US 20160168944A1

(19) United States

(12) Patent Application Publication

(10) Pub. No.: US 2016/0168944 A1

(43) Pub. Date: Jun. 16, 2016

Pulat et al.

(54) SETTING SLEEVE

(71) Applicant: **Schlumberger Technology Corporation**, Sugar Land, TX (US)

(72) Inventors: **Ozgur Pulat**, Missouri City, TX (US); **Antonio Gramcko**, Caracas (VE)

(21) Appl. No.: **14/965,558**

(22) Filed: **Dec. 10, 2015**

Related U.S. Application Data

(60) Provisional application No. 62/090,752, filed on Dec. 11, 2014.

Publication Classification

(51) **Int. Cl.**

E21B 33/128 (2006.01)

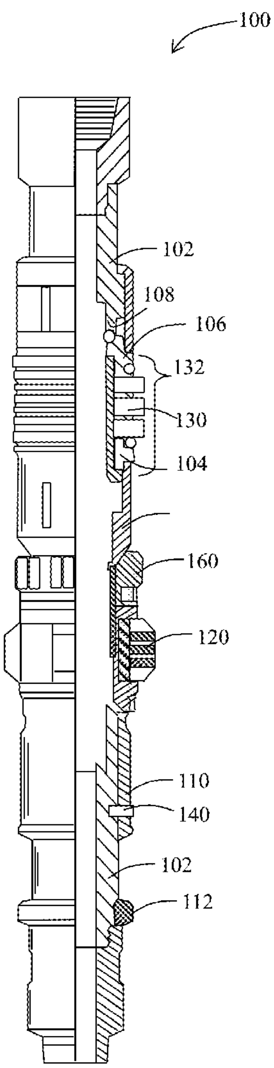
E21B 23/06 (2006.01)

(52) **U.S. Cl.**

CPC *E21B 33/128* (2013.01); *E21B 23/06* (2013.01)

(57) **ABSTRACT**

A packer has a tubular body and a setting sleeve disposed around the tubular body, where the setting sleeve has an upper end, a lower end, and a slot formed through a wall of the setting sleeve. The slot has a perimeter defining a shape of the slot, the perimeter having a top wall with a positively sloping portion extending to a top peak. The slot shape also includes a first axial extension extending axially along the sleeve from a first upper portion to a first lower portion, a second axial extension circumferentially spaced apart from the first extension and extending axially along the sleeve from a second upper portion to a second lower portion, and a lateral extension extending from the first upper portion to the second upper portion. A load pin is directly or indirectly connected to the tubular body and extends through the slot. p



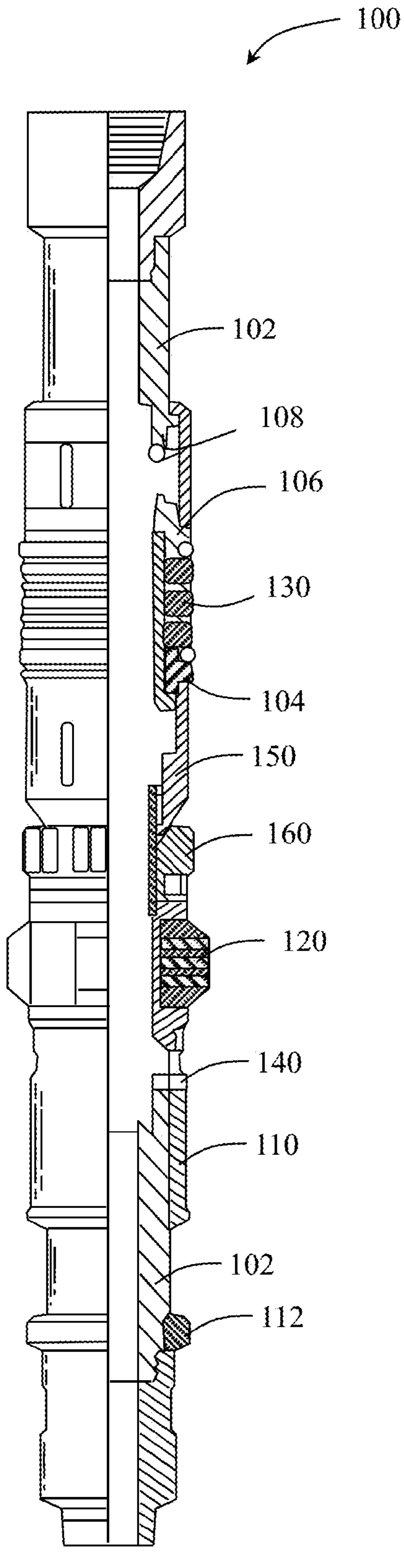


FIG. 1

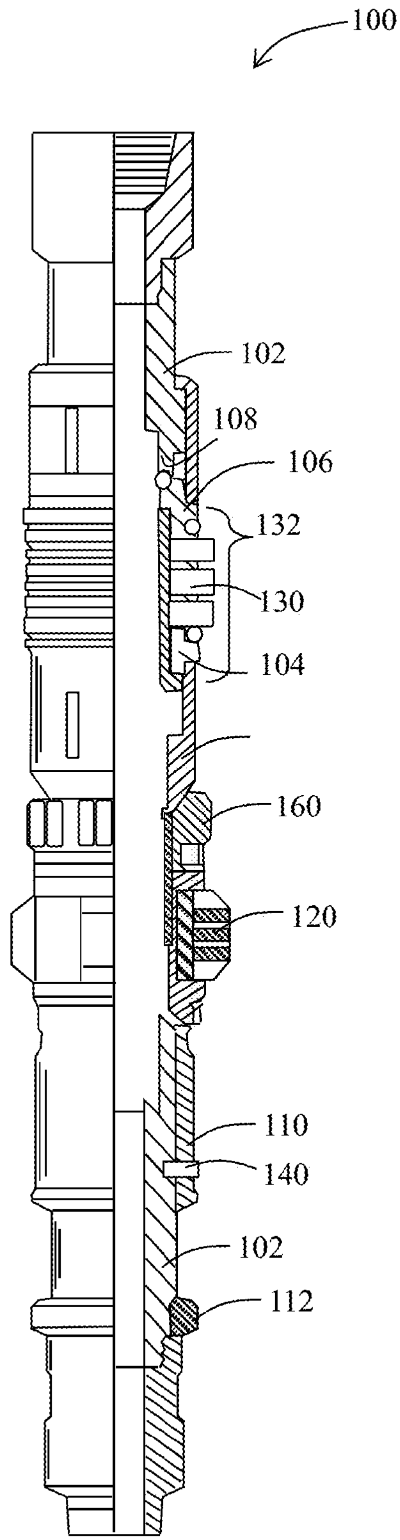


FIG. 2

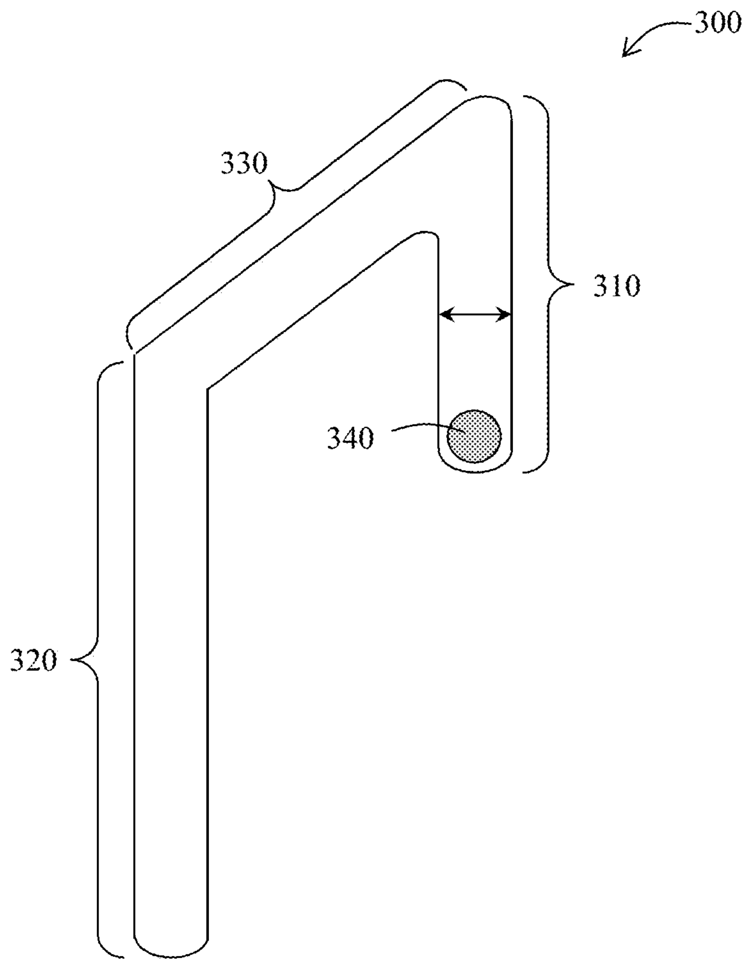


FIG. 3
(Prior Art)

