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Collet-cone slip system for releasably securing well tools

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ABSTRACT

A selectively released well tool anchor has a tubular wicker shoe cage and a tubular setting sleeve in sliding assembly over a tubular mandrel. The wicker shoe cage confines a plurality of independent wicker shoes. The tubular setting sleeve has a conical slip face that is loosely meshed with the shoe cage by a plurality of collet fingers extended from the conical slip face into meshed engagement with detents in the shoe cage. The collet fingers are secured within the detents for well run-in by calibrated shear fasteners. Slip faces on the several wicker shoes are aligned with the conical slip face to effect a radial displacement of the wicker shoes by an axial translation of the setting sleeve relative to the shoe cage. However, no relative axial translation may occur until sufficient axial compressive force between the shoe cage and setting sleeve is imposed to shear the calibrated fasteners. For selective release from the well bore, the setting sleeve has a body lock ring assembled to the internal bore of the setting sleeve. The lock ring has internal buttress threads that mesh with external buttress threads on the mandrel at a selected position along the mandrel length. Displacement of the mandrel to engage the mandrel threads with the lock ring threads draws the conical slip face from the wicker shoe slip face thereby releasing the wickers from a penetrated engagement with the well wall.

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ORIGINAL
COMPLETE SPECIFICATION
STANDARD PATENT

Invention Title: **Collet-cone slip system for releasably securing well tools**

The following statement is a full description of this invention, including the best method of performing it known to us:

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The present invention relates to methods and apparatus for producing valuable minerals from the earth. More particularly, the invention relates to an apparatus and method for setting pipe anchors to secure the position of downhole well tools such as annulus packers and subsequently releasing the tool for removal from the well.

DESCRIPTION OF RELATED ART

Downhole well tools most commonly used to secure pipe or another tool such as an annulus packer to the inside wall of a wellbore casing are frequently characterized as "slips". Characteristically, a slip comprises a plurality of radially expansible elements known to the art as a "wickers." Traditionally, a plurality of wickers are distributed circumferentially around a cylindrical mandrel. By some means, the wickers are longitudinally secured to the mandrel, but radially free to at least limited expansion from the mandrel outside diameter. The inside wall engagement surfaces of a wicker are serrated with numerous penetrating tooth points or parallel rows of cutting edges. The wicker teeth or edges are of extremely hard material and are cut sharply for penetration into the steel casing wall surface. The wicker underside is ramped to cooperate with a conical slip face. The conical slip face is a circumferential surface on a tubular sleeve. By one of various means, the tubular sleeve is displaced axially along the mandrel surface relative to the longitudinally fixed wicker to wedge the conical slip face under the wicker and against the underside ramp. As the conical slip face advances axially along the mandrel, the wicker body is forced radially outward to press the serrated tooth edges into the inside wall of the casing thereby clamping the wickers and mandrel to the casing , for example. The mandrel is frequently secured to a tubular workstring such as production tubing or drill pipe but may also be wireline deployed.

Slips used in conjunction with annulus packers are frequently arranged in pairs. One or more slip sets are above the packer and one or more are below the packer. Distinctively, the wickers of the respective slips are biased in opposite directions. For example, the bottom wickers may be biased to cut more deeply into the casing wall if uploaded. Cooperatively, the upper slips may be biased to cut more deeply into the casing wall if downloaded. Hence, longitudinal movement of the packer along the casing bore, for example, is resisted in both directions. However, utility of this nature requires that the several tools be deployed sequentially. For example, a packer unit may comprise four distinct tools: (1) a debris barrier, (2) an upper slip set, (3) a lower slip set, and (4) a packer sleeve. When the packer unit is located at the desired setting position, a predetermined deployment sequence may require that the debris barrier is first deployed. Next, the procedure may specify engagement of the upper slip set to anchor the unit to the casing wall in support of the workstring weight. Third, the packer sleeve is inflated/expanded radially outward to pressure seal the annulus between the inside casing wall and the outer tool string wall. Finally, the lower slip is set to oppose any possible downhole pressure lifting of the work or production string.

Should, by error or accident, either or both slips be set prematurely, the location of the packer may be incorrect or the integrity of the packer seal may be comprised. To mechanically order the deployment sequence of slips and other well tools, mechanisms such as shear pins, shear rings, keys and J-slots have been used with limited success. However, these devices require that a channel of one form or another be cut into the tool mandrel to such depth as to encroach upon the ultimate tool strength. For example, a shear ring groove turned into the tubular wall of a slip mandrel may reduce the cross-sectional diameter by as much as 0.200 in. When translated to the loss of mandrel tensile strength, this 0.200 in. is significant.

In some cases, it is necessary to recover the tools set by a multiple step sequence. In those cases, recovery requires that the sequence be substantially repeated in the same order as that required by the setting.

SUMMARY OF THE INVENTION

Advantageously, the invention, therefore provides, a slip setting system that may be sequenced into and out of well or pipe wall engagement.

The invention preferably includes a slip system that may be selectively programmed for the order of tool engagement and disengagement.

Also the invention may have provision of collet fingers on a slip actuating cone to prevent the slip from prematurely setting.

The invention preferably provides a mechanical connection between collet fingers from a slip cone and a slip cage that allows the cone and cage to move together during retrieval but to separate against a calibrated shear fastener when set.

