is externally supported in a desired subterranean location, said relative mandrel movement enabled by alignment of said tab with said slot.

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

said movable member comprises a collet for selective support of said mandrel for support of a crossover from which said mandrel extends into an outer screen assembly for gravel packing a desired subterranean location where said screen assembly is located.

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

alignment of said tab and said slot allows mandrel axial movement to support said collet at multiple locations on support surfaces in said outer screen assembly in one or more desired subterranean locations, while misalignment of said tab and slot prevents relative axial movement between said mandrel and said collet to prevent said collet from supporting said mandrel outside of said desired subterranean locations.

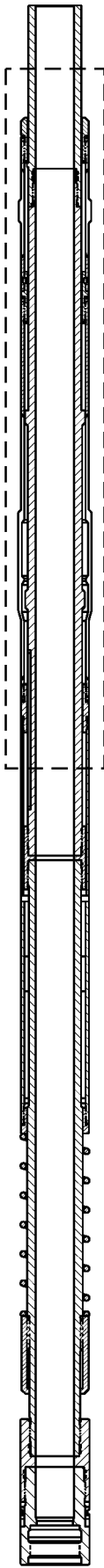


FIG. 1

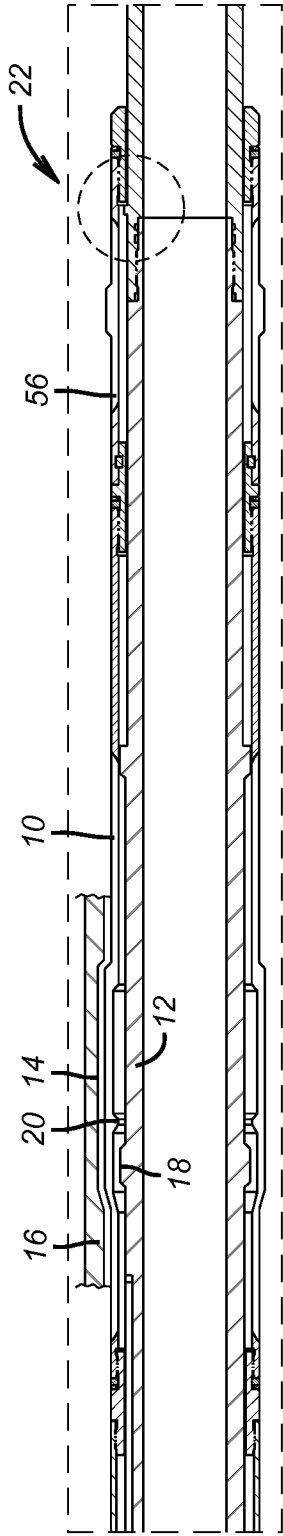


FIG. 2

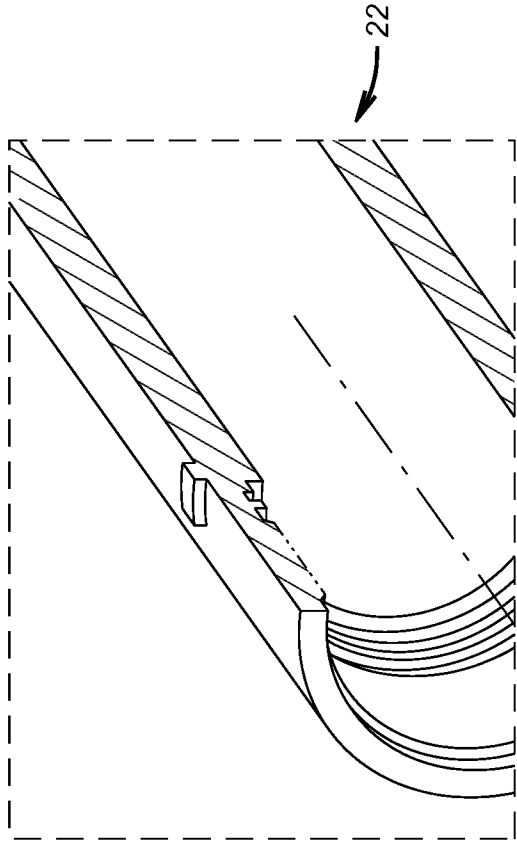


FIG. 3

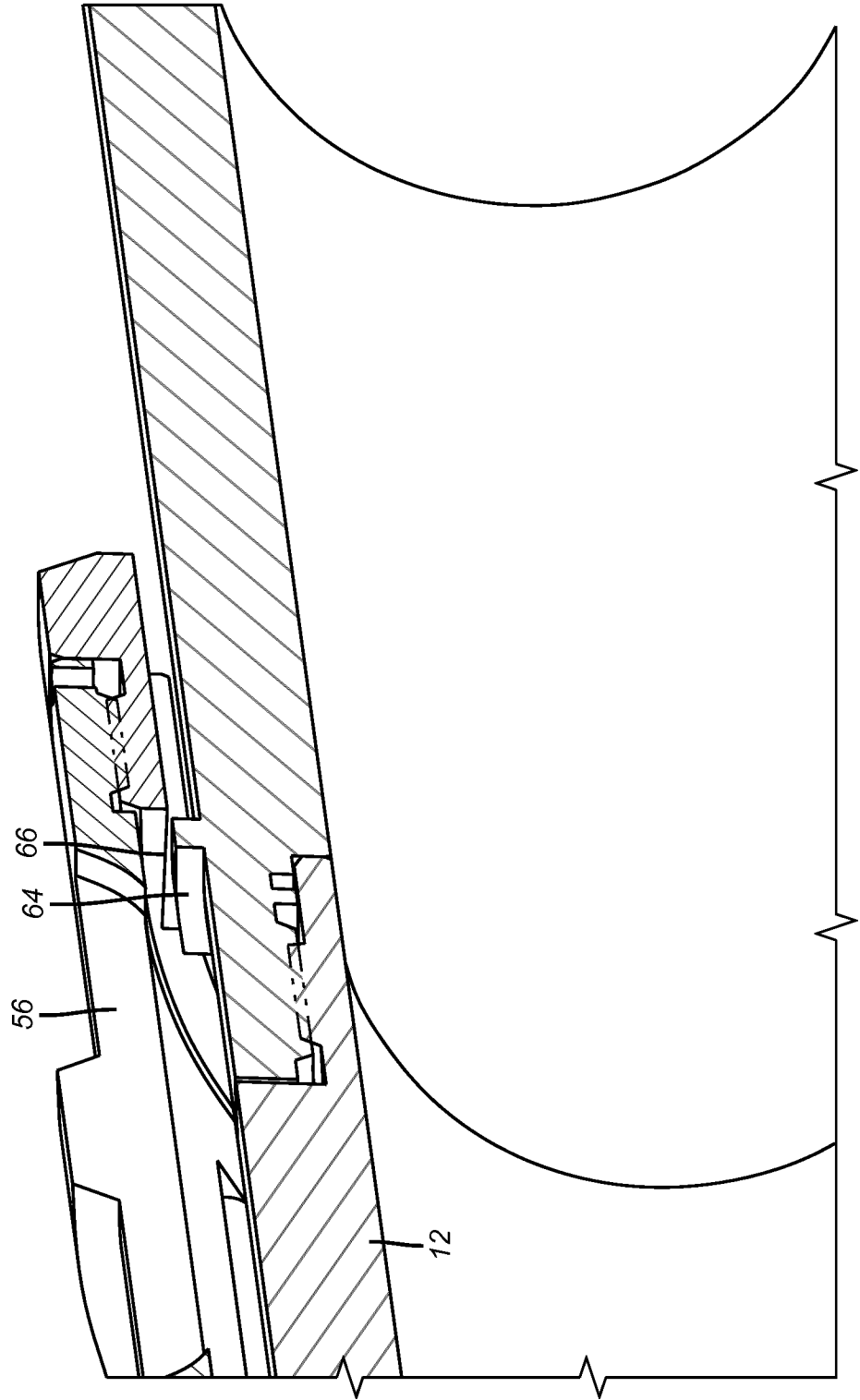


FIG. 4

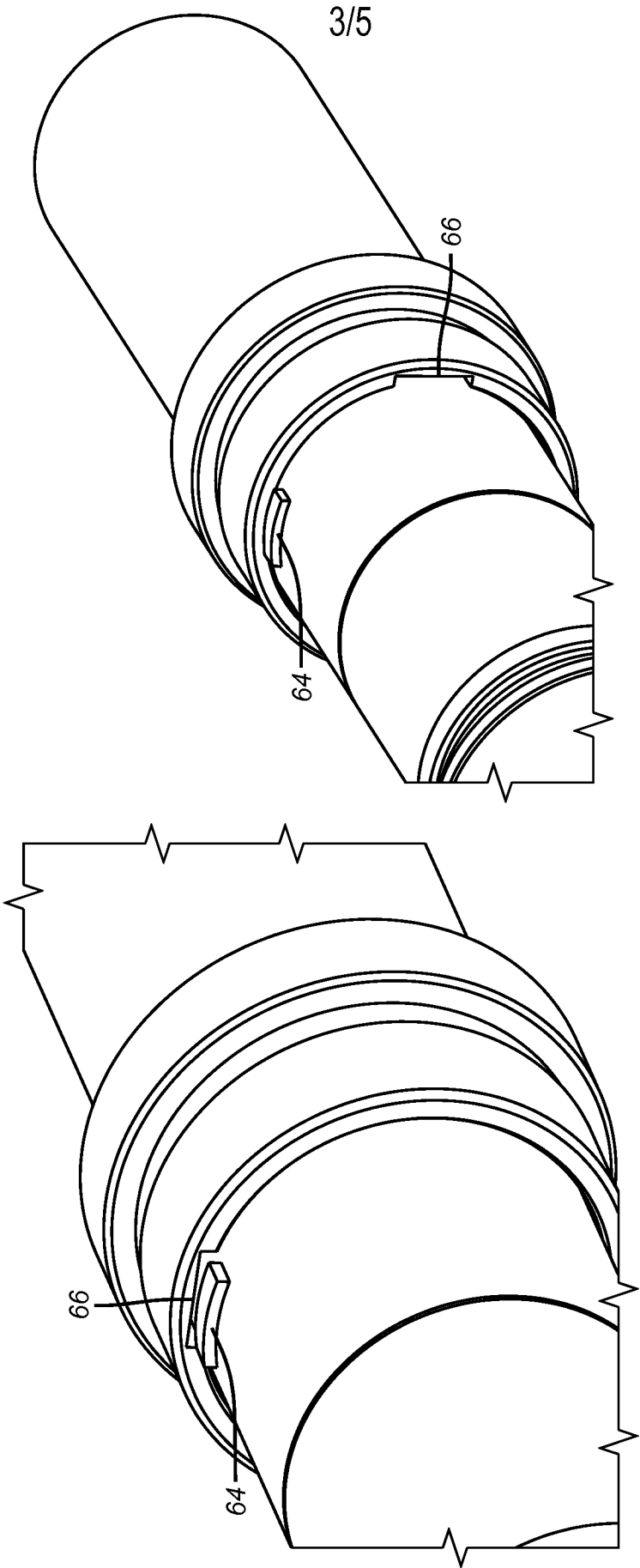


FIG. 6

FIG. 5

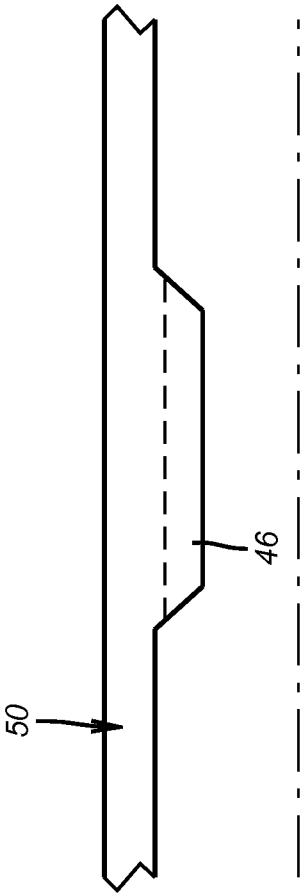


FIG. 9

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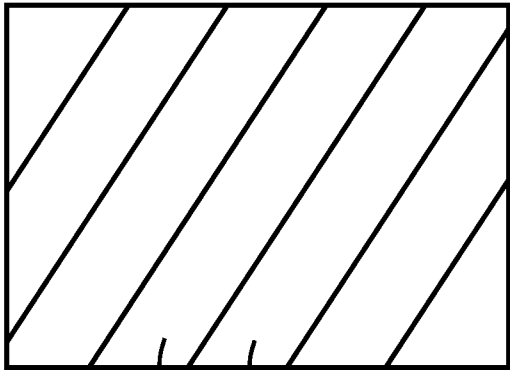