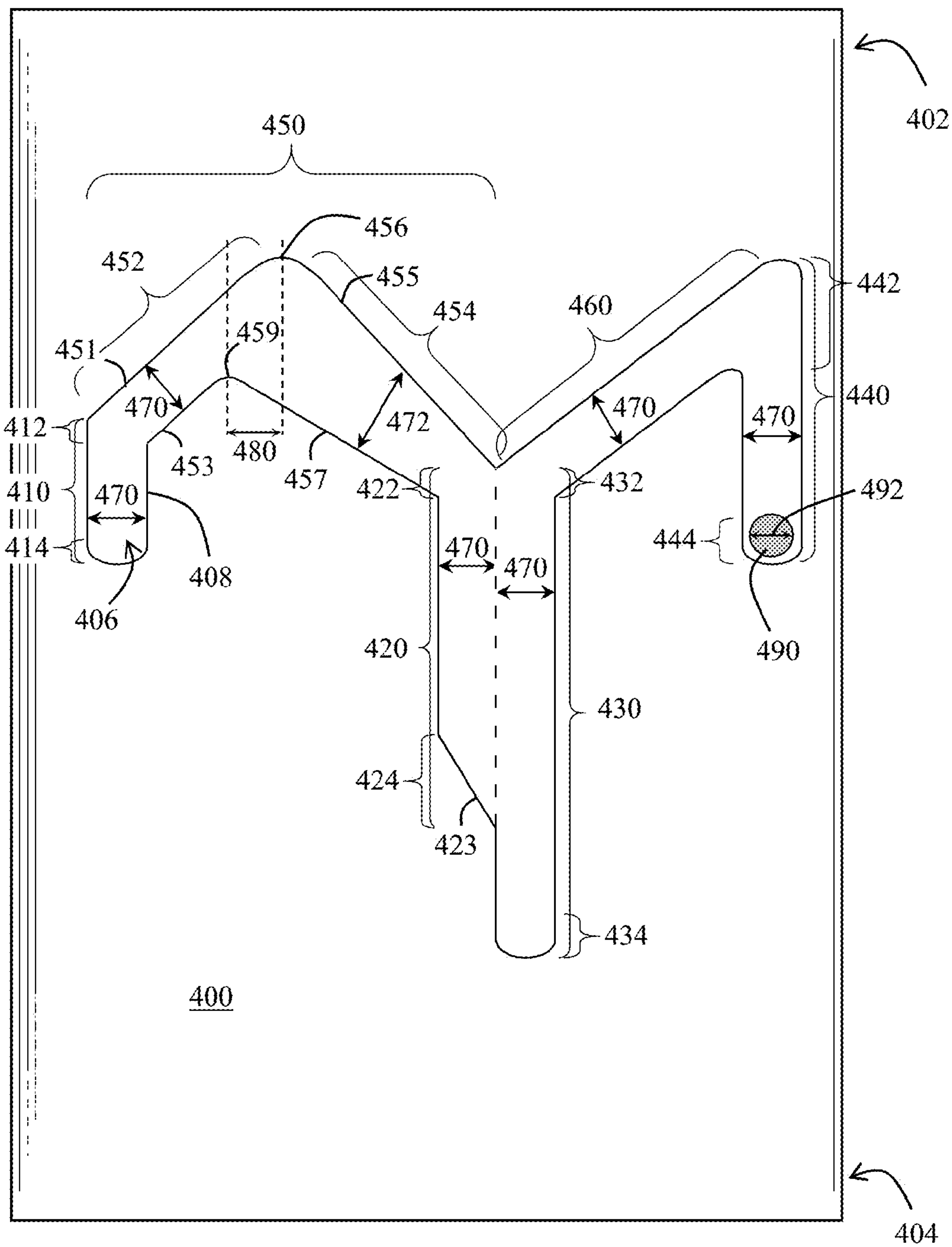

402
450
456
452
455
454
460
442
451
459
440
470
472
470
470
412
453
480
457
422
432
410
470
492
444
414
408
470
470
406
490
420
430
424
423
434
400
404

FIG. 4

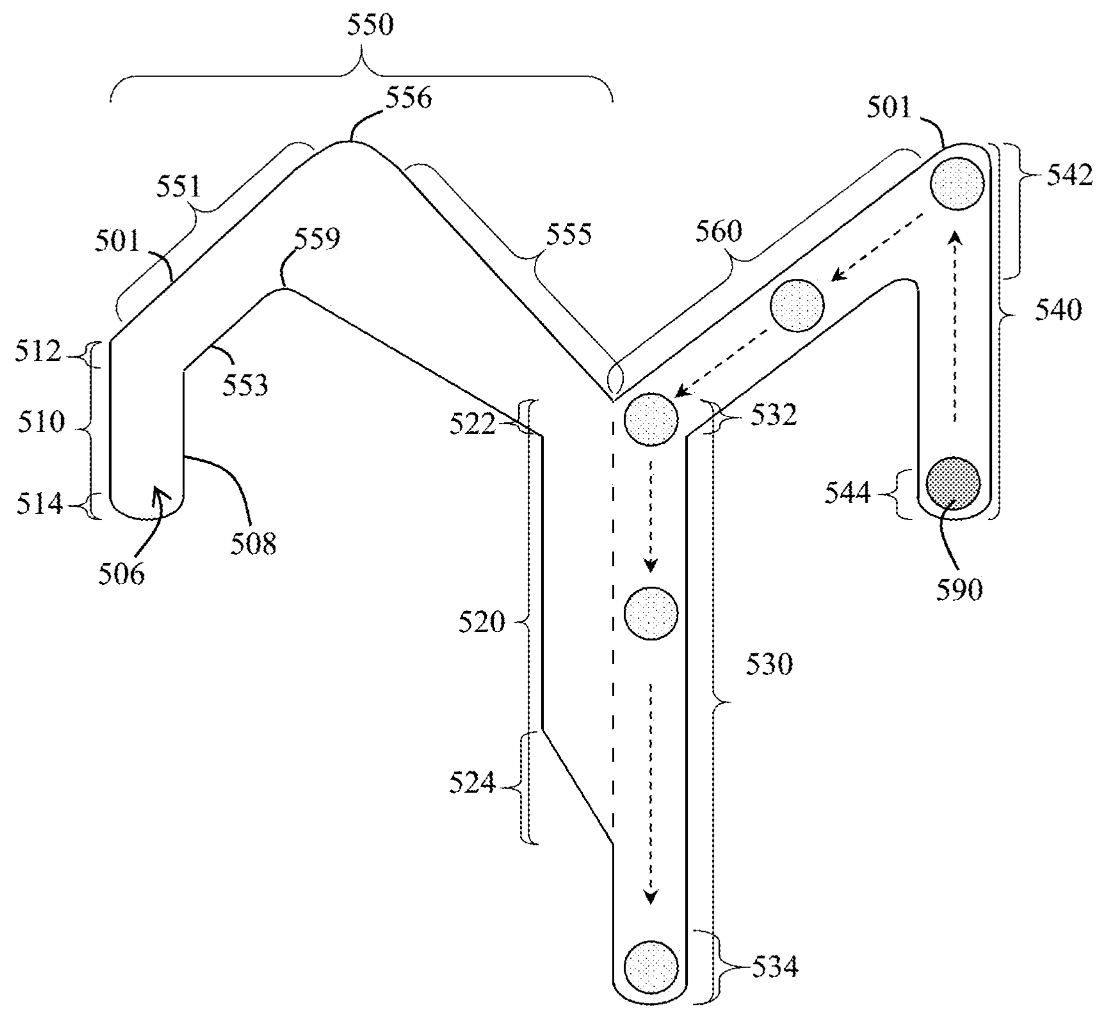

550
556
551
501
559
555
560
501
542
540
512
553
510
522
532
514
508
506
544
590
520
530
524
534