The invention preferably provides a retrievable packer system.

Advantageously, the invention includes a method and apparatus for releasing a downhole pipe anchor.

The invention may further provide a method and apparatus for rectifying movement of a packer slip element along the packer mandrel.

These and other objects of the invention as will become evident from the following description of the preferred invention embodiments are served and accomplished by a well wall anchor having a reversible deployment mechanism. The well anchor comprises a tubular wicker shoe cage preferably having a sliding fit over a tubular tool mandrel. The shoe cage may have a plurality of shoe retaining slots around the cage circumference for retaining a plurality of wicker shoes. A conical slip face is carried by a wicker engagement sleeve having a plurality of structural fingers preferably projecting axially from the slip face. The fingers are secured to the cage by calibrated failure fasteners that preferably fail within a relatively narrow but predetermined load range. The anchor wicker shoes may include retainer blocks that mesh with the shoe retaining lots in the shoe cage. An inside surface of the wicker shoes, opposite from the wicker teeth, is preferably ramped to serve as a slip face. The wicker shoe slip face may be aligned in juxtaposition with the conical slip face. The failure fastener may be in the form of shear pins that fail upon sufficient axial compression between the collet sleeve and the wicker shoe cage. The wicker expansion cone may advance against the wicker ramps to expand the wicker shoes radially for engagement of the wicker teeth with the well casing wall.

Advantageously, the combination packer and anchor is assembled over a tubular mandrel having two fixed reference structures. The upper reference structure is preferably the mounting collar for a debris barrier. The second reference structure is preferably a ring piston that is structurally secured to the mandrel. Preferably, the radially expansible elements, comprising a debris barrier, the packer sealing sleeve and upper and lower slip anchors, are operatively slidable over the mandrel between the two reference structures.

According to one aspect of the invention, the ring piston may cooperate with a double acting cylinder to axially compress the radially expandable elements of the packer. Well string bore pressure applied through a mandrel orifice into a cylinder having the ring piston as one head and a mandrel slide ring as the other head drives the cylinder against the expandable packer elements. The expandable elements are consequently compressed against the upper reference structure and expanded. These elements expand sequentially in a predetermined order as determined by calibrated shear fasteners and the relative dimensions of axial shift channels. First, the debris barrier expands to shield the lower tools from additional debris interference. Next, the upper anchor is expanded when the calibrated shear fastener between the wicker shoe cage and the actuating sleeve fails. As the wicker shoes expand and the wicker points penetrate the well wall, the compressive load along the mandrel is transferred to the well wall. Subsequently, the expandable seal sleeves of the packer are extended against the well walls. Finally, the calibrated shear fastener between the wicker shoe cage and the actuating sleeve for the lower anchor fails resulting in the lower anchor set.

For collapse of the expandable elements and removal of the packer from the well, the mandrel may be cut by any of well known means. Initially, following the cut of the mandrel, tension is drawn on the workstring from the surface to the effect of sliding the uphole portion of the cut mandrel under the anchors and packer. However, the anchor collar of the debris barrier is secured to the mandrel surface and does not slide. Hence, the upper end of the debris barrier sleeve is retracted from the well wall as the anchor collar is displaced axially from the downhole compression collar.

At the location where the debris barrier sleeve is completely retracted, the compression collar engages and abutment surface of the limit ring that is secured to the mandrel. The compression collar is preferably rigidly secured to the upper caging ring and therefore draws the caging ring with it. In turn, limit walls on the wicker shoe retaining slots engage the wicker shoe blocks. Further uphole movement of the mandrel draws the uphole wicker shoes off the conical slip face thereby permitting the shoes to withdraw from engagement with the well wall.

The caging ring may also engage the retaining blocks on the collet fingers to pull the collet sleeve and attached compression cup away from the packer seal assembly thereby decompressing the packer seal.

Further uphole displacement of the mandrel preferably brings a section of buttress threads on the mandrel surface into engagement with meshing buttress threads on the collet cone sleeve for the lower anchor. Such meshing provides a positive engagement pickup on the sleeve thereby pulling the conical slip face away from the lower wicker shoe slip face. Hence, the lower anchor disengages from the well wall. The packer and anchor assembly may now be removed from the well or repositioned to a different depth.

BRIEF DESCRIPTION OF THE DRAWINGS

The advantages and further aspects of the invention will be readily appreciated by those of ordinary skill in the art as the same becomes better understood by reference to the following detailed description when considered in conjunction with the accompanying drawings in which like reference characters designate like or similar elements throughout the several figures of the drawing and wherein:

FIGURES 1A through **1D** illustrate, in axial quarter section, the invention in operative assembly as it is initially lowered into a wellbore and before actuation of any elements.

FIGURES 2A through **2D** illustrate, in axial quarter section, the invention in operative assembly as it is actuated to set the packer sealing sleeve and the anchor wickers.

FIGURES 3A through **3D** illustrate, in axial quarter section, the invention in operative assembly as it is actuated to remove the assembly from sealing sleeve and anchor wickers from the well.

FIGURE 4 is an exploded pictorial of the present well tool anchor.

FIGURE 5 is an enlarged, quarter section detail of the present well tool upper anchor in the run-in assembly state.

FIGURE 6 is an enlarged, quarter section detail of the present well tool upper anchor in the set assembly state.