FIG. 10

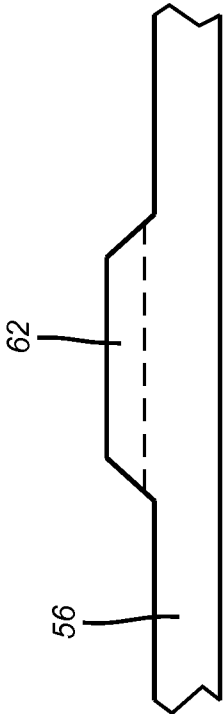


FIG. 7

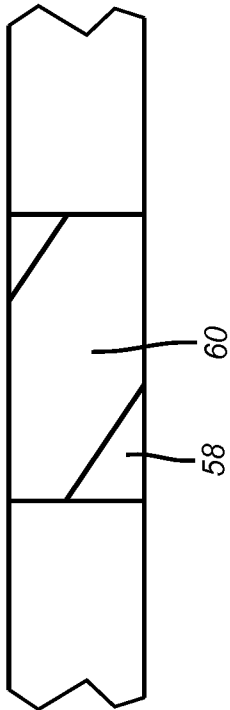


FIG. 8

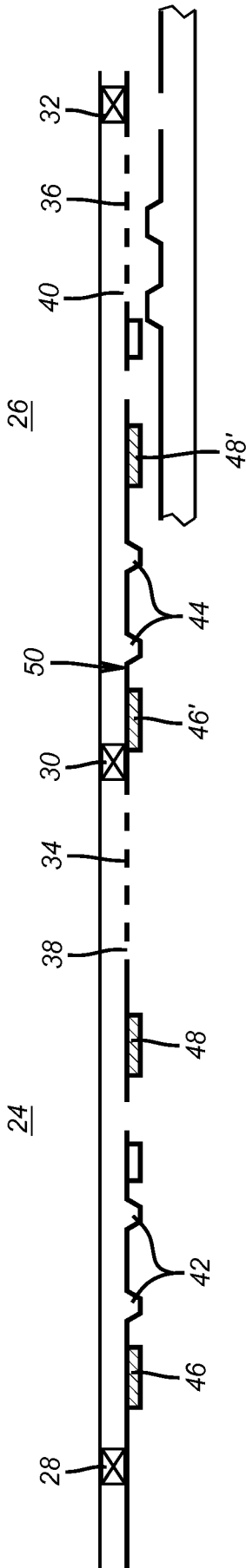


FIG. 11

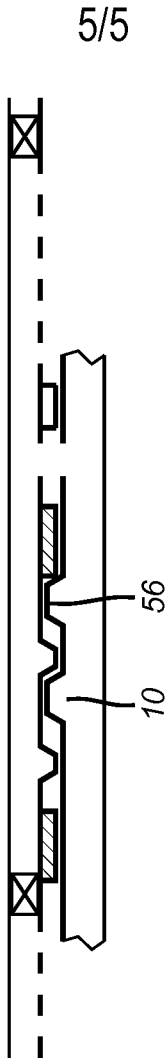


FIG. 12

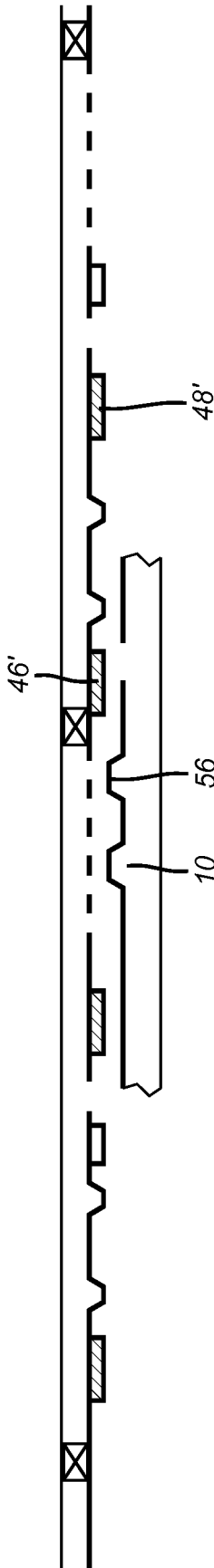


FIG. 13

A. CLASSIFICATION OF SUBJECT MATTER**E21B 43/02(2006.01)i, E21B 43/04(2006.01)i, E21B 43/08(2006.01)i, E21B 34/14(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 43/02; E21B 23/02; E21B 23/08; E21B 33/12; F16L 21/06; E21B 23/00; E21B 23/03; E21B 43/04; E21B 43/08; E21B 34/14

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: lock assembly, actuation profile, mandrel, axial movement, and slot

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 7426964 B2 (LYNDE et al.) 23 September 2008 See abstract; column 2, line 31 - column 4, line 27; and figures 1b,2b,3b.	1-18
A	US 5390735 A (WILLIAMSON, JR., JIMMIE R.) 21 February 1995 See abstract; column 1, line 38 - column 2, line 40; and claims 1-10.	1-18
A	US 6554324 B1 (HERMAN, RICHARD J.) 29 April 2003 See column 7, line 18 - column 10, line 51 and figures 1,2A-2C.	1-18
A	US 7080693 B2 (WALKER et al.) 25 July 2006 See column 1, line 49 - column 2, line 17 and claim 1.	1-18
A	US 2012-0012338 A1 (BLANTON et al.) 19 January 2012 See abstract; paragraphs [0011]-[0019]; and claims 15,17.	1-18



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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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

08 October 2013 (08.10.2013)

Date of mailing of the international search report

10 October 2013 (10.10.2013)

Name and mailing address of the ISA/KR

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2013/049197

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