FIG. 5

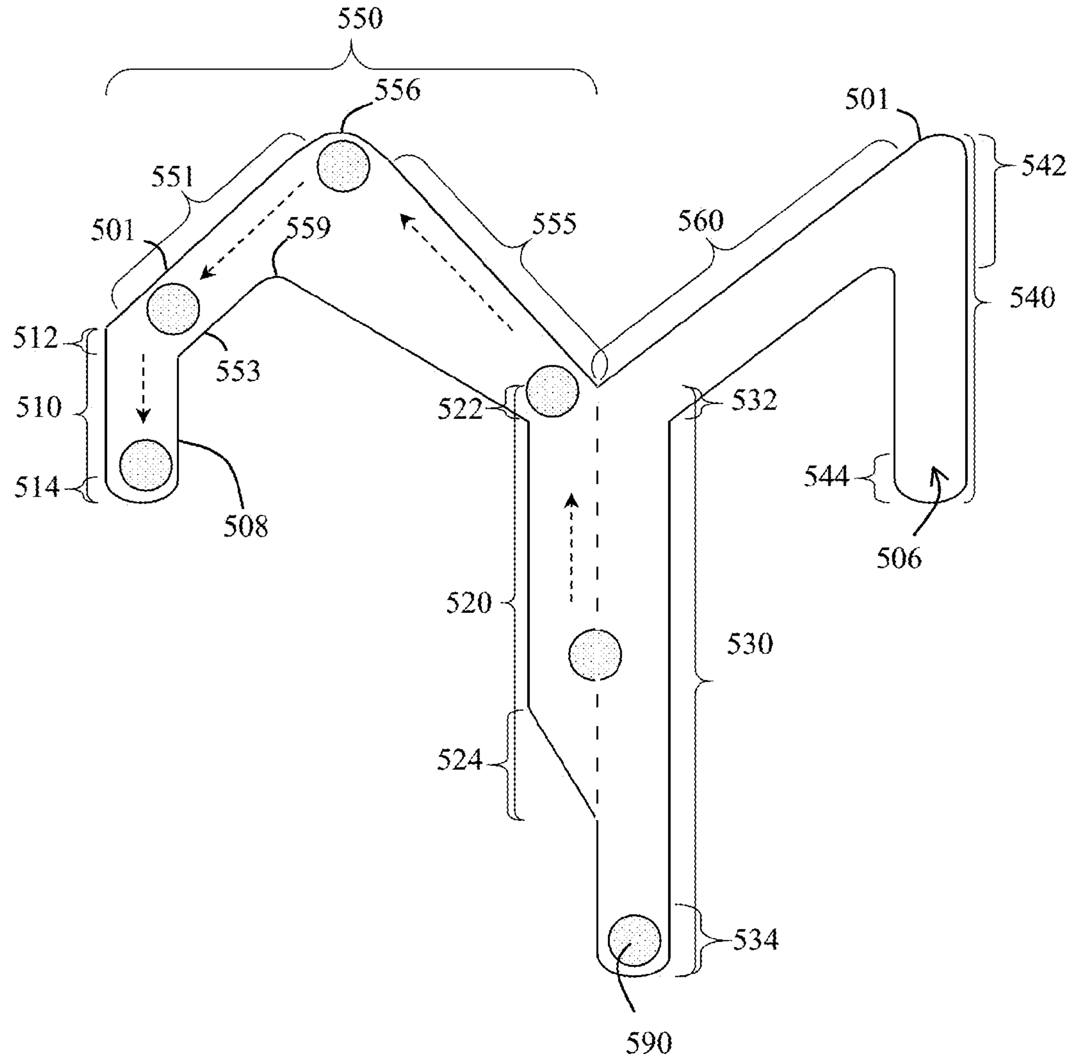

550
556
501
542
551
501
559
555
560
540
512
553
510
522
532
544
514
508
506
520
530
524
534
590

FIG. 6

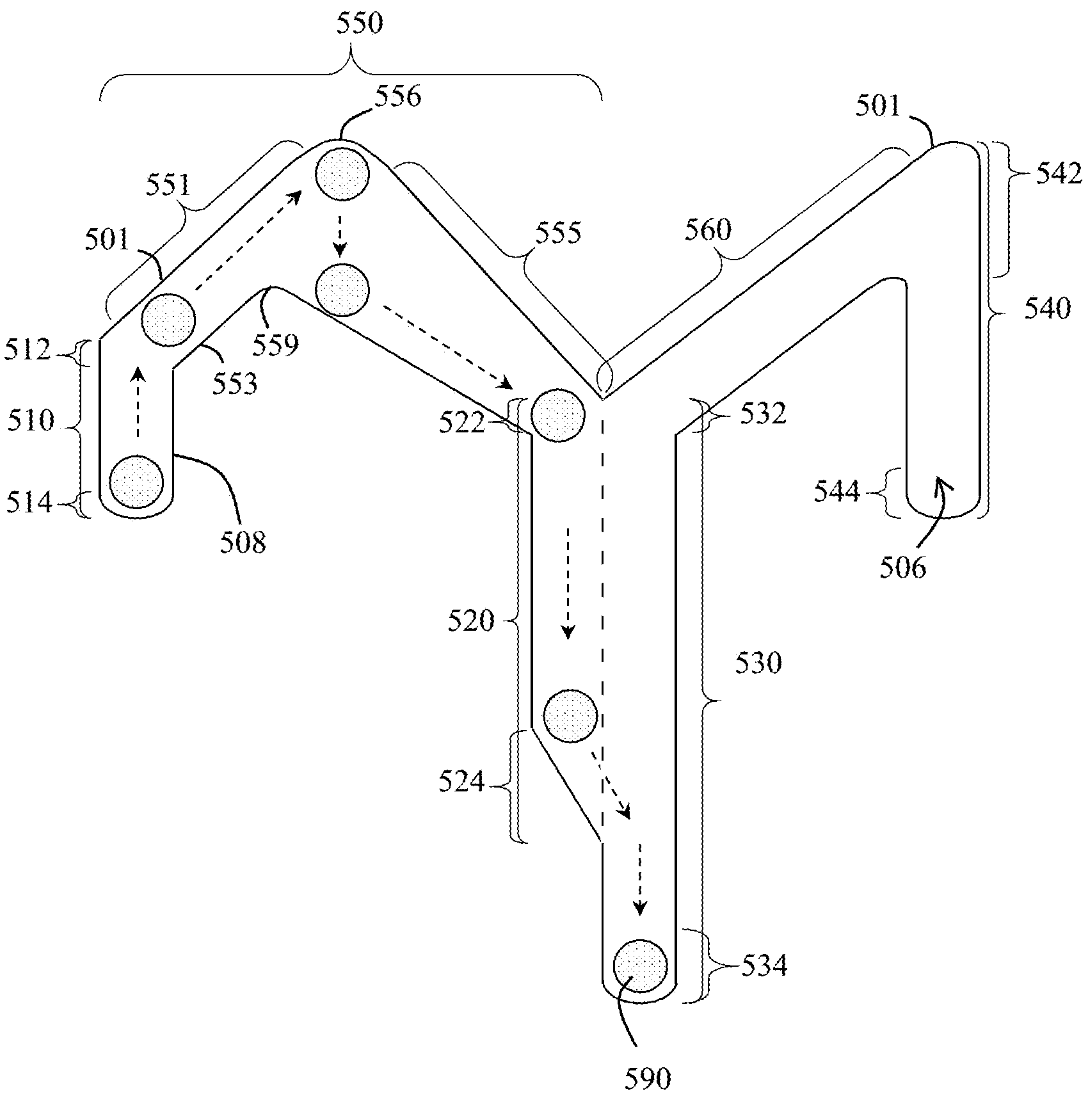

550
556
501
551
501
542
555
560
540
512
559
553
510
522
532
514
544
508
506
520
530
524
534
590