FIGURE 7 is an enlarged, quarter section detail of the present well tool lower anchor in the run-in assembly state.

FIGURE 8 is an enlarged, quarter section detail of the present well tool lower anchor in the set assembly state.

FIGURE 9 is an elevation view of the well tool anchor setting sleeve.

FIGURE 10 is an end elevation view of the well tool anchor setting sleeve.

FIGURE 11 is an axial section view of the lower well tool anchor setting sleeve.

FIGURE 12 is an axial section view of the body lock ring element of the lower well tool setting sleeve.

FIGURE 13 is end elevation of the body lock ring element of the lower well tool setting sleeve.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The invention is disclosed and described herein in the preferred embodiment context of a combined wellbore packer and workstring anchor. In this embodiment, both tools are activated hydraulically and deactivated mechanically. **Figs. 1** through **3** illustrate the invention in axial quarter section and in four axially broken segments. For the present purposes, the left edge of the drawing frame is taken as the uphole reference direction. Accordingly, **Fig. 1D** illustrates the bottom-hole interface between the present tool mandrel **12** and the well work string of pipe **10** below the mandrel **12**. **Figures 1A** through **1D** illustrate the assembly in the Arun-in@ state with the wellbore anchors and packer sleeve retracted. **Figures 2A** through **2D** illustrate the Aset@ status of the anchors and packer. **Figures 3A** through **3D** illustrate the deactivated status of the tool elements as they would be when the tools are withdrawn from the well.

With initial reference to the tool bottom and the work string **10** interface as best illustrated by **Fig. 1D**, the tool mandrel **12** is assembled by threads **13** to the work string box sleeve **11**. Also secured to the work string box sleeve **11** by assembly threads **21** is a lower cylinder wall **20**. The cylinder wall **20** extends upwardly from the box sleeve **11** and concentrically around the lower end of the mandrel **12** to confine a smooth wall, annular space **24** between the inside surface of the wall **20** and the outside surface of the mandrel **12**. Near the box sleeve **11**, the mandrel is perforated by one or more fluid flow orifices **22** for transfer of fluid pressure from within the mandrel center bore into the annular space **24**.

Additional features of the mandrel **12** include an external ring piston **16** secured to the mandrel O.D. by assembly threads **17**. On the uphole side of the ring piston **16**, the mandrel wall is again perforated by fluid flow orifices **14**. At the upper end of the mandrel **12** is a debris barrier **80** secured to the mandrel O.D. by assembly threads 86 between the mandrel **12** and an anchor collar **84**. At carefully selected position between the anchor collar **84** and the ring piston **16**, is a circumferential band of buttress thread **19** having a thread length T along the mandrel length. The buttress thread **19** depth is preferably as shallow as the specific application will allow for intrusion of annulus section thickness. Those of skill in the art know that in many cases, the ultimate tensile strength of the tool is determined by the undisturbed section thickness of the mandrel at this point. As a representative example, therefore, the buttress threads may only be about 0.017in. deep into the outer surface of the mandrel. A retainer ring slot to accomplish the same purpose would need a minimum radial depth of about 0.100 in. and provide only a single engagement face. Hence, the buttress threads require only 0.034 in. material strength loss on the diameter whereas a C-ring slot may require 0.200 in.: a 0.166 in. advantage.

In sliding assembly along the mandrel outside surface are, for example, a debris barrier, packer seal elements and position anchors. These sliding elements are preferably displaced by some form of sliding force actuator such as hydraulic piston elements. There are numerous design options for suitable fluid power applications. The particular arrangement selected for the present invention, however, compresses the sliding elements between a sleeve ram **40** and the lower abutment ridge **47** on the mandrel. With respect to **Figs. 1B**, **1C** and **1D**, a sleeve ram **40**, having a close sliding fit around the mandrel O.D. above the mandrel piston **16**, is in fixed, threaded assembly by threads **41** with an upper cylinder wall **30**. The inside diameter surface of the upper cylinder wall **30** has a sliding seal fit with the O.D. of the mandrel piston **17**. At its lower end, the upper cylinder wall **30** has a threaded assembly by threads **31** with a lower piston **26**. The lower end of the upper cylinder wall **30** is also secured to the upper end of the lower cylinder wall **20** by means of a calibrated shear fastener **33**. The lower piston **26** has a sliding seal fit relationship within the annular space **24** to provide a power cylinder displacement force against the end of the piston **26** by fluid pressure admitted from the mandrel bore through the orifice **22**.

With respect to **Figures 1B** and **8**, the sleeve ram **40** abuts the lower anchor mechanism **50**. The lap sleeve **42** of the ram **40** overlays the lap sleeve **143** of a slip shoe retainer cage **52**. The lapping sleeves **42** and **143** are secured together structurally by calibrated shear pins **43**.

The lower tubular anchor mechanism **50** is illustrated in detail by **Figures 7** through **11** as well as **Fig. 1B**. Four basic components of the mechanism include the slip shoe retainer cage **52**, the collet cone **54**, the wicker shoe **56** and the calibrated shear fasteners **43**. The lower slip shoe retainer cage **52** is substantially identical to the upper slip shoe retainer cage **72** illustrated pictorially by **Fig. 4**. Correspondently, the lower cage **52** is a tubular element having a plurality of retainer slots **141** distributed around the perimeter: four slots, for example. Between the slots are collet bosses **142** having detent pockets defined within perimeter walls **146**. The ends of the collet bosses are rigidified by circumferential webs **140**

The lower collet cone **54** includes a basic sleeve section **130** that tapers along a conical slip face **132** to the base of collet fingers **57** as clearly shown by **Figures 9** and **11**. The distal ends of the collet fingers have integral retainer blocks **134** that mesh with detents on the retainer cage. The retainer cage detents are defined by retainer walls **146** that circumscribe the detent area. For well run-in, the collet fingers are positioned to mesh the retainer blocks **134** with the detent areas of the retainer cage **52** and secured by calibrated shear fasteners **55**. The longitudinal dimension of the detent area is greater than that of the collet finger blocks for several reasons. First, sufficient finger block displacement clearance along the detent is necessary to accommodate a shear failure of the fastener **55**. Additionally, the geometry of the slip slope and the required radial displacement of the wicker shoes are essential design factors. Peripheral confinement of the retainer blocks **134** by the retainer walls **146** prevents complete disassembly.

The wicker shoes **56**, shown by **Figures 1B**, **7** and **8**, are meshed loosely between the collet fingers **57** with the slip face **122** juxtaposed against the collet cone slip face **132**. The wicker shoe retainer block is meshed loosely within the cage retainer slot **141** and the wicker shoe strap **126** extends between the mandrel **12** and the circumferential web **140** of the retainer cage. The wicker shoes are substantially immobile laterally but have free movement, to a limit, radially.

With respect to **Fig. 11**, the upper end of the collet cone sleeve **130** carries first, assembly threads **69** for assembly with the packer end cups **68**. Along a deeper counterbore from the sleeve end, internal buttress threads **131** are cut to mesh with cooperating external threads **135** on the body lock ring **58**.

The body lock ring **58**, shown by **Figures 12** and **13**, also includes internal buttress threads **137** for meshing with the buttress threads **19** around the mandrel **12**. The lock ring is also split as at **59** of **Fig. 12** to facilitate radial collapse of the ring. Materially, the body lock ring **58** is resilient as needed to expand or contract circumferentially. When the collet sleeve **130** is sliding along the mandrel surface, the lock ring I.D. is less than when the lock ring buttress threads **137** are meshed with the mandrel buttress threads **19**.

The sealing elements of the packer **60** are rubber or elastomer sleeves that are dimensionally compressed to seal the annular space between the mandrel **12** and the internal wall surface **15** of the well which may be production casing or raw, wellbore walls. In this case, there are three rubber sleeves including a center sleeve **62** that is separated longitudinally from a flanking pair of end sleeves **64** by stabilizer rings **66**.

The collet cone **74** of the upper anchor **70** bears against the upper end cup **68** of the packer **60**. With respect to **Figures 1A**, and **4** through **6**, the collet cone **74** comprises a sleeve **100** having collet fingers **77** projecting longitudinally from the base of a conical slip face **102**. Retainer blocks **106** on the distal ends of the fingers **77** are meshed with the detents **84** in the bosses **92** of the upper cage ring **72**. The detents are defined by the perimeter wall **96**. The retainer blocks **106** are secured in meshed assembly with the cage detents **94** by shear fasteners **75**. The bosses **92** of the upper cage ring are laterally spaced by circumferential webs **90**. Approximately mid-length of the cage ring are four slots **91**, for example. Similar to the lower anchor **50**, the straps **116** of wicker shoes **76** mesh loosely under the cage web **90** with the shoe retainer block **114** meshed within the retainer slots 91and the shoe slip face **112** juxtaposed with the conical slip face **102**.

The upper end of the upper cage ring **72** overlies the abutment ridge **47** that is a fixed reference point along the length of the mandrel. A compression collar element 88 of the debris barrier **80** is secured to the cage ring **72** by assembly threads **89**. The cage ring **72** is axially slidable over the limit ring **45** between upper and lower abutments

48 and **49**.

The anchor collar element **84** of the debris barrier **80** is secured to the mandrel **12** surface by assembly threads **86**. Secured between the anchor collar and the compression collar is an elastomer or rubber sleeve **82** that expands radially when the two collars are force together.

The tool is lowered into a well in the mechanical status as described above with respect to **Figures 1A** through **1D**. When located at the desired set position, the center bore of the mandrel **12** is pressurized from the surface with working fluid, which may, for example, be hydraulic oil or drilling fluid. Entering the expansion chambers **24** and **37** through the pressure orifices **22** and **14**, respectively, the lower piston **26** and sleeve ram **40** are displaced upwardly along the mandrel **12** by first shearing the fastener **33** between the lower cylinder wall **20** and the upper cylinder wall **30**. This initial movement is transferred along and through all of sliding elements of the tool to the compression collar **88** of the debris barrier **80** to first, extend the barrier sleeve **82** radially against the well wall.

When the abutment wall **49** engages the lower edge of the abutment ridge **47**, loading stress is focused upon the remaining shear fasteners. Fastener **75** between the upper anchor cage **72** and the collet finger **77** is calibrated as the second weakest fastener and fails next thereby allowing the upper anchor to collapse axially and the conical slip face **102** to be driven under the wicker shoe slip face **112**. Consequently, the wicker shoe **76** is displaced radially to drive the wickers **110** into the well wall **15**.