FIG. 7

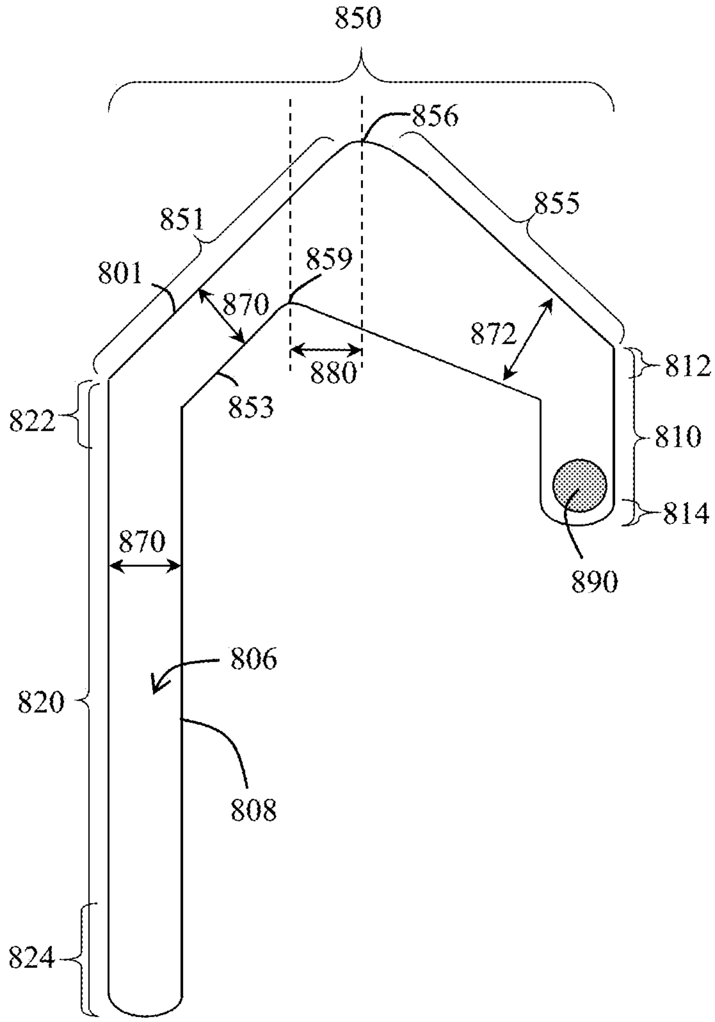

850
856
851
855
801
859
870
872
812
880
853
822
810
814
890
870
806
820
808
824

FIG. 8

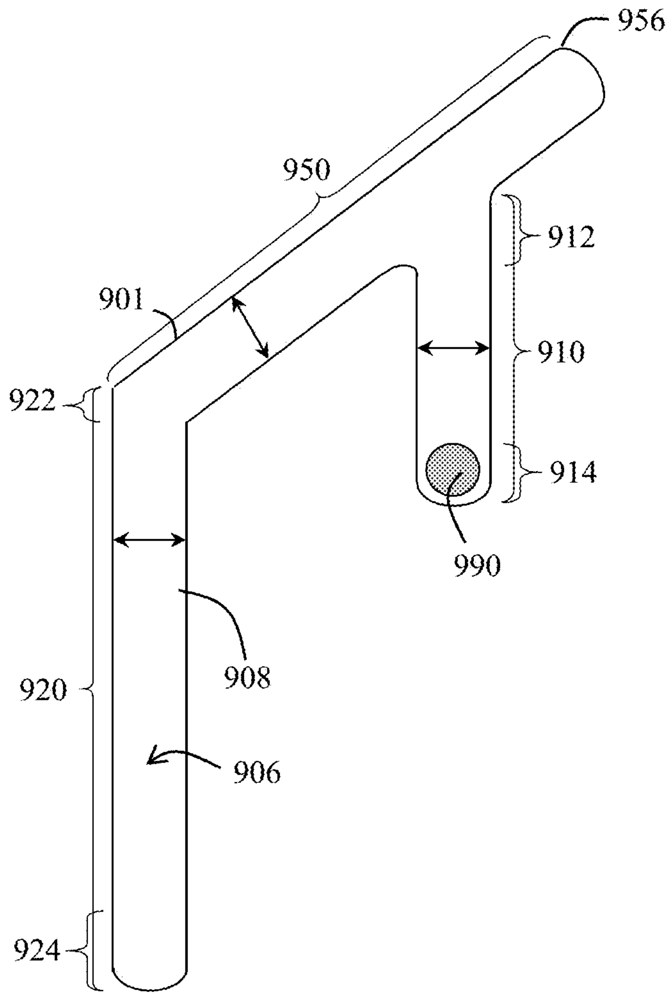


FIG. 9

SETTING SLEEVE

BACKGROUND

[0001] Hydrocarbon fluids such as oil and natural gas are obtained from a subterranean geologic formation, referred to as a reservoir, by drilling a well that penetrates the hydrocarbon-bearing formation. Once a wellbore is drilled, various forms of well completion components may be installed in order to control and enhance the efficiency of producing the various fluids from the reservoir.

[0002] Downhole packers may be used to seal an annular area formed between two coaxially disposed tubulars within a wellbore or between the formation and a tubular in a wellbore. A packer may seal, for example, an annulus formed between production tubing disposed within wellbore casing. Alternatively, some packers seal an annulus between the outside of a tubular and an unlined borehole. Routine uses of packers include the protection of casing from pressure, both well and stimulation pressures, and protection of the wellbore casing from corrosive fluids. Other common uses may include the isolation of formations or of leaks within wellbore casing, squeezed perforation, or multiple producing zones of a well. Downhole packers help prevent migration of fluid or pressure between zones. Packers may also be used to hold kill fluids or treating fluids in the casing annulus.

[0003] A downhole packer assembly may be run into a wellbore with a small initial outside diameter and then radially expanded to seal the wellbore. Packers employ flexible, elastomeric elements that expand. The expansion of the elastomeric elements may be accomplished by squeezing the elastomeric elements (somewhat doughnut-shaped) between two plates, forcing the sides to bulge outward. Packers may be set in cased holes or open holes. Open hole packers may be configured with one large sealing element that can be deformed to contact the uneven surface of the formation, yet retain sufficient strength and integrity to withstand expected differential pressures. Installing the packer downhole may involve running it on wireline, jointed pipe, or coiled tubing. While some packers may be designed to be removable, others are installed as permanent, and therefore are not retrievable. Permanent packers must be drilled out and destroyed to be removed from a wellbore. The pieces of the packer are circulated back to the surface in the drilling fluid. As such, permanent packers are constructed of materials that are easy to drill or mill out.

[0004] Some packers include a sealing element having anti-extrusion rings on both upper and lower ends. A setting tool may be run with the packer to set the packer, where the setting may be accomplished hydraulically due to relative movement created by the setting tool when subjected to applied pressure. In mechanical weight-set packers, the packer may be set mechanically due to the relative movement of the packer with the tubing. Relative movement between components of a packer may cause the slips of the packer to move radially outward and extend into the surrounding tubular casing wall. At the same time, a sealing element of the packer may be compressed into sealing contact with the surrounding tubular casing wall. The set position of the packer may be held in place by a body lock ring, which may prevent reversal of the relative movement.

SUMMARY

[0005] This summary is provided to introduce a selection of concepts that are further described below in the detailed description. This summary is not intended to identify key or essential features of the claimed subject matter, nor is it intended to be used as an aid in limiting the scope of the claimed subject matter.

[0006] In one aspect, embodiments of the present disclosure relate to a packer tool that includes a tubular body, one or more expansion components decoupled from the tubular body, and a sleeve disposed around the tubular body. The sleeve has an upper end, a lower end opposite the upper end, and a slot formed in a wall of the sleeve. The slot has a perimeter defining a shape that includes a first axial extension extending axially along the sleeve from a first upper portion to a first lower portion, a second axial extension circumferentially spaced apart from the first extension and extending axially along the sleeve from a second upper portion to a second lower portion, where the second lower portion is closer to the lower end of the sleeve than the first lower portion, and a lateral extension extending from the first upper portion to the second upper portion. The lateral extension has a positively sloping extension defined by an upper positively sloping wall of the perimeter and a lower positively sloping wall of the perimeter and a negatively sloping extension having a varying width measured between an upper negatively sloping wall of the perimeter and a lower negatively sloping wall of the perimeter, wherein the upper positively sloping wall and upper negatively sloping wall extend to a top peak, wherein the lower positively sloping wall and the lower negatively sloping wall extend to a lower peak, and wherein the top peak is circumferentially offset from the lower peak a distance around a circumference of the sleeve. A load pin directly or indirectly connected to the tubular body and extends through the slot.

[0007] In another aspect, embodiments of the present disclosure relate to a packer tool that includes a tubular body and a setting sleeve disposed around the tubular body, where the setting sleeve has an upper end, a lower end, and a slot formed through a wall of the setting sleeve. The slot has a perimeter defining a shape of the slot, the perimeter having a top wall with a positively sloping portion extending to a top peak. The slot shape also includes a first axial extension extending axially along the sleeve from a first upper portion to a first lower portion, a second axial extension circumferentially spaced apart from the first extension and extending axially along the sleeve from a second upper portion to a second lower portion, and a lateral extension extending from the first upper portion to the second upper portion. A load pin is directly or indirectly connected to the tubular body and extends through the slot.

[0008] In yet another aspect, embodiments of the present disclosure relate to methods of positioning a packer within a wellbore. The packer includes a tubular body, a load pin directly or indirectly connected with the body, where movement of the load pin corresponds with movement of the body, and a sleeve having a slot formed therein, where the load pin extends through the slot. The slot has a shape that includes a plurality of axial extensions, each axial extension extending axially along the sleeve, wherein the plurality of axial extensions includes a first axial extension and a second axial extension circumferentially spaced apart from the first axial extension. The slot further includes at least one lateral extension that includes a first lateral extension extending from a first upper portion of the first axial extension to a second upper portion of the second axial extension, wherein the first lateral extension has a top peak circumferentially spaced apart from the first and second axial extensions. Methods of positioning the packer in the wellbore may include inserting the packer into the wellbore, manipulating the tubular body to move the load pin to a set position by rotating the tubular body in a single rotational direction and pushing the tubular body downward to set the packer in the wellbore, pulling the tubular body upward to move the load pin into a neutral position to unset the packer, and pushing the tubular body downward without rotating the tubular body in an opposite rotational direction from the single rotational direction to move the load pin into a safe position to reposition the packer.

[0009] Other aspects and advantages of the claimed subject matter will be apparent from the following description and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. **1** shows a partial cross-sectional view of a weight-set packer tool.

[0011] FIG. **2** shows a partial cross-sectional view of the packer tool of FIG. **1** in a set position.

[0012] FIG. **3** shows a conventional setting slot.

[0013] FIG. **4** shows a setting sleeve according to embodiments of the present disclosure.

[0014] FIGS. **5-7** show a load pin path through a setting slot according to embodiments of the present disclosure.

[0015] FIG. **8** shows a setting slot according to embodiments of the present disclosure.

[0016] FIG. **9** shows a setting slot according to embodiments of the present disclosure.

DETAILED DESCRIPTION

[0017] In the following description, numerous details are set forth to provide an understanding of the present disclosure. However, it will be understood by those skilled in the art that the embodiments of the present disclosure may be practiced without these details and that numerous variations or modifications from the described embodiments may be possible.

[0018] In the specification and appended claims: the terms "connect", "connection", "connected", "in connection with", and "connecting" are used to mean "in direct connection with" or "in connection with via one or more elements"; and the term "set" is used to mean "one element" or "more than one element". Further, the terms "couple", "coupling", "coupled", "coupled together", and "coupled with" are used to mean "directly coupled together" or "coupled together via one or more elements". As used herein, the terms "up" and "down", "upper" and "lower", "upwardly" and downwardly", "upstream" and "downstream"; "above" and "below"; and other like terms indicating relative positions above or below a given point or element are used in this description to more clearly describe some embodiments of the disclosure.

[0019] Embodiments of the present disclosure relate generally to setting sleeves for mechanical weight-set packer tools and methods of setting such packer tools. For example, FIGS. **1** and **2** show partial cross-section views of a mechanical weight-set packer **100** in unset and set positions, respectively. The packer **100** includes a tubular body **102**, which may also be referred to as a mandrel, and an outer setting sleeve **110**, which is moveable in relation to the tubular body **102**, according to embodiments of the present disclosure. The setting sleeve **110** may be retained within an axial length along the tubular body **102** of the packer **100** by a pin **140**, which extends from the tubular body **102** and through a slot formed in the setting sleeve **110**, where the setting sleeve **110** may be moveable in relation to the tubular body **102** via the pin's path along the slot (described in detail below). The body **102** may be mounted on a work string (not shown), such as a drill pipe. The setting sleeve **110** has or is associated with spring loaded drag blocks **120**. For example, in the packer **100** shown, the drag blocks **120** are located adjacent to and above the setting sleeve **110**, where upward axial movement of the setting sleeve **110** may push the spring loaded drag blocks **120** axially upward. A retainer ring **112** may be disposed around the tubular body **102** and below the setting sleeve **110**.

[0020] The packer **100** further includes packer elements **130** assembled within a packer element assembly **132** and disposed around the tubular body **102**. The packer element assembly **132** is positioned substantially above the setting sleeve **110** and axially between annular seats **104**, **106**, which are configured to exert a reactive force in opposite axial directions to axially compress the packer elements **130**. For example, an upper annular seat **106** and a lower annular seat **104** may be decoupled from (but axially retained along) the tubular body **102**, such that in set position, a shoulder **108** formed on the tubular body **102** may contact the upper annular seat **106** and move the upper annular seat **106** axially downward relative to the lower annular seat **104**. The packer elements **130** may be formed of an elastic material or moulded rubber material, which may expand radially outward in the packer's set position, when the packer element assembly **132** is axially compressed between the annular seats **104**, **106**.

[0021] Further, when in the set position, a set of slips **160** and spring-loaded drag blocks **120** positioned axially between the packer element assembly **132** and setting sleeve **110** may radially expand and engage the inner diameter of the wellbore (or the inner diameter of a casing in a cased portion of a wellbore) to hold the packer element assembly **132** in the set position. The spring-loaded drag blocks **120** are positioned axially between the setting sleeve **110** and the set of slips **160**. The slips **160** are positioned at a lower end of a conical ramp sleeve **150**, which is positioned around the tubular body **102** and axially below the packer element assembly **132**. The conical ramp sleeve **150** has a reduced radius portion, where the outer diameter of the reduced radius portion of the conical ramp sleeve **150** slopes radially inward from an outermost diameter with distance away from the packer elements **130** to the lower end of the conical ramp sleeve **150**. When the spring-loaded drag blocks **120** are pushed axially upward by the setting sleeve **110** during setting of the packer **100**, the spring-loaded drag blocks **120** may push the slips **160** axially upward over the reduced radius portion of the conical ramp sleeve **150**, thereby expanding the slips **160** radially outward. The radially expanded slips **160** and the conical ramp sleeve **150** may support the lower annular seat **104**, such that when the tubular body **102** exerts a downward force on the upper annular seat **106**, the upper and lower annular seats **106**, **104** exert axially opposing forces on the packer element assembly **132** to radially expand the packer elements **130**. Thus, when the packer **100** is in set position, the packer elements **130** are axially compressed between components of the packer axially above and below the packer elements **130**, and the packer elements **130** expand radially outward to seal the annulus between the packer element assembly and the wellbore (or the casing of a cased portion of the wellbore) in which the packer is disposed. The packer **100** is shown in an unset position in FIG. I and a set position in FIG, **2**.

[0022] The packer element assembly **132** and the spring-loaded drag blocks **120** may be referred to as expansion components, as they are capable of expanding radially outward to contact a wellbore or wellbore casing in set position. Because the expansion components are decoupled from the tubular body **102** (but are axially retained along a length of the tubular body **102**), the expansion components do not move with the tubular body **102** as the tubular body **102** is moved with respect to the tool. Rather, the expansion components may move upon activation by relative movement between the tubular body **102** and the setting sleeve **110**. In other words, in the packer setting process, the expansion components do not follow the same movement as the tubular body **102**. Instead, during the packer setting process, the expansion components may move differently than the tubular body **102** in reaction to movement of the tubular body **102**.

[0023] For example, according to embodiments of the present disclosure, the packer **100** may be mounted on a work string (not shown) and run into a pre-formed wellbore for setting. The pre-formed wellbore may be lined by a casing. The packer **100** may be run through the wellbore until the packer **100** is in a desired location for sealing. To move into set position, the tubular body **102** is pulled upward (by pulling up on the attached work string) to move the pin **140** into a neutral position within the slot formed in the setting sleeve **110**. Weight is then set down on the work string and tubular body **102** as the work string is rotated in a single rotational direction, until the pin **140** moves into an axially lowermost point in the slot. When the pin **140** is moved into the axially lowermost point in the slot formed in the sleeve **110**, the tubular body **102** may move the greatest axial distance relative to the setting sleeve **110**, and a shoulder **108** located axially above the packer element assembly **132** and attached to or formed on the tubular body **102** may move an axial distance low enough to contact and compress the packer element assembly **132**.

[0024] Setting sleeves according to embodiments of the present disclosure have a slot with multiple axial extensions and a neutral position circumferentially offset from each of the axial extensions to translate a load in a preferential direction within a mechanical weight set packer. When landing a mechanical packer in a target position, the setting sleeve allows for movement of the string while locked into a safe position, i.e., a position where the running load is not transmitted to the expansion components of the packer. Unlike continuous rotation style setting sleeves, where repeated reciprocation of the string results in continuous rotation and indexing through the running/set positions, non-continuous rotation style setting sleeves, such as setting sleeves disclosed herein, use non-continuous rotational movements of the drill string to move to the running/set position, where the string is lifted and rotated to place the packer in the setting position. Further, a continuous rotation setting sleeve allows for 360° rotation of the load pin through the target positions, whereas non-continuous rotation setting sleeve has less than 360° rotation by providing a mechanical barrier to additional rotational motion.

[0025] Current versions of non-continuous setting sleeves have a single J-style profile for manipulation of the load pin. An example of a J-style slot on a setting sleeve is shown in FIG. **3**, where the J-style slot includes a short axial extension **310**, a long axial extension **320** spaced apart from and axially offset lower than the short axial extension **310**, and a lateral extension **330** extending from an upper portion of the long axial extension **320** to an upper portion of the short axial extension **310**. During operation of a mechanical packer having a traditional J-style setting sleeve, as shown in FIG. **3**, the load pin **340** begins in a safe position, in a lower portion of the short axial extension **310**, while running in hole. When landing the mechanical packer at a target position, the J-style setting sleeve allows for movement of the string while locked into this safe position and not transmitting any of the run-in hole load through the setting components (i.e., components of a packer that are capable of contacting and axially compressing packing elements). With the load pin **340** in the short axial extension **310** (in the safe position), the location of the packer can be manipulated vertically until it is determined that the proper landing zone has been located. An upward pull on the string pulls the setting pin into a neutral position, in the upper portion of the short axial extension **310**, before setting the packer in the landing zone. A downward load on the string combined with a rotational load in a single rotational direction will take the load pin **340** into the long axial extension **320**, i.e., the setting slot.

[0026] As connections between components in packers and/or between the packer and the string may include threaded connections, the rotational load applied to set the packer is commonly a right hand rotation (clockwise) to avoid un-threading any of the threaded connections. Once the load pin **340** is in the long axial extension **320** (setting slot), the load pin **340** is free to travel until the load is transmitted to the expansion components of the packer, thereby anchoring the packer to the casing. In the event that the packer must be released and placed back into the safe position (in the short axial extension **310**) an upward load must be transmitted to the string to move the load pin **340** back to the neutral position (in the upper portion of the short axial extension **310**). A downward load on the string may move the load pin **340** into the safe position (short axial extension **310**) allowing for repositioning of the packer. However, residual torque through the packer and string may cause the tubular body and connected load pin **340** to rotate in a right handed (clockwise) direction, which may cause the load pin **340** to miss the short axial extension **310** (the safe position) while applying the downward load. Thus, multiple attempts at putting the packer back in safe position may be performed before the packer may be repositioned.

[0027] According to embodiments of the present disclosure, a setting sleeve may have a slot formed therein that allows for setting and repositioning of a packer using a rotational load in a single rotational direction. For example, in some embodiments a setting sleeve may have a Y-style slot formed in the setting sleeve to translate a set down load in a single rotational direction within a mechanical weight set packer. In such embodiments, the single rotational direction may be a right hand torque rotation through the drill string to manipulate the setting position of the packer. The right hand rotation may act as rotational confirmation that the load pin has shifted back into a safe running position. The Y-style setting sleeve may also allow a user to choose between a single setting position, and two safe positions during operation.

[0028] Certain embodiments of the disclosure will hereafter be described with reference to the accompanying drawings, wherein like reference numerals denote like elements. It should be understood, however, that the accompanying drawings illustrate only the various implementations described herein and are not meant to limit the scope of various technologies described herein. The drawings show and describe various embodiments of the current disclosure.

[0029] Referring to FIG. **4**, Y-style setting sleeve **400** according to embodiments of the present disclosure is shown. The setting sleeve **400** has an upper end **402**, a lower end **404** opposite the upper end **402**, and a slot **406** formed through the wall of the setting sleeve **400**. As used herein, the terms "upper" and "lower" may refer to axial directions relative to each other along the setting sleeve and/or packer. In certain embodiments, the packer and/or sleeve may be rotated or oriented to where the "upper" end and "lower" end are in different positions relative to a surface of a formation. A load pin **490** extends through the depth of the slot **406** and may be directly or indirectly connected to the tubular body (not shown) running through the setting sleeve **400**. The slot **406** has a perimeter **408** defining a shape having four axial extensions and two lateral extensions extending between the axial extensions. The axial extensions include a first, second, third and fourth axial extension **410**, **420**, **430**, **440**, respectively, where the first and fourth axial extensions **410**, **440** are relatively shorter than the second and third axial extensions **420**, **430**.