As the upper anchor **70** is set, the packer sealing element **62** and **64** are compressed between the upper and lower collet sleeves and also expanded against the well wall **15**. The internal buttress threads **137** on the body lock ring **58** are not initially engaged with the corresponding threads **19** on the mandrel O.D. surface. Consequently, the lower collet cone **54** may be displaced along the mandrel surface to load compressively against the packer **60** until the calibrated shear force of fastener **55** is overcome. At that moment, the upper edge of the circumferential web **140** portion of the cage ring **52** engages the base of the wicker shoe to force the wicker shoe slip face **122** upon the conical slip face **132** thereby expanding the wicker radially until the wicker teeth **120** penetrate the well wall **15**. Engagement of the buttress threads on the body lock ring **127** attached to the upper end of the lower cylinder wall **20** with the external buttress threads **129** on the lower piston **26** irreversibly secures the relative position. This completes the packer tool setting.

Removal of the tool from the well essentially requires the same sequence of that followed when setting the tool. Specifically, the debris barrier **80** and the upper anchor **70** is released followed by release of the packer seals **60**. Upon release of the packer seals, the lower anchor **50** is released.

The foregoing sequence is initiated by cutting the mandrel **12** in the approximate region of the cut line C-C illustrated by **Fig. 2D**. This cut through the mandrel **12** tube into the lower cylinder space **24** between the upper end of the work string box sleeve **11** and the lower end of the lower piston **26** may be accomplished by any of several well known wireline tools .

Following the mandrel **12** severance at C-C, tension is drawn on the mandrel **12** from the surface along the upper workstring to lift the mandrel relative to the packer and anchors. Predominantly, the mandrel slides under the packer and anchors. The anchor collar 84 for the debris barrier is secured to the mandrel **12** by threads **86**. Consequently, the anchor collar 84 moves with the mandrel 12 and pulls on the barrier sleeve **82** to retract it from the well wall.

As the barrier sleeve **82** reaches its extended limit, the upper abutment ridge **46** on the mandrel engages the abutment wall **48** on the compression collar 88. Since the compression collar is assembled by threads 89 to the upper cage ring **72**, the connection with the upper cage ring draws the lower face of the retainer slot **91** against the upper wicker shoe retainer block **114**. This connection with the upper cage ring draws the lower face of the retainer slot **91** against the upper wicker shoe retainer block **114**. Additional pull of the mandrel after this engagement pulls the upper wicker shoe slip face **112** away from the conical slip face **102** of the upper collet cone **74** thereby disengaging the wickers **110** from the well wall **15**. The upper anchor **70** is now released.

At this point, retainer wall **96** on the upper cage ring has also engaged the retainer block **106** on the upper collet fingers **77**. Accordingly, after the wicker shoes are pulled away from the collet cone, the collet cone **74** and upper end cup **68** is pulled away from the packer **60** sealing sleeves. This removes the seal supporting compression on the sealing sleeves thereby withdrawing the packer.

Near the expanded limit of the foregoing train of connections, the buttress thread section T of the mandrel is pulled into engagement with the inner buttress threads **137** on the body lock ring **58**. This engagement pulls the conical slip face **132** on the lower collet sleeve **130** away from the lower wicker shoe slip face **122** thereby disengaging the lower wickers **120** from the well wall **15**.

When the lower anchor **50** is released, the entire weight of the lower work string **10** is transferred to the lower anchor assembly via the upper cylinder wall **30**, the sleeve ram **40** to the cage ring **52**. Given the limited support surface of these components, prudence suggest that the lower workstring weight should be shifted to more substantial structure. To this end, the retainer wall **146** on the lower cage ring **52** engages the retainer block **134** on the lower collet finger **57**. This engagement provides a structural loading train between the buttress threads **19** on the mandrel to the calibrated shear fastener **43** sleeve ram **40** and the lap sleeve **143** on the cage ring **52**. If the lower workstring weight is sufficient to shear the calibrated fasteners **43**, the workstring weight load is shifted to mandrel piston **16**.

All elements of the tool assembly are now released from the well wall **15** thereby permitting the workstring **10** to be removed from the well or repositioned to a different depth.

Although the invention has been described in terms of specified embodiments which are set forth in detail, it should be understood that this is by illustration only and that the invention is not necessarily limited thereto. Alternative embodiments and operating techniques will become apparent to those of ordinary skill in the art in view of the present disclosure. Accordingly, modifications of the invention are contemplated which may be made without departing from the scope of the claimed invention.

It will be understood that the term "comprises" or its grammatical variants as used herein is equivalent to the term "includes" and is not to be taken as excluding the presence of other elements or features.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A well tool anchor comprising:

(a) a substantially tubular wicker shoe cage for independent axial translation along a tubular mandrel;

(b) a substantially tubular wicker engagement sleeve for independent axial translation along said tubular mandrel, said sleeve having a substantially conical slip face and a plurality of structural finger projections;

(c) a plurality of wicker shoes having pipe wall penetration wickers and a slip face; and

(d) at least one calibrated failure fastener securing a meshed coupling of said shoe cage with said sleeve finger projections, whereby an axial translation of said sleeve toward said shoe cage translates said wicker shoes radially outward and an axial translation of said shoe cage away from said sleeve translates said wicker shoes radially inward.

2. A well tool anchor as described by claim 1 wherein said engagement sleeve is meshed with said shoe cage and wicker shoes to align said wicker shoe slip face in juxtaposition with said conical slip face.

3. A well tool anchor as described by claim 2 wherein a meshed alignment of said wicker shoes with said shoe cage substantially limits movement of said wicker shoes to radial displacement.

4. A well tool anchor as described by claim 2 wherein the meshed alignment of said finger projections with said shoe cage comprises a detent area of said shoe cage to limit axial disassembly of said engagement sleeve from said shoe cage.

5. A well tool anchor as described by claim 1 having a tubular mandrel for slidably aligning said shoe cage and engagement sleeve.

6. A method of releasably anchoring a well tool to a well wall comprising the steps of:

(a) providing a tubular mandrel member;

(b) slidably placing axially compressed packer seal elements over said tubular mandrel member;

(c) positioning compressively engaged anchoring members along said mandrel on axially opposite sides of said seal elements, said anchoring members having a plurality of wicker shoes confined within a meshed assembly of first and second tubular elements whereby said first tubular elements are most remote from said packer seal elements, said meshed assembly being secured by calibrated failure fasteners between said first tubular element and projections from said second tubular element;

(d) restraining the axial translation of the first tubular element on one side of said packer seal element relative to said mandrel member;

(e) axially translating the first tubular element of the other side of said packer seal elements toward the first tubular element on the one side by defeating said calibrated fasteners to radially extend said wicker shoes and said packer seal elements; and,

(f) axially translating the first tubular element on the one side of said packer seal elements from the first tubular element on the one side to radially retract said wicker shoes and packer seal elements.

7. A method as described by claim 6 wherein said wicker shoes respective to the anchoring member on the one side of said packer seal elements are extended prior to the extension of said packer seal elements and said wicker shoes respective to the anchoring member on the other side of said packer seal elements are extended after the extension of said packer seal elements.

8. The method as described by claim 6 further comprising:

providing cooperative buttress elements on said mandrel and the second tubular element on the other side of said packer elements, said buttress elements being cooperative to prevent the relative axial displacement of said second tubular element in one axial direction when engaged;

cutting said mandrel below the buttress elements on said mandrel; and lifting an uphole portion of said cut mandrel to radially retract said wicker shoes and said packer seal elements in substantially the same order as they were extended.

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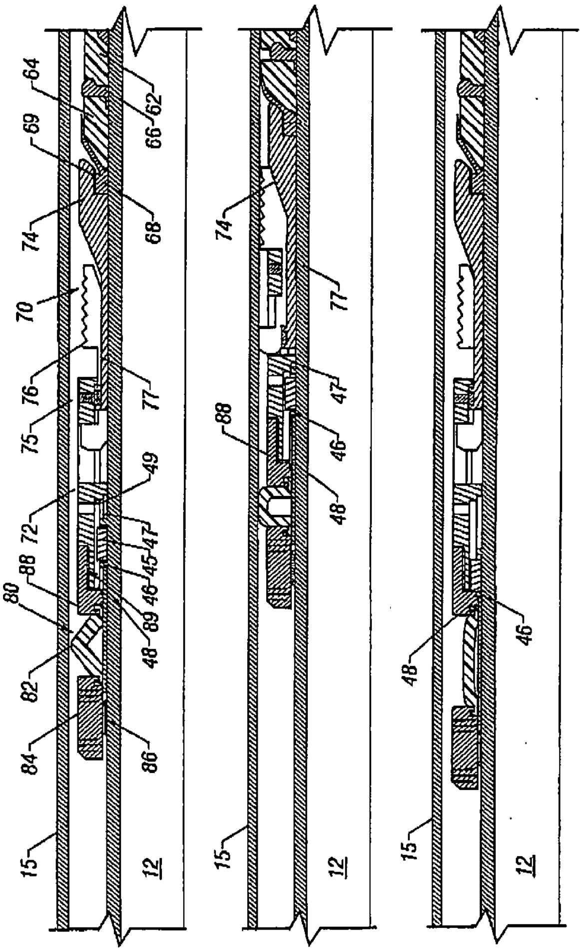