[0030] The first axial extension **410** extends axially along the setting sleeve **400** from a first upper portion **412** to a first lower portion **414**. The second axial extension **420** extends axially along the setting sleeve **400** from a second upper portion **422** to a second lower portion **424**, where the second lower portion **424** is closer to the lower end **404** of the setting sleeve **400** than the first lower portion **414**. The first upper portion **412** may be at substantially the same axial position along the setting sleeve **400** as the second upper portion **422**, or the first upper portion **412** may be axially higher or lower than the second upper portion **422** along the setting sleeve **400**. Further, the perimeter of the second lower portion **424** may include a negatively sloping wall **423**, which may be used to aid the load pin **490** in moving between the second and third axial extensions **420**, **430**.

[0031] A curved lateral extension **450** having two slanting extensions (a positively sloping extension **452** and a negatively sloping extension **454**) extending to a top peak **456** extends from the first upper portion **412** of the first axial extension **410** to the second upper portion **422** of the second axial extension **420**. The positively sloping extension **452** abuts and joins the negatively sloping extension **454** in an end-to-end configuration such that the curved lateral extension **450** forms a lateral path through which the load pin **490** may travel. Likewise, the first upper portion **412** and the second upper portion **422** abut and join to the ends of the curved lateral extension **450**, such that the first axial extension **410**, curved lateral extension **450** and second axial extension **420** form a slot path through which the load pin **490** may travel.

[0032] The third axial extension **430** extends axially along the setting sleeve **400** from a third upper portion **432** to a third lower portion **434** and abuts the second axial extension **420**. As shown, the third lower portion **434** is closer to the lower end **404** of the setting sleeve **400** than the second lower portion **424**. The fourth axial extension **440** is spaced apart from the third axial extension **430** and extends axially along the setting sleeve **400** from a fourth upper portion **442** to a fourth lower portion **444**. The fourth lower portion **444** is closer to the upper end **402** of the setting sleeve **400** than the second and third lower portions **424**, **434**. Further, the fourth lower portion **444** may at least partially overlap with the axial position of the first lower portion **414** along the setting sleeve **400**. In other words, the first and fourth lower portions **414**, **444** may be at approximately the same axial position but circumferentially offset from each other on the sleeve **400**. A second lateral extension is a second positively sloping extension **460** extending from the third upper portion **432** to the fourth upper portion **442**.

[0033] The first positively sloping extension **452** is defined by an upper positively sloping wall **451** of the perimeter **408** and a lower positively sloping wall **453** of the perimeter **408**, and the negatively sloping extension **454** is defined by an upper negatively sloping wall **455** of the perimeter **408** and a lower negatively sloping wall **457** of the perimeter **408**, where the upper positively sloping wall **451** and upper negatively sloping wall **455** extend to the top peak **456**, and where the lower positively sloping wall **453** and the lower negatively sloping wall **457** extend to a lower peak **459**. The top and lower peaks **456**, **459** are circumferentially spaced apart from both the first and second axial extensions **410**, **420**.

[0034] Further, the top peak **456** is spaced apart or offset from the lower peak **459** a distance **480** around the circumference of the setting sleeve **400**. The lower peak **459** may be offset from the top peak **456** in the single rotational direction in which the load pin **490** is rotated through the slot **406** to set and unset the packer. For example, in the embodiment shown and as described in more detail below, the load pin **490** may be moved axially upward and downward and rotationally in a single right-handed or clockwise rotational direction through the slot (by moving the tubular body to which the load pin is attached) to set and unset the packer. In such embodiments, the lower peak **459** is offset the distance **480** from the top peak **456** in a clockwise rotational direction along the circumference of the setting sleeve **400**. The offset distance **480** between the top peak **456** and the lower peak **459** may be, for example, greater than a diameter **492** of the load pin **490**, greater than **1.5** times the diameter **492** of the load pin **490**, or greater than **2** times the diameter **492** of the load pin **490**. In some embodiments, the offset distance **480** between the top peak **456** and lower peak **459** may be greater than the widths of the axial extensions **410**, **420**, **430**, **440**.

[0035] Each extension **410**, **420**, **430**, **440** has a width measured between opposite walls of the extensions along the perimeter **408**. The first, second, third and fourth axial extensions **410**, **420**, **430**, **440** and the first and second positively sloping extensions **452**, **460** may have a substantially constant and equal width **470**. To form the offset top and lower peaks **456**, **459**, the negatively sloping extension **454** has a varying width **472**. Widths **470** and **472** may be greater than the diameter **492** of the load pin **490**, such that the load pin **490** may move through each extension.

[0036] An example of a load pin path through a slot formed in a setting sleeve according to embodiments of the present disclosure during setting and repositioning of a packer is described with reference to FIGS. **5-7**. In FIGS. **5-7**, a packer tool (not shown) may include a tubular body (not shown) and a setting sleeve disposed around the tubular body, where a load pin **590** is directly or indirectly attached to the tubular body (such that the load pin **590** moves with the tubular body) and extends through a slot **506** formed in the setting sleeve.

[0037] The slot **506** has a perimeter **508** defining a shape of the slot (e.g., a Y-style slot), where the perimeter **508** includes a top wall **501** having a positively sloping portion **551** extending to a top peak **556**, a negatively sloping portion **555** extending downwardly from the top peak **556**, and a second positively sloping portion **560**. A first axial extension **510** extends axially along the sleeve from a first upper portion **512** to a first lower portion **514**. A second axial extension **520** is circumferentially spaced apart from the first axial extension **510** and extends axially along the sleeve from a second upper portion **522** to a second lower portion **524**. A first lateral extension **550** extends from the first upper portion **512** to the second upper portion **522**, where a portion of the top wall **501** defines the upper boundary of the first lateral extension **550**. A third axial extension **530** abuts/adjoins the second axial extension **520** and extends axially along the sleeve from a third upper portion **532** to a third lower portion **534**, where the third lower portion **534** is closer to the lower end of the sleeve than the second lower portion **524**. A fourth axial extension **540** is circumferentially spaced apart from the third axial extension **530** and extends axially along the sleeve from a fourth upper portion **542** to a fourth lower portion **544**. A second lateral extension is a second positively sloping extension **560** that extends from the third upper portion **532** to the fourth upper portion **542**, where another portion of the top wall **501** defines the upper boundary of the second lateral extension.

[0038] As shown, the top wall **501** forms portions of the perimeter **508** of the first lateral extension **550**, including the positively sloping portion **551** (extending from the first upper portion **512** to the top peak **556**), the top peak **556**, and a negatively sloping portion **555** (extending from the top peak **556** to the second upper portion **522**), portions of the perimeter **508** of the positively sloping extension **560**, and portions of the perimeter **508** of the fourth upper portion **542**. The top peak **556** is axially closer to the upper end of the sleeve than the first upper portion **512** and the second upper portion **522**. Further, the top peak **556** is located along the first lateral extension **550** and is between the first and second axial extensions **510**, **520**. A lower wall **553** of the perimeter **508** defining the first lateral extension **550** includes a lower peak **559**, where the lower peak **559** is offset a distance around the circumference of the sleeve from the top peak **556** in a right handed or clockwise direction.

[0039] The portion of the top wall **501** forming the perimeter **508** of the fourth upper portion **542** is at an axial location along the sleeve that at least partially overlaps with the axial location of the top peak **556** (i.e., the fourth upper portion **542** and the top peak **556** share an axial position along the sleeve). The axial location of the slot **506** upwardly bounded by the top peak **556** and the axial location of the fourth upper portion **542** may be referred to as neutral positions. When the load pin **590** is in a neutral position, the packer may be moved axially upward without activating the expansion components of the packer. Further, the first lower portion **514** is at an axial location along the sleeve that at least partially overlaps with the axial location of the fourth lower portion **544**, i.e., the first and fourth lower portions **514**, **544** share an axial position along the sleeve. The axial locations of the first and fourth lower portions **514**, **544** may be referred to as safe positions. When the load pin **590** is in a safe position, the packer may be moved within the wellbore without activating the expansion components of the packer. Thus, the axial locations of the first and fourth lower portions **514**, **544** are far enough from the lower end of the sleeve to prevent the expansion components in the packer from being axially compressed.

[0040] Briefly, methods of positioning a packer within a wellbore may include inserting the packer into the wellbore, where the tubular body of the packer may be threadedly connected to a string and have the load pin **590** directly or indirectly connected thereto (such that movement of the load pin **590** corresponds with movement of the tubular body). The sleeve having the slot **506** formed therein, as shown in FIGS. **5-7**, is disposed around the tubular body, such that the load pin **590** extends through and is capable of moving within the slot **506**. The string, and thus the tubular body, may be manipulated to move the load pin **590** into a set position (in the third lower portion **534**) within the slot **506** in order to set the packer in the wellbore, which may include rotating the tubular body in a single rotational direction and pushing the tubular body downward. The packer may be unset by pulling the tubular body upward to move the load pin **590** into a neutral position within the slot **506**. The packer may then be repositioned by pushing the tubular body downward without rotating the tubular body in an opposite rotational direction to move the load pin **590** into a safe position (i.e., first lower portion **514** or fourth lower portion **544**) within the slot **506**.

[0041] As shown in FIG. **5**, the load pin **590** may be in first safe running position, within the fourth axial extension **540** of the slot **506**. An upward pull on the string (attached to the tubular body) may move the load pin **590** into a first neutral position (in the fourth upper portion **542**) before attempting to set the packer. A downward force combined with a right hand (clockwise) rotational force may move the load pin **590** into the setting slot (in the third axial extension **530**). The axial location of the third lower portion **534** of the third extension **530** is low enough (close enough to the lower end of the sleeve) that the tubular body and connected setting components (i.e., components capable of contacting and axially compressing packing elements) may contact and compress packing or sealing element assemblies to set the packer. In other words, the load pin **590** and thus the tubular body is allowed to travel a great enough axial distance along the third axial extension **530** to allow for force to be transmitted into the setting components of the packer and anchor the packer to the casing or open wellbore.

[0042] Using a setting sleeve having a Y-style slot, such as shown in FIGS. **5-7** may provide an operator with two options for unsetting the packer and either moving into a running position, or a retrieval position. Both of these options may be separated by a single direction rotation (e.g., right handed or clockwise rotation) in some embodiments, or the absence of a rotation in some embodiments.

[0043] As shown in FIG. **6**, if the operator wishes to reposition the packer, an upward pull on the string may be combined with a right hand rotation to move the load pin **590** into a second neutral position at the top peak **556**. To enter into the second safe position in the first lower portion **514** of the first axial extension **510**, a right hand (clockwise) rotation combined with a downward load moves the load pin **590** into the second safe position (first lower portion **514**). While in the second safe position, the operator may manipulate the position of the packer along the length of the wellbore without setting the packer.

[0044] Referring to FIG. **7**, once the proper position along the length of the wellbore has been located, an upward pull on the string (and thus tubular body) may move the load pin **590** back to the second neutral position (at the top peak **556**). A downward load may then be applied to the string (without rotating in an opposite direction from the right hand/clockwise rotation) to move the load pin **590** back into the setting position (the third lower portion **534**). The lower peak **559** formed in the lower wall **553** of the first lateral extension **550** is offset from the top peak **556** in a right handed or clockwise direction an offset distance great enough to where the load pin **590** lands on a negatively sloping portion of the perimeter **508** when a downward load (without rotation) is applied to the load pin **590** from the second neutral position (proximate the top peak **556**). When the load pin **590** lands on the negatively sloping portion of the perimeter (while a downward load without rotation is being applied), the load pin **590** may slide downwardly along the first lateral extension **550** to the second and third axial extensions **520**, **530**. A selective taper at the second lower portion **524** may direct the load pin **590** back into the setting position at the third lower portion **534**, where the operator again has two options for manipulation of the packer into the first and second safe positions. From the set position the operator can also pull upward on the string without rotation to move the load pin **590** into a retrieval position, in the first or second neutral positions.

[0045] Using slot shapes according to embodiments of the present disclosure, a packer may be set, unset and repositioned using a single rotational direction in combination with upward and downward axial loads. In other words, by using slot shapes according to embodiments of the present disclosure, a packer may be operated using upward and downward axial loads without rotating the packer in two opposite rotational directions. For example, methods of positioning a packer within a wellbore according to embodiments of the present disclosure may include applying a downward load on the packer tubular body to insert the packer into the wellbore, applying an upward load on the tubular body to move a connected load pin into a neutral position within a slot of the packer setting sleeve, rotating the tubular body in a single rotational direction in combination with applying a downward load on the tubular body to move the connected load pin to a set position within a slot of the setting sleeve to set the packer in the wellbore, applying an upward load on the tubular body to move the load pin into a neutral position and unset the packer, and applying a downward load on the tubular body without rotating the tubular body in an opposite rotational direction from the single rotational direction to move the load pin into a safe position within the setting sleeve slot to reposition the packer along the length of the wellbore.

[0046] FIG. **8** shows another example of a slot formed on a setting sleeve according to embodiments of the present disclosure, which may allow for setting, unsetting and repositioning of a packer within a wellbore using a single rotational direction in combination with upward and downward axial loads.

[0047] As shown, the slot **806** has a perimeter **808** defining an altered j-style shape. The slot **806** has a first axial extension **810** extending axially along a sleeve from a first upper portion **812** to a first lower portion **814**. A second axial extension **520** is circumferentially spaced apart from the first axial extension **810** and extends axially along the sleeve from a second upper portion **822** to a second lower portion **524**. A lateral extension **850** extends from the first upper portion **812** to the second upper portion **822**. A top wall **801** of the perimeter **808** defines the upper side of the lateral extension **850** and includes an upper positively sloping wall **851** extending from the second upper portion **822** to a top peak **856** and an upper negatively sloping wall **855** extending downwardly from the top peak **856** to the first upper portion **812**. The top peak **856** is axially offset along the length of the sleeve from the first upper portion **812** and the second upper portion **822**.

[0048] A lower wall **853** of the perimeter **808** defining the lower side of the lateral extension **850** includes a lower peak **859**, a lower positively sloping wall extending from the second upper portion **822** to the lower peak **859**, and a lower negatively sloping wall extending from the lower peak **859** to the first upper portion **812**. The lower peak **859** is laterally offset from the top peak **856** an offset distance **880** around the circumference of the sleeve, where the lower peak **859** is laterally closer to the second axial extension **820** than the top peak **856**, and where the top peak **856** is laterally closer to the first axial extension **810** than the lower peak **859**. The offset top and lower peaks **856**, **859** form a varying width **872** of the lateral extension **850** along the negatively sloping portion of the lateral extension **850**. As shown, the lateral extension **850** has a width **872** that increases along the length of the negatively sloping extension from the first upper portion **812** to the top and lower peaks **856**, **859**. The widths **870** of the slot **806** along the first axial extension **810**, the second axial extension **820** and the negatively sloping portion of the lateral extension **850** may be substantially constant and equal.

[0049] The lower peak **859** is offset in the lateral direction (i.e., circumferentially) away from the top peak **856** to allow the load pin **890** to be set using a right handed or clockwise rotation in combination with applying a downward load and to be unset using upward and downward loads without applying a rotational load. In methods of positioning a packer having a setting sleeve with the slot **806** shown in FIG. **8** formed therein, the packer may be set, unset and repositioned using a single rotational direction in combination with applying upward and downward loads to the tubular body of the packer.

[0050] FIG. **9** shows another example of a slot formed in a setting sleeve according to embodiments of the present disclosure, which may allow for setting, unsetting and repositioning of a packer within a wellbore using a single rotational direction in combination with upward and downward axial loads.

[0051] As shown, the slot **906** has a perimeter **908** defining a shape of the slot **906** that includes a first axial extension **910** extending axially along a sleeve (not shown) from a first upper portion **912** to a first lower portion **914**. A second axial extension **920** is circumferentially spaced apart from the first axial extension **910** and extends axially along the sleeve from a second upper portion **922** to a second lower portion **924**. A lateral extension **950** extends from the second upper portion **922** to the first upper portion **912** and past the first upper portion **912** in a direction away from the second upper portion **922**. A top wall **901** of the perimeter **908** defining an upper side of the lateral extension **950** extends from the second upper portion **922** to a top peak **956** in a positively sloping direction. The top peak **956** is axially offset and above both the first and second upper portions **912**, **922**. Further, the top peak **956** is circumferentially offset and spaced apart from the first and second upper portions **912**, **922**, where the first axial extension **910** is located circumferentially between the top peak **956** and the second axial extension **920**.

[0052] When the load pin **990** is in the first lower portion **914**, the load pin **990** is in a safe position, and the packer may be manipulated within the wellbore without setting the packer. An upward load may be applied to the tubular body to move the load pin **990** from the safe position to a neutral position in the portion of the slot **906** at the top peak **956**. An upward load without applying a rotational load may move the load pin **990** from the safe position to the neutral position due to the positive slop of the lateral extension **950** to the top peak **956**. Particularly, the setting sleeve in which the slot **906** is formed has a weight and is movable relative to the tubular body, such that the weight of the setting sleeve may pull the sleeve downwardly relative to the load pin **990**, thereby moving the load pin **990** into the neutral position at the top peak **956** of the slot **906**. When the tubular body is pulled upward and the load pin **990** is in the neutral position at the top peak **956** of the slot **906**, the setting sleeve is pulled upward with the tubular body.

[0053] From the neutral position, the string to which the tubular body is attached may be rotated in a single rotational direction and pushed downwardly so as to move the load pin **990** down the first axial extension **910** to the safe position. When the load pin **990** is in the safe position, the load applied to the tubular body of the packer is not transferred to the setting components of the packer.

[0054] From the safe position (i.e., the first lower portion **914**), the tubular body may be moved upward and rotated in a single rotational direction (in a right handed rotation in the embodiment shown) to move the load pin **990** upward through the first axial extension **910**, and then once the load pin **990** reaches the lateral extension **950**, the single rotational load (being applied from the combination of the upward and single rotation directional loads of the tubular body) moves the load pin **990** to the second upper portion **922**. Once the load pin **990** is rotated to the end of the lateral extension, at the second upper portion **922**, a downward load may be applied to the tubular body to move the load pin **990** into the set position (i.e., in the second lower position **924**). When the load pin **990** is in the set position, load applied to the tubular body may be transferred to the setting components of the packer to set the packer. Thus, a packer may include two decoupled systems: a first system including the packer setting sleeve with a slot formed therein; and a second system including the components directly and indirectly connected to the load pin **990**. When the decoupled components are coupled together in the set position, load may be transferred to the setting components of the packer to radially expand the setting components and seal the packer to the wellbore or wellbore casing.