FIG. 1A

FIG. 2A

FIG. 3A

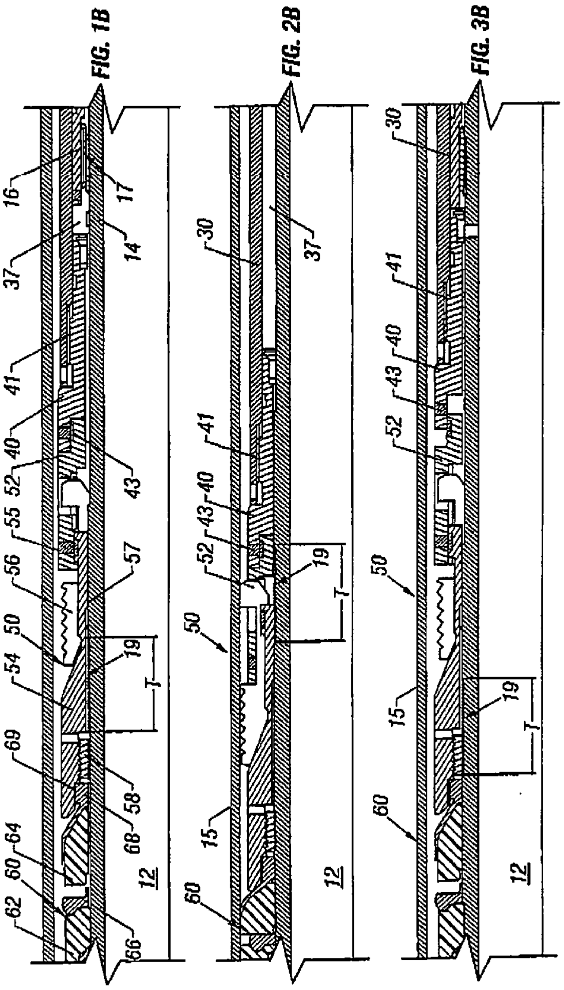
FIG. 1B
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FIG. 2B
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FIG. 3B
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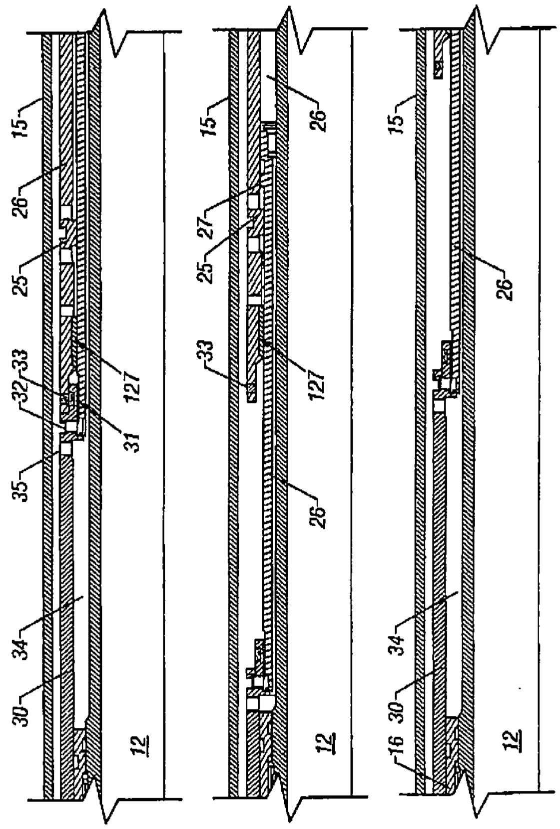
FIG. 1C FIG. 2C FIG. 3C



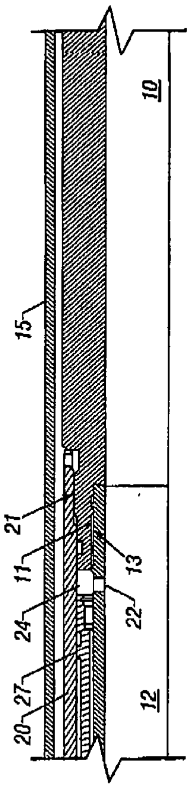


FIG. 1D

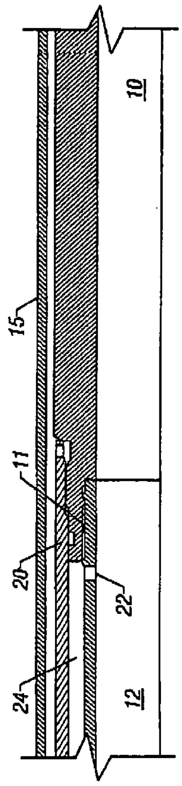


FIG. 2D

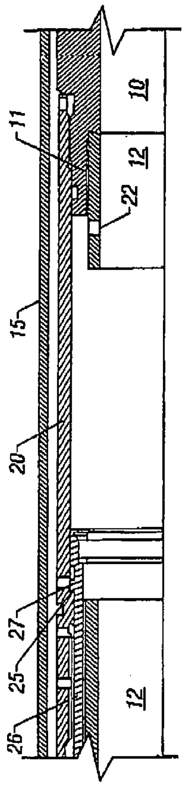


FIG. 3D

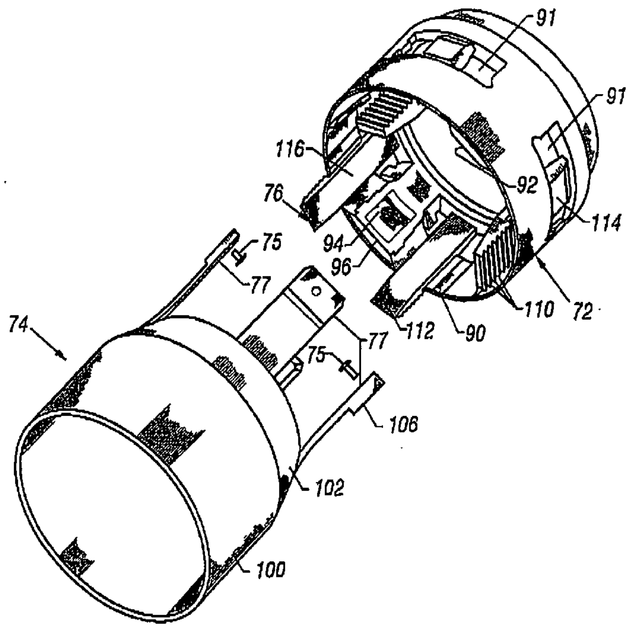


FIG. 4

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FIG. 5

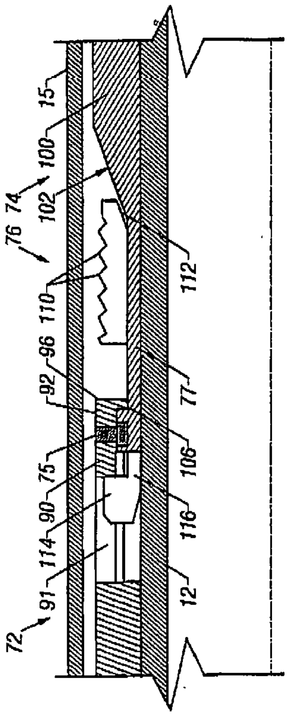

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FIG. 6

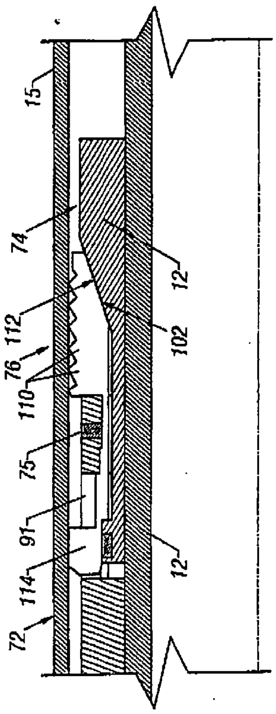

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FIG. 8

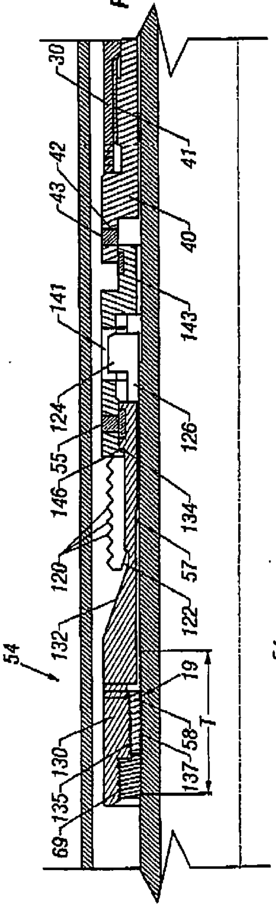
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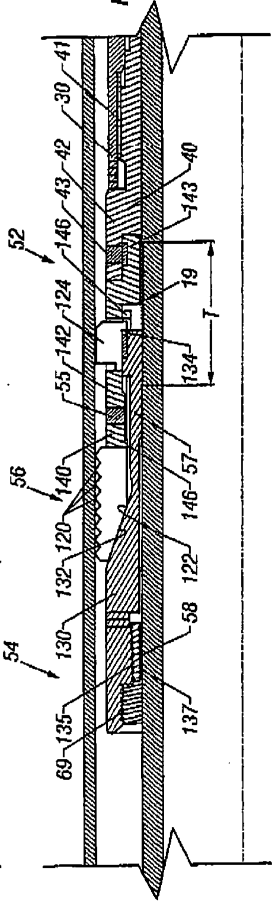
FIG. 7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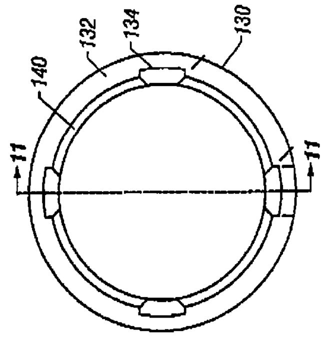

FIG. 10

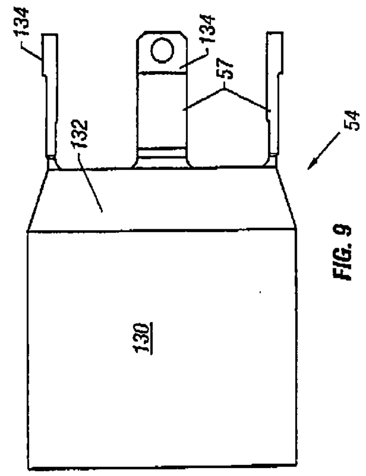

FIG. 9

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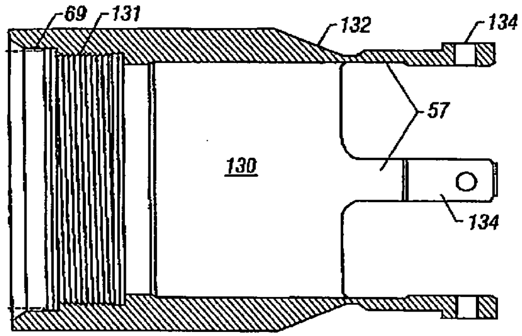

FIG. 11

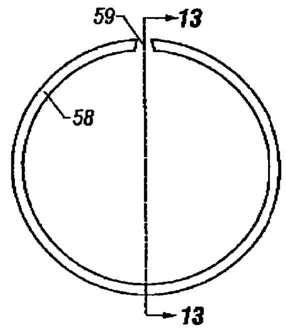

FIG. 12

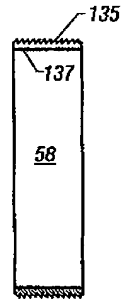

FIG. 13