[0055] According to methods of the present disclosure, a setting sleeve may have a slot formed therein with a shape engineered to selectively transfer a load from a tubular body of the packer to setting components of the packer. The slot shape may be further designed to allow for setting and unsetting of the packer by applying a rotational load in a single rotational direction in combination with upward and downward loads.

[0056] For example, methods of positioning a packer within a wellbore may include inserting a packer into the wellbore, where the packer has a tubular body, a load pin directly or indirectly connected with the tubular body (such that movement of the load pin corresponds with movement of the body), and a setting sleeve having a slot formed therein, wherein the load pin extends through and is capable of moving within the slot. The slot may have a shape that includes a plurality of axial extensions, each axial extension extending axially along the sleeve. Axial extensions may include a first axial extension and a second axial extension spaced apart from the first axial extension, and in some embodiments, more than two axial extensions. The slot shape may further have at least one lateral extension, including a first lateral extension extending from a first upper portion of the first extension to a second upper portion of the second extension, where the first lateral extension has a top peak spaced apart from the first and second extensions.

[0057] The tubular body may be manipulated to move the load pin to a set position within the slot to set the packer in the wellbore, where manipulating may include rotating the tubular body in a single rotational direction and pushing the tubular body downward.

[0058] The packer may be unset by pulling the tubular body upward to move the load pin into a neutral position within the slot. The packer may then be repositioned by pushing the tubular body downward without rotating the tubular body in an opposite rotational direction from the single rotational direction to move the load pin into a safe position within the slot.

[0059] The packer may then be re-set by pulling the tubular body upward to move the load pin into a neutral position within the slot (which may be the same or different neutral position from the un-setting stage), and then pushing the tubular body downward to move the load pin into a set position within the slot. In some embodiments, the tubular body may be rotated in the single rotational direction during pushing the tubular body downward to move the load pin into the set position. In some embodiments, the tubular body may be pushed downward to move the load pin into the set position without applying a rotational load to the tubular body.

[0060] By using setting sleeves according to embodiments of the present disclosure, an operator may set, unset and reposition a packer without rotating the packer in opposite directions. By using setting sleeves of the present disclosure with a Y-style setting slot, the operator may have two options for repositioning the packer within a wellbore in the event that trouble is encountered when trying to enter back into the safe position. A second safe position in a Y-style setting slot may be chosen through a positive right hand (clockwise) rotation of the string by forcing the load pin into the secondary safe position path (such as shown in FIG. **6**). The right hand rotation may serve as positive confirmation that the second safe profile has been selected, which would not be possible with a J-style setting sleeve, such as shown in FIG. **3**. Additionally, using setting sleeves according to embodiments of the present disclosure, an operator may employ a right hand rotation (clockwise) of the string to move the load pin from one position to another within the setting slot. The absence of left hand rotation (counter clockwise) may prevent or inhibit un-torqueing the connecting joints in the string.

What is claimed is:

1. A packer tool, comprising:

a tubular body;

one or more expansion components disposed around the tubular body; and

a sleeve disposed around the tubular body, the sleeve comprising:

an upper end;

a lower end opposite the upper end; and

a slot formed in a wall of the sleeve, wherein the slot has a perimeter defining a shape comprising:

a first axial extension extending axially along the sleeve from a first upper portion to a first lower portion;

a second axial extension circumferentially spaced apart from the first extension and extending axially along the sleeve from a second upper portion to a second lower portion, where the second lower portion is closer to the lower end of the sleeve than the first lower portion;

a lateral extension extending from the first upper portion to the second upper portion, the lateral extension comprising:
a positively sloping extension defined by an upper positively sloping wall of the perimeter and a lower positively sloping wall of the perimeter; and
a negatively sloping extension having a varying width measured between an upper negatively sloping wall of the perimeter and a lower negatively sloping wall of the perimeter,
wherein the upper positively sloping wall and upper negatively sloping wall extend to a top peak,
wherein the lower positively sloping wall and the lower negatively sloping wall extend to a lower peak, and
wherein the top peak is circumferentially offset from the lower peak a distance around a circumference of the sleeve; and
a load pin directly or indirectly connected to the tubular body and extending through the slot, wherein the distance between the top peak and lower peak is greater than a width of the load pin.

2. The packer tool of claim **1**, wherein the shape of the slot further comprises:
a third axial extension abutting the second axial extension and extending axially along the sleeve from a third upper portion to a third lower portion, the third lower portion being closer to the lower end of the sleeve than the second lower portion;
a fourth axial extension extending axially along the sleeve from a fourth upper portion to a fourth lower portion, the fourth lower portion being closer to the upper end of the sleeve than the second and third lower portions; and
a second positively sloping extension extending from the third upper portion to the fourth upper portion.

3. The packer tool of claim **2**, wherein the perimeter of the second lower portion comprises a negatively sloping wall.

4. The packer tool of claim **1**, wherein the first axial extension, second axial extension, and positively sloping extension each have a substantially constant width.

5. The packer tool of claim **4**, wherein the distance between the top peak and lower peak is greater than the substantially constant width.

6. The packer tool of claim **1**, wherein the first upper portion is at substantially the same axial position along the sleeve as the second upper portion.

7. A packer tool, comprising:
a tubular body;
a sleeve disposed around the tubular body, the sleeve comprising:
an upper end;
a lower end opposite the upper end; and
a slot formed in the sleeve, the slot comprising:
a perimeter defining a shape of the slot, the perimeter comprising a top wall having a positively sloping portion extending to a top peak;
a first axial extension extending axially along the sleeve from a first upper portion to a first lower portion;
a second axial extension circumferentially spaced apart from the first extension and extending axially along the sleeve from a second upper portion to a second lower portion; and
a lateral extension extending from the first upper portion to the second upper portion,
wherein the top wall forms portions of the perimeter of the lateral extension, and
wherein the top peak is axially closer to the upper end of the sleeve than the first upper portion and the second upper portion; and
a load pin directly or indirectly connected to the tubular body and extending through the slot.

8. The packer tool of claim **7**, wherein the top wall further comprises a negatively sloping portion extending from the top peak to the second upper portion.

9. The packer tool of claim **7**, wherein the top peak is located along the lateral extension and is between the first and second axial extensions.

10. The packer tool of claim **7**, wherein the first axial extension is located circumferentially between the top peak and the second axial extension.

11. The packer tool of claim **7**, further comprising:
a third axial extension abutting the second axial extension and extending axially along the sleeve from a third upper portion to a third lower portion, the third lower portion being closer to the lower end of the sleeve than the second lower portion;
a fourth axial extension extending axially along the sleeve from a fourth upper portion to a fourth lower portion; and
a positively sloping extension extending from the third upper portion to the fourth upper portion,
wherein the top wall further forms portions of the perimeter of the positively sloping extension and the fourth upper portion.

12. The packer tool of claim **11**, wherein the portion of the top wall forming the perimeter of the fourth upper portion is at an axial location along the sleeve that at least partially overlaps with the axial location of the top peak.

13. The packer tool of claim **11**, wherein the first lower portion is at an axial location along the sleeve that at least partially overlaps with the axial location of the fourth lower portion.

14. A method of positioning a packer within a wellbore, comprising:
inserting the packer into the wellbore, the packer comprising:
a tubular body;
a load pin directly or indirectly connected with the body, where movement of the load pin corresponds with movement of the body; and
a sleeve having a slot formed therein, wherein the load pin extends through the slot, and wherein the slot has a shape comprising:
a plurality of axial extensions, each axial extension extending axially along the sleeve, wherein the plurality of axial extensions comprises:
a first axial extension; and
a second axial extension circumferentially spaced apart from the first axial extension; and
at least one lateral extension, comprising:
a first lateral extension extending from a first upper portion of the first axial extension to a second upper portion of the second axial extension,

wherein the first lateral extension comprises a top peak spaced apart from the first and second axial extensions;

manipulating the tubular body to move the load pin to a set position to set the packer in the wellbore, the manipulating comprising rotating the tubular body in a single rotational direction and pushing the tubular body downward;

unsetting the packer, the unsetting comprising pulling the tubular body upward to move the load pin into a neutral position; and

repositioning the packer, repositioning comprising pushing the tubular body downward without rotating the tubular body in an opposite rotational direction from the single rotational direction to move the load pin into the first extension.

15. The method of claim **14**, wherein the neutral position is at the top peak, and wherein prior to manipulating the tubular body to set the packer, the tubular body is pulled upward and rotated in the single rotational direction to move the load pin from the first lower position to the neutral position.

16. The method of claim **14**, wherein the slot further comprises:

a third axial extension abutting the second extension and extending axially along the sleeve from a third upper portion to a third lower portion; and

a fourth axial extension spaced apart from the third axial extension and extending axially along the sleeve from a fourth upper portion to a fourth lower portion; and

a second lateral extension extending in a positively sloping direction from the third upper portion to the fourth upper portion.

17. The method of claim **16**, wherein prior to manipulating the tubular body to set the packer, the tubular body is pulled upward to move the load pin from the fourth lower position to the fourth upper portion.

18. The method of claim **16**, wherein unsetting the packer further comprises rotating the tubular body in the single rotational direction during pulling the tubular body upward.

19. The method of claim **16**, wherein repositioning further comprises rotating the tubular body in the single rotational direction during pushing the tubular body downward.

20. The method of claim **14**, further comprising resetting the packer in the wellbore after the packer is repositioned, the resetting comprising pulling the tubular body upward to move the load pin into the neutral position.

* * * * *